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Research Spotlight Forum

Social Sciences & Decision Making

Supporting Decision Making in High Cognitive Demand Tasks

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ABOUT YOURSELF

- PhD in Cognitive Psychology
- Early research: Memory processes, multitasking, cognitive control
- At Sandia: Support decision making and reasoning across informational sources
- Applied Cognitive Science organization: Manager: Susan Adams, 14 staff including 4 graduate student interns;
  - Expertise: Cognitive and Organizational Psychology and Human Factors
  - Experience with diverse customer bases: across DoD, NASA, TSA…

Keywords:

Decision making, automation, data analytics, artificial intelligence, expert elicitation, usability

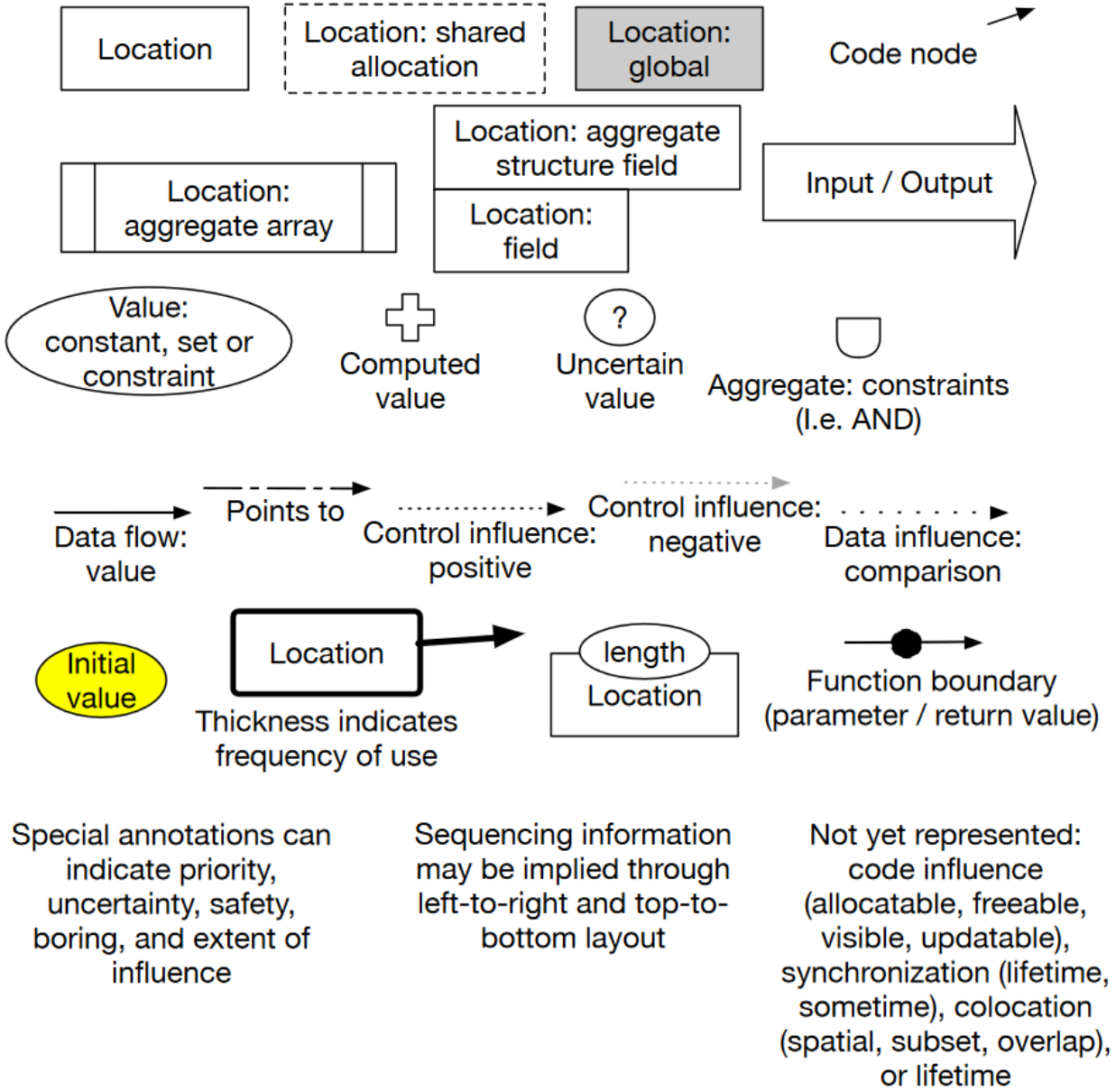
UNDERSTAND SOFTWARE

Creating a User-Centric Data Flow Visualization: A Case Study

Karin Butler(✉), Michelle Leger, Denis Bueno, Christopher Cuellar, Michael J. Haass, Timothy Loffredo, Geoffrey Reedy, and Julian Tuminaro

