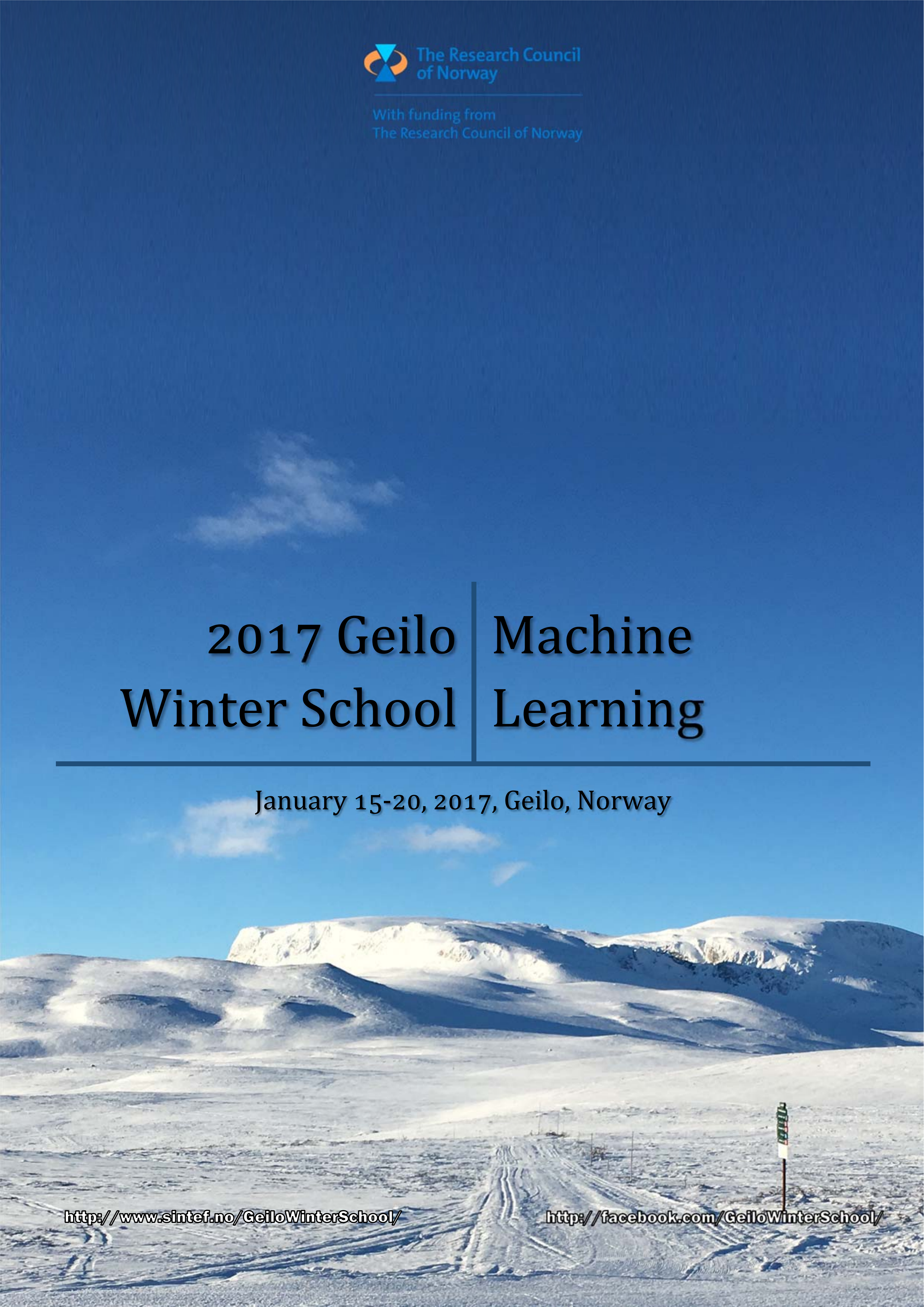

The Research Council of Norway

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The Research Council of Norway

2017 Geilo Winter School | Machine Learning

January 15-20, 2017, Geilo, Norway

http://www.sintef.no/GeiloWinterSchool/

http://facebook.com/GeiloWinterSchool/

Schedule

At a glance:

