

Judgment and Decision-Making under Uncertainty

A Proposed Cluster Hire

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Executive Summary

This proposal outlines a series of judgment and decision-making (JDM) hires that would synergistically enhance research and teaching in multiple departments across campus. The hiring plan is for four junior faculty, two in the Department of Psychology, and one in each of Computer Science and Economics. The new hires would support existing research and teaching opportunities within each of the departments, foster new interdisciplinary collaborations, and contribute to an already outstanding record of federal funding. The proposal is notable in the possibility of producing results of interest to a wide range of professionals outside of academia and the general population. Realization of this proposal would provide the University with a number of immediate benefits:

- **Interdisciplinary collaborations:** JDM is, by its very nature, interdisciplinary. It has roots in cognitive Psychology and Computer Science and has reached international prominence as a field in numerous areas including Economics.
- **Expand on excellence:** The Psychology department has been one of the pioneers in cognitive Psychology and currently includes a number of experts in the mathematical modeling and neuroimaging techniques used in decision-making research. The Computer Science department is a world leader in artificial intelligence, a field with strong ties to JDM. The Economics department is a historical leader in experimental economics, game theory, and political decision-making. All three departments have specific high-priority hiring needs in areas related to JDM.
- **Funding:** Because its rigorous scientific techniques are coupled with a host of potential applications, JDM is ideally suited to garner funding from many sources. Funding is widely available for both theoretical and applied research. Given that the startup and space requirements of such researchers are relatively low, the return on investment is likely to be high.
- **Leadership:** JDM researchers in different areas are often isolated from one another by University organization. Creation of a JDM structure that spans multiple departments and the hiring of cutting-edge researchers in fields such as the neurological basis of judgment and decision-making would position the University of Massachusetts to be a national leader in this field.

1. Overview of Judgment and Decision Making

Judgment and decision-making are pervasive, important intellectual activities engaged in by all of us in academic, professional, and social pursuits throughout every day. The ability to form good judgments and make wise and effective decisions generally is considered the mark of a successful person in the smaller as well as the larger matters of living (Connolly, et al 2003).

Thinking about what goes into a sound judgment can be traced at least as far as the ancient Greeks. Because it is of great academic and intellectual concern, discussions of sound judgment continue today among philosophers, psychologists, lawyers, managerial scientists, political scientists, computer scientists and many others outside academia (Connolly, et al, 2003). Despite its importance and application in almost every known human endeavor, the scientific study of judgment is relatively new. The speed at which it has developed, however, belies the soundness of its methods, scope of its application, and ability to generate interest in many areas. For example, JDM related research has appeared in more than 500 different professional journals (Connolly, et al, 2003). Its rapid rise as a research area has meant that the many fields that study JDM often do so in isolation. As these different fields often investigate similar questions and use compatible methods, this isolation is fostered more by historical considerations than scientific ones. Too often, university structures and research cultures reinforce this scattering of effort. One of the key benefits of this proposal is the recognition of such artificial boundaries and the creation of strong intellectual ties between the different facets of JDM researchers.

JDM has strong interdisciplinary roots. JDM began as a discipline in its own right in the 1960 during an explosion of research in cognitive Psychology known as the “cognitive revolution”. The introduction and development of the electrical computer was one of the main factors that contributed to this renewed interest in mental activity. Computer scientists, statisticians, and mathematicians provided the theoretical structures needed to evaluate the rationality of human judgment. The computer supplied the means to construct and test mathematical models of the decision-making process. The applicability of the field was immediately apparent. Indeed, the only two cognitive psychologists to win a Nobel prize did so in Economics (there is no prize for Psychology). In 1978 Herbert Simon (who is also considered one of the founding fathers of artificial intelligence) won the prize for his pioneering research into the decision-making process within economic organizations. Daniel Kahneman was given the prize in 2002 for having incorporated insights concerning human judgment and decision-making under uncertainty from psychological research into economic science.

