

**Research Report**  
**Department of Statistics**  
**AAU Klagenfurt**  
**2007–2017**

**Ten-Year Anniversary of the Department**

Manfred Borovcnik (Ed.)

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**Part I**

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### Part I

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## **Welcome Address of The Dean of the Faculty of Technical Sciences**



### **Dear Colleagues of the Department of Statistics**

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On behalf of the Faculty for Technical Sciences of the University of Klagenfurt, I warmly congratulate the members of the Department of Statistics on the 10-year anniversary of their department. An encouraging level of achievements has been established by the members of the department in these ten years; for this, one has to be grateful with respect. In the frame of the well-organised anniversary celebration, these achievements were demonstrated convincingly so that the members' enthusiasm for the discipline was impressively transmitted to the participants. This enthusiasm will surely lead the discipline of statistics at the University of Klagenfurt into a successful future. Beyond this special engagement, the great demand for statistics from various areas of applications and the new technical capabilities will ensure a prosperous development.

We are living in times of leaps and bounds in data. In all likelihood, this development will not level off; quite to the contrary, it will accelerate in the future. We are only at the beginning of the penetration of the world by sensors for the acquisition of information. In spite of all reservations about these developments and challenges that are to be faced especially in the areas of "security and privacy", in the near future, we will be able to use a multiple of data presently available in order to provide forecasts and to identify dependencies. That said radically new methodical possibilities and areas of application will soon open up for the field of statistics.

We already see these developments in the area of machine learning. The revival of artificial neural networks (ANN) is due to new ANN architectures; however, they could only be successful by a massive increase of provided data as well as processing power. We know from history that especially in the classification of data there were repeated radical changes in methodology. It should be interesting to see the further development of the competing approaches, which are largely based on the foundation of stochastics.

The still unanswered questions are multi-faceted. Quicker convergence, generalisation of the learned knowledge, justifications and explanations of the classification output, robustness as well as reliability evaluations of the widely discussed and applied ANN classification procedures are only some of the open challenges, which may be answered by alternative technologies based on stochastics.

Of course, interdisciplinary connections and trans-disciplinary use of statistics and stochastics are leading far beyond machine learning and artificial intelligence. Stochastics provides an essential basis for multiple investigations in the technical, scientific, social, and economic disciplines. Hence, the Department of Statistics is not only paramount to the Faculty for Technical Sciences; it is also a cornerstone for the University of Klagenfurt at large.

**O. Univ.-Prof. DI Dr. Gerhard Friedrich**

**Dean of the Faculty of Technical Sciences of the Alpen-Adria-University Klagenfurt**

## **Grußadresse des Dekans der Technischen Fakultät**



### **Sehr geehrte Kolleginnen und Kollegen des Instituts für Statistik**

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Im Namen der Fakultät für Technische Wissenschaften der Universität Klagenfurt darf ich herzlich zum 10-jährigen Bestehen gratulieren. Erfreulich viel wurde in diesen 10 Jahren mit großem Engagement von den Mitgliedern des Institutes geleistet und dafür ist mit Hochachtung zu danken. Im Rahmen der hervorragend gestalteten Jubiläumsfeier wurden diese Leistungen überzeugend dargestellt, sodass den TeilnehmerInnen die Begeisterung für das Fach eindrucksvoll vermittelt wurde. Diese Begeisterung wird die Statistik an der Universität Klagenfurt auch in eine erfolgreiche Zukunft führen, wobei neben dieser Begeisterung der große Bedarf aus der Praxis und neue technische Möglichkeiten eine prosperierende Entwicklung sicherstellen werden.

Wir leben in einer Zeit des sprunghaften Anstiegs von Daten. Diese Entwicklung wird sich aller Voraussicht nicht abschwächen, sondern beschleunigen. Wir stehen erst am Anfang der Durchdringung der Welt mit Sensoren zur Informationsgewinnung. Trotz allen Vorbehalten zu diesen Entwicklungen und Herausforderungen, die insbesondere im Bereich „Security and Privacy“ gemeistert werden müssen, werden wir in Zukunft ein Vielfaches der heute zur Verfügung stehenden Daten verwenden können, um Prognosen zu erstellen und Zusammenhänge zu erkennen. D.h. der Statistik eröffnen sich radikal neue methodische Möglichkeiten und Anwendungsgebiete.

Wir sehen diese Entwicklungen bereits im Bereich des Maschinellen Lernens. Die Renaissance der Künstlichen-Neuronalen-Netze (KNN) sind auf neue Architekturen zurückzuführen, die aber nur durch eine massive Steigerung der zur Verfügung stehenden Daten sowie Rechenleistung erfolgreich sein konnten. Wir wissen aus der Geschichte, dass es insbesondere bei der Klassifikation von Daten immer wieder zu Umbrüchen in der Methodik kam. Man darf daher sehr gespannt auf die Weiterentwicklung der konkurrierenden Ansätze warten, die zu einem Gutteil auf dem Fundament der Stochastik aufbauen.

Die offenen Fragestellungen sind mannigfache. Schnellere Konvergenz, Verallgemeinerung der gelernten Erkenntnisse, Erklärbarkeit, Robustheit sowie Zuverlässigkeitsabschätzungen der nun breit diskutierten und angewendeten KNN-Klassifikationsverfahren sind nur einige der offenen Herausforderungen, die auf Basis der Stochastik vielleicht durch alternative Techniken beantwortet werden können.

Die interdisziplinäre Verknüpfung und transdisziplinäre Anwendung von Statistik und Stochastik gehen selbstverständlich über Maschinelles Lernen und Künstliche Intelligenz weit hinaus. Die Stochastik liefert eine essentielle methodische Grundlage für zahlreiche Fragestellungen in den technischen, naturwissenschaftlichen sowie sozial- und wirtschaftswissenschaftlichen Disziplinen. Daher ist das Institut für Statistik nicht nur für die Fakultät für Technische Wissenschaften von zentraler Bedeutung, sondern auch ein Eckstein für die Universität Klagenfurt insgesamt.

**O. Univ.-Prof. DI Dr. Gerhard Friedrich**

**Dekan der Fakultät für Technische Wissenschaften der Alpen-Adria-Universität Klagenfurt**

## Ten Years Department of Statistics at the Faculty of Technical Sciences



### Programme of the Jubilee Ceremony on 1 Dec, 2017 (Lecture Hall 10)

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Prof. Dr. Manfred Borovcnik, Head of the Department:

Welcome of the Head of the Department and Presentation of the Department of Statistics

Dean Prof. Dr. Gerhard Friedrich:

Welcome of the Dean on behalf of the Faculty of Technical Sciences

Prof. Dr. Jürgen Pilz, Foundation Head of the Department:

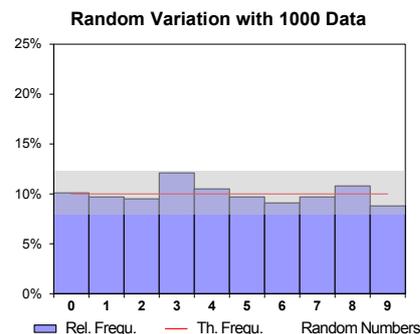
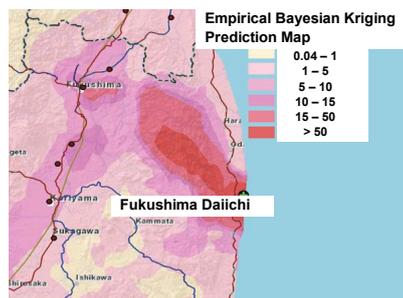
From Early Beginnings to Profound Applications of Statistics

#### *Our Alumni:*

Dr. Olivia Bluder, Senior Engineer, KAI, Villach

Dr. Horst Lewitschnig, Statistician, Infineon Technologies, Neubiberg

Dr. Philipp Pluch, Senior Crude Trader, OMV Supply & Trading Ltd., London



#### *Keynotes:*

Em. Prof. Dr. Dieter Rasch, Univ. Wageningen, NL, Univ. f. Bodenkultur, Wien:

Optimal Combination of Gupta's Subset Selection Procedure with Bechhofer's Indifference Zone Approach

Prof. Dr. Michael G. Schimek, Med. Univ. Graz, Statistics & Research Atelier Vienna:

Applied Statistics towards the Future of Data Science – Challenges and Opportunities for the AAU

*Poster Exhibition:* Projects of the Department and Alumni

*Buffer:* In the hall and the seminar room at the Department of Statistics

## Welcome Addresses of Our Cooperation Partners



### List of Welcome Addresses

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Em. O. Univ.-Prof. Dr. Haro Stettner, Professor Emeritus of the Department of Statistics

Prof. Dr. Dr. Michael G. Schimek

Statistical Bioinformatics, IMI, Medical University Graz; recent guest professor at the Department of Statistics: Auf dem Weg der Angewandten Statistik in die Data-Science-Zukunft

Dr. Werner Scherf

Vorstand Carinthian Tech Research (CTR), Villach

Univ.-Prof. Mag. Dr. Werner G. Müller

Institut für Angewandte Statistik, Johannes-Kepler-Universität Linz

Univ.-Prof. Dr. Arne Bathke

Fachbereich Mathematik, Dekan der Universität Salzburg

Prof. Dr. Herwig Friedl

Institut für Statistik, Technische Universität Graz

Prof. Dr. Walter Krämer

Fakultät für Statistik, Technische Universität Dortmund

Professor Dr. Christian P. Robert

Centre de Recherche en Mathématiques de la Decision, Université Paris Dauphine

Prof. James V. Zidek, PhD, FRSC, Professor Emeritus

Department of Statistics, The University of British Columbia (UBC)

Prof. Don Kulasiri, PhD

Centre for Advanced Computational Solutions, Lincoln University, Christchurch, New Zealand

Assoc. Prof. Dr. Atif Evren

Department of Statistics, Yıldız Technical University, Istanbul, Turkey

Univ. Prof. Dr. Jürgen Maaß

School of Education, Abteilung MINT-Didaktik, Johannes-Kepler-Universität Linz

Ao. Univ. Prof. Mag. Dr. Karl Josef Fuchs

Fachbereich Mathematik, Universität Salzburg

Prof. Dr. Joachim Engel

President of the International Association for Statistics Education

Univ.-Doz. Dr. Ödön Vancsó, Head of the Mathematics-Didactics Centre

Department of Mathematics, Eötvös-Lóránd-Universität Budapest

Prof. Dr. Ramesh Kapadia, FRSS, C. Stat., FLMS

University London and Offsted, recently guest professor at the Department of Statistics

Dr. Carmen Batanero, Senior Lecturer

Facultad de Ciencias de la Educación, Universidad de Granada

## Institut für Statistik

Em. O. Univ.Prof. Dr. Haro Stettner

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### **Liebe Kolleginnen und Kollegen, liebe Studierenden am Institut für Statistik!**

Die Statistik an der Universität Klagenfurt hat eine steile Karriere hinter sich.

Als ich am 25. August 1976 hier meine Professur antrat, geschah dies unter der Mitaufgabe, die Anwendungen der Mathematik in Kärnten zu unterstützen und zu fördern.

Es zeigte sich auch nach kurzem, dass hier ein dringender Bedarf seitens vieler Institutionen vorlag – ich darf die Kärntner Holzindustrie, die Draukraftwerke, die Klagenfurter Dependence der Philips-Werke, das – damalige – Landeskrankenhaus und eine große Anzahl weiterer Interessenten anführen, die mit dem neuen Arbeitsbereich “Angewandte Mathematik und Statistik” in Kooperation traten.

Eine Zusammenstellung aus den letzten Jahren weist weit über 100 Forschungsprojekte aus, oft in Verbindung mit Diplomarbeiten oder Dissertationen, und zum Teil mit erheblichen Förderungen durch die verschiedenen Forschungsfonds verbunden.

Besonders statistische Beratung war gefragt, und es ist den damaligen universitären Entscheidungsträgern hoch anzurechnen, dass sie diesen Bedarf zur Kenntnis genommen und ihm mit dem Ausbau des Bereichs “Angewandte Statistik”, nämlich seiner personellen Stärkung auch Rechnung getragen haben.

Den – vorläufig – organisationstechnischen Höhepunkt dieser Expansion bildete vor 11 Jahren die Einrichtung eines eigenen Institutes für Statistik an der neugeformten Technischen Fakultät – die konstituierende Sitzung fand am 6. Dezember 2006 statt, und Jürgen Pilz wurde erster Institutsvorstand. Die seitherige Entwicklung in Forschung, Lehre und Anwendungen hat diesen Beschluss als richtig und zukunftsweisend erwiesen.

Ich möchte meine tiefe Befriedigung über dieses erfreuliche Geschehen in den letzten vierzig und besonders den letzten elf Jahren aussprechen, wo – um Goethe zu zitieren –

... wo guter Wille, kräftig durch Verstand,

und Tätigkeit, vielfältige, zur Hand ...

– und wünsche dem Institut, seinen Mitarbeitern und allen, die seine Angebote wahrnehmen, weiterhin viel Freude an unserer Wissenschaft und eine fruchtbringende Tätigkeit zum Wohle unserer Gesellschaft!

**em. O.Univ.Prof.Dr. Haro Stettner**



Institut für Medizinische Informatik,  
Statistik und Dokumentation

Medizinische Universität Graz

## Auf dem Weg der angewandten Statistik in die Data-Science-Zukunft

Spektabilität, Vorstand und Gründungsvorstand, geschätzte Kolleginnen und Kollegen, werte Absolventinnen und Absolventen, sehr geehrte Festgäste!

Es ist mir eine große Ehre aus Anlass des zehnjährigen Bestehens des Institutes für Statistik an der Alpen-Adria Universität zu Ihnen sprechen zu dürfen. Meine Verbundenheit mit dem Institut ist nicht nur geographischer Natur, Graz ist die nächstgelegene österreichische Universitätsstadt, sondern auch persönlicher Natur: berufliche Kontakte mit den Wegbereitern des heutigen Institutes, insbesondere Emeritusprofessor Haro Stettner und Prof. Manfred Borovcnik.

Auf den explizit ersten Lehrstuhl für Statistik in Klagenfurt wurde im Jahr 1994 Prof. Jürgen Pilz berufen. Zuvor, von 1993 bis 1994, war ich als Gastprofessor für Angewandte Statistik am Institut für Mathematik der damaligen Universität für Bildungswissenschaften tätig. Dies war kurz nach meiner Habilitation für das Gesamtfach Statistik an der Karl-Franzens Universität Graz.

Der Begriff *Data Science* war damals noch nicht bekannt. Aber *Data* waren zu dieser Zeit bereits im Zentrum meiner Tätigkeit: Ich war jene Person in Klagenfurt, die die statistische Programmiersprache S einführte. S war eine bahnbrechende Entwicklung der Bell Laboratories in den USA, ab 1988 New S genannt, und ist heute in ihrer modernen Implementierung als R bekannt. In meine damalige Lehre, aber auch Forschung, baute ich noch einen weiteren Aspekt ein: statistische Modellierung in der Abfolge Modellidentifikation, -schätzung und -kritik auf der Basis des sogenannten „White Book“ (Chambers, J. M. und Hastie, T. J. (1992): *Statistical Models in S*. CRC Press, Boca Raton). Dieses Werk leitete eine nachhaltige Entwicklung ein, die noch heute in der *Big Data*-Analytik unverzichtbar ist: die einheitliche Formelnotation (erkennbar am Tilde-Zeichen) bei der Modellspezifikation und *Data Frames* als Datenobjekte. Mit dem genannten Rüstzeug machten wir sofort computergestützte Übungen. Meine Studierenden der Mathematik und Informatik waren begeistert. So entstand eine solide Basis für den bis heute andauernden umfassenden Einsatz von R am Institut für Statistik.

Von 1991–1993 arbeitete ich in einem FWF-Grundlagenprojekt mit Prof. Haro Stettner zusammen. Sein Titel war „Asymptotik, Numerik und Implementation des Backfitting-Algorithmus bei Verallgemeinerten Additiven Modellen“. Damals galt international das Interesse den non-parametrischen Alternativen zu den Generalisierten Linearen Modellen. Der Backfitting-Algorithmus war das erste Schätzverfahren für rein non-parametrische Regressionsmodelle auf der Basis linearer Glätter. Über seine theoretischen Grundlagen und sein numerisches Verhalten, abhängig von der Art der beteiligten Glätter (Kern, Spline oder lokale Polynome) war damals noch wenig bekannt. Prof. Wolfgang Härdle (Humboldt Universität zu Berlin) und ich gaben 1996 ein Buch mit dem Titel „*Statistical Theory and Computational Aspects of Smoothing*“ (Physica, Heidelberg) heraus. Es enthält auch einen Beitrag zu dem genannten FWF-Projekt.

In den Folgejahren, leider ohne Beteiligung der Klagenfurter Kollegenschaft, beschäftigte ich mich mit weiteren Schätzansätzen, insbesondere für semiparametrische Regressionsmodelle.

In den frühen 1990er Jahren gab es auch statistische Kolloquien und Seminare in Klagenfurt, teilweise in Kooperation mit der Sektion Steiermark-Kärnten der Region Österreich-Schweiz der Internationalen Biometrischen Gesellschaft, die oft von Prof. Manfred Borovcnik organisiert wurden. Bedeutende Sprecher waren hier zum Beispiel Prof. Angelika van der Linde (Universität Bremen) und Prof. Wilfried Grossmann (Universität Wien). Van der Linde war damals eine ausgewiesene Expertin in glättenden Splines und Bayes-Methodik und Grossmann ein Innovator in Datenstrukturen wie sie heute im Kontext von *Big Data* aktuelles Forschungsthema sind. Überdies war Grossmann ein Brückenbauer zwischen Statistik und Informatik wie wir ihn bei den aktuellen *Big Data*-Herausforderungen mehr denn je brauchen würden. Klagenfurt war ohne Zweifel bereits auf der Landkarte der Statistik verzeichnet lange bevor es zur Gründung des heute gefeierten Institutes kam. Was wir derzeit sehen, ist eine Profilbildung in den Bereichen der technikorientierten angewandten Statistik (durch Gründungsvorstand Prof. Jürgen Pilz) und der Forschung zu den Vermittlungs- und Ausbildungsmethoden im Fach Statistik (durch Vorstand Prof. Manfred Borovcnik).

Die wesentliche Frage ist jedoch: Wie kann die Zukunft des Instituts für Statistik aussehen?

Faktum ist, dass fast alle neuen Technologien ohne das hier vertretene Fach nicht denkbar wären:

- keine Mobiltelefonie ohne Statistik,
- keine Webdienste ohne Statistik
- kein Satellitenmonitoring ohne Statistik
- keine biometrische Erkennung ohne Statistik
- keine Smarttechnologien ohne Statistik
- keine autonom fahrenden Autos ohne Statistik
- keine vernetzten Maschinen ohne Statistik
- keine personalisierte Medizin ohne Statistik

Diese Liste könnte fast beliebig fortgesetzt werden.

Welche gemeinsamen Merkmale haben nun all diese High-Tech-Anwendungen? Es sind in erster Linie:

- enorme Datenmengen, oft mit einer räumlichen und/oder zeitlichen Komponente
- Echtzeitdaten (data streams)
- hohe Komplexität, also schwach oder nicht strukturierte Daten
- hohe Dimensionalität, also um viele Größenordnungen mehr unbekannte Parameter als Beobachtungseinheiten oder aber niedrige Dimensionalität bei unerschöpflich vielen Beobachtungseinheiten
- schwierige Separierbarkeit von relevanter Information und Noise

Hier greifen klassische statistische Paradigmen nicht mehr. Ohne Zweifel werden neue Analysemethoden benötigt. Doch die statistische Grundlagenforschung hat bereits jetzt viele Fundamente gelegt, auf denen *Data Science*-Ansätze aufgebaut werden können. Denken wir nur an die schon erwähnten Glättungsmethoden, aber auch an die große Klasse der Penalisierungsverfahren. Damit haben wir Werkzeuge um mit schwach besetzten Systemen (data sparsity) umgehen zu können. Eine Kombination dieser beiden Verfahren eröffnet bereits jetzt Möglichkeiten für die Analyse hoch komplexer Daten.

Spätestens nach meiner Gastprofessur am Institut für Statistik im letzten Wintersemester sollten diese Verfahren hier nicht mehr unbekannt sein. Das Interesse und die Motivation der Studie-

renden waren groß und die Lehre auf diesen neuen Gebieten sollte aus den genannten Gründen unbedingt fortgesetzt werden.

Wenden wir uns nun weiter der aktuellen fachlichen Entwicklung zu:

*Big Data* ist in aller Munde. Nicht wenige Entscheidungsträger in Politik, Wirtschaft und Wissenschaft vertreten die Meinung, dass die Herausforderungen der neuen Technologien nur durch eine neue Disziplin namens *Data Science* gemeistert werden könnten. Somit stellt sich die Frage nach den Inhalten von *Data Science*.

Um diese zu beantworten, möchte ich folgende objektive Betrachtung anstellen: Ein Hauptreferenzwerk ist der aktuelle Sammelband „*Handbook of Big Data*“, herausgegeben von Peter Bühlmann (ETH Zürich) gemeinsam mit anderen (CRC Press, Boca Raton, 2016). An diesem Werk haben 34 Autoren mitgearbeitet. Ich habe mir nun deren fachliche Herkunft angesehen und zwischen den akademischen Fächern Statistik, Biostatistik, Mathematik und Informatik (Computerwissenschaften) unterschieden. Das Ergebnis sieht folgendermaßen aus:

- Statistik: 15 Personen
- Biostatistik: 8 Personen
- Mathematik: 2 Personen
- Informatik: 9 Personen

Somit sind 23 Autoren Statistikinstituten zuzuordnen. Das ist eine klare Mehrheit von fast 70% der insgesamt 34 Autoren.

Sieht man sich darüber hinaus Master- und Doktoratsstudien in *Data Science* von nordamerikanischen Forschungsuniversitäten an, die hier die Vorreiter waren, dann dominieren auch dort die Statistikdepartments. An der University of California, Berkeley, kann man zum Beispiel ein PhD in Statistik absolvieren mit dem Zusatz “with a Designated Emphasis in Computational Science and Engineering” und damit dem *Data Science*-Aspekt entsprechend Rechnung tragen.

Lassen Sie mich nun die wesentlichen fachlichen Schwerpunkte des Themenbereichs *Data Science* aufzeigen. Es sind dies:

1. Datenhaltung (Datenbanken)
2. Datenzentrierte explorative Methoden (Überlappung mit Data Mining von einst)
3. Entwicklung effizienter Algorithmen (Numerik für enorm große Datensätze)
4. Angewandte Graphentheorie (Netzwerktheorie)
5. Modellschätzung (einschließlich Variablenselektion)
6. Regularisierungsmethoden (Penalisierungsverfahren)
7. Inferenzmethoden („computer age statistical inference“)
8. Statistisches Lernen (Weiterentwicklung des maschinellen Lernens)
9. Targeted Learning
10. Ensemble-Methoden (z. B. „divide and recombine“)

Die Datenhaltung (1) ist eine informatische Vorleistung aber keine spezifische Aufgabe von *Data Science*. Die datenzentrierten explorativen Methoden (2) sind interdisziplinär. Die Entwicklung effizienter Algorithmen (3) ist primär der numerischen Mathematik geschuldet. Zur angewandten Graphentheorie (4) gibt es Beiträge von der Informatik als auch der Statistik. Modellschätzung (5) ist ein ureigenes Thema der Statistik. Dasselbe gilt für die Regularisierungsmethoden (6) und die Inferenzmethoden (7). Das maschinelle Lernen hat im statistischen Lernen (8) eine bedeutende Weiterentwicklung erfahren. Viele dieser hier genannten statistischen Forschungsaspekte werden in dem epochalen Buch von Trevor Hastie, Robert Tibshirani und Jerome Friedman (alle Stanford University) mit dem Titel *The Elements of Statistical Learning. Data Mining, Inference, and Prediction* (Springer, New York, 2009, 2. Auflage) behandelt. Es ist meines Wissens der einzige Statistiktitel, der regelmäßig in den Buchregalen

von Informatikern zu finden ist. Der rezente Ansatz des Targeted Learning (9) ist eine eigenständige statistische Entwicklung für kausale Inferenz von Mark van der Laan (University of California, Berkeley) mit erheblichem Potential für große komplexe Datenbestände. Zu den Ensemble Methoden (10) gibt es sowohl statistische als auch informatische Forschungsansätze.