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
07:30 - 09:00		Breakfast				
09:00 - 09:45		Robert Jenssen Michael Kampffmeyer	Filippo Bianchi	Devdatt Dubhashi	Nils Lid Hjort	Nils Lid Hjort
09:45 - 10:30						
10:30 - 11:00		Break				Checkout by 11:00
11:00 - 11:45						
11:45 - 12:30						Summary and lunch
12:30 - 15:00		(Lunch 12:30 - 14:00)				
15:00 - 15:45		Joaquin Vanschoren	Devdatt Dubhashi	Devdatt Dubhashi	Mark Tibbetts	
15:45 - 16:30						
16:30 - 17:00	Coffee					
17:00 - 17:45	Introduction	Robert Jenssen	Joaquin Vanschoren	Nils Lid Hjort	Poster session	
17:45 - 18:30	Joaquin Vanschoren					
18:30 - 19:15						
19:30	Dinner					

Detailed program:

Sunday:

16:30 – 17:00: Coffee
17:00 – 17:45: **A. R. Brodtkorb**: Welcome & Intro
17:45 – 19:15: **J. Vanschoren**: Machine learning in Python
19:30: Dinner

Monday:

09:00 – 10:30: **R. Jenssen & M. Kampffmeyer**: Deep learn.
10:30 – 15:00: Break
15:00 – 16:30: **J. Vanschoren**: Classification and regression with Scikit-learn
16:30 – 17:00: Coffee
17:00 – 18:30: **R. Jenssen**: Spectral clustering & kernel methods
19:30: Dinner

Tuesday:

09:00 – 10:30: **F. M. Bianchi**: Recurrent neural networks
10:30 – 15:00: Break
15:00 – 16:30: **D. Dubhashi:** Word embeddings
16:30 – 17:00: Coffee
17:00 – 18:30: **J. Vanschoren:** Preprocessing and dimensionality reduction
19:30: Dinner

Wednesday:

09:00 – 10:30: **D. Dubhashi**: Summarization
10:30 – 15:00: Break
15:00 – 16:30: **D. Dubhashi**: Word senses
16:30 – 17:00: Coffee
17:00 – 18:30: **N. L. Hjort**: Model selection and averaging
19:30: Dinner

Thursday:

09:00 – 10:30: **N. L. Hjort: Confidence distributions**
10:30 – 15:00: Break
15:00 – 16:30: **M. Tibbetts**: Practical ML in industry
16:30 – 17:00: Coffee
17:00 – 18:30: Poster session
19:30: Dinner

Friday:

09:00 – 10:30: **N. L. Hjort**: Bayesian nonparametrics
10:30 – 11:45: Break (Remember check out by 11:00)
11:45 – 14:30: Summary and lunch
15:19 Train to Oslo
15:41 Train to Bergen

The Geilo winter school is funded by the Research Council of Norway. It is organized by **André R. Brodtkorb** and the scientific committee consisting of **Inga Berre** (University of Bergen), **Xing Cai** (Simula, University of Oslo), **Anne C. Elster** (Norwegian University of Science and Technology), **Margot Gerritsen** (Stanford), **Helwig Hauser** (University of Bergen), **Knut-Andreas Lie** (SINTEF, Norwegian University of Science and Technology), **Hans Ekkehard Plesser** (Norwegian University of Life Sciences), **Geir Storvik** (University of Oslo), and **Ståle Walderhaug** (SINTEF, Arctic University of Norway).

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Devdatt Dubhashi

Nils Lid Hjort

Robert Jenssen

Michael Kampffmeyer

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Joaquin Vanschoren

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Joaquin Vanschoren is Assistant Professor of Machine Learning at the Eindhoven University of Technology (TuE, Eindhoven, Netherlands). He is the founder of OpenML.org, a collaborative machine learning platform where scientists automatically can log and share data, code and experiments, and the platform automatically learns from the data to help people perform machine learning better. His research interests include large-scale data analysis of data including social, streams, geo-spatial, sensors, network, and text.

These three lectures offer a hands-on introduction into machine learning with Python. They start off with (re)establishing the basics of using Python for data analysis, but will quickly turn to the practice of machine learning. Students will collaborate with each other, learning from each other how to build the best models.

Introduction to ML in Python: We start with discussing essential libraries and tools. We will use scikit-learn as our main machine learning library and OpenML for collaborating online. Instructions will be provided beforehand about what to install and setting up your environment. We will use Jupyter Notebooks for many of the instructions. Next, we discuss the basics of using Python for machine learning, using a simple application to discuss data loading, basic data operations and visualizations, and we will train and evaluate our first machine learning models.