It should then come as no surprise that funding for JDM research is strong. Multiple federal agencies including NSF, NIH, DARPA, and AFOSR all currently fund basic theoretical and applied research in JDM. Furthermore, many JDM researchers receive funding in collaboration with other researchers in different fields. For example, the national institute on drug abuse has funded research examining decision-making behavior in high-risk and drug-use populations. In fact, most of the programs mentioned in section 4 specifically require interdisciplinary projects.

It has never been more important to study JDM than now. Decisions made by individuals in corporations and governments have the ability to affect the environment and its inhabitants on a global scale. Decisions regarding economic, health, legal, military, and environmental policies all require sound judgment by individuals and groups. Furthermore, although there is a realization that the isolation of different JDM researchers slows development, there have been few institutions that have produced coherent JDM centers. Through the creation of a working JDM group and hiring researchers that bridge existing gaps, the University of Massachusetts is poised to become a world leader in the development of the theory and empirical techniques of JDM. Moreover, JDM has entered the public discourse in a broad way, so the field is already in the minds of policy makers ranging from economics to nanotechnology. Thus, the basic research we envision these hires supporting would have a ready audience in many policy fields and enhance the University's visibility in important current debates.

JDM consists of three main branches: normative, descriptive, and proscriptive. That is, JDM researchers study how decisions would ideally be made, how people actually make decisions, and, given human limitations, how people should make decisions. Each of these branches of research is encompassed in the hiring profiles provided below.

JDM is one of the major subdisciplines of cognitive Psychology. The two Psychology JDM hires will focus on the descriptive aspect of JDM. Normative theories are often invoked and prescriptive theories often follow, but the focus is descriptive. Historically, psychological decision-making behavior has been studied using empirical methods and mathematical models. That is, behavior is experimentally studied and hypotheses are described and tested using the language of mathematics. The first hire would come from this strong and remarkably successful tradition. There has been a recent surge in cognitive neuroscience, the study of the neurological underpinnings of cognitive behavior. Using these relatively new techniques, JDM researchers have made great theoretical and empirical advances and have attracted funding and the attention of a new generation of researchers. The second hire will study JDM using cognitive neuroscience techniques.

In Computer Science, JDM is a central part of artificial intelligence. Artificial intelligence is a broad interdisciplinary field whose primary goals include (1) building intelligent machines for a wide range of application domains; (2) formalizing knowledge and mechanizing intelligence and decision-making; (3) using computational models to understand and explain complex behavior of machines, humans, and organizations; and (4) making computers as easy to work with as people. Each one of these objectives has a high intersection with the JDM cluster. Just to give a few examples, descriptive theories of decision-making are important for developing expert systems that can employ human strategies to solve complex problems. They are also crucial for developing intelligent tutoring systems that can evaluate the student's level of competence. Developing effective normative theories of decision-making—ones that can be implemented efficiently as computational processes—is a focal area of AI research. Such normative frameworks are used extensively to develop autonomous systems that can perceive the world, create their own plans, and act in the world (for example, autonomous space exploration systems). Prospective theories are important in computer systems that interact with people and need to predict possible future actions. Examples include opponent modeling in game playing systems. In addition, research in cognitive psychology on how people make decisions and judgments help inform research in modeling computer decision-making.

Game theory is the branch of JDM that studies decision-making behavior in situations in which success depends on the choices of others. In Economics, the areas of game theory and experimental economics are central to analyzing policy on many current issues of concern, including health care, social security, and consumer behavior in response to declines in the value of wealth. Experimental methods allow for the control of important variables in the study of economic institutions, information, policies, etc, both in the laboratory and in the field. Laboratory techniques also make it possible to observe and control variables that would not be observable in the field, such as the preferences of buyers and the costs of sellers in the trading of an artificial good. Thus experiments generate important insights and data for understanding and describing why people make different decisions in different cultural, political, and economic environments. Game theory provides the normative theoretical underpinnings for experimental economics in that empirically testable hypotheses come from models of behavior. Game theory is particularly suited to contexts in which competing interests must decide how and how much to negotiate, hence the relevance to policies, which must consider and weight concerns of disparate constituencies.

