Kshitij Goyal

PhD Researcher in Machine Learning

GitHub | Personal webpage

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Professional Experience

PhD Researcher @ DTAI lab, KU Leuven, Belgium *Oct' 2018- present*

Topic: Machine Learning with Constraints: Towards Trustworthy AI; *Advisor*: Prof. Hendrik Blockeel

- **Learning Models that Provably Satisfy Domain Constraints** *(primary goal of the thesis)*
  - Developed a new framework and an optimisation approach to learn models that can **certify domain constraints** (e.g., safety constraints, fairness constraints) for **all possible predictions**.
  - Learning approach uses **combinatorial optimisation** for learning the models, and combines it with **gradient descent** to **achieve scalability**.
  - Evaluation on various **regression**, **classification** and **structured prediction** tasks demonstrated that our approach, in contrast to existing approaches like regularization, is able to **certify domain constraints.**
  - Proposed **novel evaluation metrics** to evaluate constraint certification.
- **Music Playlist Generation** *(awarded the **best paper** at BNAIC'22)*
  - Working with **industry partner "Tunify"**, developed and implemented an approach that combines **rule based classification** with **PU learning** to automatically **identify music playlists.**
  - Proposed a **clustering** based method to **identify new playlists** from **customer data**, leading to an identification of more than **50 new playlists** previously unidentified by the domain experts.
- **Iteratively Improving Tree Performance by Optimising Subtrees**
  - Proposed and implemented an approach to **improve the performance** of an already learned tree by **optimising sub-trees** iteratively.
  - Demonstrated that the proposed approach improves the performance of CART and lookahead trees to close to **optimal levels**, while being **tractable for deep trees**.
- **Identifying Feature Interaction Constraints to Improve Predictive Performance in Tree Based Models**
  - Conceptualised an approach to use the **feature interactions** from data, identified via a **wrapper approach**, as constraints in the existing XGBoost framework.
  - Interaction Constraints led to an average **improvement of 5%** in the performance for various regression tasks.

Business Analyst - Zynga Games, Bangalore, India *April - Sep' 2017*

- Analysed key performance metrics for multiple mobile games to **provide insights** for business strategies in addition to developing an **in-house tool** to perform A/B tests on newly rolled updates.

Business Analyst - Accenture Management Consulting, Bangalore, India *June 2014 - Mar' 2017*

- As part of a team, developed **fraud detection techniques** for a reliability management system for an automotive giant to **reduce post-sale expenses**. Proposed approach resulted in a projected **reduction** in warranty spend by **$249** over the course of 4 years.
- Optimised stock levels at central warehouses across multiple locations for a European telecom giant. **Improved** the total stock value by **9%** by proposing a **rebalancing solution** between different warehouses.

Data Analyst Intern - Media iQ Digital, Bangalore, India *May - July 2013*

- **Developed forecasting models** to predict **digital impressions** won by an airline carrier for a given bid.

Education

MSc in Artificial Intelligence, KU Leuven *(graduated magna cum laude)* *Sep' 2017 - Sep' 2018*

Master thesis: Proposed and implemented a variant of the classic RankNet approach of ranking documents which personalises the results based on user profiles.

MSc (Integrated) in Mathematics and Scientific Computing, IIT Kanpur, India *June 2009 - May 2014*

Master thesis: Analysis of middle censored data under a shifted exponential distribution

Skills

General: Machine Learning · Combinatorial Optimisation · Satisfiability and Logic · Deep Learning · Data Mining · Tree Based Models · Statistics · PU Learning

Programming: Python · SQL · R · Java

Libraries: PyTorch · NumPy · Scikit-learn · Pandas · XGBoost · Altair · z3py · Scoop

Languages: English (Full Professional Proficiency) · Hindi (Native)

Publications

1. SaDe: Learning Models that Provably Satisfy Domain Constraints. (pdf) *ECML 2022*
   K. Goyal, S. Dumancic, H Blockeel
2. Automatic Generation of Product Concepts from Positive Examples. (pdf) *BNAIC 2022*
   K. Goyal, W. Meert, H Blockeel, E. V. Wolputte, K. Vanderstraeten, W. Pijpops, K. Jaspers
3. Feature Interactions in XGBoost. (pdf) *AIMLAI-ECML 2019*
   K. Goyal, S. Dumancic, H Blockeel
4. DeepSaDe: Learning Neural Networks that Guarantee Domain Constraint Satisfaction (pdf) *(under review)*
   K. Goyal, S. Dumancic, H Blockeel

Leadership & Awards

- Teaching assistant for three courses: taught exercise sessions and prepared assignments *2018 - 2022*
- Thesis advisor to 5 students: projects in areas of **personalised search**, **music streaming, game theory & constrained learning** *2018 - 2022*
- Department representative for the thesis administration for MSc Computer Science at KU Leuven *2019 - 2022*
- Research paper **reviewer** for ECML'19 and ECML'22
- Received the **best paper award** at BNAIC'22
- Awarded **2nd prize** at the KU Leuven Datathon *2017-2018*
- Awarded the prestigious **INSPIRE** scholarship by the government of India for undergraduate studies *2009-2014*