Was sagt uns nun diese Liste? Die überwiegende Zahl der fachlichen Schwerpunkte von *Data Science* betrifft statistische Arbeitsgebiete. Viele von ihnen, wie zum Beispiel die Modellschätzung oder die Inferenzmethoden, basieren auf theoretischen Konzepten, die seit Jahrzehnten in der statistischen Datenanalyse bewährt sind. Vieles davon ist in der Sprache R implementiert und frei zugänglich.

An dieser Stelle sei angemerkt, dass bei *Big Data* oft nur an Data Mining, also die Exploration von Datenstrukturen, gedacht wird. In Wahrheit geht es jedoch fast immer um Modellbildung und Entscheidungsfindung. Selbst relativ einfache Aufgaben wie maßgeschneiderte personalisierte Werbung im Web erfordert Eigenschaftsmodelle typischer Benutzergruppen. Die in naher Zukunft auf uns zukommende Industrie 4.0, informations- und kommunikationsgesteuerte industrielle Produktion, ist nicht denkbar ohne neue inferenzstatistische Methoden für Entscheidungen in Netzwerken, um nur eine Aufgabe zu nennen.

Man darf zusammenfassend sagen dass das Fach Statistik eine große Zukunft hat und der statistische Beitrag zu *Data Science* wesentlich größer ist als üblicherweise kommuniziert wird. *Big Data* ist zu einem guten Teil angewandte Statistik von morgen. Entsprechend ausgestattet, mit neuen Aufgaben versehen, sollte das Institut für Statistik an der Alpen-Adria Universität Klagenfurt diese Zukunft maßgeblich mitgestalten und einen wichtigen Beitrag zu einer zeitgemäßen technischen Ausbildung leisten können.

Mit den besten Wünschen für die Zukunft, auf viele weitere Jahrzehnte,

Ihr

**Prof. Dr. Dr. Michael G. Schimek**



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**Alpen-Adria-Universität Klagenfurt**

z.Hd. Hr. Univ.-Prof. Dr. Jürgen Pilz  
Institutsvorstand des Instituts für Statistik  
Universitätsstraße 65-67  
A-9020 Klagenfurt am Wörthersee

Villach, 23. November 2017

**Glückwünsche zum 10-jährigen Jubiläum des Institutes für Statistik**

Sehr geehrter Herr Prof. Pilz,

Seit der Gründung des Institutes für Statistik an der Alpen-Adria-Universität Klagenfurt besteht eine kontinuierliche Verbindung und Kooperation mit dem CTR Carinthian Tech Research, Kärntens Forschungszentrum für intelligente Sensorsysteme und Systemintegration. Aufgrund des Wesentlichen und weiter zunehmenden Stellenwertes statistischer Methoden im Bereich der Signal- und Sensorauswertung einerseits und dem persönlichen Einsatz von Prof. Pilz konnten sowohl Lösungsansätze gemeinsam entwickelt, wie auch der akademische Nachwuchs in Form von Diplomarbeiten und Dissertationen gefördert werden.

Wir gratulieren allen Institutsangehörigen herzlich zum 10-jährigen Jubiläum und freuen uns auf zukünftige – gemeinsam adressierte - Herausforderungen!

Herzliche Grüße

Dr. Werner Scherf

Vorstand CTR AG (CEO/CTO)

Dipl.-Ing. Simon Grasser MBA  
Vorstand CTR AG (CFO)



An das  
Institut für Statistik  
der Alpen-Adria-Universität Klagenfurt

Univ.Prof. Mag. Dr. **WERNER G. MÜLLER**  
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## **Grußworte zum zehnjährigen Institutsjubiläum**

Linz, 23.11.17

Sehr geehrte Damen und Herren!  
Liebe Mitglieder des Instituts und Feiernde!

Mit großer Freude übermittle ich diese Grußadresse anlässlich des zehnjährigen Bestehens des Instituts für Statistik an der Universität Klagenfurt, weil ich in vielfältiger Art dem Institut verbunden bin. Ich war wegen des überlappenden Forschungsinteresses an der statistischen Versuchsplanung Doktoratsprüfer bei so manchem Mitglied des Instituts, Kollege Pilz im Gegenzug Gutachter bei meiner Habilitation. Kurz vor der Institutsgründung gelang es uns auch, ein gemeinsames Projekt „Optimum Design for Correlated Processes“, welches vom FWF finanziert wurde, durchzuführen. Auch seit dessen Abschluss verfolge ich die Aktivitäten in Klagenfurt auf diesem Gebiet mit anhaltendem Interesse.

Die Gründung neuer Institute ist keine Selbstverständlichkeit und oft insbesondere wegen interner Widerstände keine einfache Sache. Für die Sichtbarkeit und gesellschaftliche Präsenz unseres Faches aber ist die Tatsache, dass es in jeder größeren österreichischen Universität dadurch nun ein Statistikinstitut gibt, von großer Relevanz.

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Die Mitglieder des Instituts in Klagenfurt haben diese Sichtbarmachung übrigens in vorbildhafter Weise betrieben. Sie haben sich außerdem stets in die Aktivitäten der österreichischen statistischen Gesellschaft in gewinnbringender Art eingebracht, zuletzt etwa durch die Organisation eines Schwerpunktes bei den Statistiktagen. Die internationale Präsenz ihrer Forschungen mit zahlreichen Fachpublikationen tut das Übrige.



Ich wünsche deshalb allen Beteiligten weiterhin gedeihliches Forschen und Lehren am gemeinsamen Institut für viele zukünftige Jahre,

mit freundlichen Grüßen

A handwritten signature in blue ink, appearing to read 'Werner G. Müller', is shown within a light blue rectangular border.

Werner G. Müller



Dekan  
Naturwissenschaftliche Fakultät  
Universität Salzburg

Univ.-Prof.  
Dr. Arne C. Bathke

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Salzburg, im November 2017

**Herzlichen Glückwunsch!**

Liebe Kolleginnen und Kollegen an der Alpen-Adria Universität Klagenfurt,

es ist mir eine große Freude, Euch zum zehnjährigen Bestehen des Instituts für Statistik zu gratulieren! Leider kann ich diese Gratulationswünsche nicht persönlich überbringen, sie sind aber nicht minder herzlich!

Nur mit einer starken und gewichtigen Statistik kann eine Universität heutzutage in der Forschung erstklassig sein, denn erstklassige Forschung ist meistens quantitativ, und oft interdisziplinär. Wer teuer Daten erhebt und diese dann billig – also ohne Involvierung von Fachexperten aus der Statistik – auswertet, verschwendet meistens Steuergelder und trägt fast immer zum wachsenden Bestand nicht reproduzierbarer Forschung bei.

Die Leitung der AAU hat diese Problematik offenbar schon vor längerer Zeit erkannt und schließlich vor zehn Jahren sogar die Institutionalisierung der Statistik unterstützt. Man darf also auch Eurer Universitätsleitung gratulieren, zu Weitsicht und nachhaltiger Unterstützung.

Ihr habt dieses Institut mit Leben gefüllt und Euch in der interdisziplinären und methodischen Forschung national und international einen Namen gemacht. Als gute Vorbilder in der Wissenschaft schreckt Ihr dabei auch nicht vor kontroversen Themen zurück – Hut ab: Die Menschheit braucht solche engagierten Wissenschaftskollegen wie Euch!

Dass Ihr Euch vor zehn Jahren „selbständig“ gemacht habt, war also auch für die AAU ein großer Schritt, das Bestreben nach internationaler wissenschaftlicher Wettbewerbsfähigkeit zu demonstrieren.

Dass Ihr diese zehn Jahre so gut überstanden habt (für mich u.a. dadurch dokumentiert, dass Ihr derzeit eine Professur besetzen dürft), ist umso erfreulicher. Es war sicher nicht immer eine leichte Zeit, denn nicht nur zwischen den Universitätsstandorten, sondern auch innerhalb derselben, besteht ja leider permanent Konkurrenz um die zu wenigen finanziellen Mittel. Die Zehnjahresmarke erreicht zu haben, spricht für Eure Beharrlichkeit und Ausdauer, aber auch für die Substanz des Faches, dass Ihr vertretet.

Mögen Euch, mögen dem Institut für Statistik an der Alpen-Adria Universität Klagenfurt noch viele erfolgreiche Jahre beschieden sein.

Möget Ihr weiter wachsen, noch kräftiger blühen, und weiterhin in vielerlei Form (u.a. Publikationen und Alumni) gedeihen!

Herzliche Glückwünsche aus Salzburg,  
Arne Bathke

## Institute of Statistics

*O.Univ.-Prof. Dr. Jürgen Pilz  
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*Grußworte aus Graz!*

29. November 2017

*Die Grazer Statistik gratuliert dem Institut für Statistik der Alpen-Adria Universität Klagenfurt zum 10-jährigen Jubiläum recht herzlich. Es ist phantastisch zu sehen, welche enorme Breite in Forschung wie auch Lehre ein personell relativ kleines Institut wie ihr es seid, aufweist. Besonders stolz könnt ihr auch auf eure erfolgreichen Kooperationsprojekte mit der Industrie und der Wirtschaft sein, was durch zahlreiche Publikationen in einschlägigen Fachjournalen unterstrichen wird. Beeindruckend ist auch die unglaublich große Anzahl der Habilitationsabgänger und Doktoranden an eurem Institut.*

*Wir schicken unsere besonderen Glückwünsche an alle Institutsangehörigen und freuen uns auf eine weiterhin gute Zusammenarbeit in den kommenden Jahrzehnten zum Wohle der Statistik in Österreich.*



Herwig Friedl

Dortmund, 8. November 2017

Lieber Herr Borovcnik,

erstmal herzlichen Glückwunsch zu der schönen Rezension Ihres neuen Buches und natürlich auch zur 10-Jahres-Feier Ihres Instituts. Am 1. Dezember bin ich zu einer Jurysitzung für den Kulturpreis „Deutsche Sprache“ in Kassel, sonst hätte ich mir wirklich überlegt, den Festakt zu einer kleinen spontanen Urlaubsreise nach Österreich zu nutzen. Und natürlich komme ich gerne Ihrer Bitte nach einer kleinen Grußadresse nach.

Ihr

Walter Krämer

**Verehrter Herr Kollege,**

zur 10-Jahres-Feier Ihres Institutes übermittle ich die herzlichsten Grüße aus der ersten und bisher leider immer noch einzigen eigenen Fakultät für Statistik im ganzen deutschen Sprachgebiet. In dieser Rolle hätten wir gerne mehr Gesellschaft, vielleicht wächst ja Ihr Institut zu einer regelrechten Fakultät heran? Ich selbst habe ja meine Statistiker-Laufbahn in Wien begonnen und schätze die österreichische Statistik ganz außerordentlich, warum sollte das nicht möglich sein?

Unabhängig davon erinnere ich mich sehr gerne an unsere gemeinsamen Jahre bei „Stochastik in der Schule“ und an unser Interesse an der statistischen Allgemeinbildung, die ja leider in Deutschland wie in Österreich gleichermaßen am Boden liegt. Die dringend nötige „Numeralisierung“ der Öffentlichkeit ist eine gewaltige Aufgabe, an der auch Ihr Institut mit Vorlesungen, Vorträgen, Büchern und Medienauftritten engagiert mitarbeitet.

Dafür wünsche ich Ihnen auch in Zukunft alles Gute und weiterhin viel Erfolg.

Nochmals Ihr

**Walter Krämer**

**Université Paris Dauphine**  
CENTRE DE RECHERCHE EN MATHÉMATIQUES DE LA DÉCISION

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November 30, 2017

**10th anniversary of the Department of Statistics**

Dear Colleagues,

On the happy occasion of the celebration of the 10th anniversary of your department in the University of Klagenfurt, I would like to send you my congratulations for the development and achievements of this department, as well as convey to you my warmest wishes for its future!

I have had the opportunity and pleasure to visit your department twice in the past, once in 2005 during the Meeting of the Austrian Statistical Association, along with Professor Peter Müller, where we first met with Professor Pilz, and second for a week of short courses on computational statistics, in September 2006, which gave me the additional opportunity to climb Großglockner!

I also want to recall the attempt Professor Pilz, Professor Bernardo, and a few other colleagues from all across Europe made to create a European network of Bayesian masters, under the denomination of EuroBayes and the support of Erasmus Mundus. While this attempt failed, we still managed to exchange a few students across the nodes of this network and I dearly wish it would have worked!

I am definitely looking forward my upcoming visit to Salzburg for the 10th International Workshop on Statistics and Simulation where Professor Pilz and I will meet again, but in the meanwhile wish the department and all its members, staff, and students, the best for the coming years and challenges.

Meilleurs vœux de Paris,



**Christian P. Robert**  
Professor of Statistics,  
and Senior Member, Institut Universitaire de France



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Ref: JVZ.279

November 30, 2017

Professor Dr Jürgen Pilz  
Alpen-Adria- Universität Klagenfurt  
Institut für Statistik  
Universitätsstr. 65-67  
9020 Klagenfurt, Austria

Email: Juergen.Pilz@aau.at

Dear Professor Pilz

SUBJECT: Congratulations on your Department's 10th Anniversary

To you as Founding Head and your colleagues, I offer my heartiest congratulations on the 10th anniversary of the founding of your Institut für Statistik. I really appreciated your invitation to visit your Department in 2008 and to give a graduate course on spatial statistics. I was struck by the quality of the research you and your colleagues were doing and also of the students enrolled in my course. As well I appreciated the warmth of the hospitality you and your colleagues accorded me. I would add that the evolution of your Institut really has been a great success story in a discipline, statistical science, which has now assumed enormous importance in the world at large.

On a more personal note, I have enjoyed our research interactions over the years. As I recall we first met at the 1991 Valencia Conference and there I learned about our overlapping research interests. That then led to your visit to my University as a Guest Professor in the fall of 2010 where we had a lot of stimulating discussion, in particular about the area of spatial sampling, something that still does not get the attention it deserves in my opinion.

To conclude, I wish you and your colleagues well and hope that you and I will soon have the opportunity to renew our long research collaboration.

Regards,

A handwritten signature in black ink that reads 'James V Zidek'.

James V Zidek, PhD, FRSC  
Professor Emeritus, Department of Statistics, Room 3112  
tel: (604) 822 4302 | fax: (604) 822 6960  
email: [jim@stat.ubc.ca](mailto:jim@stat.ubc.ca) | home page: <http://www.stat.ubc.ca/~jim/>

## **Collaboration between Klagenfurt University and Lincoln University**

Dear Jürgen,

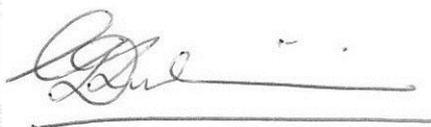
It is our pleasure to congratulate you and the Institut für Statistik for the 10<sup>th</sup> Anniversary in December 2017.

We would like to contribute to yours and our developments by continuing our collaboration with you which began in 2016/7 while you were on sabbatical in New Zealand. Stochastic analysis of environmental and Industrial problems is becoming more and more important as the complexities of problems increase, and therefore, I can see that your institute will contribute greatly to the understand of these problems at deeper levels. As you know that we are keen to work with you on topics of joint interest in the future; e.g.on parameter uncertainty and statistical surrogate modelling for complicated mathematical computer models. We hope that new approaches developed by you and your institute will be of great value to us to provide a much greater understanding of these problems.

We look forward to future collaborations and visits either for sabbaticals or on joint projects involving research students to develop these powerful techniques.

We wish you and your department well.

Yours Sincerely,



Prof. Don Kulasiri, PhD (Virginia Tech), FMSSANZ  
Head  
Centre for Advanced Computational Solutions (C-fACS)  
Email: [don.kulasiri@lincoln.ac.nz](mailto:don.kulasiri@lincoln.ac.nz)



Faculty of Arts and Sciences

## Department of Statistics

22nd of November, 2017

### **Ladies and Gentlemen at the Department of Statistics at the AAU in Klagenfurt**

My name is Atif Evren. I am a member of the department of Statistics of Yildiz Technical University in Turkey. I send this message to celebrate the anniversary of the establishment of Statistics Department of Alpen-Adria-University.

Since 2009, our departments have collaborated closely within the frame of Erasmus Treaty. We really appreciate this collaboration, since by this treaty, we easily can share our ideas on statistical reasoning and thinking. During this period, several students from our department benefited very much from their stays in your department. As well as taking some statistics and mathematics courses in German language, these stays certainly should have introduced them new perspectives on the way to become a world citizen, and new understandings on people from other cultures.

Besides, Prof. Dr. Manfred Borovcnik from Alpen-Adria-University visited our department several times. We have learnt quite a lot from his lectures, and his participations in our scientific meetings!

On the preface of the first edition of his book; “An Introduction to Probability Theory and Its Applications”, William Feller notes that when his book was written, few mathematicians outside the Soviet Union recognized probability as a legitimate branch of mathematics. Applications and teaching were very limited in 1940’s. Now, the progress is enormous. Yet some challenges are on the way. We can overcome the obstacles more easily by some organizations on larger scale.

Here, in our university, the statistics department is not one of the older ones. It was formerly organized by some lecturers from the Mathematics Department in the early 1990’s. We owe a lot to them but now we are on a different stage of progress. Currently, we have a younger generation of statisticians and mathematicians, and a recently-formed center for statistical studies whose management is very eager for collaborations.

With these thoughts, we congratulate the first ten-years anniversary of the Statistics Department of Alpen-Adria University! We know that we have always good colleagues and friends there!

**Assoc. Prof. Dr. Atif Evren**



Institut für Statistik  
Alpen-Adria-Universität  
Klagenfurt

Univ. Prof. Dr.  
**Jürgen Maaß**  
Abteilung für MINT Didaktik  
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Linz, den 8.11.2017

### **Mein persönlicher Glückwunsch zum Jubiläum des Instituts für Statistik**

an der Alpen-Adria-Universität Klagenfurt gründet sich insbesondere auf der weisen Entscheidung des Institutes, dem Kollegen Manfred Borovcnik eine wissenschaftliche und persönliche Heimat zu bieten. Professor Borovcnik wurde für die – zumindest in Österreich einzigartige – Kombination „Stochastik und ihre Didaktik“ habilitiert. Eine positive Verbindung von forschender Mathematik auf Universitätsniveau und Mathematikunterricht ist schon lange (im Wesentlichen hat es nach den Meraner Reformen – untrennbar verbunden mit Felix Klein! – vor mehr als 100 Jahren nur ganz wenige und nicht sehr erfolgreiche Versuche gegeben, aktuell erforschte Mathematik in die Schule zu bringen, etwa bei den Fraktalen und Julia-Mengen) und fast vollständig abgerissen – bis auf ganz wenige Ausnahmen wie ihn.

Da nach der Etablierung von Themen aus Stochastik und Statistik in den Lehrplänen der österreichischen Schulen erst allmählich und in stets zu geringem Umfang Grundkenntnisse aus diesen Bereichen in den Köpfen der Lernenden und Lehrenden verankert werden, ist sein stetes Bemühen, zu einem besseren und wenn möglich sogar tatsächlichen Verständnis von Stochastik beizutragen, sehr zu würdigen. Ich persönlich habe davon profitiert: Einerseits hat er sehr schöne Vorträge im Kepler Symposium an der Universität Linz gehalten. Andererseits hat er als Berater und Mitautor an mehreren Beiträgen zur Didaktik der Stochastik sehr produktiv mitgewirkt.

Ganz besonders möchte ich ihm auch an dieser Stelle dafür danken, dass er es dabei geschafft hat, gleichzeitig taktvoll sein Entsetzen über meine Wissenslücken in Stochastik zu verbergen, auf die fachliche Korrektheit unserer Beiträge zu achten und sich bei Ausflügen in wissenschaftliche Hintergründe der behandelten Themen so einbremsen zu lassen, dass die fertigen Aufsätze für Lehrende und Lernende an Schulen verständlich sind.

Aufgrund dieser sehr positiven Erfahrungen möchte ich meinen persönlichen Glückwunsch mit der Hoffnung verbinden, dass die Kooperation noch über viele Jahre fortgesetzt werden kann.

**Univ. Prof. Dr. Jürgen Maaß**

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### **Grußadresse anlässlich des 10 Jahre Jubiläums des Instituts für Statistik an der Alpen-Adria-Universität Klagenfurt**

In meiner Funktion als Leiter der Arbeitsgruppe für Didaktik der Mathematik und Informatik an der Paris Lodron Universität Salzburg übermittle ich anlässlich des 10 Jahre Jubiläums des Instituts für Statistik an der AAU Klagenfurt die besten Glückwünsche meiner Mitarbeiter Günter Maresch, Simon Plangg, Alfred Dominik, Marion Zöggeler sowie Emeritus Fritz Schweiger zum Jubiläum.

Seit vielen Jahren besteht eine enge Verbindung mit Vorstand Prof. Manfred Borovcnik. In den letzten beiden Jahren hat Prof. Borovcnik Ingo Engert-Oostingh beim Abschluss des Dissertationsprojekts mit zahlreichen Ratschlägen unterstützt, war Gutachter der Dissertation und auch Diskutant in der finalen Verteidigungsprüfung von Herrn Engert-Oostingh.

Zudem lehrte Vorstand Prof. Borovcnik an der School of Education und am Fachbereich Mathematik im Wintersemester 2016/17 als Gastprofessor an der Universität Salzburg. In den Pflichtlehrveranstaltungen ‚Fachdidaktisches Seminar‘ (SoE) bzw. ‚Statistik für das Lehramt‘ (FB Mathematik) unterrichtete er die Studierenden im Lehramt Mathematik mit großer fachlicher sowie fachdidaktischer Kompetenz aus Statistik bzw. Didaktik der Stochastik.

Im Herbst des Jahres 2017 hatte ich die schöne Aufgabe, die Session ‚Statistik-Ausbildung an den Schulen‘ im Rahmen des ÖMG-DMV-Kongresses 2017 an der Universität Salzburg gemeinsam mit Prof. Borovcnik zu organisieren und durchzuführen. Dank der sehr guten Kontakte von Prof. Borovcnik konnten wie namhafte Referent(inn)en für die beiden Halbtage gewinnen. Aktuell steht gerade die nächste Nummer unserer Zeitschrift ‚Mathematik im Unterricht‘ vor der Fertigstellung. Prof. Borovcnik hat seinen Reviewings als Gasteditor für die Beiträge zur Didaktik der Stochastik ganz wesentlich zur Qualität der nächsten Nummer beigetragen.

An der Universität Salzburg wird durch die Kooperation mit Prof. Borovcnik das Modell einer Integration der Fachdidaktik Stochastik in das Fach – ein Konzept, das sich seit vielen Jahren an der AAU Klagenfurt bewährt – ebenfalls realisiert. Für die Implementierung dieses Modells, das zweifelsohne zum Wohl beider Seiten besteht, sind wir Prof. Borovcnik zu großem Dank verpflichtet.

**Prof. Dr. Karl Josef Fuchs**

Salzburg, 1. Dezember 2017



## INTERNATIONAL ASSOCIATION FOR STATISTICAL EDUCATION

### **Welcome from the International Association of Statistics Education**

It is my great pleasure to congratulate the Department of Statistics at the University of Klagenfurt to its 10<sup>th</sup> anniversary. These are exciting times to be involved in statistics. Emerging data sources provide new sorts of evidence, provoke new sorts of questions, make possible new sorts of answers and shape the ways that evidence is used to influence decision making in private, professional and public life. In addition, burgeoning progress in hardware and software development and the inception of computer intensive algorithms pave the way to powerful methods of data analysis, from innovative visualizations of complex data to methods of data mining and machine learning. These advances are changing the nature of evidence that is available, the way it is presented and used and the skills needed for its interpretation.

Recent developments impact not only the statistical methodology and, as applications, empirical methods of scientific inquiry but affect society and its citizenry as a whole. Bill Cleveland, who was the first person to use the term data science, emphasized the need to focus of communication and postulated from research oriented statistics groups to allocate energy and resources on pedagogy. Statistics is much about communication of conclusions and reasoning. Challenges include the communication of concepts and ideas to empirical researchers in other fields, but also help the public to understand and reason about quantitative evidence in a world awash with data.