2. Existing strengths and gaps on campus in areas related to JDM

Psychology

The Psychology department is exceptionally strong. A 2005 AQAD review stated that “The Department of Psychology at UMass has historically been an extremely strong department. In 1995 the NRC ranked the department 27th of 190 departments surveyed. The review committee feels that the department has maintained its high quality in the last 10 years. The quality of research being conducted in the department is quite impressive, as evidenced by the number and quality of faculty publications and the amount of extramural support. ... The department is one of the absolute best at UMass, in terms of its research excellence, extramural funding, and teaching.” The review goes on to say that cognitive psychology, with which JDM is most commonly aligned, has “excellent individual faculty in memory, basic vision, and computational modeling” and notes that “there is clear collaboration across departments at the university... Such collaborations have, in part, contributed to the high rate

of external funding.” The proposed JDM hires would continue such collaboration with the Computer Science and Mechanical and Industrial Engineering (Baker, Fisher) departments and create areas of collaboration with Economics. Such collaborations will only increase funding opportunities.

Like all departments across campus, the Psychology department has lost faculty numbers in recent years. The AQAD review maintains that “strength in both basic human cognition and further extension into areas that cut across areas, such as cognitive neuroscience, will be particularly important to maintain the current excellence in this area.” The proposed neuroscience hire is explicitly mentioned in the review and would extend the strength of the department into this increasingly important field. Such a hire would be able to interact with current exceptional Psychology neuroscientists such as Lisa Sanders, Kyle Cave, Matthew Davidson, Neil Berthier, and Lisa Scott. It is important to note that cognitive neuroscience is now a critical research area as evinced by the number of grant opportunities and interested graduate students. Such a hire would also nicely complement the non-human neuroscience researchers in the department such as Melinda Novak and Agnes Lacreuse. The proposed empirical and modeling hire would strengthen the core cognitive faculty and would interact directly with the computational modelers such as Andrew Cohen (who would serve as director of this program), Caren Rotello, Adrian Staub, and Jeffrey Starns. Because language (Adrian Staub & Lisa Sanders), memory (Caren Rotello & Jeffrey Starns), and concepts (Andrew Cohen) are key to the study of JDM, such a hire would also build very strong bridges within the cognitive faculty. Both hires also have strong potential to strengthen bridges to social (Ronnie Janoff-Bulman, Nilanjana Dasgupta, and Linda Tropp) and developmental (Lisa Scott, Neil Berthier, Matthew Davidson) faculty. As the AQAD review concludes, with such support, the “department should be in an excellent position to maintain and improve its quality, and meet its goal of moving from one of the top 15% departments nationally to the top 10%.”

Computer Science

The Computer Science department is one of the most highly-ranked, internationally visible departments on campus. It is also well known as one of the world’s leading centers of research in artificial intelligence, consistently ranked among the top 10 departments in that area. Several senior faculty members (Barto, Croft, Lesser) are viewed internationally as pioneers of their corresponding fields (Machine learning, information retrieval, and multi-agent systems). In FY 2008, new research awards accepted by Computer Science faculty totaled more than \$15 million, the largest among all the departments on campus.

Despite these strengths, the computer science department has also identified significant gaps in several AI areas related to JDM, and an urgent need to hire a replacement for professor Victor Lesser well before he retires, so that the department can leverage his expertise and reputation to attract a star young researcher in this field. An investment in AI is among the top priorities in the department, following the departure of one recently tenured faculty, leaving the department with just one assistant professor in AI (who is scheduled to be promoted and tenured next year).