Classification and regression with scikit-learn: We will introduce the main algorithms for classification and regression. We'll cover k-Nearest Neighbors, Linear models, Naive Bayes, Decision Trees, Ensembles (Bagging and Boosting), Support Vector Machines and Neural Networks. We will also discuss the basics of how to evaluate models and optimize their parameters.

Pipelines: data preprocessing and dimensionality reduction: For many forms of data, we cannot simply apply machine learning algorithms. In this lecture, we first explore basic preprocessing techniques such as scaling, feature encoding, and missing value imputation. Next, we explore dimensionality reduction (e.g. PCA and t-SNE) and feature selection techniques. Finally, we discuss how to construct pipelines of operations to model data from start to finish.

Robert Jenssen (Arctic. Univ. Norway)

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Robert Jenssen is Associate Professor at the Arctic University of Norway (UiT, Tromsø, Norway) Professor II at the Norwegian Computing Center (NR, Oslo, Norway), and Senior Researcher at the Norwegian Center on Integrated Care and Telemedicine (University Hospital of North Norway). At the Arctic University of Norway he directs the Machine Learning @UiT Lab, with a focus on using information theoretic learning, kernel methods, graph spectral methods, and big data algorithms with deep learning.

Spectral clustering and kernel methods: This talk will present spectral clustering, a modern form of clustering using eigenvalues (the spectrum) and eigenvectors of certain data matrices, from a kernel methods perspective. The talk will start by a brief introduction to kernel methods in order to build context, with a special focus on the kernel matrix. Thereafter nonlinear PCA (kernel PCA) will be discussed, including embeddings (projections) onto lower dimensional spaces. Thereafter, we will turn to spectral clustering from a graph viewpoint and the Laplacian matrix. Finally, the recent information theoretic spectral clustering method known as kernel entropy component analysis will be discussed. Examples of code and applications will be given.

Michael Kampffmeyer (Arctic. Univ. Norway)

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Michael Kampffmeyer is a Ph.D. student at the Arctic University of Norway, where he works on applications and development of deep learning algorithms in a joint effort with researchers at the Norwegian Computing Center in Oslo, Norway. Michael studies issues related to transfer learning, the handling of different image resolutions and multi-modality. He is also interested in the combination of CNNs and unsupervised learning.

Deep learning with convolutional neural networks (joint with R. Jenssen): Deep learning and especially Convolutional Neural Networks (CNNs) have in recent years had a tremendous impact in the field of machine learning and computer vision. CNNs constitute the state of the art on many tasks, mainly in image processing, but also more and more in text processing and other fields that make use of structured data. This lecture will cover these networks starting from the general architecture and the way these networks are learned using backpropagation, to more recent advances in the training process such as dropout and batch normalization. Multiple applications, such as image classification and segmentation will be considered.

Filippo M. Bianchi (Arctic. Univ. Norway)

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Filippo Bianchi is a post doc at the Arctic University of Norway. He received his B.Sc. in Computer Engineering (2009), M.Sc. in Artificial Intelligence and Robotics (2012) and PhD in Machine Learning (2015) from the "Sapienza" University, Rome. Filippo has worked 2 years as research assistant at the Computer Science department at Ryerson University, Toronto, and his research interests in machine learning and pattern recognition, graph and sequence matching, clustering, classification, reservoir computing, deep learning and data mining.

Recurrent neural networks: Recurrent Neural Networks (RNN) are a type of neural networks whose hidden processing units (neurons) in each hidden layer receive inputs not only from external signal or previous layers, but also from the output of the layer itself or from successive layers, relative to past time intervals. An RNN can approximate any deterministic or stochastic dynamical system, up to a given degree of accuracy, if an optimal training of the internal weights is provided. In this presentation, we introduce the basics of the RNN model and we cover some of the main strategies adopted for training these networks. Then, we review the main state-of-the-art RNN architectures that have been developed, discussing the main advantages and drawbacks for each approach. Finally, we quickly present the main software libraries used to implement RNNs and the most important fields of their application.

Devdatt Dubhashi (Chalmers)

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Devdatt Dubhashi is Professor at Chalmers University of Technology (Gothenburg, Sweden), where he leads the Algorithms, Machine Learning, and Computational Biology group. He has a PhD from Cornell University (USA), has been a postdoc at Max Planck Institute (Germany), and his research interests include design and analysis of randomized algorithms, machine learning for Big Data, and computational biology. He has previously served as an expert on the Data Driven Innovation report and on a Big Data panel for the OECD.