Some statistics educators who believe to reduce formal mathematics and emphasize conceptual thinking might help students understand statistics better. Yet, within the discipline issues of teaching and theoretical and practical investigations in didactic research have a rather low ranking. But, in cooperation with cognitive sciences, both statistics as a discipline and statistics education can indeed develop further for their mutual benefit.

Klagenfurt, over the last ten years and beyond, provides compelling proof in the realization of a very fruitful symbiosis. The small department developed high-end applications as well as deep-thought approaches in the didactics of statistics and is a living demonstration for a successful synergy for a prospering science that contributes to its methodological advances, provides valuable applications and adds to the empowerment of a broader citizenry to apply critical thinking and quantitative reasoning for the better of society.

**Joachim Engel**

**President elect**

**International Association for Statistical Education**



**MATHEMATICS TEACHING AND EDUCATION CENTRE**  
**EÖTVÖS LORÁND UNIVERSITY**  
**FACULTY OF SCIENCE**  
**INSTITUTE OF MATHEMATICS**

**Zur 10-Jahres-Feier des Instituts für Statistik an der Universität Klagenfurt**

Ich gratuliere zum zehnten „Geburtstag“ des Institut für Statistik und besonders unserem altem Partner, Professor Borovcnik. Unsere Bekanntschaft hat schon in 1994 begonnen als ich als junger Universitätsassistent von der Eötvös-Lóránd-Universität Budapest drei Monate in Klagenfurt verbrachte.

Später trafen wir uns regelmäßig an GDM-Tagungen und arbeiteten zusammen im Stochastik-Arbeitskreis der GDM. Professor Borovcnik hat mich im Jahr 2004 an ICME-10 in Kopenhagen in seiner Topic Study Group als Invited Speaker eingeladen. Bei der ICME-11 in Monterrey im Jahr 2008 waren wir wieder in einer Gruppe und ähnlich auch in Ljubljana bei der ICOTS-8-Conference in 2010.

Inzwischen wurde Professor Borovcnik mehrmals nach Budapest als Gastvortragender eingeladen, und zwar in Jahren 2011, 2013, 2017. Er hat einmal auch an einer großen Lehrertagung in Ungarn (László Rátz Tagung in Vác) einen Hauptvortrag gehalten.

Unser gemeinsames Forschungsthema war seit je her Bayes-Statistik im Unterricht. Dazu hatte ich schon früh intensive Forschungen angestellt und auch Unterrichtsexperimente in den Seminaren der Lehramtsausbildung sowie in Schulklassen durchgeführt. Neben Dieter Wickmann von der TU Aachen war Manfred Borovcnik der wichtigste Ansprechpartner bei der Reflexion des Zugangs sowie der Interpretation und Einordnung unserer Ergebnisse.

Aus Anlass unseres letzten Treffens haben wir eine Mitarbeit mit einem meiner Doktoranden Péter Fejes-Tóth diskutiert und besprochen. Er hat uns in der Entwicklung der Statistik- und Wahrscheinlichkeitsdidaktik sehr viel geholfen. Wir sind sehr dankbar für die Kooperation mit ihm. Meine Teilnahme in einer internationalen Forschungsgemeinschaft wäre ohne seine Unterstützung nicht zustande gekommen.

Manfred Borovcnik hat schon mit meinem Vorläufer, Professor Tibor Nemetz, sehr gute Kontakte gehabt und im Jahr 1996 für die ICME-8 in Sevilla eine internationale Studie gemeinsam durchgeführt. Es ging dabei um die Verbreitung bestimmter Sichtweisen zur Didaktik der Stochastik, die Durchsetzung dieser Themen in den nationalen Curricula und die Möglichkeiten, sich wissenschaftlich zu qualifizieren. Das war sehr wichtig in der damals noch sehr jungen Wissenschaftsdisziplin.

Ich freue mich, dass die Zusammenarbeit weiterlaufen konnte. Es tut mir sehr leid, dass ich wegen anderer Pflichten bei dieser Feier nicht anwesend sein kann.

**Dr. Ödön Vancsó, Universitätsdozent**  
**Leiter des Mathematisch-Fachdidaktischen Zentrums**  
**Eötvös-Lóránd-Universität Budapest**

Budapest, 24. November 2017

## **Statistics at the Alpen-Adria-University of Klagenfurt: 10<sup>th</sup> Anniversary**

It is a notable achievement to celebrate 10 years of the Institute of Statistics. This message is sent to you by a Fellow of the Royal Statistical Society whose headquarters are near to the burial place of the Reverend Thomas Bayes. As one of your Guest Professors, I have been proud to call myself a Bayesian for almost four decades, when we used to teach these ideas to teachers at the Polytechnic of the South Bank. I have been privileged to continue the tradition to your own student teachers who are excited and stimulated by the ideas and will take them forward in their own teaching careers.

As it happened even the London Mathematical Society, of which I am a Fellow had a talk by the Head of Research at Uber on the application of Bayesian Statistics to his own field of machine learning. He made links to neural learning and explained how Bayes formula is relevant in this current field of research which has led to computers beating humans at Go and even poker: this is based on a new field of research called Bayesian deep learning. This shows that we need to continue to promulgate these ideas more widely.

Klagenfurt is beautifully located and caters for an international body of students. This enabled me to give my lectures in English. Technical support also allowed me to give some lectures via skype. As a University you continue in the tradition of Oxford and Cambridge in having smaller and intensive tutorial groups which helps students learn more effectively.

My collaboration with Professor Manfred Borovcnik started in the rather unlikely location of the hills of the Peak District. These do not compare with the *Kärnten* mountain range, yet still have their own charm and beauty. The occasion was the 1st International Conference in Statistical Education in Sheffield, the home of the first (and only) extensive school project on the teaching of statistics. The ideas in those booklets remain relevant today. For example, an early teaching booklet seeks to show children why getting a six on a die is no harder than other numbers, though such a thought may become ingrained in their young minds for good stochastic reasons. Statistics has grown increasingly important in our society and probability underpins our approach to uncertainty and risk.

Our collaboration has helped Klagenfurt to become a world renowned centre for the teaching of probability. This culminated in the opening (and longest) two chapters in the recent research text on Probabilistic Thinking, published in the renowned Springer series on Advances in Mathematics Education. This builds on our previously edited book on Chance Encounters, a fitting description of how paths cross and lead to deeper understanding of academic ideas. So, though I cannot be with you in person, I will certainly be there in spirit and look forward to many more years of collaboration.

**Professor Dr Ramesh Kapadia, FRSS, C.Stat., FLMS**

22 Nov, 2017



**Dra. Carmen Batanero**  
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**UNIVERSIDAD DE GRANADA**

***Departamento de Didáctica de la Matemática***

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To the Department Department of Statistics  
c/o The Head of the Dept. Prof. Dr. Manfred Borovcnik  
Klagenfurt University

**Dear Sir and Madams**

15 Nov, 2017

The aim of this message is to express my greeting on the occasion of the celebration of the department's 10 years anniversary.

From what I see on the Internet and hear, the Department of Statistics has a wide range of applications among which include statistics education, an area where I have worked for many years with Dr. Manfred Borovcnik whom I know since long, more precisely since an international conference held in 1996 on statistics education at my university, Universidad de Granada, as a satellite of the ICME congress which was held in Sevilla.

Since then I have developed a friendship and a respect for Dr. Borovcnik whose writings have given me many insights for my own work. We have worked together in different tasks for the promotion of statistics education; for example he is now Editor of Statistics Education Research Journal, the main journal of the International Association for Statistics Education (IASE), while I also served as Editor or Associate Editor of this journal.

We met almost every year along 20 years at various conferences and organised together some invited paper sessions on probability and statistics education (such as in CERME IV in Sant Feliú de Guixols, Spain, or in ICME 2008 in Monterrey, Mexico, where subsequently he edited a thematic issue in the International Electronic Journal for Mathematics Education). Manfred was member of the Scientific Committee and invited speaker at the Joint ICME/IASE Conference held in 2008 in Monterrey, Mexico, which I organised and is author of a chapter in the related Springer book.

More recently he was been an invited speaker at the Topic Study Group in Probability at the ICME 13 conference in Hamburg and is author of a book chapter resulting from the work on this group, which is currently in press in Springer. Another example of collaboration is the book, Statistics and Probability at High School we wrote together for Sense Publisher.

In summary; these are just a few examples of the long history of collaboration and its many results from which I am very grateful to Dr. Borovcnik. I hope this letter contributes to the celebration and wish the department a flourishing period with many ground-breaking projects and my colleague productive years to come.

With my best regards

**Dra. Carmen Batanero**  
**Senior Lecturer. Mathematics Education**

## History and Staff of the Department of Statistics



### Early Beginnings

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Prior to the appointment of the first professor in statistics at the University of Klagenfurt in 1994, there have been several initiatives in statistics lead by Prof. Dr. Haro Stettner. Amongst others, Univ.-Doz. Dr. Dr. Michael G. Schimek has been guest professor at the Department of Mathematics. There were also connections to the Technical University of Graz (Prof. Dr. Josef Gölles), the Institute of Applied Statistics at Joanneum Research, Graz (Univ.-Doz. Dr. Manfred Borovcnik) and the Biometric Section Kärnten – Steiermark of the Austro-Swiss Region of the International Biometric Society with a steady exchange of methods and ideas also with the University of Ljubljana (Prof. Dr. Anuška Ferligoj).

Jürgen Pilz began his work as full professor in Applied Statistics on 7 February, 1994. The small research group of statistics was embedded in the Department of Mathematics; it comprised two university assistants, Albrecht Gebhardt and Rose-Gerd Koboltschnig, and Beate Simma as secretary. Work started with the installation of a Pentium 90 and a first project in applied statistics: “The Status of Health among the Population of the City of Klagenfurt”.

### First Graduations

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Soon after, the first graduations followed: Hanno Schwarz und Gunter Spöck (1997). The first doctoral theses followed and were successfully finished:

- Albrecht Gebhardt: Neural Networks – An Alternative to Spatial Statistics? (1998).
- Rose-Gerd Koboltschnig: Application of Bayesian Models in Spatial Epidemiology – the Case of Lung-Cancer Data in Western Austria (1998).
- Sven Grube: The Application of Generalised Linear Models for the Determination of Local Disparities of Pathogenesis (2000).

### Beginning Cooperations

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Cooperations with local industries and banks began around the millenium: Hypo Alpe Adria Bank, Carinthian Tech Research (CTR), and Infineon. Beginning in 1995, international cooperation partners were found at the University of Lausanne, La Sapienza, Rom, École de Mines, Paris, Centre de Geostatistique, Fontainebleau, the University of Rejkjavik, and Petromodel Iceland. First projects were:

- Centre for Information and Valorisation of European Radioactive Contaminated Territories (CIVERT, 2000–2004).
- Optimal Design of Experiments for Correlated Processes (FWF) (2003–2005).
- Development of a Global Network for Secure Communication based on Quantum Cryptography (SECOQC, 2004–2008).
- Statistical Process Management in the Aggregates Industries – PETROSCOPE (Eureka Project E!2569, 2004–2008).

## **New Perspectives – Foundation of the Faculty of Technical Sciences and the Department of Statistics**

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Starting with 2006, new perspectives were opened with the preparations to found a new faculty, the Faculty of Technical Sciences: This was the opportunity to establish the Department of Statistics in 2007. There were three persons with a *venia legendi*, Prof. Stettner, Prof. Pilz, Prof. Borovcnik, and university assistants Dr. Gunter Spöck and Dr. Albrecht Gebhardt, as well as project assistant Dipl.-Ing. Philipp Pluch; Beate Simma continued to serve as secretary also in the new department.

## **Euro-Bayes Master's Programme**

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Members of the Department developed a EuroBayes Master study programme since right from the beginning of the department together with colleagues from five European Universities. The programme was intended to provide a Europe-wide university education granting a European Master in Bayesian Statistics and Decision Analysis. In 2009, the treaty was ready to be signed by the following universities:

- Helsingin Yliopisto (Helsinki, Finland)
- Universität Klagenfurt (Klagenfurt, Austria)
- Universidad Carlos III (Madrid, Spain)
- Université Paris-Dauphine (Paris, France)
- Università degli Studi “La Sapienza” (Rome, Italy)
- Universitat de València (Valencia, Spain)

The study programme was fully worked out and we found already outside funding, which was granted by the Carinthian Tech Research CTR for four years. It is documented in an annex to the jubilee brochure – not only for historical reasons – the programme is still trend-setting. Finally, we missed to find enough resources from inside the university to finance it after the initial phase of four years.

## **The University's Developmental Plan for 2010–12**

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The second professorial position (Prof. Stettner) from the beginning of the Department of Statistics (Prof. Stettner' original “*venia*” was Mathematics and its Didactics”) was moved back to the Department of Mathematics in 2010 with Stettner's retirement. However, the University of Klagenfurt had a second full professorship at the Department of Statistics in its Developmental Plan for 2010–12 with a realisation by 2014 at the latest and with a prospect for a third professorship in Applied Statistics in the frame of industry-sponsored professorships.

Actually, the university reverted to the issue of a second professorship in 2012, and with some loops. With a call for a full professorship in Stochastic Processes rather than Applied Statistics in 2014, a list of three candidates has been established. Yet, the negotiations between the first on the list and the rector of the university were stopped in early 2016.

After that, in February 2017, a new call for a *temporary* professorship (for 5 years) has been announced, again with the orientation Stochastic Processes. The public hearings have taken place in October 2017. The position is currently in the process of being filled in.

### Staff at the Department at its Foundation – 4 May, 2007

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*Secretary:* Beate Simma

*Professors:* Jürgen Pilz, Haro Stettner, Manfred Borovcnik

*Assistants:* Albrecht Gebhardt, Gunter Spöck

*Project Assistants:* Philipp Pluch, Hannes Kazianka, Hannes Müller

*Technical Assistant:* Helmut Klinkan

### Staff at the Department – 2017

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#### *Department Secretary*



Beate Simma



Jürgen Pilz



Haro Stettner



Manfred Borovcnik



Gunter Spöck



Albrecht Gebhardt



Johannes Winkler

*PhD / Project Assistants*



Firdos Khan



Corinna Kofler



Daniel Kurz

*Students Assistants*



Maximilian Arbeiter



Konstantin Posch



Lukas Sommeregger



Kathrin Spendier



Jasmin Wachter

### PhD and Project Staff at the Department of Statistics 2007–2017

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Jan 2016 – Dec 2018	Corinna Kofler: Automatic Defect Classification: Back Surface of Structured Thin Wafer. Infineon Technologies Austria AG.
Nov 2013 – Jul 2017	Firdos Khan: Improved Hydrological Projections and Statistical Downscaling of Process-Based Climate Models for the Upper Indus Basin. Higher Education Commission (HEC), Pakistan.
Jul 2015 – Jun 2017	Daniel Kurz: Enabling Power Technologies for 300mm Wafers (EXBI) – Burn-In Strategies. ENIAC-JU-FP7-Project EPT300.
Apr 2012 – Sep 2015	Daniel Kurz: Enabling Power Technologies for 300mm Wafers – Innovative Methods for Early Failure Modeling. ENIAC-JU-FP7-Project EPT300
Nov 2009 – Apr 2013	Muhammad Mohsin: A New Class of Distributions Generated from Functional Scale Parameters. Higher Education Commission (HEC), Pakistan.
Feb 2009 – Apr 2011	Michael Mulyk: Snapshot Spectral Imaging. COMET I Programme, FFG Bridge, Tissue Gnostics (Wien), and Carinthian Tech Research (CTR), Villach.
Jan 2007 – Jul 2010	Ijaz Hussain: Spatio-Temporal Interpolation & Spatial Sampling Design for Precipitation in Pakistan during Monsoon. Higher Education Commission (HEC), Pakistan.
Sep 2006 – Aug 2009	Hannes Kazianka: INTAMAP – Interoperability and Automated Mapping. EU-FP6-IST Project.
Apr 2007 – Jan 2009	Hannes Müller: INTAMAP – Interoperability and Automated Mapping. EU-FP6-IST Project.
Jan 2004 – Jun 2008	Vera Hofer: Petroscope – Statistical Process Management in the Aggregates Industry. EUREKA-Project E!2536.
Apr 2004 – Oct 2008	Philipp Pluch: SECOQC – Secure Communication in Quantum Cryptography. EU-FP6-IST Project.

### Internships and Other Staff at the Department of Statistics 2007–2017

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2016 – 2017	Ioannis Spyroglou
2006 – 2008	Stephan Jank

### Student Assistants 2007–2017

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Wi 2017/18	Maximilian Arbeiter, Konstantin Posch, Lukas Sommeregger, Kathrin Spendier
Su 2017	Maximilian Arbeiter, Lukas Sommeregger, Jasmin Wachter
Wi 2016/17	Maximilian Arbeiter, Jasmin Wachter
Su 2016	Martin Pleschberger, Michael Scheiber, Jasmin Wachter
Wi 2015/16	Maximilian Arbeiter, Martin Pleschberger, Konstantin Posch, Michael Scheiber

### Head of the Department / Vice Head 2007–2017

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2016 – 2017	Manfred Borovcnik / Jürgen Pilz
2014 – 2015	Jürgen Pilz / Manfred Borovcnik
2011 – 2013	Jürgen Pilz / Gunter Spöck
2007 – 2010	Jürgen Pilz / Haro Stettner

## The Relevance of Statistics

### Statistical Literacy – Or, The Stork Brings the Babies



Increasingly, statistical evaluations of databases control the world: Amazon calculates what we want to buy; via our search queries, Google interprets who we are; preventive healthcare is based on statistics. Manfred Borovcnik spots a need for extending our competencies in statistics.

This text has been written by Romy Müller on the basis of her interviewing Manfred Borovcnik. The original text in German published in *ad astra*, the magazine of the Alpen-Adria-University Klagenfurt, has been translated by Manfred Borovcnik into English.

*Text: Romy Müller Photo composition: privat & ChampooB/Shutterstock.*

The stork brings the babies – there is no doubt about this! This is substantiated by the fact that the number of births is decreasing when there are fewer storks. Professor Borovcnik from the Department of Statistics uses this old example to illustrate how data are interpreted generally. However, in the case of the storks, there is a third variable in the form of grade of industrialisation. This variable is responsible for increasing building development of land areas, which cuts back the habitat of the stork population. And with increasing industrialisation, more women get employed, which induces lower birth rates. If read correctly, the babies are not delivered by the storks but the growing industrialisation is part of a phenomenon, in which the co-relation between stork populations and births is embedded. For Borovcnik, referring to this wider context enables us to recognise that statistics can always only serve as a tool, which requires competent readers to find an adequate interpretation of the “facts”.

The significance of Statistical Literacy is greater than ever today, which is reflected by statistical methods that are successfully utilised in machine learning and deep learning. The resulting technologies will affect our future in science and in everyday situations drastically. It is not only about that the individual can understand how online retail giants dupe us into buying things, there are also instances

for the relevance of statistics and probability beyond the digital world. Borovcnik refers to two examples that comprise the topics of future and risk and often provoke non-rational behaviour: Gambling and insurance.

“An insurance policy implies the exchange of a risk in the future and money that has to be paid off immediately.” The client who considers paying out such a policy finds himself in a situation of risk and uncertainty and wants to buy out security while the insurance company finds itself in a safe fixed situation with no risk at all. “For that matter, it is not possible to insure oneself against the risk itself, e.g., to have no accident, but only to insure against the financial consequences of an accident. The manoeuvre of the insurance company is, however, to counterfeit also this part as a constituent of the policy.” In gambling, the illusion is about something positive, a high prize that is “made” a reality. In gambling, the player leaves a situation without risk, and the casino exposes itself to an alleged risk. However, in the end, the casino will surely win if only the players continue to stake their money.

Individuals perceive the probabilities in the case of insurance and at gambling differently from what they really are – either empirically or mathematically. Borovcnik continues to express his views, “We find a conflict between psychic and formal elements. The psychic element is archetypal, the formal is artificially superimposed. Naturally, this makes it difficult to shape Statistical Literacy. However, I would like to ensure that the formal elements are backed up by extending knowledge and competences on probability and risk.”

Borovcnik has written his PhD thesis on the Bayesian controversy in the foundations of probability. In his habilitation thesis, he investigated the relation between intuitions and mathematics. More recent research projects are: Literacy in Probability and Risk; Risk in Health; Technology-Supported Learning Including To Build up a Library with Applets for Key Concepts in Statistics.

### **Recommended reading:**

Batanero, C. & Borovcnik, M. (2016). *Statistics and Probability in High School*. Rotterdam: Sense.

Source of the original article in German: ad astra – Magazin für Wissenschaft und Kultur der Alpen-Adria-Universität 2/2017, 46.

## **What is Statistics about**

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*Text: Jürgen Pilz*

Modern Statistics is the science of learning from data. As a discipline it is concerned with the collection, analysis, and interpretation of data, as well as the effective communication and presentation of results relying on data. Statistics lies at the heart of any type of quantitative reasoning necessary for making important advances in the engineering, natural, environmental, medical and social sciences, and for making important decisions in business, industry and public policy.

Traditionally, statistics is about gathering data and working out what the numbers can tell us. From the earliest farmer estimating whether he had enough grain to last the winter to the scientists of the Large Hadron Collider confirming the probable existence of new particles, people have always been making inferences from data. Statistical tools like the mean or average summarise data, and standard deviations measure how much variation there is within a set of numbers. Frequency distributions – the patterns within the numbers or the shapes they make when drawn on a graph – can help predict future events.

Two fundamental ideas in the field of statistics are uncertainty and variation. There are many situations that we encounter in science and daily life in which the outcome is uncertain. In some cases the uncertainty is because the outcome in question is not determined yet (e.g., we may not know whether it will rain tomorrow) while in other cases the uncertainty is because although the outcome has been determined already we are not aware of it (e.g., we may not know whether we passed a particular exam). The mathematical language used to discuss uncertain events is probability. The mathematical theory of probability had its beginnings with the early investigations of Pascal and Fermat in the middle of the 17<sup>th</sup> century, when they were discussing about gambling. Kolmogorov (1933) developed a rigorous mathematical foundation of probability theory.

On the other hand, any measurement or data collection effort is subject to a number of sources of variation. By this we mean that if the same measurement were repeated, then the answer would likely change. In 1808, Gauss, with contributions from Laplace, derived the normal distribution – the bell-shaped curve fundamental to the study of variation and error. Statisticians attempt to understand and control – where possible – the sources of variation. Modern statistics started with the publication of R. A. Fisher's book „Design of Experiments“ in 1935, which gave ways of deciding which results of scientific experiments are significant and which are not. From 1940-45, Alan Turing and his team at Bletchley Park cracked the German wartime Enigma code using methods of Bayesian statistics and Colossus, the first programmable electronic computer.

Statistics is a highly interdisciplinary field; research in statistics finds applicability in virtually all scientific fields and research questions in the various scientific fields motivate the development of new statistical methods and theory. In developing methods and studying the theory that underlies the methods statisticians draw on a variety of mathematical and computational tools. Two of these key developments over the last decades are bootstrapping (Bradley Efron, 1979), a simple way to estimate the distribution of almost any sample of data, and Monte Carlo Markov Chain (MCMC, Gelfand & Smith, 1990) methods, which make it possible to compute large hierarchical models that require integrations over many unknown parameters, for example in Bayesian statistics, computational physics and chemistry, computational biology and linguistics, etc. The widespread use of such powerful computational tools would have been impossible without the emergence of the statistical programming language R (released in 1993), now a standard tool all over the world.

Today, vast amounts of data are transforming the world and the way we live in it. Statistical methods and theories are used everywhere, from health, science and business to managing traffic and studying sustainability and climate change. This, in turn, will create the need for a much closer collaboration between statisticians, mathematicians, computer scientists and domain scientists. The call for a new generation of data scientists working at this interface is becoming more and more unmistakable; there is a strong need to develop data-science university curricula. The McKinsey Global Institute is expecting a shortage of 140,000 to 190,000 data scientists by 2018 in the US alone (see Manyika et al. 2011). We invite our young people to prepare for a data-science career. A master in mathematics with specialisation in statistics at our Alpen-Adria-University will provide them with a solid basis for it!