A new hire in the broad area of multi-agent systems (focused on computational game theory) would be an invaluable collaborator for several groups within the department and for the JDM cluster. Within the department, this hire would complement our expertise in resource-bounded reasoning, learning and planning under uncertainty (Barto, Lesser, Zilberstein), decision theory (Zilberstein), computational models of bounded rationality and meta-reasoning (Lesser, Zilberstein), machine learning (Barto, Jensen, Mahadevan, McCallum, Siegelmann), networking and peep-to-peer systems (Kurose, Levine, Towsley, Venkataramani), security and privacy (Fu), and intelligent tutoring systems (Woolf). The research of these faculty members will both benefit from the additional expertise of the new faculty member, and also help attract, recruit and nurture a top candidate.

Additionally, the cluster hires in other departments will help forge close interactions with CS researchers working on computational theories of motivation, reward, and addiction (Barto, Siegelmann), computational models of learning and adaptation in animal motor control systems (Barto), developmental and cognitive robotics (Gruppen), knowledge discovery (Jensen), and biological and neural computation (Siegelmann).

Economics

The Economics department was a leader in experimental economics and game theory until the retirements of Professors Samuel Bowles and Herbert Gintis. The department has been trying for some time to rebuild in this area and have been fortunate to have Professor Woojin Lee, whose main interest is the link between economic status and political decision making, and Professor Peter Skott, whose interest in game theory applies to macroeconomics. However, Professor Skott is not mainly a game theorist and the department does not currently have an experimental economist. With an experimental person the department could build on the work of Professors Lee and Skott by providing opportunities for collaborative support in empirical investigation of their theoretical models. (Note too that the collaborations within economics could include other colleges, since the Resource Economics Department, now in the School of Management, also is engaged in research in experimental economics. For example, Professor John Spraggon's research concerns consumer behavior in response to marketing strategies.)

3. Profiles of new faculty that will be hired into the JDM cluster

Psychology

Hires in Psychology include, first, a theoretical and modeling researcher and, second, a cognitive neuroscientist. Both researchers should focus on the descriptive aspect of JDM, i.e., how people actually make choices and decisions. The hires will address theories of JDM, as opposed to working solely on applications or empirical work (but with an eye to applications of interest to professionals outside of academia and the general population). The core research should be cognitive in nature, but could draw from social and developmental perspectives. To best connect with the current Psychology faculty, the hire would ideally examine how cognitive processes such as memory, language, and categorization interact with JDM. To connect more deeply with other areas of the psychology department and other departments across the campus, interests in affect, motivation (NSB), stress (NSB), social (social Psychology & Sociology), and cultural (Anthropology) influences, or real-world complexity (Economics, Computer Science, Legal Studies, & Political Science) would be a plus.

The first hire will utilize mathematical models as a research tool. This tool is particularly important in JDM, but it would also provide a very strong connection with other cognitive Psychology faculty and build on an existing strength. The use of these tools would also be a natural bridge to other departments (Management, Economics, Computer Science, Engineering, etc). The hiring of computational modelers is currently high on the cognitive faculty's priority list.

As it is becoming more prevalent and important for grants, the second hire will study similar theoretical questions, but will use neuroscience techniques. It is important that the cognitive and behavioral questions and theories remain paramount. The Psychology department is currently working to develop a core neuroscience faculty presence, so such a hire is highly aligned with departmental goals. Such a researcher would connect well with current neuroscientists both within Psychology and in other departments such as Biology.

Computer Science

An ideal JDM hire in computer science would cover a large subset of the following areas that have been identified as important expertise that the campus is lacking.

- Design of new electronic marketplaces and negotiation protocols that allow people and software agents to express their preferences and generate good outcomes. Design incentive mechanisms to reach good outcomes.
- Models and algorithms for group decision making, coalition formation, coordination and communication.
- Methods that facilitate group decision-making: social choice, mechanism design, preference aggregation techniques, and voting mechanisms.
- Computational game theory.

