

Preface

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This volume contains the accepted technical papers of the Ninth Symposium on Conformal and Probabilistic Predictions with Applications (COPA 2020). The Symposium was originally intended to be held in Verona (Italy), but due to the coronavirus pandemic the event was held online on September 9–11, 2020.

The main part of this volume presents some latest advances in the theory and applications of conformal predictors. In total there are 17 accepted papers with authors coming from 8 countries.

Two invited talks are to be presented by well-known researchers. The first one by Vladimir Vapnik (Royal Holloway, University of London) and Rauf Izmailov (Perspecta Labs, USA) is entitled *Complete statistical theory of learning: learning using statistical invariants*. It forms the first part of the proceedings. The second invited talk *Risk and complexity in prediction problems* is to be presented by Marco Campi and Simone Garatti (University of Brescia, Italy); this is its abstract:

We show that the risk (probability with which a shortfall occurs) and complexity (number of relevant data-points to determine a solution) are strictly connected concepts in a general data-driven decision-making framework.

When these concepts are applied to prediction, they lead to extremely tight evaluations of the distribution of the probability of prediction error.

These results are relevant to all approaches in prediction theory that contain a compression scheme, including SVM (Support Vector Machine), SVR (Support Vector regression), SVDD (Support Vector Data Description) and others.

The second part develops the methodology of conformal prediction; it contains eight papers:

- *Constructing normalized nonconformity measures based on maximizing predictive efficiency* by Anthony Bellotti, which offers new methods of training conformal predictors (going beyond just training the underlying algorithms) in the case of regression.

- *Training conformal predictors* by Nicolo Colombo and Vladimir Vovk, which offers direct methods of training conformal predictors in the case of classification.
- *Conformal multi-target regression using neural networks* by Soundouss Messoudi, Sébastien Destercke, and Sylvain Rousseau, one of the first papers applying conformal prediction to multi-task learning.
- *Conformal calibrators* by Vladimir Vovk, Ivan Petej, Paolo Toccaceli, Alexander Gammernan, Ernst Ahlberg, and Lars Carlsson, designing fully flexible conformal predictive distributions.
- *A histogram based betting function for conformal martingales* by Charalambos Eliaades and Harris Papadopoulos, exploring new ways of testing the assumption of data exchangeability.
- *Mondrian conformal regressors* by Henrik Boström and Ulf Johansson, making an important step towards designing fully flexible conformal regressors.
- *Evaluating different approaches to calibrating conformal predictive systems* by Hugo Werner, Lars Carlsson, Ernst Ahlberg, and Henrik Boström.
- *Conformal anomaly detection for visual reconstruction using gestalt principles* by Ilia Nouretdinov, Alexander Balinsky, and Alexander Gammernan, one of the first papers applying conformal prediction to machine vision.

There are three papers in the third part, devoted to probabilistic prediction:

- *Mixing past predictions* by Alexander Korotin, Vladimir Vyugin, and Evgeny Burnaev, applying prediction with expert advice to long-term prediction of time series.
- *Fast probabilistic prediction for kernel SVM via enclosing balls* by Nery Riquelme-Granada, Khuong An Nguyen, and Zhiyuan Luo, suggesting ways to apply Venn-Abers predictors to very large datasets.
- *Practical investment with the long-short game* by Najim Al-Baghdadi, David Lindsay, Yuri Kalnishkan, and Sian Lindsay, proposing novel applications of prediction with expert advice to finance.

There are five papers in the fourth part, devoted to applications of conformal prediction:

- *Batch mode active learning for mitotic phenotypes using conformal prediction* by Adam Corrigan, Philip Hopcroft, Ana Narvaez, and Claus Bendtsen.
- *A conformalized density-based clustering analysis of malicious traffic for botnet detection* by Bahareh Mohammadi Kiani.
- *Classification of aerosol particles using inductive conformal prediction* by Linn Karlsson, Henrik Boström, and Paul Zieger.
- *BERT-based conformal predictor for sentiment analysis* by Lysimachos Maltoudoglou, Andreas Paisios, and Harris Papadopoulos.

- *Application of conformal prediction interval estimations to market makers' net positions* by Wojciech Wisniewski, David Lindsay, and Sian Lindsay.

There will be two poster presentations at the Symposium:

- *Evaluation and extension of inductive Venn–Abers predictive distribution* by Ilia Nouretdinov, James Gammerman, and Daljit Rehal.
- *A transformer conformal predictor for paraphrase detection* by Patrizio Giovannotti.

We are indebted to our sponsors, the University of Verona (Italy) and Royal Holloway, University of London (UK). Our special thanks go to Stena Line for their support and help in organising the Symposium.

We are very grateful to the members of the Programme Committee for their hard work in reviewing the papers and making acceptance decisions:

Ernst Ahlberg (Sweden), Vineeth Balasubramanian (India), Alexander Balinsky (UK), Tony Bellotti (UK), Claus Bendtsen (UK), Henrik Boström (Sweden), Evgeny Burnaev (Russia), Lars Carlsson (Sweden), Giovanni Cherubin (Switzerland), Marco Cristani (Italy), Matteo Fontana (Italy), Mohamed Hebiri (France), Shen-Shyang Ho (USA), Ulf Johansson, (Sweden), Yuri Kalnishkan (UK), Rikard Laxhammar (Sweden), Guang Li (China), Tuwe Löfström (Sweden), Khuong An Nguyen (UK), Ilia Nouretdinov (UK), Evgueni Smirnov (Netherlands), Ola Spjuth (Sweden), Paolo Toccaceli (UK), Jesus Vega (Spain), Fan Yang (China).

The task of reviewing was shared by sub-reviewers, whose help is also gratefully appreciated:

Staffan Arvidsson McShane (Sweden), Niharika Gauraha (Sweden), Philip Harrison (Sweden), Rachid Oucheikh (Norway).