Project Title: CoCoA: Continuous Combinatorial Auction

Names of the Nominees: The project is lead and driven jointly by faculty at University of Minnesota (Professors Gediminas Adomavicius, Shawn P. Curley and Alok Gupta) and George Mason University (Professor Pallab Sanyal, formerly a doctoral student at University of Minnesota).

Project Summary: Combinatorial auctions—in which bidders can bid on combinations of goods—can increase overall social welfare of trades when goods exhibit complementarities. However, the mechanism has yet to become popular in the electronic marketplace, primarily due to the computational complexity of determining winners in such auctions and the cognitive complexity of formulating combinatorial bids. In the <u>Co</u>ntinuous <u>Co</u>mbinatorial <u>A</u>uction (CoCoA) project, we follow design science principles to design, build, validate, and evaluate a combinatorial bidding environment that is aimed at lowering the computational and cognitive hurdles in order to realize the potential of the novel mechanism. A large set of laboratory experiments implements the ideas generated by our research and validates that the designed artifact can generate high social welfare and is also easy to use, completing the end-to-end design process (from problem identification and feasibility analysis to the artifact implementation and value demonstration).

The work is within the realm of information systems related design science because unlike the traditional approaches of solving for optimal set packing problem (an NP-hard problem), we design a search-based approach where optimal allocation can be computed in constant time comparing several look-up queries. Our approach essentially turns the computation problem into managing an exponential data structure with linear time updates and constant query times. While the approach is limited by the size of memory, it allows for execution of a real-time combinatorial auction. Since the approach is for a business problem and is based on design and management of a data structure and associated queries for operations, we believe that it fits the definition of design science work. In addition to designing and developing computational capabilities for enabling continuous combinatorial auctions, another important goal of the project has been to foster the acceptance and usage of the complex mechanism through the availability of information and tools that are aimed at meeting the users' task demands. Therefore, we design and implement several different information feedback artifacts for combinatorial auctions. The primary evaluative approach applies economic theories (traditional as well as behavioral) and several technology acceptance paradigms (including the technology acceptance model, TAM, and the net promoter score, NPS) to compare alternative information feedback designs. Our work paves the way for continuous combinatorial auction mechanisms in online consumer-oriented commerce.

Supporting Documents and Evidence

<u>Theoretical/computational basis of building the artifact</u>

Primary supporting document (peer-reviewed journal publication):
- Adomavicius, G., A. Gupta. 2005. Towards Comprehensive Real-Time Bidder Support in Iterative Combinatorial Auctions. *Information Systems Research* 16(2) 169-185.

The above supporting document supersedes the preliminary versions of this work (peer-reviewed conference/workshop publications):
- G. Adomavicius and A. Gupta. Providing Real-Time Feedback to Bidders: Homogeneous-versus Heterogeneous-Item Combinatorial Auctions. *14th Workshop on Information Technology and Systems (WITS'04)*, Washington, D.C., December 2004.
- G. Adomavicius and A. Gupta. Towards the Comprehensive Bidder Support in Combinatorial

Auctions. *13th Workshop on Information Technology and Systems (WITS'03)*, Seattle, Washington, December 2003.

Description of how design science principles were followed to design and build the artifact and evaluation of the user acceptance

Primary supporting document (peer-reviewed journal publication, currently under review):

- Adomavicius, G., Curley, S. P., Gupta, A., and Sanyal, P. User Acceptance of Complex Electronic Market Mechanisms: Role of Information Feedback. *Revise and Resubmit at **Journal of Operations Management***.

The above supporting document supersedes the preliminary versions of this work (peer-reviewed conference/workshop publications):

- G. Adomavicius, S. Curley, A. Gupta, and P. Sanyal. User Perceptions in Continuous Combinatorial Auctions: Effects of Information Feedback. *12th INFORMS Conference on Information Systems and Technology (CIST-2007)*, Seattle, Washington, November 2007.

Evaluation of the artifact using economic measures

Primary supporting document (peer-reviewed journal publication, conditionally accepted):

- Adomavicius, G., Curley, S. P., Gupta, A., and Sanyal, P. Impact of Information Feedback in Continuous Combinatorial Auctions: An experimental study of economic performance. *Conditionally accepted at **MIS Quarterly***.

The above supporting document supersedes the preliminary versions of this work (peer-reviewed conference/workshop publications):

- G. Adomavicius, S. Curley, A. Gupta, and P. Sanyal. Impact of Information Feedback on the Outcome of Continuous Combinatorial Auctions. *Workshop on Information Systems Economics (WISE 2007)*, Montreal, Quebec, Canada, December 2007.
- G. Adomavicius, S. Curley, A. Gupta, and P. Sanyal. Design and Effects of Information Feedback in Continuous Combinatorial Auctions. *Twenty Eighth International Conference on Information Systems (ICIS-2007)*, Montreal, Canada, December 2007.

Evaluation of the artifact using the analysis of user behavior

Primary supporting document (peer-reviewed journal publication, forthcoming):

- Adomavicius, G., Curley, S. P., Gupta, A., and Sanyal, P. 2011. Effect of Information Feedback on Bidder Behavior in Combinatorial Auctions. *Forthcoming at **Management Science***.

The above supporting document supersedes the preliminary versions of this work (peer-reviewed conference/workshop publications):

- G. Adomavicius, S. Curley, A. Gupta, and P. Sanyal. Impact of Information Feedback on Bid Characteristics in Continuous Combinatorial Auctions. *17th Workshop on Information Technology and Systems (WITS'07)*, Montreal, Canada, December 2007. (Nominated for the Best Paper Award.)

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- Strategies, Performance, and Acceptability in the Dynamic, Competitive Environment of Continuous Combinatorial Auctions (PIs: S. Curley, A. Gupta, and G. Adomavicius). *National Science Foundation (NSF)*, Directorate for Social, Behavioral, and Economic Sciences, "Decision, Risk, and Management Sciences" program, 2010-2013 ($393,772).