Besides strengthening the JDM cluster, a new hire in these areas will contribute to many other groups within the Computer Science department (computer networking, electronic commerce, robotics, and intelligent tutoring system) and to other research on campus (in Psychology, Economics, Business, and Engineering).

The Computer Science department tried to hire in this area and made an offer to a star young researchers in 2006. Despite strong efforts, that person decided to go elsewhere, partly because he felt that the other university offered a richer environment for collaboration outside of Computer Science. Being hired as part of a cluster would help allay such concerns.

Economics

The Economics department is especially interested in an experimental economist who can collaborate across disciplines with anthropologists, political scientists and sociologists. Work done earlier in this department by faculty now retired was path breaking in assessing the role of cultural norms in decision-making across cultures exactly because of the interdisciplinary character of the research. It has been an on-going goal of the department to strengthen the remaining expertise in this area, so a cluster hire in decision making is completely aligned with existing priorities.

Decision-making is affected profoundly by both economic circumstances of individuals and their perceptions of both their circumstances and the state of the economy as a whole. Whether decision-making is about social or political questions, experiments and other research (including that of our Professor Lee) have shown that economics matters. Thus the role of economics in the very act of decision-making needs to be considered. Secondly, experimental economics has much to offer from its experience in experimental design of tests of decision-making. As noted above, the best research in this field is interdisciplinary, involving social status, norms and cultural specificities as well as what may be universal economic motives and incentives. We expect that experimental economics can inform and learn from other disciplines studying factors like norms and cultures.

4. Research opportunities in JDM

All of the major federal funding agencies support research in the broad area of JDM. A sample list of sources that have funded basic JDM research is provided in the appendix. Researchers in JDM, however, have also been successful at finding funding for applied work in collaboration with other researchers. Just a few of many potential examples are also provided in the appendix.

UMass faculty have done well obtaining funding from these and similar programs, but not at the scale that a cluster would be able to obtain (i.e., MURI grants that provide several millions of dollars over 5 years). The cluster would allow us to apply for the larger grants that require significant interdisciplinary expertise.

The trajectory for research funding shows signs of significant improvement, including in JDM areas. President Obama has stated his intention to double the funding of the National Science Foundation within the next few years, and has already channeled at least \$3 Billion in one-time new funding to the NSF. The Defense Advanced Research Projects Agency (DARPA) has gone through a change of leadership that is expected to significantly increase the availability of funding for research. One example in the JDM area is the new SELF program, seeking to advance the scientific understanding of meta-reasoning and self-explanation. DARPA looks to exploit this advancement by building systems that can reason about their own successes and failures and can explain this reasoning to others.

5. Anticipated impact of the cluster

5.1 Impact on research

Although there are some important collaborations on campus in the area of judgment and decision-making, their number and scale are far below the critical mass required to develop large-scale research initiatives. The cluster participants, with the help of the new hires whose areas of expertise close important gaps we currently have, will

be able to take advantage of larger and significant funding opportunities. The impact will not be limited to the three leading departments involved in this proposal. There are additional new connections and cluster participants that span numerous departments on campus. A partial list of UMass faculty with potentially strong ties to the proposed cluster is provided in the appendix.

The cluster also has the potential to aid in the development of strong ties to other universities and increase large-scaling funding opportunities. For example, a number of recent MURI grants were awarded to multiple university teams studying decision-making. The teams consisted of psychologists, computer scientists, mathematicians, statisticians, and engineers, among others. A few examples of AFOSR MURI grants supporting JDM research is provided in the appendix along with examples of other large MURI initiatives focus on decision-making.

