SIMON FRASER UNIVERSITY

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Attn: Canadian Artificial Intelligence Association

Re: Outstanding MSc. Thesis award for Kurt Routley

I strongly support Kurt Routley's nomination for a Convocation Medal. Kurt finished his M.Sc. degree in Spring 2015. Kurt's thesis used advanced AI techniques (Markov games and reinforcement learning) to model hockey dynamics. The main application was a novel approach to player ranking.

Significance. One of the two main problems in sports analytics is evaluating the performance of players. (The other one is predicting match outcomes.) The movie "Moneyball" introduced the power of statistical player evaluation to a large audience. Kurt's thesis applied AI techniques to present a novel approach to player ranking in ice hockey, a very popular (and very Canadian) sport with a huge economic and social impact. The basic idea is that a Markov game model (multi-agent version of Markov decision process) defines the value of an action at a given state of the game (basically, how much the action improves expected reward, e.g. chance of winning). AI algorithms such as dynamic programming can be used to compute this value efficiently, even for very large state and action spaces. Kurt used the total number of a player's action values to rank players. The resulting ranking scored well on a number of validation measures, and identified undervalued players that represent a good bargain for teams looking to trade (the "moneyball problem").

Originality. The AI way of thinking that Kurt brings to bear on hockey analytics is completely novel for almost everyone in that field. The general idea of assigning values to actions is the standard approach to player rankings and has been long established in baseball. The problem is that in a continuous-flow game like ice hockey, the value of an action depends on its *medium-term* effects. The standard analytics studied for ice hockey omit such effects, because analysts have simply lacked the conceptual and computational tools for capturing them. Thus standard analytics focus on goals (the +/- score), and at most one action preceding the goals (assists, shots). Medium-term effects such as penalties that increase scoring chances have been omitted. As a result, hockey analysts base their player rankings on very few of the events that occur on the ice (no penalties, hits, passes, face-offs etc.). His thesis shows the power of AI concepts for evaluating the value of *all* events in ice hockey.

Impact. Kurt has published a paper on hockey analytics at the prestigious *UAI* conference, as the first author. A follow-up paper was presented at the *Sportsanalytics Workshop at the European Conference for Machine Learning*. He has also been invited to present at the *Vancouver Hockey Analytics* conference this year. Kurt's findings have

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already attracted interest from industry; we have started a collaboration with SportLogic, a Montreal-based company that supplies video analysis for ice hockey.

Data Collection. Kurt wrote a program called a web crawler that downloads play-by-play data from the National Hockey League website and inserts the data into a relational database. This is harder than it may sound as it requires fixing many inconsistencies in the website's format, changes between seasons etc. The data comprise 14 NHL seasons, over 17,000 games and over 4 million events (hits, goals, penalties, faceoffs, shots, etc.). This dataset has been added to the SFU library's Radar collection of research datasets. It is a significant contribution to the hockey analytics community. Together with colleagues from Statistics SFU and Laval University, Kurt's database was the basis for a paper on referee analytics. This paper was submitted to the American Statistical Association Data Science journal, and has been accepted subject to revisions.

Other work. In addition to his research on ice hockey dynamics, Kurt has published a well-received paper on machine learning for relational databases in the IEEE symposium on Computational Intelligence, an influential international conference. This research grew out of a course project for a graduate course on Machine Learning. The paper was well received at the IEEE symposium, and has led to an ongoing international collaboration with researchers from the Czech Technical University in Prague. Kurt's research on learning for relational databases involved extensive simulation experiments--he has done enough work for two Master's Degrees! Nonetheless time to completion was below average, 1 year and 8 months compared to 2-3 years that are the average in the Applied Sciences faculty.

Internal Examiner: SFU does not usually require a separate examination report from the thesis examiner beyond the defense. I have therefore asked Tim Swartz, Kurt's examiner, to write a separate endorsement letter. Tim is leading authority on sports analytics. He is one of the editors of the *Journal for Quantitative Analysis in Sports*, and has made appearances on CBC, BBC, and local media. Last year he won a research award from the American Statistical Association. We were lucky to have him advising us on Kurt's thesis.

Sincerely,

Oliver Schulte

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