## References

- Efron, B. (1979). Bootstrap methods: Another look at the jackknife. *Annals of Statistics*, 7(1), 1-26.
- Gelfand, A. E. & Smith, A. F. M. (1990), Sampling-based approaches to calculating marginal densities. *Journal of the American Statistical Association*, 85(410), 398–409.
- Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C., & Hung Byers, A. (2011). Big data: The next frontier for innovation, competition, and productivity. Report May 2011. McKinsey Global Institute. Online: [www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation](http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/big-data-the-next-frontier-for-innovation).

## Applied Statistics on the Path to its Data-Science Future

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This essay originates from those parts of the speech of Prof. Michael G. Schimek on the occasion of the ten-year anniversary of the Department of Statistics, which refer to the development of Applied Statistics to the future of Data Science. Adaptation and translation: M. Borovcnik.

When Jürgen Pilz was appointed as the first full professor in Statistics (with the nomination of “Applied Statistics”) in 1994, the term *Data Science* was unknown at that time. Yet, there were groundbreaking new developments in connection to data. The statistical language S had just been developed by Bell Laboratories in the USA, called New S as from 1988 on. Today, in its modern implementation, this language is known as R. The then new book by Chambers and Hastie (1992) on “Statistical Models in S”, known as the “White Book”, had a tremendous influence on Applied Statistics. It focussed on the sequence of model identification, model estimation, and model critique for the statistical modelling process and it changed and impregnated the academic teaching in applied statistics classes.

This book influenced also the development of statistics towards the direction of data science and still is indispensable in today’s *Big Data* analytics, including its unifying mathematical notation in the model specification (recognisable with the tilde sign) and the notion of *Data Frames* for data objects. It helped constitute a solid basis for students of mathematics, statistics, and informatics and paved the way to the wide-spread use of R, also at the Department of Statistics in Klagenfurt.

The 1990s also saw an international effort in the investigation of non-parametric alternatives to the generalised linear models. For example, the backfitting algorithm, propagated in the book “Generalized Additive Models” by Hastie and Tibshirani (1990), was the first estimation method allowing to extend generalised linear models on the basis of linear smoothers. The properties of such estimators were studied in dependence of the type of smoother (kernel, spline, or local polynomials) by various authors, see for instance the discussion in the volume “Statistical Theory and Computational Aspects of Smoothing” by Härdle and Schimek (1996).

The profile of the Klagenfurt department developed strongly into the direction of engineering orientated Applied Statistics with a focus on Bayesian methods in spatial statistics. Typical applications are climate modelling, environmental statistics (including mapping of critical variables), and industrial statistics (such as automated defect classification). Certainly a highlight is the fact that the Kriging algorithm developed in Klagenfurt was implemented in the top-GIS software *Geostatistical Analyst*. Industry-sponsored research projects also made it possible to attract and retain excellent students at the department.

A further interest of the department may be seen in Statistics Education including investigations into comparative statistical inference, modelling as a genuine element of statistics, and the connections between probability and risk. These aspects, which all signify the genuine character of statistics, enhance its teaching.

Let us look at the future of the department with respect to the development of the discipline in general.

It is a reality that nearly all new technologies are not conceivable without the discipline of statistics and its achievements. The following list could be extended almost indefinitely:

- No mobile phones without statistics;
- No web services without statistics;
- No satellite monitoring without statistics;
- No biometric recognition without statistics;
- No smart technologies without statistics;
- No autonomous cars without statistics;
- No networked machines without statistics;
- No personalised medicine without statistics.

What are the common characteristics of all these high-tech applications? Primarily, the common features extend to

- Enormously big data-sets, often with a spatial and/or time component;
- Data streams in real time;
- High complexity but also weakly structured or unstructured data;
- High dimensionality; that means many more unknown parameters than observation units, or low dimensionality with seemingly indefinite observation units;
- Difficult separability of relevant information and noise.

Here, classical statistical paradigms are no longer appropriate. Undoubtedly, new methods for analysis are required. Yet fundamental statistical research has already laid the foundations upon which *Data Science* approaches may be established. Think of the smoothing methods of the 1990s but also of the large class of penalising procedures among many other achievements. Penalisation techniques as an example provide the tools to deal with data sparsity in matrix systems. Now, a combination of all these statistical achievements provides new perspectives for the analysis of highly complex data structures. To include such techniques into academic teaching will further future job opportunities for the students.

Now, let us discuss the current developments in the discipline:

Everyone is currently referring to *Big Data*. Not just a few decision-makers in politics, business, and science articulate the view that the challenges of the new technologies can only be met by a new discipline called *Data Science*. This raises the question of the contents of *Data Science*.

To answer this question, one may look at the topical anthology “*Handbook of Big Data*” edited by Peter Bühlmann (ETH Zürich) together with co-workers (Bühlmann et al., 2016). This book comprises the current status of *Big Data* and reflects the views of 34 authors who contributed to it. The disciplinary home of these authors gives rise to some insight. Regarding the academic disciplines of statistics, biostatistics, mathematics, and informatics (computer science), the result is as follows:

- Statistics: 15 authors
- Biostatistics: 8 authors
- Mathematics: 2 authors
- Informatics: 9 authors

All in all, 23 authors may be attributed to statistics departments. This yields a clear majority of nearly 70% of the 34 authors. Furthermore, in inspection of master and doctoral programmes in *Data Science* at US and Canadian research universities, which have played a pioneering role in the field, one notices again a strong dominance of statistics departments. At the University of California, Berkeley, for example, it is possible to graduate with a PhD in Statistics with the additional specification “with a Designated Emphasis in Computational Science and Engineering”, which subsumes all aspects of *Data Science*.

The main disciplinary foci of the subject area *Data Science* are the following:

1. Data retention and management (data bases)
2. Data-centric exploratory methods (overlap with the earlier Data Mining)
3. Development of efficient algorithms (numerics for enormously big data-sets)
4. Applied graph theory (theory of networks)
5. Model estimation (including variable selection)
6. Regularisation methods (penalising methods)
7. Inferential statistical methods (computer-age statistical inference)
8. Statistical learning (advancement of machine learning)
9. Targeted learning
10. Ensemble methods (e.g., divide and recombine)

Data management (1) is a preliminary achievement of informatics but not a specific task of *Data Science*.

Data-centred exploratory methods (2) are of interdisciplinary character.

The development of efficient algorithms (3) is primarily due to advancements of numerical mathematics.

For applied graph theory (4), there are substantial contributions from informatics as well as from statistics.

Model estimation (5) is a vested topic of statistics. The same applies to regularisation methods (6) and inferential statistical methods (7).

Machine learning has found a substantial advancement by statistical learning (8).

The recent approach of targeted learning (9) is a self-contained statistical development for causal inference by Mark van der Laan (University of California, Berkeley), which has a high potential for big and complex datasets.

For ensemble methods (10), there are both statistical and informatics research approaches.

Many of the research aspects that are listed above are treated extensively in the seminal book by Trevor Hastie, Robert Tibshirani and Jerome Friedman (all Stanford University) with the title “*The Elements of Statistical Learning. Data Mining, Inference, and Prediction*”. By the way, it seems to be the only statistics book that regularly finds its way to the bookshelves of computer scientists.

What can we learn from this list above? The predominant number of technical foci of *Data Science* relate to statistical fields of work. Many of these fields, such as model estimation or inferential methods are based on theoretical concepts that have proven their value in statistical data analysis for decades. Most of these methods are implemented in R and are open source.

It is crucial to note that *Big Data* is often associated with *Data Mining*, i.e., the exploration of data structures. However, in practice nearly always building of models and making of decisions is involved. Even a comparably simple task such as the customised advertising in the Internet requires models of features of typical users and consumers, respectively. We will be confronted with *Industry 4.0* in the near future. The information-based and communication-controlled industrial production is not thinkable without new methods to provide statistical inference in networks, to name one out of many future tasks.

To summarise, the discipline of statistics faces a promising future and its contribution to *Data Science* is much larger than it is usually communicated. To a considerable extent, *Big Data* is Applied Statistics of tomorrow. With appropriate resources and the specification of new tasks, the Department of Statistics at the Alpen-Adria-University in Klagenfurt should be able to shape this demanding future and contribute its share to a modern engineering education.

## References

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- Chambers, J. M. & Hastie, T. J. (Eds.) (1992). *Statistical Models in S*. Pacific Grove, CA: Wadsworth & Brooks/Cole.
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- van der Laan, M. J. & Rose, S. (2011). *Targeted learning. Causal Inference for observational and experimental data*. New York: Springer.

## **My Journey to the Centre of Statistics**

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*Lukas Sommeregger*, Student assistant at the Department of Statistics

My first encounter with statistics was during my time at the Gymnasium. There, we learned not only about a variety of probability distributions, but also about numerous practical applications of probability calculus and statistics. I did not come to realise until much later that this was not too common for school education at that time. It was probably then that my passion for statistics was firstly ignited.

During my times searching for the “perfect” subject of study at university, it was a discussion about probability theory, which allowed me to remember the direction my heart truly lies in (“If your predecessor lost in a game of Russian Roulette, do you spin the chamber again, or do you keep it as it is?”). At that time, I was still studying business and law, something almost diametrically opposed to my current master studies of Technical Mathematics.

In retrospect, it is therefore no big surprise that I ended up working at the Department of Statistics. Already at the very beginning of my bachelor studies at the Alpen-Adria University, the senior students used to discuss about how interesting and practically relevant the subject of statistics is. This opinion was shared by many students – after all, even then, the majority of alumni were statisticians.

In my very first course relevant to the subject – Stochastik 1 – my background knowledge received a stable foundation. The practical exercises were a welcome breath of fresh air in my third, rather otherwise “dry” semester. This was mainly due to the interesting and funny nature of the exercises as well as the engagement of the two student assistants at that time – Johannes Winkler and Jasmin Wachter. Thank you both for your dedication in teaching and helping the students. I wish to highlight the lasting effect of the legendary lecture “Fun with Stochastics – On Your Way to being Pokémon Champion” in which Johannes Winkler taught about distributions and probabilities solely using examples from the game series “Pokémon” – much to the amusement of his listeners, including myself.

From then on, statistics and probability remained exciting for me. Often, I marvelled at the multitude of practical applications we learned about, which was something I was missing in several other parts of my studies at that time. Another thing I want to point out is that we enjoyed numerous guest professors who often gave interesting insights into their research fields, respective workplaces, and their everyday professional lives. Above all, the credit is due to Prof. Jürgen Pilz for his commitment in maintaining close contact with local business and industries providing opportunities for internships and projects for us students – even today!

At this point, I also want to express my gratitude towards the alumni that spoke at our series of colloquia called “Mathematik in der Praxis”, that we organised to provide students with insight into the conditions and challenges in real workplaces. The spectrum of presentations ranged from banks and industry to research institutions and well-known multinational companies. It certainly speaks for the department that the alumni were happy to agree to speak to new students and obviously enjoyed to meet again with familiar faces.

The atmosphere at the department is a pleasant one. Apparently, it happened that, for the oral examination, the examinee and the professor sat together for a cup of coffee and kept talking even long after the examination had finished.

All in all, I wish all members and colleagues at the Department of Statistics another 10 years of fruitful and pleasant collaboration so that we will have much to discuss when we will meet in 10 years to celebrate the next anniversary. I would like to thank all members for their engagement and dedication with respect to studies, teaching, and personal relations.

## Views and Aphorisms about Statistics

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“All models are wrong, but some of them are useful.”

George E. P. Box (1978)

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“Those who ignore statistics are condemned to reinvent it. Statistics is the science of learning from experience.”

Bradley Efron (2006)

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“Teach the students how, where and when to apply these models so that they become useful.”

Jürgen Pilz (2017)

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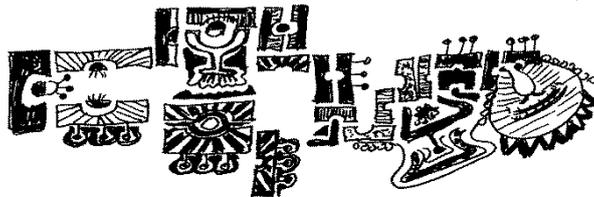
“Data science becomes the art of extracting labels out of thin air.”

Eran Malach & Shai Shalev-Shwartz (2017).

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“Statistics is the grammar of science.”

Karl Pearson (The title of his 1892 book was “The Grammar of Science”)



“To call in the statistician after the experiment is done may be no more than asking him to perform a post-mortem examination: he may be able to say what the experiment died of.”

Sir Ronald A. Fisher (Indian Statistical Congress, Sankhya, 1938)

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“Over time, any particular mechanical or procedural function can be expected to be taken over by software. So the biggest needs for every statistical cook, from the person who simply heats up TV dinners to the Michelin-star chef, are needs for conceptual understanding. We might encapsulate this as meaning trumps mechanics.”

Chris Wild (2017)

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“If your experiment needs statistics, you ought to have done a better experiment.”

Sir Ernest Rutherford (before 1952; at least ascribed to him).

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“I often get asked why people find probability so unintuitive and difficult. After years of research, I have concluded it’s because probability really is unintuitive and difficult.”

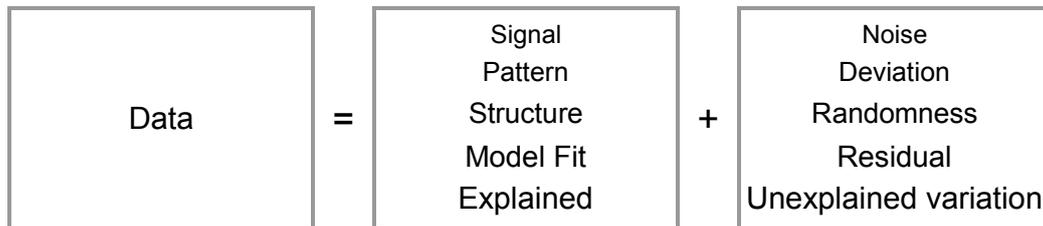
David Spiegelhalter (2014)

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“To his rhetoric question “What does probability *mean*?” David Spiegelhalter gives the following three descriptions of probability “Probability is a ‘Virtual’ number – not directly measurable; Probability does not exist; Any description is a metaphor.”

David Spiegelhalter (2014)

“A core concept of modeling statistical data is what Borovcnik (2005) calls the structural equation that represents data as decomposed into a signal to be recovered and noise.”



Different versions of Borovcnik’s structural equation

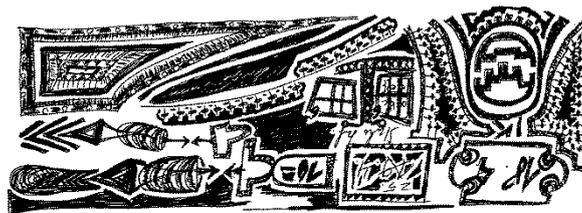
Joachim Engel (2008)

“Nobody wants data”, David Hand was widely quoted. “What they want are the answers.”

Tim Harford (2014)

“Data can tell lies. – Big Data can tell bigger lies. – The big thing for small data is random error. – The big thing for big data is bias.”

Chris Wild (2017)



“But even good, gold-standard data can tell us bad (misleading) things. The three major reasons that we worry about in which data can mislead us are: bias, random error and confounding. These, and what we try to do to overcome them, must therefore play a central role in statistical literacy. [...] Confounding is central for thinking about causal reasoning and inherently involves multivariate contexts. So all of this happens even under ideal conditions.”

Chris Wild (2017)

“We have seen that context information can have a large effect on people’s ability to use small probabilities in forming risk judgments. [...] It is also very useful for these contextual scenarios to be comparable to each other for people to get a sense of how differences in probability map onto differences in riskiness.”

Howard Kunreuther, Nathan Novemsky, and Daniel Kahneman (2000)

“I hope very much that pressure is not put on women to attend. The decision must be theirs, and a truthful account of the facts must be made available to the public and the individual patient. It will not be what they want to hear.”

M. Maureen Roberts, Clinical Director of the Edinburgh Breast Screening Cancer Project (1989)

“For events with small probabilities, relevant data is missing. [...] Screening schemes are usually applied to detect rare diseases. The smaller the probability, the less reliable the results of implementing the scheme.”

Borovcnik (2017)

## Research Groups at the Department of Statistics



### Applied Statistics

#### Key Research Areas

Statistical learning methods Bayesian Statistics.  
 Spatial Statistics.  
 Environmental Statistics.  
 Design of Experiments.  
 Bayesian Epidemiology.  
 Bayesian Machine Learning.

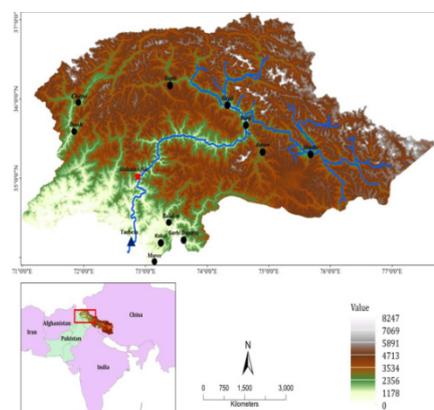
#### Selected Projects

Automatic classification of defectives on wafers (Infineon).  
 Risk assessment of drift deposition on soils after hand-held pesticide application in the Andean region (Colombia).  
 Snapshot spectral imaging for nano-medical applications (FFG Bridge).  
 Environmental surveillance and risk management (EU INTAMAP).  
 Reliability modelling for 300mm wafer technology (EU ENIAC-JU, EPT300).



#### Contact

Prof. Dr. Jürgen Pilz  
 Juergen.Pilz@aau.at



### Environmental Statistics and Risk Evaluation

#### Key Research Areas

Applied and Bayesian statistics.  
 Environmental monitoring networks.  
 Pollution dispersion modelling.  
 Environmental health risk analysis.  
 Stochastic differential equations.  
 Pattern recognition & AI.

#### Selected Projects

Pollution dispersion modelling –  
 HCB contamination of an Alpine valley:
 

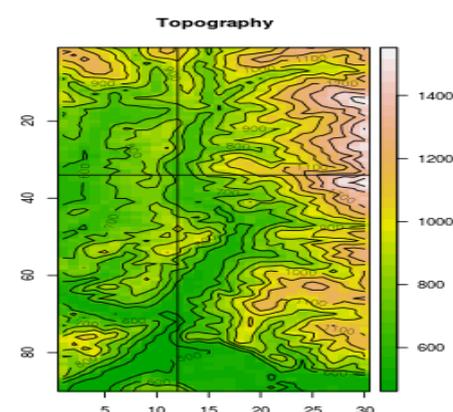
- Establishing a sensor network
- Analysis of blood and urine samples
- Analysis of spruce needles and soil

 Monitoring and alarm systems for elderly people.  
 Inspection of wafer back surfaces.



#### Contact

Prof. Dr. Gunter Spöck  
 Gunter.Spoeck@aau.at





## Statistics Education

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### Key Research Areas

Analysis of the Bayesian controversy in the foundations.  
A comparison between classical statistical inference and resampling.

Probability and risk literacy.

Research in the history and philosophy of probability.

Technology-enhanced learning.

### Selected Projects

A comparative study of statistical inference from an educational point of view.

Probability, risk, and decision making.

Risk in health: More information – more uncertainty.

Research process and probabilistic modelling – stochastic thinking.

Dynamic applets for teaching statistics.

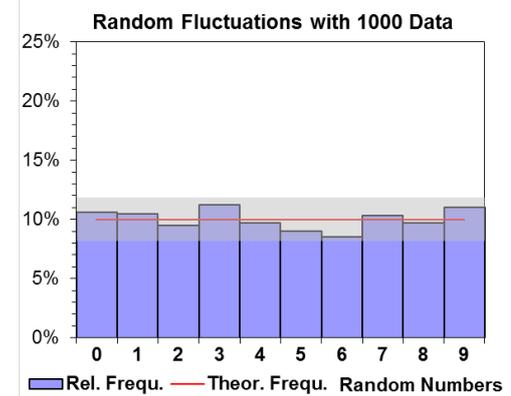
Key issues for courses in introductory statistics for non-mathematical studies.



### Contact

Prof. Dr. Manfred Borovcnik

Manfred.Borovcnik@aau.at



## Qualifications from Staff and Alumni



### Habilitations

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- 27.4.2015 Dr. Dr. *Vera Hofer* habitates at the AAU in the field „*Applied Statistics*“ (An-gewandte Statistik). Title of her habilitation thesis is “Predictive Analytics with Ap-plications in Business and Industry” (*Pilz*).
- 21.3.2014 Dr. *Hannes Kazianka* habitates at the AAU with his thesis “Bayesian Methods for Analyzing Spatial, Environmental and Image Data”. Nominal field of the venia do-cendi is “Statistik” (*Pilz*).
- 14.11.2011 Dr. *Gunter Spöck* habitates at the AAU. Title of his thesis is “The Application of Bayesian Statistics and Convex Design Methodologies to Geo-Statistical Prediction and Sampling Design”. Nominal field of the venia docendi is “Statistik” (*Pilz*).

### PhD Promotions from Staff and Project Staff

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- 27.7.2017 *Khan, Firdos*: Improved Hydrological Projections and Statistical Downscaling of Process-Based Climate Models for the Upper Indus Basin (*Pilz*).
- 18.6.2015 *Kurz, Daniel*: Advanced Statistical Models for Semiconductor Burn-in Studies (*Pilz*).
- 10.1.2013 *Mohsin, Muhammad*: A New Class of Distributions Generated from Functional Scale Parameters (*Pilz*).
- 8.4.2011 *Mulyk, Michael*: Application of Unsupervised Spectral Unmixing Techniques in Medical Imaging Processing (*Pilz*).
- 13.7.2010 *Hussain, Ijaz*: Spatio-Temporal Interpolation and Spatial Sampling Design for Pre-cipitation in Pakistan during Monsoon (*Pilz*).
- 20.8.2009 *Kazianka, Hannes*: Spatial Modeling and Interpolation Using Copulas. Promotio sub auspiciis praesidentis in March 2010 (*Pilz*).
- 31.3.2008 *Hofer, Vera*: Statistical Process Management in the Aggregates Industry. Promotio sub auspiciis praesidentis in May 2008 (*Pilz*).
- 26.1.2007 *Pluch, Philipp*: Theory for Quantum Probability: A Reformulation and an Applica-tion of Classical Stochastic Theory for Quantum Probability and Quantum Statistical Inference (*Pilz*).

## Promotions Sub Auspiciis Praesidentis 2007–2017

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### 2018 Cand. Prom. Sub Auspiciis

*Christian Niemetz: Statistical Design and Process Optimization – With Applications to the Decor Paper Printing Industry (Pilz).*

### 2009

*Kazianka, Hannes: Spatial Modeling and Interpolation Using Copulas. EU-FP6-IST Project “INTAMAP – Interoperability and Automated Mapping” (Pilz).*

*Promotion sub auspiciis praesidentis rei publicae of DI Hannes Kazianka in March 2010. The Ring of Honour of the Republic of Austria is handed over by the Austrian President Heinz Fischer.*



### 2007

*Hofer, Vera: Statistical Process Management in the Aggregates Industry. Part of the EUREKA-Project E!2536 PETROSCOPE (Pilz).*

*Promotion sub auspiciis praesidentis rei publicae of Dipl.-Ing. MMag. Dr. Vera Hofer in May 2008. The Ring of Honour of the Republic of Austria is handed over by the Austrian President Heinz Fischer.*



## Students Success 2007–2017

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24 PhD dissertations

39 Master's theses

See the list of alumni at the Department of Statistics 2007–2017, which provides also an overview on currently ongoing theses with titles and supervisors.

## PhD Theses

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Supervisor in brackets

### 2017

*Christian Niemetz*: Statistical Design and Process Optimization – With Applications to the Decor Paper Printing Industry (*Pilz*).

*Khan, Firdos*: Improved Hydrological Projections and Statistical Downscaling of Process-Based Climate Models for the Upper Indus Basin. Higher Education Commission HEC, Pakistan (*Pilz*).

### 2016

*Zernig, Anja*: Device Level Maverick Screening. Cooperation with KAI Villach (*Pilz*).