5.2 Impact on education

Psychology

The Psychology department would be able to offer undergraduate and graduate courses in empirical, theoretical, and neurological JDM. Although common at other peer institutions, none of these courses are currently offered at UMass. Such courses would likely be an important educational component, not only for students of psychology, but for students across campus. For example, Managerial and Behavioral Accounting students would directly benefit as would students from Mechanical and Industrial Engineering, Computer Science, Political Science, Education, Legal Studies, and Economics. Because it is recognized that such topics are important for many disciplines, current cognitive Psychology courses are often taken by students from across campus (Computer Science, Linguistics, Management, Education, etc). JDM courses would easily fall within this category. Because they tend to mix students from different disciplines, such courses also tend to have a wide impact on education, often leading students to cross-disciplinary research. These hires would also be likely candidates for student committees from these diverse areas.

Computer Science

The computer science department does not offer currently courses in the area of computational game theory, social choice, mechanism design, and preference aggregation techniques. Such courses have become an integral part of modern computer science and are regularly offered at peer institutions. These are courses of great interdisciplinary value that a new JDM hire would allow us to develop. While occasional seminars in these areas have been offered in the past and attracted significant participation from a variety of departments, they also underscored the need to develop regular undergraduate and graduate courses on these topics. Example of just a few such courses offered by Computer Science departments include Algorithmic Aspects of Game Theory (Berkeley), Topics in Algorithmic Game Theory (Stanford), Algorithmic Game Theory (Cornell), Game-Theoretic Artificial intelligence (Brown), Economics and Computation (Yale), Cryptographic Game Theory (MIT), and Computational Game Theory (UPenn). Hiring an expert in this area and developing similar courses at UMass is an important outcome of this proposal.

Economics

The Economics department will expand course offerings in experimental economics and add courses in advanced game theory. The current course offerings in experimental economics (at present through the Resource Economics department) and game theory always experience excess demand because students realize that the skills taught in these courses are fundamental to both their understanding of economics and their resumes when on the job market. Alumni board members, who advise us on the qualifications necessary for economics majors to be successful in the job market, emphasize the importance of exposure to game theory and familiarity with at least a subset of empirical methods, including experiments. Advanced courses in experimental economics and game theory at the graduate level from a social science perspective will complement the courses offered in other departments on campus.

6. Organizational structure and resources

6.1 Cluster organization and governance

The following structure will be put in place to monitor, advise, and report on the cluster's performance:

- Andrew Cohen (Psychology) will serve as the cluster director with Shlomo Zilberstein (Computer Science) and Diane Flaherty (Economics) serving as co-directors. The directors can be updated yearly based on the current JDM faculty.
- The cluster directors will create a group of affiliate faculty members on campus, manage the cluster's web site and organize periodic meetings.
- The cluster will maintain a centralized list of relevant funding opportunities, active research projects, relevant talks, and seminars in each of the departments.
- Cluster meetings will focus on exploring specific funding opportunities and initiatives and the formation of groups of faculty members to participate in these initiatives.
- Cluster members will be invited to actively participate in recruiting efforts of new faculty with relevant expertise (both those funded under this cluster initiative and others).

6.2 Resources

Psychology

Psychology JDM researchers are relatively modest in their need for both startup and space. The Psychology department has recently identified potential space for new cognitive hires. The Psychology department has historically been able to offer competitive packages to cognitive Psychology hires. Indeed, the department has an excellent success rate at hiring and keeping cognitive faculty. Part of the willingness to support such hires stems from the observation that they tend to have an excellent return on investment. For example, three of the four recent cognitive Psychology hires have been successful in attaining federal grants (the fourth hire is in his first year – a list of recent, related grants from Psychology, Computer Science, and Economics is provided in an appendix). The modeling and empirical hire will have particularly low startup and space needs. The neuroscience hire will most likely need some money for fMRI time and access to imaging equipment. The Psychology department currently has 3 EEG machines (although, if EEG is required, the hire will probably want exclusive access to an EEG machine) and access to the Cooley-Dickinson fMRI scanner on University Drive. Hiring researchers with an especially strong reliance on fMRI technology will eventually require the university to acquire a dedicated scanner (which is not necessary for the hires in this proposal).

Computer Science

Providing funding for a position in Computer Science requires a relatively modest investment, and has strong prospects of bringing large and continuing returns.