Word Embeddings and Applications in Cognitive Computing: Word embeddings and more generally distributed representations in continuous spaces have been extremely successful in many recent advances in machine learning (ML), in particular, natural language processing (NLP). In this series of lectures, we will give an introduction to word embeddings such as Google's word2vec and their applications in key cognitive computing tasks. In the process we will also touch upon central tools in ML such as optimization methods and closely related areas such as Deep Learning with neural networks.

Word Embeddings: We will give an introduction to word embeddings and show how they can be computed in a highly scalable manner. In the process we will introduce key techniques from optimization such as gradient descent and its stochastic variants.

Summarization: We will explain the problem of multi-document summarization and discuss key concepts such as sub modularity in developing methods to solve it. We will introduce submodular optimization and show how it can be used together with word vectors can be used to extract summaries.

Word Senses: The same word can have different meanings when used in different contexts. We will introduce the problems of word sense disambiguation and word sense induction and show how various methods can use word vectors to solve these problems.

Nils Lid Hjort (University of Oslo)

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Model selection and model averaging: The prototypical statistical inference problem is to utilise data, say $\boldsymbol{y}$, to reach relevant inference statements for one or more parameters of primary interest, say $\boldsymbol{\mu}$. I will start out by going through the maximum likelihood approach for such a setup. Here a parametric model, involving some $\boldsymbol{f}(\boldsymbol{y}, \boldsymbol{\theta})$, leads first to an estimate $\widehat{\boldsymbol{\theta}}$ and then to a corresponding estimate for our focus parameter, say $\widehat{\boldsymbol{\mu}} = \boldsymbol{\mu}(\widehat{\boldsymbol{\theta}})$. Importantly, the apparatus also yields estimates of precision, typically in terms of a standard error (estimated standard deviation of the final estimate), so that, in essence, each proposed parametric model leads to an estimate and a confidence interval for any focus parameter.

The next step is to compare such estimates across a collection of competing models, say $\hat{\mu}_j$ for candidate models $j = 1, \dots, k$. There are various key methods for handling such problems, typically involving penalisation of attained log-likelihood maxima. The most important of these are the information criteria AIC, BIC, FIC, associated with Akaike, Bayes, and Focus. A further option is to average the different estimates $\hat{\mu}_j$ across candidate models, which is called model averaging.

I will walk my way through the most relevant ideas in this terrain, and provide illustrations, also with real data.

Literature: Gerda Claeskens and Nils Lid Hjort: Model Selection and Model Averaging, Cambridge University Press, 2008.

Confidence distributions and related topics: In various substantive quantitative sciences, from biology and medicine to climate and economics, the statistical summary, even from complicated data structures and sophisticated models for complex phenomena, is often `only' a point estimate and a standard error, perhaps presented as a 95 percent confidence interval. Sometimes the statistical machineries used involve Bayesian components, and then necessarily involving prior distributions. There are at least two reasons for wishing for a more coherent and scientifically more relevant statistical summary. The first is related to aspects of bias and skewness; not every estimator has a distribution close to a Gaussian. This means that confidence intervals could or should be skewed. The second reason is the reliance on prior distributions, which may be too subjective.

These are reasons for building an alternative apparatus for statistical inference and reporting, via what we call confidence distributions. These are partly like the Bayesian posterior distributions, but without priors. They may be used to read off confidence intervals at all levels, and they may be used to coherently combine information across different sources. I will provide the basics of this approach, and give illustrations, also related to `data fusion', the task of combining information across diverse sources.

Literature: Tore Schweder and Nils Lid Hjort: Confidence, Likelihood, Probability: Statistical Inference With Confidence Distributions, Cambridge University Press, 2016.

Bayesian nonparametrics: Bayesian inference amounts to combining a prior distribution for a parameter vector with a data-based likelihood to reach posterior distributions. This is largely speaking a widely successful way of carrying out practical statistical analyses. At the core of this is of course the Bayes theorem, which requires the unknown aspects of the probability model to be represented as a parameter vector. The ambitious goal of Bayesian nonparametrics is to extend the Bayesian machineries to situations and models where the parameter vector is infinite- or very high-dimensional, typically of a higher dimension than the data themselves. This could amount to having a prior distribution for a fully unknown regression curve or a nonparametric density. Getting such approaches to work involves careful conceptual and mathematical constructions and typically also a heavier computational burden. I will provide an introduction to these themes, again with illustrations from real data.