### 2015

*Kurz, Daniel*: Advanced Statistical Models for Semiconductor Burn-in Studies. ENIAC-JU-FP7-Project „EPT300 – Enabling Power Technologies for 300mm Wafers” (*Pilz*).

*Plankensteiner, Kathrin*: Application of Bayesian Networks Bayesian and Stochastic Models to Predict Smart Power Switch Lifetime. Cooperation with KAI Villach (*Pilz*).

*Arnold, Thomas*: Multivariate Analysis of Hyperspectral Image Data from Human Soft Tissue Tumours. Cooperation with CTR Villach (*Pilz*).

*Engert-Oostingh, Ingo*: Ein genetisch orientierter Lehrgang zur Wahrscheinlichkeitsrechnung. Co-supervised with Prof. K. Fuchs, Univ. Salzburg (*Borovcnik*).

### 2013

*König, Sandra*: Stochastic Analysis of Security and Capacity of a Quantum Network (*Pilz*).

*Mohsin, Muhammad*: A New Class of Distributions Generated from Functional Scale Parameters. Higher Education Commission HEC, Pakistan (*Pilz*).

### 2012

*Griedl, Dominik*: Portfolio-Optimierung mit alternativen Anlageklassen. Project with Griedl GmbH & Co KG (*Pilz*).

*Al Machot, Fadi*: A Robust Event Detection under Uncertainty in Video/Audio Surveillance Systems. Co-supervised with Prof. K. Kyamakya, AAU Klagenfurt (*Kyamakya/Pilz*).

### 2011

*Bluder, Olivia*: Prediction of Smart Power Device Lifetime Based on Bayesian Modeling. Cooperation with KAI Villach, Competence Center for Industrial and Automotive Applications (*Pilz*).

*Mulyk, Michael*: Application of Unsupervised Spectral Unmixing Techniques in Medical Imaging Processing. Cooperation with CTR Villach, Carinthian Tech Research, COMET I Programme, “Snapshot Imaging” Project (*Pilz*).

### 2010

*Poetsch, Laura*: Early Failure Detection by Robust Statistics and Spatial Point Processes. Cooperation with Infineon Villach (*Pilz*).

*Hussain, Ijaz*: Spatio-Temporal Interpolation and Spatial Sampling Design for Precipitation in Pakistan during Monsoon. Higher Education Commission HEC, Pakistan (*Pilz*).

*Nkurunziza, Hermenegilde*: Spatio-Temporal Association between Malaria and Climate in Burundi. North-South Dialogue Programme, Austrian Academic Exchange Service, OEAD (*Pilz*).

**2009**

*Kazianka, Hannes*: Spatial Modeling and Interpolation Using Copulas. EU-FP6-IST Project “IN-TAMAP – Interoperability and Automated Mapping” (*Pilz*) (sub auspiciis).

*Rass, Stefan*: On Information-Theoretic Security: Contemporary Problems and Solutions. Co-supervised with Prof. Dr. P. Horster, AAU Klagenfurt (*Horster/Pilz*).

*Lewitschnig, Horst*: Stress Interaction Models. Cooperation with Infineon Villach (*Pilz*).

*Wakounig, Samo*: On weighted Estimation and Inference by Semi-parametric Methods of Survival Analysis. Co-supervised with Prof. M. Schemper, Med. Univ. Wien (*Borovenik*).

**2007**

*Hofer, Vera*: Statistical Process Management in the Aggregates Industry. Part of the EUREKA-Project E!2536 PETROSCOPE (*Pilz*) (sub auspiciis).

*Muringer, Sonja*: Advanced Process Control Based on Multivariate Control Charts and Dynamic Linear Models. Cooperation with Infineon Villach (*Pilz*).

*Kraiger, Björn*: Value at Risk – Bayesscher Zugang und Verifikation konkreter Probleme anhand von ausgewählten Monte-Carlo-Methoden. Cooperation with Pioneer Investment Vienna (*Pilz*).

*Pluch, Philipp*: Theory for Quantum Probability: A Reformulation and an Application of Classical Stochastic Theory for Quantum Probability and Quantum Statistical Inference. EU-FP6-IST Project “SECOQC – Secure Communication in Quantum Cryptography” (*Pilz*).

## Diploma and Master's Theses

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### 2017

*Alagić, Dženana*: A Statistical Measure for Fatigue Induced Degradation in Metal Layers (*Pilz*).

*Alagić, Vedo*: Test Pattern Extraction for Semiconductor Wafer Test Data (*Pilz*).

### 2016

*Polzer, David Philipp*: Development and Enhancement of a Virtual Metrology Configuration and Implementation of Random Forests (*Pilz*).

*Schranner, Stefan*: Optimal Bayesian Experimental Design for Crossover Semiconductor Lifetime Studies (*Pilz*).

*Weinberger, Christoph Walter*: Rating-Systeme – Ein statistischer Zugang (*Borovcnik*).

*Juritsch-Beyer, Andrea-Sybille*: Logistische Regressionsmodelle und ihre Anwendung in der medizinischen Statistik (*Stettner*).

*Scherr, Petra*: Modelling – A Key to Understand Random Situations (*Borovcnik*).

*Jury, Marina*: Qualität von Verfahren zur Schadenreservierung (*Pilz*).

*Maier, Tanja*: Räumliche statistische Analyse und Messnetzplanung für HCB- und Hg-Daten aus dem Görtschitztal (*Spöck*).

*Mitsch, Christian*: Box-Jenkins- und Zustandsraummodelle zur Prognoseentwicklung von multivariaten Zeitreihen in R (*Pilz*).

### 2015

*Vollert, Natalie*: Application and Verification of Advanced Design of Computer Experiment Approaches for Fundamental Semiconductor Structures (*Pilz*).

*Kofler, Corinna*: Automatic Defect Classification in Topography Images of Silicon Wafers (*Spöck/Pilz*).

### 2014

*Schuster, Josef Kurt*: Statistical Evaluation of Funds Using R (*Pilz*).

*Wieser, Thomas Florian*: Autonomous Task Selection of Unmanned Aerial Vehicles for Delivery of Goods: Partitioning versus Non-partitioning Policies (*Spöck*).

*Živadinović, Milan*: Multivariate Datenanalyse von hyperspektralen Bilddaten (*Spöck*).

*Graf, Thomas*: Vine Copulas und deren Anwendung in der Finanzmathematik (*Spöck*).

*Krassnitzer, Karl Patrick*: Modellierung des claims development result mittels dynamischer linearer Modelle (*Pilz*).

*Lembacher, Andreas*: Data Mining for Financial Risk Management (*Spöck*).

*Lenzi, David*: Optimal Prediction and DoE of Correlated and Uncertain Data (*Pilz*).

*Aichern, Michael*: Optimal Experimental Designs for Generalized Linear Models (*Pilz*).

### 2013

*Zernig, Anja*: Optimal Design of Experiments for Semiconductor Data following a Mixtures-of-Experts Model (*Spöck*).

## 2012

*Krabber, Silke*: Anwendung der Zeitreihenanalyse und Dynamischer Linearer Modelle in Statistics and Finance (*Pilz*).

*Kurz, Daniel*: On a Sampling Decision System using Virtual Metrology (*Pilz*).

*Mößbacher, Christian*: Random Numbers – Sequences Based on Linear Feedback (*Borovcnik*).

## 2011

*Stueckler, Peter*: Modellierung stochastisch abhängiger Prozesse und Extremereignisse durch multivariate Zeitreihen und Copulas (*Pilz*).

*Binter, Andreas*: Modellierung stochastischer Cash-Flows (*Pilz*).

*Grün, Petra Sara*: Die Anwendung von Generalisierten Linearen Gemischten Modellen in der Tourismusbranche (*Pilz*).

*Plankensteiner, Kathrin*: Application of Bayesian Models to Predict Smart Power Switch Lifetime (*Pilz*).

## 2010

*Lessiak, Katharina*: Application of Generalized Linear (Mixed) Models and Nonparametric Regression Models for the Analysis of QKD Networks 2010 (*Pilz*).

## 2009

*Fu-Müller, Lisha*: Wavelet Analysis (*Pilz*).

*Mulyk, Michael*: Application of Generalized Poisson Regression Models to the Prediction of Tourist Income (*Pilz*).

*Niemetz, Christian Thomas*: Markov Random Fields in Image Processing – A Practical View on Texture Generation and the Restoration of Images (*Pilz*).

## 2008

*Hubmann, Lisa Anna*: Predictive Modelling for Virtual Testing in the Aggregates Industry (*Pilz*).

*Bluder, Olivia Belinda*: Statistical Analysis of Smart Power Switch Life Test Results (*Pilz*).

*Krierer, Peter*: Modelle zur Bewertung von Kreditrisiken und Kreditderivaten (*Pilz*).

## 2007

*Mirnig, Ines*: Zeitreihenanalyse mit R (*Pilz*).

*Kazianka, Hannes*: Classification Techniques for Hyper-Spectral Medical Image Data (*Pilz*).

*Poetsch, Laura*: Stochastic Assessment of Burn-In at Infineon Technologies Austria AG (*Pilz*).

*Piechl, Claudia*: Measurement Data Analysis – Method to detect Drift on Device Level (*Pilz*).

*Hassler, Martin*: Optimierung der V-Streuung einer speziellen Technologie anhand statistischer Modellbildung (*Pilz*).

### PhD Theses Currently under Supervision – 1.12.2017

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*Kofler, Corinna*: Automatic Defect Classification: Wafer Back Surface of Structured Thin Wafer (Spöck)

*Maier, Tanja*: Modelling of Person Behaviour through Machine Learning and Markov Chains: Individualized Response System for Independently Living Elderly People (Spöck)

*Riazy, Shirin*: Automatic Sleep-Staging of Two-Channel EEG Measurements (Pilz)

*Spyroglou, Ioannis*: Prediction of Asthma in Children. Jointly with Democritus University of Thrace (Spöck)

*Vollert, Natalie*: Optimization of Arbitrary Parameters in FE Simulations Based on Adapted Treed Gaussian Process Models (Pilz)

### Master's Theses Currently under Supervision – 1.12.2017

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*Arbeiter, Maximilian*: Modellierung von Schadstoffdispersion anhand eines dynamischen Discountingmodells und eines stochastischen Partikelmodells (Spöck)

*Mache, Tamina*: Sensitivity Analysis and Design of Spectrum Analyzers (Pilz)

*Petschnigg, Christina*: Penalized and Sparse Bayesian Regression Estimation for Machine Learning (Pilz)

*Pleschberger, Martin*: Runtime Optimization and Visualization for Automated Pattern Analysis (Pilz)

*Posch, Konstantin*: Hyperspectral deep learning for fruit and vegetable recognition and Bayesian Deep Learning to accurately determine model uncertainty (Pilz)

*Scheiber, Michael*: Advanced spatio-temporal prediction methods for pesticide dispersion and turbulence data (Pilz)

*Šiko, Mitar*: Online Kernel Regression (Pilz)

*Unterweger, Romana Regina*: Development of a controller using a Bayesian dynamic linear filtering approach (Pilz)

*Wachter, Jasmin*: Novel methods for robust location estimation in the presence of large outlier populations (Pilz)

*Wedenig, Philipp*: Feature extraction methods to detect damage patterns in microstructure images (Pilz)

Supervisor in brackets

## Positions of Our Alumni 2007–2017

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A selection of companies where our alumni work in higher positions:

### **Banking System and Financial Industries**

Österreichische Nationalbank (ÖNB), Wien.

Deutsche Bank, Frankfurt.

Kärntner Sparkasse, Klagenfurt.

Bank für Kärnten und Steiermark (BKS), Klagenfurt.

Erste Bank, Wien.

Kärntner Landesversicherung (KLV), Klagenfurt.

Wüstenrot, Salzburg.

Mountain View Data, Diex.

### **University-Near Research Institutions**

University of Graz, Graz.

Joanneum Research, Graz.

### **Industries**

OMV Group (formerly Österreichische Mineralölverwaltung AG), London.

Deutschland Card, München.

Infineon Technologies Austria: Semiconductor & System Solutions, Villach.

Flex, formerly Flextronics International Ltd., Singapore.

AVL List, Graz.

KAI Kompetenzzentrum Automobil- und Industrieelektronik GmbH, Competence Center, Villach.

Carinthian Tech Research (CTR), Villach.

IPAC Improve Process Analytics and Control GmbH, Villach.

Treibacher Chemische Werke, Althofen.

Kärntner Elektrizitäts-Landesaktiengesellschaft (KELAG AG), Klagenfurt.

SAPP Management AG (Pulp and Paper Production), Klagenfurt.

## Essential Projects at the Department of Statistics 2007–2017



### Overview

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One focus of the research and developments at the Department of Statistics in Applied Statistics is on Bayesian spatial statistics and Bayesian Kriging models. The investigations led to improvements of algorithms, which are implemented; the Klagenfurt ideas have been revised, improved, or included as they are in several packages of international relevance. The most important is the GIS software Geo-statistical Analyst. The other interests span from quantum cryptography, wavelets for classification problems, to industrial statistics (automatic classification of defects, early lifetime failures, or burn-in strategies).

The research area of Environmental Statistics and Risk Evaluation has become a vital research topic of the department in the last years. This includes climate modelling, environmental statistics and risk evaluation. The investigations include the planning of optimal sampling designs, the collection of data, and the mapping of relevant environmental variables.

The research area Biometry and Statistics in Medicine accompanies medical research from the planning of studies, the modelling and analysis of the data, until the interpretation and publication of the results. This area also includes considerations on Public Health such as the evaluation of risks in health issues.

In Statistics Education, the interests and approaches are similarly multi-faceted: Based on an analysis of the Bayesian controversy in the foundations, there are investigations on a comparative study of methods for statistical inference (which has been awarded a late-breaking session at the World Statistics Congress in Hong Kong 2014), modelling as a construction principle for statistics curricula, historical studies of the emergence of stochastic concepts, investigations of conceptual links between probability and risk (and how these links may be used for education). Not least are to mention our endeavours to integrate e-learning elements and dynamic applets for learning key concepts into the academic teaching.

### Projects in Applied Statistics

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#### **Automatic Defect Classification on Wafers (ADCW): Back Surface of Structured Thin Wafer**

*Project partners / grant:* Infineon, Villach.

The project's goal is the development of mathematical-statistical methods for the automatic classification of defects on the back surface of structured thin wafers. The algorithms are implemented in Matlab.

*Further information:* See the session "Various Modeling Approaches in Semiconductor Manufacturing" of the Winter Simulation Conference 2017, Las Vegas, [ssl.linklings.net/conferences/wsc/wsc2017\\_program/views/at\\_a\\_glance.html](http://ssl.linklings.net/conferences/wsc/wsc2017_program/views/at_a_glance.html).

*Keywords:* Classification, Pattern recognition, Machine learning.

*Project lead:* Jürgen Pilz, Gunter Spöck.

*Project staff:* PhD project Corinna Kofler.

*Project term:* Jan 2016 – Dec 2018.

### **Optimization and Surrogate Modelling for Multiphysics Systems**

*Project partners / grant:* Carinthian Tech Research (CTR), Villach.

For modelling the spatio-temporal dynamics and optimizing geometrical structural parameters of multiphysics systems it is essential to find accurate and computationally fast surrogate models according to some chosen cost function. E.g., for linear position detection systems, a major focus of interest lies in obtaining the ideal size of a cylindrical magnet. The structure of this cost function adds much complexity since it is very sensitive to noise in the training data. In the course of the project, Gaussian and Additive Gaussian Process models have been developed, and the performance of these models has been analysed in more detail for training data with different noise levels. The methods were shown to compensate different noise levels very well. This feature is of special interest for expensive simulation studies as it enables a trade-off between computing time and quality of the simulation data.

*Further information:* [www.ctr.at/fe-kompetenz/microsystem-technologies/](http://www.ctr.at/fe-kompetenz/microsystem-technologies/), [www.ctr.at/fe-zentrum/ctr-mitarbeiterinnen/](http://www.ctr.at/fe-zentrum/ctr-mitarbeiterinnen/).

*Keywords:* Design of computer experiments, Surrogate modelling, MARS, BART, Functional Anova.

*Project lead:* Jürgen Pilz.

*Project staff:* PhD project Natalie Vollert.

*Project term:* Apr 2015 – March 2018.

### **Enabling Power Technologies for 300mm Wafers (EXBI) – Extended Burn-In Strategies**

*Project partners / grant:* ENIAC-JU-FP7-Project EPT300. Coordinator: Infineon Technologies, Neubiberg.

The project's goal was to develop burn-in strategies and investigate methods for the optimal determination of the lifetime distribution of early failures in the semiconductor industries.

*Keywords:* Optimal design of experiments, Bayes statistics, Reliability, Burn-in.

*Project lead:* Jürgen Pilz.

*Project staff:* Post-Doc Project Daniel Kurz.

*Project term:* Jul 2015 – Jun 2017.

### **Modelling – Simulation – Optimization (MSO) of Discrete, Continuous, and Stochastic Systems**

*Project partners / grant:* The Doctorial Programme MSO is supported by the Karl-Popper-Kolleg of the AAU Klagenfurt.

Mathematical models of systems, e.g., in modern Information Technology, quite often exhibit discrete and continuous aspects as well as their interaction. This concerns the modelling of time in dynamical systems either as a continuum or a finite/countable number of instances when observations are taken or when control acts, and strongly influences the analysis of the qualitative behaviour of such systems as well as their design via continuous or combinatorial optimisation methods. Moreover, robustness with respect to uncertainty caused by noise or perturbations is a crucial issue in such systems and needs stochastic modelling as well as estimation, prediction and model validation. The rigorous and efficient treatment of these problems requires knowledge from a wide range of mathematical fields.

*Further information:* [www.math.aau.at/mso/](http://www.math.aau.at/mso/).

*Keywords:* Numerical and qualitative analysis of dynamical systems, Nonlinear and combinatorial optimization, Extremal discrete structures, Statistical data analysis, Bayesian spatio-temporal prediction, Inverse problems.

*Project lead:* Barbara Kaltenbacher, Clemens Heuberger, Jürgen Pilz, Christian Pötzsche, Franz Rendl.

*Project staff:* PhD project Natalie Vollert and Post-Doc project Daniel Kurz (July 2015 – June 2017).

*Project term:* Oct 2014 – May 2018.

### **Enabling Power Technologies for 300 mm Wafers (EPT300) – Innovative Methods for Early Failure Modelling**

*Project partners / grant:* ENIAC-JU-FP7-Project EPT300. The project included 22 industrial partners (Infineon, LAM Research, Philips, AMS, SILTRONICS, etc.) and university research partners (TU Dresden, TU Eindhoven, Alpen-Adria-University Klagenfurt).

Goal of the project was to develop statistical methods for the process control of the new wafer technology for the production of chips for use in car and industry electronics. With the results of this project, European semiconductor manufacturing and equipment and materials industries will be first in the world with a 300 mm power semiconductor processing line dedicated to power-device production. AAU's responsibility in the project is reliability modelling with an emphasis on sequential burn-in strategies for pilot series. Several publications in well-ranked journals (e.g., IEEE) came out of this project.



*Further information:* [www.ept300.eu/](http://www.ept300.eu/).

*Keywords:* Weibull failure models, Bayes predictive modelling.

*Project lead:* Jürgen Pilz.

*Project staff:* PhD project Daniel Kurz.

*Project term:* Apr 2012 – Sep 2015.

### **Unique Word Orthogonal Frequency Division Multiplexing (UW-OFDM)**

*Project partners / grant:* D-A-CH project (FWF) with the following partners: Embedded Systems and Signal Processing, AAU (Prof. Huemer, Dr. Lunglmayr), Spatial Statistics Group, AAU (Prof. Pilz), Mobile Radio Communications, University Erlangen-Nürnberg (Prof. Huber).

The project's goal was to investigate the new Unique Word Orthogonal Frequency Division Multiplexing (UW-OFDM) procedure, which has been developed to improve the wide-spread Orthogonal Frequency Division Multiplexing (OFDM) method of transmitting information. OFDM is, e.g., applied in the wireless LAN system and will be used also in the future standard of mobile radio communications LTE (Long Term Evolution).

*Keywords:* Mobil radio network, Orthogonal frequency division multiplexing, Transmitting power.

*Project lead:* Jürgen Pilz, Mario Huemer.

*Project staff:* PhD project Alexander Onitz.

*Project term:* May 2011 – Apr 2014.

### **A New Class of Distributions Generated from Functional Scale Parameters**

*Project partners / grant:* Higher Education Commission (HEC), Pakistan.

In this project, a new class of bivariate distributions has been generated from a functional scale parameter. A scale parameter generally expresses the variability of a distribution. The new bivariate distribution is created by compounding two standard distributions, considering one of them to include a functional scale parameter. We used three standard distributions, i.e., Gamma, Exponential and Pareto distributions, to generate new families of bivariate distributions and applied them in hydrology, ecology and environmental sciences quite successfully.

*Further information:* [scholar.google.com/citations?user=rjVVF74AAAAJ&hl=en](https://scholar.google.com/citations?user=rjVVF74AAAAJ&hl=en).

*Keywords:* Copula and metadistribution modelling, bivariate exponential distribution.

*Project lead:* Jürgen Pilz.

*Project staff:* PhD project Muhammad Mohsin.

*Project term:* Nov 2009 – April 2013.

### **Optimisation of Portfolios with Alternative Classes of Assets**

*Project partners / grant:* Griedl GmbH & Co KG.

Goal of the project was the development of alternative risk measures for portfolios with non-Gaussian distributed return rates of the constituents. In particular, Bayesian alternatives were taken into account. The results have been empirically validated not only for stock return rates but also for less conventional assets such as hedge funds, private equity funds and real estate funds.

*Further information:* [www.aau.at/en/statistics/alumni/](http://www.aau.at/en/statistics/alumni/).

*Keywords:* Expected shortfall, Multivariate density estimation, Portfolio allocation, efficient frontiers.

*Project lead:* Jürgen Pilz.

*Project staff:* PhD project Dominik Griedl.

*Project term:* Aug 2008 – Mar 2012.

### **Snapshot Spectral Imaging for Nano-Medical Applications**

*Project partners / grant:* COMET I Programme, “Snapshot Imaging”, FFG Bridge, Tissue Gnostics (Wien); the coordination of the project is organised by Carinthian Tech Research (CTR), Villach.

In contrast to classical sequential spectral imaging (SI) scanning procedures, snapshot spectral imaging allows for the compilation of spatial and spectral information by a single image. Aim of the project was the development of statistical methods and algorithms for the separation of overlapping emission spectra (spectral unmixing), especially for multi-channel applications. The results have been applied for procedures in diagnosing prostate cancer.

*Further information:* [www.tandfonline.com/doi/full/10.1080/02664763.2010.529879](http://www.tandfonline.com/doi/full/10.1080/02664763.2010.529879).

*Keywords:* Spectral imaging, Spectral unmixing, Statistical classification, Compositional Models.

*Project lead:* Jürgen Pilz.

*Project staff:* PhD project Michael Mulyk.

*Project term:* Feb 2009 – Mar 2013.

### **Petroscope II – Statistical Process Management in the Aggregates Industry**

*Project partners / grant:* Eureka Project E! 3665. The project includes partners from Iceland (lead contractor: Petromodel Iceland Ltd.), Italy, Austria, and Spain.

The overall aim of the PETROSCOPE II project was to develop an optoelectronic measurement equipment, Petroscope R, and related modelling and simulation software, for the construction aggregates industry, i.e., quarries, asphalt and concrete producers, testing agencies, etc. The equipment and software are designed for measuring the fundamental properties – size, shape and composition – and for modelling the engineering and performance properties such as abrasive resistance, strength and bulk density and to simulate the packing of sand, gravel and crushed rock particles in concrete and other added value composite materials and structures made thereof.

*Further information:* [www.eurekanetwork.org/project/id/3665](http://www.eurekanetwork.org/project/id/3665).

*Keywords:* Statistical classification, Spectral imaging, Image processing, Generalised linear models.

*Project lead:* Jürgen Pilz.

*Project staff:* Vera Hofer, Lisa Hubmann.

*Project term:* Jul 2008 – Jun 2010.

### **Intelligent Customer Relationship Management (CRM) for Business-to-Business Applications**

*Project partners / grant:* Customer Experts Consulting GmbH Graz

Goal of the project was the statistical modelling of market potentials of logistics and machine building companies and implementation of the models in R.