The cost of a position in Computer Science is modest. A typical Computer Science faculty member requires only office space and computing support. Office space for new hires is already readily available. In addition, computer and communications equipment for a new hire has a relatively low cost, usually less than \$10,000. Computer Science faculty recruitment does typically require a startup package that can amount to \$250,000. This amount is primarily for support of research assistants and summer research during the first years. In support of this cluster, the Computer Science department is willing to share this startup cost on a 50-50 basis. Thus total startup costs to the campus would be less than \$125,000. The salary for a new Computer Science faculty member may be a bit higher than for other science faculty members, at approximately \$90,000 per academic year.

The return on this investment can be expected to be quite substantial. Computer Science faculty members can be expected to start to obtain substantial research funding within two years of their initial appointments, and it should be noted that their funding almost invariably carries full overhead. Most new faculty members in the Computer Science Department have secured funding of at least \$200,000 per year within their first two years. At that level of research funding overhead of at least \$70,000 per year is returned to the campus. That being the case, the

upfront startup package investment in such a faculty member is typically completely paid back within a few years. And by the time of their tenure decision, such faculty members are bringing to the campus research overhead support that exceeds the sum of their salary and the cost of their startup package, amortized over the period of their pre-tenure appointments.

Economics

At the department level, the Economics department has committed resources in the recent past to hire in these fields and will do so in the future. The department will provide start up money in larger amounts than usual for experimental economics hires because of the costs of running experiments. The department has space for up to three new hires, one of whom would be in this cluster. Furthermore, the SBS college has been very receptive in the past year to the need to support higher salaries for our new junior faculty. The department has found that the relatively low salaries to be a barrier to closing deals particularly in experimental economics, so the college will need to continue to respond at least partially to the going market rate for new economics Ph.D.'s.

Appendix – Potential Funding Sources

Examples of potential basic funding sources:

- NSF: Human and Social Dynamics program:
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=11678
- NSF: Decision, Risk and Management Sciences:
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5423
- NSF perception, action, cognition: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5686
- NSF Cognitive Neuroscience: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5316
- NSF Robust Intelligence Cluster: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=500053
- NSF Methodology, Measurement, and Statistics:
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5421
- NSF Academic Research Infrastructure Program: Recovery and Reinvestment:
http://www.nsf.gov/od/oia/programs/ari/*<http://www.nsf.gov/od/oia/programs/ari
- NSF Major Research Instrumentation: Recovery and Reinvestment (MRI-R2):
<http://www.nsf.gov/od/oia/programs/mri/>
- AFOSR: Mathematical Models of Cognition and Decision:
<http://www.wpafb.af.mil/library/factsheets/factsheet.asp?id=12393>
- AFOSR: Collective Behavior and Socio-Cultural Modeling:
<http://www.wpafb.af.mil/library/factsheets/factsheet.asp?id=12394>
- DARPA: Self Explaining Learning Framework Program:
<http://www.darpa.mil/ipto/personnel/cox.asp>
- MacArthur Foundation: to study cross-cultural variation in basic economic decisions using experiments in several countries in games like the ultimatum game
- NSSEFF The National Security Science and Engineering Faculty Fellowship program: Conducting innovative basic research in areas of long term interest to the Department of Defense

Examples of potential applied funding sources:

- National institute on drug abuse: <http://www.nida.nih.gov/>
- NIH Focal Cognitive Deficits in CNS Disorders (Neuroscience, deficit):
<http://grants.nih.gov/grants/guide/pa-files/PA-07-035.html>

Appendix – JDM MURI Grants & Initiatives

Examples of recent AFOSR JDM MURI Grants:

- 2009 Learning Decision Architectures for Intelligent Cooperative Control of Autonomous Systems
- 2007 Dynamic Decision Making in Complex Task Environments: Principles and Neural Mechanisms
- 2005 Computational Models for Belief Revision, Group Decisions, and Cultural Shifts