Literature: Nils Lid Hjort, Chris Holmes, Peter Müller, Stephen Walker: Bayesian Nonparametrics, Cambridge University Press, 2010.

Mark Tibbetts (Arundo Inc)

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Mark Tibbetts is a data scientist at Arundo with a background in high energy physics and over ten years experience analyzing large datasets using advanced statistical techniques. He has a Ph.D. from Imperial College London, and has been a post doc and researcher at Berkeley Lab (2010-2015) working with CERN, where he had a leading role in projects analyzing data for the ATLAS experiment. His research interests include the application of machine learning methods to industrial big data, and he aims to deliver high impact contributions to large scale data analysis and software engineering projects.

Industrial use-cases and workflows for ML: Applying machine learning techniques to industrial use cases is not as simple as taking preprocessed historical data and fine tuning models in scikit-learn. Those data must be located and extracted. Extracted data must be quality assessed and database signals mapped to uniform equipment hierarchies. Hierarchical data might have low statistics, missing signals and be labelled unreliably. Using real world examples I will discuss how a data scientist presented with such hurdles can overcome them to find high value insights in industrial data with machine learning techniques. I will then address how models can be deployed in an industrial setting allowing real time insights from new data as it is recorded.

Poster Presenters

Sergey Alyaev — Johannes Beil — Shaafi M Kaja Kamaludeen — Anna Kvashchuk — Marcia Raquel da Silva e Sousa Vagos — Femke B Gelderblom — Sebastian Matthias Braun — Johannes Langguth — Jean Rabault — Min Shi — Eleonora Piersanti — Ingerid Reinertsen — Lukasz Mentel — Mohammed Sourouri — Allan Peter Engsig-Karup — Aina Juell Bugge — Chaoran Fan — Philipp Lösel — Evi Zouganeli — Mario Martínez-Zarzuela — Daniel Stensrud Olderkjær — Carlos González Gutiérrez — Hugues Fontenelle — Arvid Lundervold — Viviane Timmermann — Erlend Hodneland — Erich Suter — Céline Cunen — Aliaksandr Hubin — Ketil Malde — André Ourednik — Yaman Umuroglu — Andrea Raffo — Ole-Johan Skrede — Juozas Vaicenavicius

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NOTES

The Geilo Winter Schools in eScience

The very first winter school was organized in 2001 by Knut-Andreas Lie, then Research Director for SINTEF Applied Mathematics. He wanted to create a meeting place for Ph.D. students and young researchers to foster interaction and catch up on recent developments within eScience. This was at a time when a 1.6 MB file was considered "huge", and the first school topic was "Cluster computing".

Having organized the winter school for over 10 years, Knut-Andreas Lie gradually passed on the responsibility to André R. Brodtkorb who is the current organizer. The first seven schools were funded by the Research Council of Norway through the BeMatA program, and continued with nine years of funding by the eVITA program. The school is currently a project funded by the IKTPLUSS program for the period 2016-2020.

The school has provided hundreds of lectures on topics relevant to the Norwegian eScience community over the last 16 years, ranging from parallel computing and Big Data to Monte Carlo simulations and continuum mechanics. The schools have attracted over 850 participants from industry, research, and academic institutions in Norway, Scandinavia, and the world.

Dr. Holms hotel

Geilo is renowned as one of the best winter sports resorts in Northern Europe, located in the mountains between Oslo and Bergen. Geilo lies at an altitude of 800 meters with its highest alpine slope starting at 1178 meters above sea level. This ensures good snow conditions throughout the winter. Geilo offers 35 varied and well groomed downhill slopes and 18 lifts with a capacity of 25.000 trips pr. hour. Moreover, there are excellent possibilities for cross country, with approximately 500 km of trails, both in the valley and in the mountains.

Dr. Holms Hotel is a distinguished hotel situated right next to the ski slopes. It was opened in 1909 by Dr. Ingebrikt Christian Holm, coinciding with opening of the railway. The intended use was for asthmatic city dwellers from Oslo and Bergen to refresh with the clear and unpolluted mountain air (Dr. Holm was a specialist in respiratory diseases). It has been occupied during the second World War, expanded multiple times, and even sports its own hotel ghost, the gray lady. If you're lucky, you might meet her in the staircase in the gray hours of the morning.

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The Research Council of Norway

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SINTEF