*Further information:* [www.customer-experts.com/de/branchenfokus/beispiel3.php](http://www.customer-experts.com/de/branchenfokus/beispiel3.php).

*Keywords:* Market potential, Generalised linear models, Logistic link function.

*Project lead:* Jürgen Pilz.

*Project staff:* Yogesh Trivedi, Indian Institute of Technology Kharagpur.

*Project term:* May 2005 – Apr 2007.

### **Petroscope – Statistical Process Management in the Aggregates Industry**

*Project partners / grant:* Eureka Project E!2569. The project includes partners from Iceland (lead contractor: Petromodel Iceland Ltd.), Slovenia, Austria, and UK.

Goal of the project was the development of a software package for modelling the performance of aggregates and concrete. The project led to European patent No. 7440. It also led to the promotion sub auspiciis of Vera Hofer with the thesis: Statistical Process Management in the Aggregates Industry.

*Further information:* [www.eurekanetwork.org/project/id/2569](http://www.eurekanetwork.org/project/id/2569).

*Keywords:* Spectral curves classification, wavelet modelling, Support vector machines.

*Project lead:* Jürgen Pilz.

*Project staff:* PhD project Vera Hofer (sub auspiciis).

*Project term:* Jan 2004 – Jun 2008.

### **TechModel Software**

*Project partners / grant:* Petromodel Iceland Ltd.

Goal of the project was the development of a statistical software suite for modelling and analysis of aggregates to be used in the road construction industry.

*Further information:* [www.petromodel.is/petroscope-3d-sizeshape-development](http://www.petromodel.is/petroscope-3d-sizeshape-development).

*Keywords:* Regression modelling, Aggregates classification, Design of experiments.

*Project lead:* Jürgen Pilz.

*Project staff:* Robert Breitenacker, Lisa Hubmann.

*Project term:* Apr 2002 – Jun 2008.



### **Secure Communication in Quantum Cryptography (SECOQC) – Development of a Global Network**

*Project partners / grant:* Integrated EU-FP6-IST project with 41 partners.



The vision of SECOQC was to provide European citizens, companies and institutions with a tool that allows facing the threats of future interception technologies. The project's results provide the basis for a high-security communication network that combines the technology of quantum key distribution with components of classical computer science and cryptography. They use quantum cryptography to build an instrument that can be operated in an economic environment. The scientific and technological developments during the last decade have created a stable foundation for this project, which has contributed essential progress to the still open tasks and research issues.

*Further information:* [www.secoqc.net](http://www.secoqc.net).

*Keywords:* Quantum information, Quantum cryptography, Quantum statistics.

*Project lead:* Jürgen Pilz.

*Project staff:* PhD project: Philipp Pluch.

*Project term:* Apr 2004 – Oct 2008.

## **Projects in Environmental Statistics and Risk Evaluation**

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### **Pollution Dispersion Modelling – HCB and Heavy Metals Contamination of an Alpine valley: Part I: Establishing a Sensor Network. Part II: Blood and Urine. Part III: Spruce Needles and Soil**

*Project partners / grant:* Initiative Zukunft Görtschitztal, Initiative Rettet das Görtschitztal.

The project investigates soil and health data after a huge local emission of HCB. Samples of soil are investigated for levels of contamination of HCB and Hg; analogously, spruce needles are sampled. A model for dispersion of the contamination is developed, based on a Lagrange Particle Model and the Gaussian Plume Model. Furthermore, the level of contamination of HCB and heavy metals in the urine of children is examined.

*Keywords:* Pollutant dispersion, HCB, Hg, Spatial interpolation, Heavy metals in urine samples.

*Project lead:* Gunter Spöck.

*Project staff:* Master's project of Maximilian Arbeiter; Master's Project of Tanja Maier.

*Project term:* Jan 2015 – Dec 2020.

### **Monitoring and Alarm Systems for Elderly People**

*Project partners / grant:* P.SYS, Villach.

“Detect and connect”. Based on methods of machine learning and Markov decision processes, we model the behaviour of elderly people and investigate the possibilities to detect change-points in their behaviour automatically, which indicate the presence of an “accident“. Goal of the project is the selection of relevant variables, which should be chosen to monitor elderly people from a remote control point. And to intervene on-site in such cases that are identified as accidents.

*Further information:* [www.psyesengineering.com/care.htm](http://www.psyesengineering.com/care.htm).

*Keywords:* Elderly people, Markov chains, Change-point detection, Control theory.

*Project lead:* Bart Scholte van Mast, Gunter Spöck.

*Project staff:* PhD project of Tanja Maier and Maximilian Arbeiter.

*Project term:* Jan 2017 – Dec 2020.

### **Prediction of Asthma in Children**

*Project partners / grant:* Democritus University of Thrace.

New classification and regression methods for the detection of asthma in children are investigated. With various methods of regression and classification, the procedure of selecting the most relevant variables is the key issue. The project investigates the efficiency of such selection procedures for the case of asthma of children.

*Further information:* Spyroglou, I., Spöck, G., et al. (2018) “A Bayesian logistic regression approach in asthma persistence prediction” to appear in *Epidemiology, Biostatistics and Public Health*, [ebph.it/](http://ebph.it/).

*Keywords:* Generalised linear models (GLM), Logistic regression, Classification, Bayesian networks.

*Project lead:* Ioannis Spyroglou, Gunter Spöck.

*Project term:* Nov 2016 – Dec 2020.

### **Modelling of Turbulence Data**

*Project partners/grant:* Lincoln University of Christchurch, NZ.

*Further information:*

[www.researchgate.net/publication/27814669\\_Unstable\\_equilibrium\\_modelling\\_waves\\_and\\_turbulence\\_in\\_water\\_flow](http://www.researchgate.net/publication/27814669_Unstable_equilibrium_modelling_waves_and_turbulence_in_water_flow).

*Keywords:* Karhunen-Loève expansions, Spatio-temporal covariance function modelling, Velocimetry.

*Project lead:* Jürgen Pilz, Robert Connell.

*Project staff:* Michael Scheiber (Master's Thesis).

*Project term:* Nov 2016 – Mar 2018.

### **Drift Deposition on Soil after Hand-Held Pesticide Application: Risk Assessment and Sampling Effectiveness**

*Project partners / grant:* Andean Region (Colombia).

The project investigated the proper use of statistical tools to assess risk of drift deposition on soil after hand-held pesticide application in the Andean region (Colombia). A further aim was to investigate effective sampling for drift deposition to improve the quality of the data.

*Further information:* [meetingorganizer.copernicus.org/EGU2017/EGU2017-13729.pdf](http://meetingorganizer.copernicus.org/EGU2017/EGU2017-13729.pdf).

*Keywords:* Spatial Interpolation, Drift, Pesticide, Sampling Effectiveness.

*Project lead:* Jürgen Pilz, Glenda Garcia-Santos.

*Project staff:* Martin Pleschberger and Michael Scheiber (Master's Thesis).

*Project term:* Mar 2015 – Feb 2017.

### **Improved Hydrological Projections and Statistical Downscaling of Process-Based Climate Models for the Upper Indus Basin**

*Project partners / grant:* Higher Education Commission (HEC), Pakistan.

In this study, the future availability of water was projected for the Indus River under the A2, B2, RCP4.5 and RCP8.5 emission scenarios. A meta-analysis has been conducted to improve the projections by combining the results from the emission scenarios. Our meta-analysis provides higher confidence in RCPs projections. Furthermore, the results show that sufficient water will be available in the Indus River to meet the demand of Pakistan's agriculture and industry sectors in the next decades, with the exception of scarcity of water in only very few months under each scenario.

*Further information:* [onlinelibrary.wiley.com/doi/10.1111/wej.12237/abstract](http://onlinelibrary.wiley.com/doi/10.1111/wej.12237/abstract).

*Keywords:* Regional Climate Modelling, Meta-analysis, Bayesian time series, Spatial copulas.

*Project lead:* Jürgen Pilz.

*Project staff:* PhD project Firdos Khan.

*Project term:* Nov 2013 – Jul 2017.

### **Spatio-Temporal Interpolation and Spatial Sampling Design for Precipitation in Pakistan during Monsoon**

*Project partners / grant:* Higher Education Commission (HEC), Pakistan.

This project focused on three major objectives: identification of homogeneous climate regions in Pakistan, accurate space-time interpolation of precipitation during monsoon season and selection of optimal monitoring network sampling designs for interpolation of precipitation with and without external drift variables.

*Further information:*

[www.adv-geosci.net/25/97/2010/](http://www.adv-geosci.net/25/97/2010/), [www.inderscience.com/info/inarticle.php?artid=38369](http://www.inderscience.com/info/inarticle.php?artid=38369).

*Keywords:* Spatio-temporal geostatistics, Hierarchical clustering, Spatial sampling design.

*Project lead:* Jürgen Pilz.

*Project staff:* PhD project Ijaz Hussain.

*Project term:* 2010 –2013.

### **Interoperability and Automatic Mapping (INTAMAP) – Environmental Surveillance and Risk Management**

*Project partners / grant:* STREP-FP6 (IST)-Project. The project included partners from Austria, Germany, Netherlands, Italy, Great Britain, and Greece.

The main objective of this project was to develop an interoperable framework for real-time automatic mapping of critical environmental variables by extending spatial statistical methods and employing open, web-based data exchange and visualisation tools. To illustrate the potential of the framework at the European scale we applied the framework to produce a system for automatic mapping of radiation levels reported by 29 European countries that participate in the European Radiological Data Exchange Platform (EURDEP). In case of hazards and emergencies (e.g., pollution peaks, nuclear/radiological accidents, flash-floods), maps of environmental variables interpolated from monitoring network measurements are needed in real time with minimum or no human intervention to reflect the monitored situation. In particular when dealing with unforeseen events (hot spots or extreme values), environmental monitoring systems (EMS) usually lack adequate automatic mapping systems. Because spatial interpolation has an associated interpolation error, mapping systems must inform decision makers about the uncertainties associated with the interpolated maps, such as by means of probabilities that a critical threshold is exceeded over a certain geographic region. Combining these probabilities with population density yields a system for rapid assessment of exposed population at risk. This project addressed key issues of GMES and integrates the results in an INSPIRE compliant framework, based on open standards (OGC/Orchestra/OASIS) and web (feature) services.



*Further information:*

[www.researchgate.net/publication/41104498\\_INTAMAP\\_an\\_interoperable\\_automated\\_interpolation\\_web\\_service](http://www.researchgate.net/publication/41104498_INTAMAP_an_interoperable_automated_interpolation_web_service).

*Keywords:* Radiological monitoring, Spatial statistics.

*Project lead:* Jürgen Pilz.

*Project staff:* Start with Philipp Pluch as post-doc (now OMV, London) and then PhD project Hannes Kazianka (sub auspiciis).

*Project term:* Sep 2006 – Aug 2009.

## Projects in Biometrics and Statistics in Medicine

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### Risk in Health

Risk is a major factor in health, with a strong focus on minimising risk wherever possible. The mathematical starting point is probability. Reliable or relevant data is often missing or hard to get. Moreover, the results of studies are all too easily interpreted wrongly – even by medical experts. Usually it is seen as useful to have more information in making decisions.

The project should investigate the exemplar of breast cancer and screening systems in general: Which information is available to quantify the risk inherent in the procedure? What are the constituents for decisions? How do decisions differ by the role, a person resumes in the decision (the patient, the medical doctor, the ministry of health etc.)?

*Further information:*

[www.researchgate.net/publication/304119439\\_Risk\\_in\\_Health\\_More\\_Information\\_and\\_more\\_Uncertainty](http://www.researchgate.net/publication/304119439_Risk_in_Health_More_Information_and_more_Uncertainty)  
[www.researchgate.net/publication/267798899\\_Determinants\\_of\\_Decision-making\\_in\\_Risky\\_situations](http://www.researchgate.net/publication/267798899_Determinants_of_Decision-making_in_Risky_situations).

*Keywords:* Quality of information, Types of risk, Risk management, Personal preferences, Rational decision, Risk communication.

*Project lead:* Manfred Borovenik.

*Project staff:* Cooperation with Ramesh Kapadia.

*Project term:* Jul 2009 – ongoing.

### Efficiency of Palliative Care Training

*Project partners / grant:* Klinikum Klagenfurt.

To maintain physical performance and cognitive functions in the elderly, multimodal training programs (MTP) are used, which are based on physical training, physiotherapy procedures, psychological training, etc. To increase the efficiency of such programmes, it is suggested to apply a new variant of adaptation to interval normobaric hypoxia, interval hypoxic-hyperoxic training. A placebo-controlled randomised clinical trial is intended to check the success of this kind of training.

*Further information:* [link.springer.com/article/10.1134/S2079057017030031](http://link.springer.com/article/10.1134/S2079057017030031).

*Keywords:* Interval hypoxia-hyperoxy, Elderly patients, Cognitive functions, Physical endurance, Multimodal rehabilitation programs.

*Project lead:* Haro Stettner.

*Project staff:* Cooperation with Rudolf Likar.

*Project term:* Jan 2015 – Dec 2017.

### Optimisation of the Care of Patients in Carinthian Care Homes for Elderly People

*Project partners / grant:* Klinikum Klagenfurt.

Beyond the empirical evidence of the efficiency of multimodal training programs (MTP) – see the project Efficiency of Palliative Care Training – it is essential to optimise the conditions of physical training, physiotherapy procedures, psychological training, etc. This study should clarify the ways that sustainably improve physical performance and cognitive functions in the elderly.

*Further information:* [link.springer.com/article/10.1134/S2079057017030031](http://link.springer.com/article/10.1134/S2079057017030031).

*Keywords:* Interval hypoxia-hyperoxy, Elderly patients, Cognitive functions, Multimodal rehabilitation.

*Project lead:* Haro Stettner.

*Project staff:* Cooperation with Rudolf Likar.

*Project term:* Jan 2015 – Dec 2017.

### **Prophylaxis for Operations Close to the Hips**

*Project partners / grant:* Klinikum Klagenfurt.

This study investigated prognostic factors for the post-operative outcome of operations close to the hips. Analysed are the protocols of 116 patients (Oct 2014 – May 2015) from the clinical centres Klinikum Klagenfurt und KH Wolfsberg. Of specific significance for patients' survival and for the occurrence of DELIR (a kind of amnesia syndrome) are the ISAR (identification of seniors at risk) score and the MINICog. DELIR is measured by the Confusion Assessment Method (CAM). ISAR and Mini-Cog<sup>®</sup> are easily performed tests that yield a reliable classification for cognitive impairments; both tests are interrelated and have a relation to elder patients' outcome in various treatments. In this project, such a relation should be investigated for the case of operations close to the hips.

*Keywords:* Pain prophylaxis, Hips-near operations, DELIR, ISAR, MiniCog<sup>®</sup>.

*Project lead:* Haro Stettner.

*Project staff:* Cooperation with Rudolf Likar.

*Project term:* Jan 2015 – Jul 2017.

### **Hypoxic Preconditioning**

*Project partners / grant:* Klinikum Klagenfurt.

Intermittent hypoxic–hyperoxic training (IHHT) may complement a multimodal training intervention for improving cognitive function and exercise tolerance in geriatric patients. This assumption should be checked by a randomised controlled trial. The success of the programme will be measured by suitable tests for the cognitive function (Dementia-Detection Test and Sunderland Clock-Drawing Test). Additionally, the functional exercise capacity will be measured by a walk test.

*Further information:* [www.ncbi.nlm.nih.gov/pmc/articles/PMC5651371/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC5651371/).

*Keywords:* Medical statistics, Experimental biology, Intermittent hypoxia, Geriatric patients, Cognitive performance, Dementia, Exercise tolerance, Multimodal training.

*Project lead:* Haro Stettner.

*Project staff:* Cooperation with Rudolf Likar.

*Project term:* Jan 2014 – Dec 2017.

### **Optimisation of Sampling for the Inspection of Billing Schemes in Health Systems**

*Project partners / grant:* Kärntner Landesregierung; Kärntner Gebietskrankenkasse.

The official billing system in Austrian hospitals (Leistungsorientierte Krankenanstaltenfinanzierung, LKF) requires to collect a multitude of single data that overall contribute to the financing of the various health centres. The heterogeneity of the single data makes it difficult to impossible to examine the validity of the data. A sophisticated sampling scheme adapted to the specific characteristics of the cases should guarantee that the billing system captures the true costs effectively and in a valid manner.

*Keywords:* Medical statistics, Sampling plan, Subgroup sampling.

*Project lead:* Haro Stettner.

*Project term:* Jan 2014 – Dec 2017.

## Projects in Computational Statistics

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### **Interpolation packages akima, tripack and interp for R: Interpolation Algorithms Based on Triangulation of Scattered Data**

*Project partners / grant:* Roger Bivand, NHH Norwegian School of Economics.

Based on the work of H. Akima and R. Renka, triangulation and linear and spline interpolation of irregular gridded data is implemented as Fortran code in two R packages (akima and tripack). The aim of this project is to re-implement these ideas using modern techniques such as Rcpp and the Eigen matrix library. Finally, code under a free license will be produced and distributed as R package (interp). As a side effect, a two-dimensional kernel regression has been implemented, which provides an estimation of partial derivatives of irregularly gridded data.

*Further information:* [www.user2017.brussels/uploads/bivand\\_gebhardt\\_user17\\_a0.pdf](http://www.user2017.brussels/uploads/bivand_gebhardt_user17_a0.pdf); [link.springer.com/article/10.1007/PL00011460](https://link.springer.com/article/10.1007/PL00011460).

*Keywords:* Interpolation, Triangulation, Splines.

*Project lead:* Albrecht Gebhardt.

*Project staff:* Albrecht Gebhardt, Roger Bivand, Maximilian Arbeiter.

*Project term:* 1998 – 2018.

### **GPUoct: Octave Library Implementing Matrix Operations via CUDA / Simulation of Dispersion**

*Project partners / grant:* Initiative Zukunft Görtschitztal.

The aim of this project is the implementation of CUDA-based matrix operations in Octave in a way similar to GPUmat for Matlab. It uses a CuBLAS as a parallelised replacement for several matrix sub-routines and covers single, double and sparse matrix types. The second part of this project deals with the implementation of GPU capabilities in octave and its usage for the analysis of pollutant dispersion.

*Further information:* [www.osg.or.at/download/files/%7B4BAB660F-5F03-4370-BC34-4BFF20356429%7D/11\\_Albrecht\\_Gebhardt.pdf](http://www.osg.or.at/download/files/%7B4BAB660F-5F03-4370-BC34-4BFF20356429%7D/11_Albrecht_Gebhardt.pdf); [wwwu.aau.at/agebhard/posterwien2015.pdf](http://wwwu.aau.at/agebhard/posterwien2015.pdf).

*Keywords:* CUDA, BLAS, Parallel computing, GPU-computing, Octave.

*Project lead:* Albrecht Gebhardt, Gunter Spöck.

*Project staff:* Albrecht Gebhardt, Gunter Spöck.

*Project term:* Jan 2015 – Dec 2020.

### **Estimation of Higher-Order Transition Matrices with Application in Simulation**

*Project partners / grant:* P.SYS, Villach.

Transition matrices of discrete Markov chains are estimated in a computationally efficient way. This involves leveraging the sparsity of the higher-order transition arrays. Using the estimated transition probabilities, simple simulations of, e.g., texts have been implemented. This project has its root in a school project.

*Further information:* [stochastik-in-der-schule.de/sisonline/struktur/Jahrgang31-2011/Heft%203/2011\\_3\\_GebhardBorovcnik.pdf](http://stochastik-in-der-schule.de/sisonline/struktur/Jahrgang31-2011/Heft%203/2011_3_GebhardBorovcnik.pdf).

*Keywords:* Markov chains, Transition matrix.

*Project lead:* Albrecht Gebhardt.

*Project staff:* Albrecht Gebhardt.

*Project term:* 2011 – 2018.

## Entropy-Based Sampling Design with Implementation in R

*Project partners / grant:* Department of Discrete Mathematics, Technical University Graz.

A branch-and-bound algorithm for determining the exact solution of a spatial sampling design based on an entropy-criterion has been implemented. The R package also includes heuristic approaches to determine initial solutions, namely the greedy and dual greedy algorithms. For several applications it has been shown that the initial solutions determined by heuristics are already optimal designs leading to speed improvements over concurring design of experiments (DOE) algorithms.

*Further information:* [netlibrary.aau.at/urn:nbn:at:at-ubk:1-24552](http://netlibrary.aau.at/urn:nbn:at:at-ubk:1-24552).

*Keywords:* Design of experiments, Branch-and-bound algorithm, Greedy heuristics.

*Project lead:* Claudia Gebhardt.

*Project staff:* Claudia Gebhardt, Albrecht Gebhardt.

*Project term:* 1999 – 2015.

## Sampling Design Algorithms for Spatial Statistics Problems

Our sampling-design algorithm based on the Karhunen-Loève expansion, published in

Spöck, G. & Pilz, J. (2010). Spatial sampling design and covariance-robust minimax prediction based on convex design ideas. *Stochastic Environmental Research and Risk Assessment*, 24(3), 463-482.

has been taken up and improved by

Gauthier, B., Pronzato, L. (2017). Convex relaxation for IMSE optimal design in random-field models. *Computational Statistics & Data Analysis*, 113, 375-394.

In 2012, the package ESRI ArcGIS 10.1 Geostatistical Analyst has implemented our published idea of Empirical Bayesian Kriging; this package is part of the GIS software ArcInfo/ArcView. ESRI (Richmond, CA) is the global market leader in GIS (geographic information systems). The idea has been published in

Pilz J., Spöck G. (2008). Why do we need and how should we implement Bayesian Kriging methods. In: *Stochastic Environmental Research and Risk Assessment*, 22(5), 621-632.

The key is to implement a parametric bootstrap to Bayesian Kriging. The semivariogram is bootstrapped and its empirical distribution is used as posterior in a Bayesian approach to Kriging. This way the uncertainty of covariance estimation is fully taken into account during Kriging. It is so important that ESRI has implemented this approach because now the public can base predictive intervals on all the uncertainty of covariance estimation involved in Kriging.

*Further information:* [desktop.arcgis.com/en/arcmap/10.3/guide-books/extensions/geostatistical-analyst/what-is-empirical-bayesian-kriging-.htm](http://desktop.arcgis.com/en/arcmap/10.3/guide-books/extensions/geostatistical-analyst/what-is-empirical-bayesian-kriging-.htm); [www.esri.com/news/arcuser/1012/empirical-byesian-kriging.html](http://www.esri.com/news/arcuser/1012/empirical-byesian-kriging.html).

*Keywords:* Empirical Bayesian Kriging, Parametric bootstrap of semivariogram, GIS software, Karhunen-Loève expansion, Spatial sampling design, Convex design.

*Project lead:* Jürgen Pilz, Gunter Spöck.

*Project term:* 2008 – 2011.

## Projects in Statistics Education

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### Risk and Decision Making

*Project partners / grant:* Barath Sriraman.

While there is a lifestyle following the motto “no risk – no fun”, humans usually try to avoid risks. It is well known that individuals deviate from a rational approach to the risky situation with which they are confronted. Risk perception and the difficulties to perceive risks are to be analysed starting from experiments by Kahneman and Tversky and Gigerenzer and Todd. Based on these studies, the aim is to evaluate tools that have been suggested to foster risk literacy and to develop them further.

To understand and judge the psychological and educational aspects of risk better, a general framework for the concept of risk will be established.

*Further information:* [www.researchgate.net/project/Risk-and-Decision-Making](http://www.researchgate.net/project/Risk-and-Decision-Making).

*Keywords:* Risk; Uncertainty, Meaning of probability, Risk Perception, Decision Making, Risk literacy, Mathematical thinking, Probabilistic evidence, Archetypical strategies, Logic of decisions, Visualisation of risks, Elementary approaches to risk.

*Project lead:* Manfred Borovcnik.

*Project staff:* Partially in cooperation with Ramesh Kapadia, and Ödön Vancsó.

*Project term:* Jan 2017 – ongoing.

### The Construct of Probability Literacy – What Distinguishes Probability from Statistical Literacy

*Project partners / grant:* Educação Matemática Pesquisa.