Examples of current, large MURI initiatives that focus on decision-making:

- Advances in Approximate and Hybrid Reasoning for Decision Making Under Uncertainty (Centered at UC Irvine)
- Adversarial Decision-Making (Centered at UT Austin)
- Belief Dynamics and Decision-Making (Centered at MIT)
- Connections between Mathematical and Behavioral Decision-Making Models and Software models for human decision-making (Centered at University of Arizona, Tucson)
- Decision Making in the Presence of Uncertainty (Centered at UC Berkeley, part of An Integrated Approach to Intelligent Systems)
- Decision-Making under Uncertainty (Centered at Stanford University)

Appendix - Potential UMass Collaborators

The following is a partial list of potential JDM collaborators from across the UMass campus.

- Computer Science:
 - Barto, Croft, Fu, Grupen, Jansen, Jensen, Kurose, Lesser, Levine, Mahadevan, McCallum, Siegelmann, Towsley, Venkataramani, Woolf, Zilberstein.
- Economics:
 - Flaherty, Lee, Skott.
- Education:
 - Churchill, Eiseman, Rallis.
- Mechanical and Industrial Engineering:
 - Baker, Fisher.
- Neuroscience and Behavior:
 - Blaustein, De Vries, Forger, Lacreuse, Novak, Richardson.
- Political Science:
 - Bushouse, Schaffner.
- Psychology:
 - Berthier, Cave, Cohen, Dasgupta, Davidson, Isbell, Janoff-Bulman, Macmillan, Pietromonaco, Rotello, Sanders, Scott, Starns, Staub, Tropp.
- Resource Economics:
 - Rojas, Spraggon, Stranlund.
- School of Management:
 - Diamond, Giacobby-Miller, Iyer, Kida, Mangaliso, Piercey, Sharma, Smith, Warnick, Woodard.

Appendix - Partial List of Recent UMass Grants Related to the Proposed JDM Hires

The following is a partial list of recent external grants from current UMass faculty in Psychology, Computer Science, and Economics related to the proposed JDM hires.

A. Barto, PI. National Science Foundation, “SGER: Building Blocks for Creative Research,” 6/1/07-5/31/09, \$186,815.

A. Barto, Co-PI. AFOSR, “Achieving Robustness through Learned Competence,” 8/1/08-7/31/2011, \$600,000 (approved total).

A. Barto, PI, partner for “Intrinsically Motivated Cumulative Learning Versatile Robots.” proposal to the European Commission 7th Framework Programme (FP7) on Research, Technological Development and Demonstration, 5/1/09-4/30/2013, approximately \$144,210 (Exact amount dependent on currency exchange rate).

A. Barto, PI of subcontract from University of Oklahoma, DARPA, “Using GO as a platform for knowledge guided exploration.” 9/1/08-5/31/09, \$45,011.

N. Berthier, PI. National Science Foundation, “Development of Reaching in Human Infants”, 9/15/2002-8/31/2006, \$240,686.

A. Cohen, PI. National Science Foundation, “Inducing features from visual noise using statistical machine learning techniques”, 11/15/06-1/1/10, \$149,980.

V. Lesser, PI. National Science Foundation, “Collaborative Research: Distributed Interpretation in a Communication-Limited Environment”, 5/15/05 – 4/30/09, \$375,000.

V. Lesser, PI. Lockheed Martin (DARPA Prime), “Integrated Learning”, 5/30/06 – 6/30/09, \$698,540.

V. Lesser, PI. Raytheon Co., “Multi-Agent Approach for Heterogeneous Persistent Surveillance”, \$100,000, 11/12/08 – 8/29/2009.

V. Lesser, PI. National Science Foundation, “NSF-CNPq Collaborative Research: Combining Cognitive & Utilitarian Coordination in a Layered Agent Architecture”, 10/01/00 – 9/30/04, \$199,683.

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