Chance is a view imputed on real world, which is a feature of modern life as nowadays people do no longer take it as given that their life is fundamentally uncertain. One aspect of taking control over uncertainty is entrenched with a probability view and related models. There were times and cultures that accepted uncertainty or dealt differently with it. Anyway, uncertainty is not controlled in the sense of eliminated; only the material consequences of uncertainty are – somehow – controlled.

This project should clarify the role of probability in modern science and politics in generating, substantiating and using evidence. Differences and the overlap with statistical literacy should be clarified. Ultimate goal of the project is to describe the construct of probability literacy by suitable categories.

*Further information:* [revistas.pucsp.br/index.php/emp/article/view/31495/21953](http://revistas.pucsp.br/index.php/emp/article/view/31495/21953).

*Keywords:* Probabilistic thinking, Probability literacy, Risk literacy, Mathematical thinking, Theoretical character of probability, Probabilistic evidence, Conditional probability, Archetypical strategies, Logic of decisions, Insurance contract.

*Project lead:* Manfred Borovcnik.

*Project staff:* Partially in cooperation with Cileda de Queiroz and Ramesh Kapadia.

*Project term:* Jan 2015 – ongoing.

### Projects in Applied Statistics as Case Studies for Statistics Education

*Project partners / grant:* Yıldız Technical University, Istanbul.

Statistics is genuinely entrenched by its applications. Crucial steps in modelling are required to fit the mathematical world to a real-world situation. This process of modelling may be best captured by case studies. There are various levels of case studies reaching from simple authentic examples of application to full projects in applied statistics done for a client from outside the academic world or a research colleague from the physics or informatics department. The project intends to investigate the potential of such applications for university courses of statistics. A background hypothesis of the project is: The

process of modelling requires more than mathematical qualifications; it requires more and more diverse mathematical knowledge than a theoretical course; however, this knowledge does not suffice. Referring to R. A. Fisher, one may state that the great flops in applying statistics occur before the data are collected. Thus, careful planning of a statistical project in its early phases is vital.

To establish material so that students can actively undergo applications right from this planning phase, to support students to play their active role, to find ways to back the academic teacher to assist their students, is the prime goal of this project. Essential is an active role of the students: In a way, they may play the statistical consultant who engages in the clarification and analysis of a problem in interaction with a client while they may get advice about possible methods (about their adequateness or about technical details to understand the method) from their academic teacher.

*Further information:* [www.researchgate.net/project/Projects-in-Applied-Statistics-as-Case-Studies-for-Statistics-Education](http://www.researchgate.net/project/Projects-in-Applied-Statistics-as-Case-Studies-for-Statistics-Education).

*Keywords:* Applied Statistics, Case studies, Collaborative work, Industry projects, Simulate real practice, Systems analysis.

*Project lead:* Manfred Borovcnik.

*Project staff:* Cooperation with Atif Evren.

*Project term:* Jan 2014 – ongoing.

### **A Comparative Study of Statistical Inference from Foundational and Educational Points of View**

*Project partners / grant:* International Statistical Institute.

Going back to the monograph *Comparative Statistical Inference* by Barnett (1973), there is a strong interest to investigate the various approaches towards statistical inference also from an educational point of view. The various approaches have their own merits but also severe drawbacks. See also the recent discussion on null hypothesis significance testing in the American Statistical Association. The various approaches should be investigated for their efficiency for teaching statistical inference.

In particular, the following approaches will be the focus of the comparative study: Significance tests of Fisher and the test policy by Neyman and Pearson (including sequential tests), decision theory (introducing loss functions), the Bayesian approach, and the re-randomization and bootstrap strand. The goal is also to explore appropriate pathways to inferential reasoning for education at any level.

*Further information:* [www.researchgate.net/project/A-Comparative-Study-of-Statistical-Inference-from-Foundational-and-Educational-Points-of-View](http://www.researchgate.net/project/A-Comparative-Study-of-Statistical-Inference-from-Foundational-and-Educational-Points-of-View).

*Keywords:* Null hypothesis significance testing, Neyman Pearson test policy, Bayesian inference, Resampling, Bootstrap, Comparative inference.

*Project lead:* Manfred Borovcnik.

*Project staff:* Partially in cooperation with Ramesh Kapadia.

*Project term:* Jan 2012 – ongoing.

### **Bayesian Inference in Schools and the Bayesian Controversy in the Foundations of Probability**

*Project partners / grant:* Eötvös Lóránd Univ. Budapest.

The subjectivist position towards probability is criticised for being subjective (!) while the objectivist view on probability has gaps in the foundations of inferential statistics. The objectivist conception seems closer to the ideal of objectivity while the subjectivist theory embraces the inferential statistics part with the help of Bayes' theorem. In the controversy on the foundations, the decision was in favour of the objectivist conception in order to avoid any subjective connotation of probability (Stegmüller, 1973, or Hacking, 1975; 1990), especially to preserve the scientific character of physics where proba-

bility had already played an essential role since the second half of the 19<sup>th</sup> century. In applications, statisticians nowadays use whatever is better for their problem and to a certain extent any application has subjective features.

Yet, the Bayesian formalism causes enormous problems of understanding. While the theory of stochastics is presented in an objectivist manner, examples cover often cases of Bayesian problems, which have a genuine subjectivist character. To find ways to teach the concepts of probability properly and at a level that favours understanding, is the prime goal of this project.

*Further information:* [www.researchgate.net/project/Bayesian-Inference-in-Schools-and-the-Bayesian-Controversy](http://www.researchgate.net/project/Bayesian-Inference-in-Schools-and-the-Bayesian-Controversy); [www.aiem.es/index.php/aiem/article/view/32](http://www.aiem.es/index.php/aiem/article/view/32).

*Keywords:* Bayesian controversy, Bayes' formula, Conditional probability, Subjective probability, Odds, Probabilistic thinking, Fallacies, Paradoxes in probability.

*Project lead:* Manfred Borovcnik.

*Project staff:* Manfred Borovcnik, Ödön Vancsó, Ramesh Kapadia.

*Project term:* Jan 2011 – ongoing.

### **Key Issues for Courses in Introductory Statistics and Probability**

*Project partners / grant:* Macquarie Univ., Sidney.

Probability is highlighted by theoretical concepts, which are far from being intuitive. The first step of the project is to identify key concepts; the second step is to clarify these concepts not only using mathematical tools by illustrating either their value in context or their specific properties. A more direct approach beyond the mathematical exposition of the theorems is a basic requirement of educational efforts in statistics not only for students of studies different from mathematics. Also, the focus within mathematics lies heavily on the derivation of the mathematical connections and their logical proof relative to axioms and optimising criteria. This guarantees the justification of the concepts but does not necessarily allow for deeper understanding.

One main idea of the project is to focus on facets of probability that allow i., for linking the various interpretations of probability, and ii., for linking probability to statistical inference. As one tool of meta-instruction, didactic animations should be investigated for their relative merits to teach complex concepts. The project is intended to identify criteria for good animations, and to design animations to the found principles and test them in teaching.

*Further information:* [www.researchgate.net/project/Key-Issues-for-Courses-in-Introductory-Statistics-and-Probability](http://www.researchgate.net/project/Key-Issues-for-Courses-in-Introductory-Statistics-and-Probability).

*Keywords:* Intuitions in mathematics, Central theorems, Meta strategies for understanding concepts, Link interpretations of probability, Link of probability to statistical inference.

*Project lead:* Manfred Borovcnik.

*Project staff:* Partially in cooperation with Ayşe Bilgin.

*Project term:* Jun 2010 – ongoing.

### **E-Learning and Technology-Enhanced Learning – Dynamic Applets for Teaching Stochastics**

*Project partners / grant:* Yıldız Technical University, Istanbul.

New Technologies changed the applications of statistics completely so that more statistics is applied nowadays than 25 years ago, which generates a need for a wider education in statistics even at an introductory level. At the same time, these technologies open the way to teach the subject matter of statistics completely differently than in the pre-computer era.

The project's aims are: To investigate various approaches of technology-based teaching; To identify key issues for their success; To provide recommendations and orientations for dealing with advantages or problems in using specific technology; To design small applets for learning crucial concepts. The elaborations refer to an introductory probability and statistics course. Some options of technology-supported approaches are: large-scale e-learning projects; locally organised computer-based learning environments; additional applets used to illustrate complex concepts; calculations outsourced to software.

*Further information:* [www.researchgate.net/project/Key-issues-for-courses-in-introductory-statistics-and-probability-at-university-level-for-non-mathematical-studies](http://www.researchgate.net/project/Key-issues-for-courses-in-introductory-statistics-and-probability-at-university-level-for-non-mathematical-studies).

*Keywords:* Success criteria for e-learning, Feedback for students, Exemplary solutions to tasks, Statistical applets.

*Project lead:* Manfred Borovcnik.

*Project staff:* Cooperation with Atif Evren, Martin Schenk and Joachim Mittag.

*Project term:* Jan 1999 – ongoing.

### **Probability, Risk, and Decisions (Twin Concepts, Risk in Science and Society)**

*Project partners / grant:* Alpen-Adria-University Klagenfurt.

The aim of this project is to investigate how risk is embedded in probability and how probability can be used to solve problems of risk. An analysis of risk forms the centre topic of the project, which shows – from a modern perspective – how risk is connected to probability. Decisions in risky situations draw from the various approaches to probability and from rational and behavioural views to decisions. An analysis of the historical development corroborates the idea that situations of conceptual growth for the notion of probability may be re-interpreted as situations under risk. Risky situations often combine small probabilities and high impact (cost, damage). It is obvious that in such cases, there is room for individual, idiosyncratic perceptions that differ from “official” connotations.

The idea is to redefine the goals for further research in probability education by the established link between probability and risk (the twin character of probability and risk). And to find approaches for the small-probabilities problem, which may be seen in Spiegelhalter's ideas of micromort and micro-life or in Borovcnik's multiplicative version of the Bayesian formula.

*Further information:* [www.researchgate.net/project/Probability-and-risk](http://www.researchgate.net/project/Probability-and-risk).

*Keywords:* A priori probability, Frequentist probability, Subjectivist probability, Probabilistic thinking, Risk, Uncertainty, Twin character of probability and risk.

*Project lead:* Manfred Borovcnik.

*Project staff:* Partially in cooperation with Ramesh Kapadia.

*Project term:* Jan 2010 – Jan 2018.

### **Probability and Statistics in High School**

*Project partners / grant:* Univ. de Granada, Sense Publishers.

This is a book project, which is aimed at synthesising the current status of research in statistics education. Statistics and probability are tightly interwoven with the context of the problems, which have to be modelled. The authors demonstrate how investigations and experiments provide promising teaching strategies to help high-school students acquire statistical and probabilistic literacy. In the first chapter, the authors put into practice the following educational principles, reflecting their views of how these subjects should be taught: a focus on the most relevant ideas postponing extensions to later stages; illustrating the complementary/dual nature of statistical and probabilistic reasoning; utilising the potential of technology and showing its limits; and reflecting on the different levels of formalisation to

meet the wide variety of students' previous knowledge, abilities, and learning types. The remaining chapters deal with exploratory data analysis, modelling information by probabilities, exploring and modelling association, and with sampling and inference.

Throughout the book, a modelling view of the concepts guides the presentation. In each chapter, the development of a cluster of fundamental ideas is built around a statistical study or a real-world problem that leads to statistical questions requiring data in order to be answered. The concepts developed are designed to lead to meaningful solutions rather than remain abstract entities. For each cluster of ideas, the authors review the relevant research on misconceptions and synthesise the results of research in order to support teaching of statistics and probability in high school. What makes this book unique is its rich source of worked-through tasks and its focus on the interrelations between teaching and empirical research on understanding statistics and probability.

*Further information:* [www.researchgate.net/project/Probability-and-Statistics-in-High-School](http://www.researchgate.net/project/Probability-and-Statistics-in-High-School);  
[www.sensepublishers.com/catalogs/bookseries/other-books/statistics-and-probability-in-high-school/](http://www.sensepublishers.com/catalogs/bookseries/other-books/statistics-and-probability-in-high-school/).

*Keywords:* Empirical-research-based teaching, Synthesis of current research, Statistical literacy, Probability literacy, Paradigmatic tasks, key misconceptions, technology-supported teaching.

*Project lead:* Manfred Borovcnik.

*Project staff:* Cooperation with Carmen Batanero.

*Project term:* Jul 2013 – Jul 2016.

### **History, Philosophy, and Paradoxes in Probability**

*Project partners / grant:* Egan Chernoff.

The historical emergence of the concept of probability was delayed in comparison to other mathematical fields. For a wider understanding of the concepts, it is helpful to know the reasons and to know the great controversies about the development of the theory. What were historical connotations of probability? How was the concept justified and how and for which purpose was it used for? Paradoxes have played a great role in the development of theories in general and especially in probability and statistics. Paradoxes are a sign of a conflict unresolvable at the current level of theory so that they either pinpoint its limitations or they become the driving force of further development of the theory.

Goals of the project: To trace the historic emergence of probability by steps of conceptual development. To find categories of paradoxes (and the lighter form of puzzles) and explain the paradoxical feature of them and the role they played for shaping the concepts. To transfer insight about the historical emergence to the design of teaching material and to the organisation of learning in class.

*Further information:* [www.researchgate.net/project/History-Philosophy-and-Paradoxes-in-Probability](http://www.researchgate.net/project/History-Philosophy-and-Paradoxes-in-Probability).

*Keywords:* Fundamental ideas, Divination, Division of stakes, Combinatorial multiplicity, Law of large numbers, Inverse probability, Bayes' problem, St. Petersburg problem, Expectation, Independence, Classical probability, Frequentist probability, Subjective probability, Puzzles and paradoxes.

*Project lead:* Manfred Borovcnik.

*Project staff:* Cooperation with Ramesh Kapadia and Ödön Vancsó.

*Project term:* Jan 2012 – Dec 2014.

### **Complexities and Difficulties of Conditional Probability**

*Project partners / grant:* Univ. of València.

It is well known that Bayesian problems (such as in medical diagnosis, when one wants to know the probability to have the disease in question after a positive medical finding has been established) are very difficult for many persons. Such problems are not always solvable by the Bayesian formula depending on the input data. In teaching, however, the input data are very often restricted to the standard situation where the Bayesian formula has to be applied. More generally, binary Bayesian problems are the generalised form of such problems.

The project's goal is to find task variables that influence the success rate of test persons. Task variables to investigate are the structure of the problem, the context, and the format of the input data (which can be given in probabilities, percentages, or whole numbers). Going back to empirical studies of Huerta who also introduced the concept of structure of such problems, the goal of this study is to try to replicate Huerta's results from Spanish secondary school to an international environment and also to the level of university. It is anticipated that the achievement in such problems is not much better for university students depending on the structure of the problem.

*Further information:* [www.researchgate.net/project/Complexities-and-Difficulties-of-Conditional-Probability](http://www.researchgate.net/project/Complexities-and-Difficulties-of-Conditional-Probability).

*Keywords:* Bayesian problems, Binary problems, Empirical study, Test questions, Task difficulty, Task variables.

*Project lead:* Manfred Borovcnik.

*Project staff:* Cooperation with Pedro Huerta, and Ramesh Kapadia.

*Project term:* Apr 2009 – Dec 2012.

### **Research Process and Probabilistic Modelling – Fundamental Ideas and Stochastic Thinking**

*Project partners / grant:* Univ. de Granada, IOE, Univ. of London.

Essential features of probability and statistics are missed if it were passively 'consumed' or learned. Usually notions arise more or less out of an abstraction from real world. In statistics, the concepts are often the result of an imputation of an idea to reality. This artificial character is best learned by returning to the roots, i.e., by modelling. We describe modelling in probability and statistics, the basic competencies required, and our experiences with teachers.

The goal of the project is

- To transmit a modelling-entrenched view on statistics, which is extremely prolific for modelling.
- To find innovative examples of case studies for teaching the aspects of statistics outlined above.
- To corroborate the view that modelling enriches the picture of mathematics and has a strong formative potential for probabilistic and statistical concepts.
- To support the idea that modelling can successfully be learnt as a handicraft by doing it.

*Further information:* [www.researchgate.net/project/Research-Process-and-Probabilistic-Modelling](http://www.researchgate.net/project/Research-Process-and-Probabilistic-Modelling).

*Keywords:* Case studies, Modelling, Empirical research process, Significance test, Influence factors.

*Project lead:* Manfred Borovcnik.

*Project staff:* Partially in cooperation with Carmen Batanero and Ramesh Kapadia.

*Project term:* Jan 2001 – 2012.

### **Reform of the Education of Statistics at Secondary Level in Colombia (Qué es y qué debería ser en educación estadística)**

*Project partners / grant:* Colombian Ministry of Education

The Colombian Ministry of Education started its reform of the secondary curricula with an investigation of the status quo and the desirable goals. That approach applied also for the field of probability and statistics. For that purpose, a few didactical PhD dissertation projects were outlined to accompany the reform. For probability, the question was how to integrate Bayesian ideas into a generally frequentistically orientated approach towards the concept of probability. For descriptive statistics, besides the exposition of techniques, the question was how to make the concepts meaningful by connecting to empirical research. For inferential statistics, the question was how to find an accessible approach to statistical tests with a reasonable level of complexity.

*Further information:* [wwwg.uni-klu.ac.at/stochastik.schule/Boro/index\\_inhalt](http://wwwg.uni-klu.ac.at/stochastik.schule/Boro/index_inhalt).

*Keywords:* Secondary school curricula, Probability and Statistics, School reform.

*Project lead:* Manfred Borovcnik

*Project staff:* Cooperation with Lucia Zapata; Univ. Medellín; Pedro Rocha Salamanca, Univ. Distrital, Bogotá.

*Project term:* Jan 2010 – Dec 2011.

### **Electronic Publishing of Research**

*Project partners / grant:* International Electronic Journal of Mathematics Education (IEJME).

Following McLuhan, the medium of research has influenced the message (massage) of the results and – not surprisingly – the research has changed its character during this process. This project investigates the potential of electronic communication beyond the circumstance that papers can be made available on the Internet.

Some examples are: To collate pertinent information dynamically, To enhance the validity of investigations by adding interview protocols or used tasks, To separate the presentation of ideas from the supporting details (references) and at the same time To extend the reference section from mere bibliographical data to an explanation why such a reference is given and not a different source, which means to embed the references into a research framework. There are more ways of exploiting the specific potential of electronic publishing (such as discussion fora, or collaborating interactively in research in statu nascendi with comments open to the community, etc.) to find and investigate for their relative merits. This study will enable developments relevant for other areas of research.

*Further information:* [iase-web.org/Conference\\_Proceedings.php?p=ICOTS\\_8\\_2010](http://iase-web.org/Conference_Proceedings.php?p=ICOTS_8_2010).

*Keywords:* Hyperlinks, Probability education, Electronic publishing, Interactivity.

*Project lead:* Manfred Borovcnik.

*Project staff:* Cooperation with Ramesh Kapadia.

*Project term:* Jan 2008 – Dec 2011.

## International Relations of the Department of Statistics 2007–2017



### Rankings of Staff and Former Staff (Selection)

	h-index	ResearchGate ranking		Citations	Top cited
		Points	Top %		
Borovcnik	9	17.16	37.5	375	60
Gebhardt	8	13.71	45	717	477
Kazianka	7	15.81	40	179	60
Khan	3	11.99	45	29	17
Kurz	4	10.29	45	51	11
Pilz	17	30.99	12.5	1533	477
Spöck	8	18.07	35	280	74
Stettner	24	34.65	7.5	2060	69

### Top-Cited Papers

- Rasch, D., Pilz, J. Verdooren, R., Gebhardt, A. (2011). *Optimal experimental design with R*. Boca Raton, FL: Chapman and Hall.
- Pilz J., Spöck G. (2008). Why do we need and how should we implement Bayesian Kriging methods. *Stochastic Environmental Research and Risk Assessment*, 22(5), 621-632.
- Breschan, C., Platzer, M., Jost, R., Stettner, H. (2007). Midazolam does not reduce emergence delirium after sevoflurane anesthesia in children. *Pediatric Anesthesia*, 17(4), 347-52.
- Borovcnik, M., Bentz, H.-J. (1991). Empirical research in understanding probability. In Kapadia, R. & Borovcnik, M. (Eds.), *Chance Encounters: Probability in Education* (pp. 73-106). Dordrecht: Kluwer.
- Kazianka, H., Pilz, J. (2010). Copula-based geostatistical modeling of continuous and discrete data including covariates. *Stochastic Environmental Research and Risk Assessment*, 24(5), 661-673.
- Ali, S., Li, D., Congbin, F., Khan, F. (2015). Twenty first century climatic and hydrological changes over Upper Indus Basin of Himalayan region of Pakistan. *Environmental Research Letters*, 10(1). Online: [doi.org/10.1088/1748-9326/10/1/014007](https://doi.org/10.1088/1748-9326/10/1/014007).
- Kurz, D., Lewitschnig, H., & Pilz, J. (2014). Advanced Bayesian estimation of Weibull early life failure distributions. *Quality and Reliability Engineering*, 30(3), 363-373.

## Guest Professors and Guest Lecturers at the Department of Statistics 2007–2017

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- Su 17 Prof. Dr. Dr. Vera Hofer, Institut für Statistik und Operations Research, Univ. Graz:  
*Statistics and Finance*
- Wi 16/17 Prof. Dr. Dr. Michael G. Schimek, Statistical Bioinformatics, IMI, Medical University  
Graz: *Selected Topics of Statistics: Regression, Classification and Statistical Learning*  
Dipl.-Ing. Dr. Horst Lewitschnig, Infineon Technologies, Neubiberg:  
*Selected Topics of Statistics: Reliability Theory*  
Prof. Dr. Ramesh Kapadia, IOE, University of London:  
*Didactics of Probability Theory*
- Su 16 Dipl.-Ing. Dr. Horst Lewitschnig, Infineon Technologies, Neubiberg:  
*Statistical Process Control*
- Wi 15/16 Dipl.-Ing. Dr. Horst Lewitschnig, Infineon Technologies, Neubiberg:  
*Statistical Process Control*
- Su 15 Dipl.-Ing. Dr. Jürgen Hartinger, Vorstandsdirektor, Kärntner Landesversicherung:  
*Statistics and Finance*  
Prof. Dr. Ramesh Kapadia, IOE, University of London and Offsted:  
*Selected Topics of Statistics: Making Decisions The Taming of Risk*
- Wi 14/15 Dr. Gerhard Buchacher, Head of SEE Group Risk Control, Hypo Alpe-Adria-Bank:  
*Statistics and Finance*
- Su 14 Doz. Dr. Hannes Kazianka, On-Site Supervision Division – Significant Institutions,  
Österreichische Nationalbank: *Statistics and Finance*
- Wi 13/14 Dipl.-Ing. Dr. Horst Lewitschnig, Infineon Technologies, Neubiberg:  
*Statistical Process and Quality Control*
- Su 13 Dr. Gerhard Buchacher, Head of ALM Risk Control, Hypo Alpe-Adria-Bank:  
*Statistics and Finance*  
Prof. Dr. Ramesh Kapadia, IOE, University of London:  
*Statistical Decision Theory*
- Wi 12/13 Prof. Dr. Ramesh Kapadia, IOE, University of London and Offsted:  
*Selected Topics of Statistics: Didactics of Probability Theory*
- Su 12 Dipl.-Ing. Dr. Horst Lewitschnig, Infineon Technologies, Neubiberg:  
*Statistical Process and Quality Control*
- Su 11 Dr. Gerhard Buchacher, Head of ALM Risk Control, Hypo Alpe-Adria-Bank:  
*Statistics and Finance*
- Wi 10/11 Dipl.-Ing. Dr. Horst Lewitschnig, Infineon Technologies, Neubiberg:  
*Statistical Process and Quality Control*
- Su 10 Dr. Gerhard Buchacher, Head of ALM Risk Control, Hypo Alpe-Adria-Bank:  
*Statistics and Finance*
- Wi 08/09 Prof. Dr. James V. Zidek, Department Statistics, Univ. British Columbia, Vancouver:  
*Spatial Data Analysis*
- Wi 04/05 Prof. Dr. Dieter Rasch, Universiteit Wageningen:  
*Linear and Non-Linear Regression Analysis*

## Guest Lectures at Our Department

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“Applied Statistics towards the Future of Data Science – Challenge and Opportunity”

Prof. Dr. Dr. Michael G. Schimek, Statistical Bioinformatics, IMI, Med. Univ. Graz; 1 Dec 2017

“Optimal Combination of Gupta’s Subset Selection Procedure with Bechhofer’s Indifference Zone Approach”

Em. Prof. Dr. Dieter Rasch, Univ. Wageningen, NL, Univ. f. Bodenkultur, Wien; 1 Dec 2017

“Inferential Aspects of Multiple Ranked Lists”

Prof. Dr. Dr. Michael G. Schimek, Statistical Bioinformatics, IMI, Med. Univ. Graz; 18 Dec 2015

“Multi-Criteria Decision Making Methods”

Doz. Nimet Yapici Pehlivan, University of Konya, Department of Statistics; 25 Jun 2014

“Famous Puzzles and Paradoxes that Accompany the Emergence of Probability”

Prof. Dr. Ramesh Kapadia, IoE, University of London; 6 Jun 2013

“A New Lifetime Distribution”

Prof. Dr. Çoskun Kuş, Selçuk University Konya; 24 Jul 2012

“Risk in Science and Society: Towards new pedagogies of probability”

Prof. Dr. Ramesh Kapadia, IoE, University of London; 9 Jul 2010

“Some Discussions on Turkish Statistics Education”

Prof. Atif Evren, Prof. Dogan Yıldız, Yıldız Technical University, Istanbul; 28 Jan 2009

“Probability and Statistics – Stimulating Examples with TI InterActive!”

Mag. Friedrich Tinhof, T3 Österreich; 7 Mar 2008

“Wason Cards, Loaded Dice and Coloured Tinker Cubes for First Steps in Uncertainty”

Prof. Dr. Laura Martignon, Vocational University Ludwigsburg; 3 Oct 2007

## Guest Professorships Outside

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- |          |  |
|----------|--|
| Wi 16/17 | Jürgen Pilz is guest professor at the University of Canterbury, Department of Statistics, Christchurch: <i>Applied Statistics</i>  |
| Wi 15/16 | Manfred Borovcnik is guest professor at the Paris-Lodron-Universität Salzburg, Department of Mathematics: <i>Statistics for Teacher-In-Service</i>                                       |
| Su 13    | Gunter Spöck is guest professor at the University of Natural Resources and Life Sciences (BOKU), Institute of Applied Statistics and Computing (IASC), Vienna: <i>Spatial Statistics</i> |
| Wi 10/11 | Jürgen Pilz is guest professor at the University of British Columbia (UBC), Department of Statistics, Vancouver: <i>Applied Statistics</i>   |

## Plenaries and Panels

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“Some Points to Reflect on the Role of Statistics for Civic Empowerment”

Manfred Borovenik and Christoph Wassner (Invited Discussants).

IASE Roundtable “Promoting Understanding of Statistics about Society”, Berlin, Germany, 19–22 Jul 2016.

“The Influence of New Technologies, Software, and E-Learning – Key Issues for Enriching Courses in Introductory Statistics and Probability”

Manfred Borovenik (Plenary Talk).

10<sup>th</sup> International Statistics Days Conference, Giresun, Turkey, 7–9 Oct 2016.

“Some Advances in Bayesian Spatial Prediction and Design”

Jürgen Pilz (Plenary Lecture).

18<sup>th</sup> European Meeting of Young Statisticians (EYMS), Osijek, Croatia, 26–30 Aug 2013.

“Decision-Theoretic Modelling of Early-Life-Failures in Semiconductor Manufacturing”

Jürgen Pilz (Plenary Talk).

3<sup>rd</sup> International Symposium on Games and Decisions in Risk and Reliability (GDRR), Kilkenny, Ireland, 8–10 Jul 2013.

“Spatial Sampling Design with Skew Distributions: The Special Case of Trans-Gaussian Kriging”

Gunter Spöck (Professorial Candidate Lecture).

Department of Natural Resources Management, Texas Tech University, 26 Jul 2012.

“Sequential Design and Analysis with R”

Jürgen Pilz (Plenary Talk).

11<sup>th</sup> Int. Conference on Optimal Design – Theory and Application, Vienna, 25–30 Sep 2011.

“Resiliency of Agriculture and Natural Resources to Climate Change and Variability”

Jürgen Pilz (Invited Discussant).

2010 Joint Statistical Meeting of the ASA, Vancouver, Canada, 31 Aug – 5 Sep 2010.

“More Information – More Uncertainty in Issues of Health”

Manfred Borovenik (Plenary Lecture).

Forum of Austrian Ethics Commissions, Klagenfurt, 30 Apr 2010.

“Interfacing Geostatistics and GIS for Environmental Mapping”

Jürgen Pilz (Invited Discussant)

Int. Workshop on Space-Time Analysis for Environmental Mapping, Epidemiology and Climate Change, SAMSI, Raleigh, North Carolina, 13–16 Sep 2009.

“The Interplay of Probability and Statistics in Teaching and in Training the Teachers”

Manfred Borovenik, Jean Claude Girard, Delia North, and Gabriella Ottaviani.

Panel Discussion, ICMI Study and IASE Round Table Conference „Statistics in School Mathematics. Challenges for Teaching and Teacher Education”, Instituto Tecnológico de Monterrey, México, 30 Jun – 4 Jul 2008.

“How Modern Technologies have Changed the Curriculum in Introductory Courses”

Manfred Borovenik (Invited Discussant).

56<sup>th</sup> Session of the ISI World Statistics Congress, Lisboa, Portugal, 22–29 Aug 2007.

## Organisation of Conferences and Workshops

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### **11<sup>th</sup> Ethics Day of the Ethics Commission of the Federal State of Carinthia „Migration – A Challenge for the Health System”**

Casineum Velden, 23 Nov. 2017.

Organisers: The Ethics Commission of the Federal State of Carinthia, M. Borovcnik (AAU Klagenfurt) is a member of the organising team.

There is rarely a topic that is more controversial and emotionally laden than refugees and migration. This Ethics Day approached the topic from various perspectives. The range extended from ethics of communication on migration, structural implications on the health system, implications on specific areas such as emergency medicine, paediatrics and obstetrics, to the practical care and support of refugees.

See: [www.ethikkommission-kaernten.at/index.php/aktuelles.html](http://www.ethikkommission-kaernten.at/index.php/aktuelles.html).

### **Austrian Statistics Days**

Univ. of Salzburg, 13–15 Sep. 2017.

Organisers: A. Bathke (Univ. Salzburg), M. Borovcnik (AAU Klagenfurt), K.-J. Fuchs (Univ. Salzburg), and A. Futschik (Univ. Linz).

This conference offered a platform for the exchange of latest research within the Austrian community of statisticians. This year, there were sessions on Multivariate Inference, Statistics and Education, and Approximate Bayesian Computation and Likelihood-Free Statistics. There was also a public lecture held by Walter Schachermayer on the topic “Wie wahrscheinlich ist der Zufall?” Furthermore, the ceremony for the Young Researchers Award provided an opportunity for short talks of the awardees.

#### *Session “Statistics and Education”*

Organisers: M. Borovcnik (AAU Klagenfurt), K.-J. Fuchs (Univ. Salzburg).

Meanwhile, statistics and probability are core elements of international curricula and, accordingly, these fields have been implemented also in mathematics teacher education programmes at the university. Besides keynotes on Understanding Uncertainty and Statistical Literacy by Analysing Official Data, the session covered various aspects of stochastics education: Learning probability by games; The role of context for teaching probability; Education of teacher students in stochastics; Applets to illustrate crucial concepts of probability and statistics in Excel and on the Smartphone. The organisers encouraged intensive discussions to the presentations, which are reflected in the published papers.

See: [www.osg.or.at/main.asp?VID=1&kat1=108&kat2=686&kat3=597](http://www.osg.or.at/main.asp?VID=1&kat1=108&kat2=686&kat3=597);  
[www.researchgate.net/publication/322117535\\_Mathematik\\_im\\_Unterricht\\_Ausgabe\\_8](http://www.researchgate.net/publication/322117535_Mathematik_im_Unterricht_Ausgabe_8).

### **ÖMG-DMV-Congress 2017 – 6<sup>th</sup> Austrian Stochastics Days**

Univ. of Salzburg, 11–15 Sep 2017.

#### *Section 14: „Statistics”*

Organisers: Markus Pauly (Univ. Ulm), Jürgen Pilz (AAU Klagenfurt).

Topics: Ranks and Pseudo-Ranks (Edgar Brunner), Statistics in dependent p-generalised elliptically contoured sample distributions (Wolf-Dieter Richter).

See: [fuchsc.sbg.ac.at/congress/Salzburg2017-Book\\_of\\_Abstracts.pdf](http://fuchsc.sbg.ac.at/congress/Salzburg2017-Book_of_Abstracts.pdf).

### **61<sup>st</sup> ISI World Statistics Congress**

Marrakech, Marocco, 16–21 Jul 2017.

*Invited Paper Session: A Comparative Study of Statistical Inference from an Educational Point of View.*

Organiser: Manfred Borovcnik (AAU Klagenfurt).

The aim of the session was to initiate a critical discussion about classical methods of statistical inference, the Bayesian approach to inference, a decision-oriented approach to inference, and using resampling in inference. The latter resampling school has gained massive attention within the statistics education community. The principal aim was to discuss merits and disadvantages of the various approaches towards statistical inference. A side goal was to find a legitimation for statistical inference in the curriculum of secondary schools and debate on possibilities of teaching statistical inference in the era of big data. There was also one invited speaker for each of the approaches and a critical essay on the challenges of informal inference based on resampling.

*Invited Paper Session: The Session of the IASE Journal.*

Organiser: Manfred Borovcnik (AAU Klagenfurt).

Statistics Education Research Journal (SERJ) is the flagship journal of the IASE. The session offered insight into the process of forming a research journal with high reputation and a wide outreach in the scientific community. In the session, there was also input for innovative ways of publication of research results. The session witnessed a lively discussion of current hot topics of the journal at a point where it will be moved from the societal umbrella to a big publishing house. Open access, costs, and maintaining IASE's influence on shaping the journal are vital issues in this transition process.

See:

[www.researchgate.net/publication/320456661\\_A\\_Comparative\\_Study\\_of\\_Statistical\\_Inference\\_from\\_an\\_Educational\\_Point\\_of\\_View\\_-\\_Invited\\_Paper\\_Session](http://www.researchgate.net/publication/320456661_A_Comparative_Study_of_Statistical_Inference_from_an_Educational_Point_of_View_-_Invited_Paper_Session); [www.researchgate.net/publication/320456053\\_The\\_Session\\_of\\_the\\_IASE\\_Journal\\_-\\_Statistics\\_Education\\_Research\\_Journal\\_SERJ](http://www.researchgate.net/publication/320456053_The_Session_of_the_IASE_Journal_-_Statistics_Education_Research_Journal_SERJ).

### **8<sup>th</sup> International Workshop on Simulation (IWS)**

Univ. of Natural Resources and Life Sciences (BOKU), Vienna, 21–25 Sep 2015.

Organisers: V. Melas (St. Petersburg State Univ.), K. Moder (BOKU, Vienna), J. Pilz (AAU Klagenfurt), D. Rasch (BOKU, Vienna).

This international conference was devoted to statistical techniques in stochastic simulation, data collection and analysis of scientific experiments and studies representing broad areas of interest. Keywords: Statistical simulation, Optimal design of experiments, Business statistics, Stochastic processes.

*Session on Bayesian Reliability Analysis and Design, 8<sup>th</sup> International Workshop on Simulation (IWS)*

Organiser: J. Pilz.

Topics: A Bayesian model to approximate  $\Delta T$  for semiconductor cyclic stress testing; Advanced Bayesian estimation of Weibull early-failure distributions; D-optimum scanning node activation for parameter estimation of spatio-temporal processes; Statistical hypothesis testing to detect unreliable semiconductor devices.

See: [iws.boku.ac.at/](http://iws.boku.ac.at/).

### **9<sup>th</sup> International Statistics Day Symposium 2014**

Side-Antalya, 10–14 May 2014.

*Session on “How Applications of Statistics Enrich Statistics Education”*

Organiser: M. Borovcnik (AAU Klagenfurt).

The potential of applications to enrich statistics education was the focus of this session. Especially the approach of cases studies seems very suitable to show the multifarious challenges to the students, and to reveal the opportunities and difficulties of modelling and applying the abstract methods. We connected to the deliberations of the grand old R. A. Fisher whose driving force in developing new statistical methods always has been his problems from applications: “To call in the statistician after the experiment is done may be no more than asking him to perform a post-mortem examination: he may be able to say what the experiment died of.” Keywords: Applied Statistics, Case studies, Collaborative work, Industry projects, Simulate real practice, Systems analysis.

### **8<sup>th</sup> British Congress of Mathematical Education (BCME 8)**

Nottingham, England, 14–17 Apr 2014.

*Session on “Risk and Bayesian Probability in Schools”*

Organiser: M. Borovcnik (AAU Klagenfurt). Speakers: David Spiegelhalter (Risk Centre, Univ. of Cambridge) and Ramesh Kapadia (Univ. of London).

What can education learn from real-world communication of risk and uncertainty? Risk is a hot topic, whether it concerns the benefits and harms of screening or the chance of an earthquake. It is challenging to explain both unpredictability and uncertain knowledge to the public, and yet these are also essential elements in education in probability and statistics. Current approaches in communicating risk and uncertainty can contribute substantially to educational practice. Examples of public communication and classroom materials were used in this session to illustrate these ideas.

### **59<sup>th</sup> ISI World Statistics Congress**

Hong Kong, 25–30 Aug. 2013.

*Late-Breaking Session “Statistical Inference – An Unresolved Issue in Statistics Education”*

Organisers: M. Borovcnik (AAU Klagenfurt) and J. Engel (Univ. Ludwigsburg).

Inferential statistics is the scientific method for evidence-based knowledge acquisition. Many approaches to it have been developed: Significance tests of Fisher, the test policy by Neyman and Pearson, decision theory, the Bayesian approach, and the re-randomisation and bootstrap strand. From the statistics education community, more *informal* approaches have been advocated to make inference more accessible to students. However, simplicity of an approach is not the only argument. We must teach what is relevant from the body of science to the next generation so it does not get lost. Clarifying comparative investigations are urgently needed to halt the trend to eliminate inferential statistics from curricula. The speakers explored appropriate pathways to inferential reasoning for any level.

See: [2013.isiproceedings.org/index.php?r3=nr&r4=STitle&r5=All&Search=Go&r1=NR](http://2013.isiproceedings.org/index.php?r3=nr&r4=STitle&r5=All&Search=Go&r1=NR).

### **11<sup>th</sup> Int. Conference on Optimal Design of Experiments-Theory and Application**

Univ. of Natural Resources and Life Sciences (BOKU), Vienna, 25–30 Sep 2011.

This conference was devoted to theoretical developments as well as practical applications of experimental design. It addressed researchers and practitioners. The organisers welcome papers devoted to both the development of mathematical theory and related algorithms, as well as practical applications. The conference followed the tradition of St. Petersburg Workshops on Simulation and Model Oriented Data Analysis (MODA). Keywords: Optimal design of experiments; Statistical simulation.

Proceedings: [mzvtagung.boku.ac.at/Proceedings.pdf](http://mzvtagung.boku.ac.at/Proceedings.pdf).

*Session on “Program Packages for Designs”*

Organiser: J. Pilz (AAU Klagenfurt).

Topics: The R-package Optimal Design of Experiments; Industrial design of experiments in R; How powerful is my study? Integrated design of experiments and analysis of results with JMP and SAS.

*Session on “Demonstration of Experimental Design Packages”*

Organiser: A. Gebhardt (AAU Klagenfurt).

Topics: Size of experiments in ANOVA models with R; Sequential design and analysis with R.

**SIMNET Summer School 2010, Statistical and Stochastic Modelling**

TU Graz, 9–10 Sep 2010

*Workshop Basics of Spatial Statistics (Grundlagen der Räumlichen Statistik)*

Organiser: A. Gebhardt (AAU Klagenfurt).

There is an increasing amount of data collected as geo-data including the coordinates of the investigated variables. This amplifies the scope of spatial statistics to geo-sciences, which is beyond its classical fields of applications. In contrast to classical statistics, spatial statistics basically deals with correlated data. For this purpose, concepts such as regionalised variables, stationarity of processes, variogram-based models, and modelling has to be introduced. In the workshop, the search method of Kriging and optimal predictions based on Kriging were dealt with. The workshop concluded with embedding the geo-statistical methods in the theory of point processes as exemplars of stochastic processes.

**Eight International Conference on Teaching Statistics (ICOTS 8)**

Ljubljana, Slovenija, 11–16 Jul 2010

*Invited Paper Session “Similarities and Contrasts in Teaching Mathematical and Statistical Thinking*

Organiser: M. Borovcnik (AAU Klagenfurt).

Mathematical concepts enable to structure thinking; corresponding models help to structure reality. They provide tools to recognise and solve problems. Mathematical models are used also in stochastics. Yet, there seems to be a difference in usage and connotation. *The principal thesis of this session was that mathematical and stochastic thinking are different.* Similarities and differences in mathematical and stochastic thinking were considered based on case studies discussing such issues, or on feedback from learners reflecting the topic. The overall aim was to use these characteristics of thinking to develop didactical opportunities to improve the teaching of both mathematics and stochastics.

Proceedings: [iase-web.org/Conference\\_Proceedings.php?p=ICOTS\\_8\\_2010](http://iase-web.org/Conference_Proceedings.php?p=ICOTS_8_2010).

**StatGIS09 “Geoinformatics for Environmental Surveillance”**

Milos Island, Greece, 17–19 Jun 2009.

Organisers: D. Cornford (Aston Univ.), G. Dubois (JRC, European Commission), D. Hristopulos (Technical Univ. of Crete), and E. Pebesma (Univ. of Münster), J. Pilz (AAU Klagenfurt).

The conference provided a forum for the discussion of current problems, trends and approaches in spatial statistics, applications thereof and their interface with geographic information systems. It addressed researchers as well as practitioners interested in learning about recent developments and sharing their experiences in these areas. Statistical issues that were covered ranged from the analysis of data provided by heterogeneous networks, the automatic detection of anomalies for early warning, to the real-time interpolation of data collected by mobile devices, or the fast processing of environmental data for reducing computing times. Key topics: GIS, Geoinformatics, Geostatistics.

See: [www.stat.aau.at/Tagungen/statgis/2009/](http://www.stat.aau.at/Tagungen/statgis/2009/).

*Workshop “Bayesian Geostatistics”*. Tools and methods for detecting and handling extreme events.

Organiser: J. Pilz (AAU Klagenfurt).

This workshop presented the main concepts, tools and methods of Bayesian geostatistics. We started with classical Bayes ordinary Kriging, extended the ideas to include uncertainty with respect to variogram parameters and also presented the main ideas of modern model-based Bayesian geostatistics. Finally, we introduced the new concept of copula-based geostatistics, which is particularly well-suited to deal with extreme observations. The use of this concept was demonstrated by analysing real data with the copula R-package that has been developed within the INTAMAP project.

#### **11<sup>th</sup> International Congress of Mathematical Education (ICME 11)**

Monterrey, México, 6–13 Jul 2008.

*Topic Study Group on Research and Development in the Teaching and Learning of Probability*

Organisers: M. Borovcnik (AAU Klagenfurt), C. Batanero (Univ. Granada), D. Pratt (Univ. London), Y. Wu (East China Normal Univ.).

There are powerful arguments in favour of a strong role for probability within stochastics curricula: i. Sound probabilistic judgements support rational decision-making in important situations, such as medical tests, jury verdicts, investments, assessment, etc. ii. Equally, reasoning about uncertainty is an important everyday skill (such as risk in financial markets, and reliability). iii. Probability is essential in understanding any inferential procedures in statistics. iv. Probability offers a tool for modelling and “creating” reality. The challenge is to teach probability through designing materials and tools that facilitate understanding. Papers on the following topics were encouraged: Individuals’ corner (ideas of students), impact of technology (including e-learning), teachers’ corner (their conceptions; shaping teacher pre- and in-service), fundamental ideas (what is fundamental to understand probability).

See: [iase-web.org/Conference\\_Proceedings.php?p=ICME\\_11\\_2008](http://iase-web.org/Conference_Proceedings.php?p=ICME_11_2008)

#### **StatGIS Conference 2007**

Univ. of Klagenfurt, 24–26 Sep 2007.

Organiser: J. Pilz (AAU Klagenfurt).

The conference provided a forum for the discussion of current problems, trends and approaches in spatial statistics, applications thereof and their interface with geographic information systems. It addressed researchers as well as practitioners who want to learn about recent developments and share their experiences in these areas.

See: [www.stat.aau.at/Tagungen/statgis2007/](http://www.stat.aau.at/Tagungen/statgis2007/).

## Awards and Functions in Committees and Journals, and Contracts

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### Awards

- Jointly with Prof. J. Engel (Ludwigsburg), M. Borovcnik is winner of a “late-breaking session”, 59<sup>th</sup> ISI World Statistics Congress, Hong Kong (2013).
- G. Spöck gives a candidate lecture at the Dep. of Natural Resources Management, Texas Tech Univ. He was ranked among the first three for the tenure professorship in Quantitative Ecology.
- H. Kazianka and J. Pilz are joint winners of Computational Best Papers. They received the Best Paper Award of the Year 2011 of the Journal of Computers & Geosciences from the International Association of Mathematical Geology for their paper: Bayesian spatial modeling and interpolation using copulas. *Computers & Geosciences*, 37(3), 310-319.
- J. Pilz and M. Borovcnik are Elected Member of the International Statistical Institute (ISI); J. Pilz is also a member of the Institute of Mathematical Statistics (IMS).

### Commissions and Committees

- J. Pilz was chair of the appointment committee “Stochastic Processes” at the Alpen-Adria-University Klagenfurt (2016–2017).
- M. Borovcnik was member of the appointment committee for the professorship in “Stochastic Processes” at the Alpen-Adria-University Klagenfurt (2016–2017).
- J. Pilz was chair of the appointment committee “Stochastic Processes” at the Alpen-Adria-University Klagenfurt (2014–2015).
- G. Spöck was member of the appointment committee for the professorship in “Stochastic Processes” at the Alpen-Adria-University Klagenfurt (2014–2015).
- J. Pilz was chair of the habilitation commission for E. Resmerita (Alpen-Adria-University Klagenfurt, 2013) and G. Laaha (Univ. of Natural Resources and Life Sciences, BOKU, Vienna, 2008).
- M. Borovcnik was juror of Mediaprix (2001-2008 with interruptions) and Swiss Virtual Campus (2003-04).
- M. Borovcnik is member of the Ethics Commission of the Federal State of Carinthia (since 1999).
- M. Borovcnik is member of the Didactics Commission of the Austrian Mathematical Society (since 1987).
- M. Borovcnik is founder of the Working Committee “Statistics in Education and School” of the Austrian Statistical Society in 1997 (leader till 2008).

### Journals

- J. Pilz is Associate Editor of “Frontiers in Environmental Sciences”, Past Associate Editor of the statistics journals “Metrika” and “Journal of Statistical Planning and Inference”, and Past Associate Editor of “Stochastic Environmental Research and Risk Assessment (SERRA)”.
- J. Pilz is member of the Editorial Board of “Spatial Statistics”, “The Open Statistics & Probability Journal”, “SOP Transactions on Statistics and Analysis”, “Geoinformatics & Geostatistics”.
- M. Borovcnik is co-editor of Statistics Education Research Journal (SERJ, since 2015) and co-editor of “Stochastik in der Schule” (since 1986).

### Erasmus Contracts

The Department has established Erasmus contracts providing opportunities for exchange for students and academic staff with the following universities: Hacettepe University of Ankara (since 2015), Polytechnic University of Timisoara (since 2013), Università La Sapienza, Rome (since 2012), University of Konya (since 2010), and Yıldız Technical University, Istanbul (since 2010).

**Research Report  
Department of Statistics  
AAU Klagenfurt  
2007–2017**

**Ten-Year Anniversary of the Department**

**Part II**

Part II is contained in a separate volume.

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