Internally funded through the LDRD office (Laboratory Directed Research & Development)

- Collaboration with Georgia Tech



UNDERSTANDING SOFTWARE - Rapid Analysis of Mission Software Systems (RAMSeS)

Detecting Cybersecurity Threats in Software

PROBLEM: Software explosion requires reliance on automated processes and tools for aspects of program understanding.

QUESTIONS: What do we automate? How do we integrate new tools into work flows to support needed understanding?

- PROJECT 1 (Nicole Murchison, Megan Nyre-Yu): Supporting the analyst who is inexperienced with program analysis tools; integrated and interactive visualizations for supporting learning and understanding
- PROJECT 2 (Cheryl Bolstad, Megan Nyre-Yu): Understanding current manual analysis workflows and goals to direct future development of tools that support decision making
- PROJECT 3 (Laura Matzen): Experimental test of the use of computer memory models to aid program understanding.

FUNDING: Multiple funding sources

Collaboration with GTRI and Georgia Tech

SUPPORTING DECISION MAKING QUALITY

Supporting Expert Elicitation of Estimates of Uncertainty

PROBLEM: Need to better characterize the uncertainties in data about systems. Often relying on a point estimate without understanding the uncertainty about that estimate.

Situations without adequate testing to characterize system.

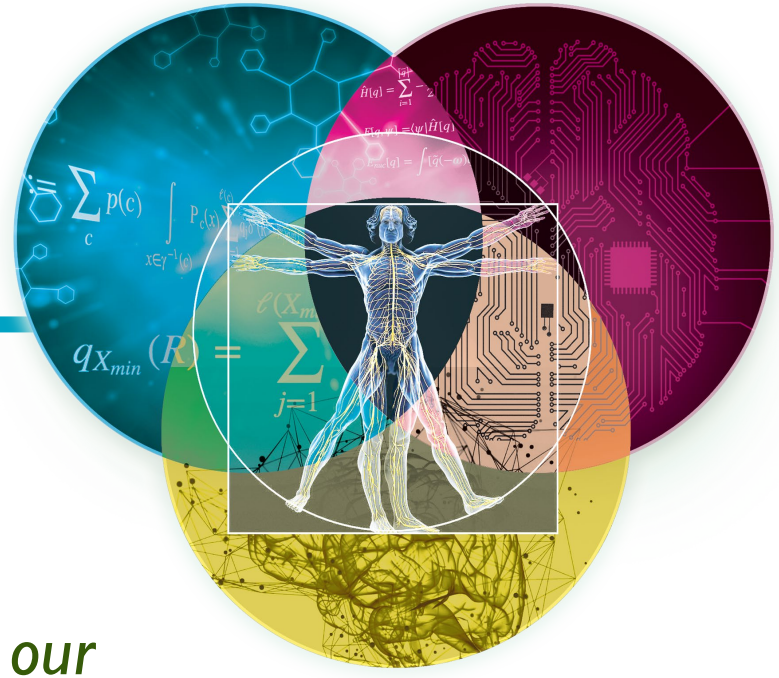
APPROACH: In collaboration with our Statistical Sciences organization, developing procedures for eliciting and/or combining subject matter experts judgements of uncertainty about risks that are untested Utilizing psychological and decision making best practices.

FUNDING: NNSA

SUPPORTING DECISION MAKING QUALITY

Decision Making Process

1. Appropriate framing
2. Generation of possible alternatives
3. Meaningful and Reliable Information
4. Clear values & Trade-offs
5. Logically Correct Reasoning



Technical Research Thrusts Identified

#1 – Human Systems Theory, *Asmeret Naugle*

Building fundamental theory of social systems to advance our understanding of people and group decision making.

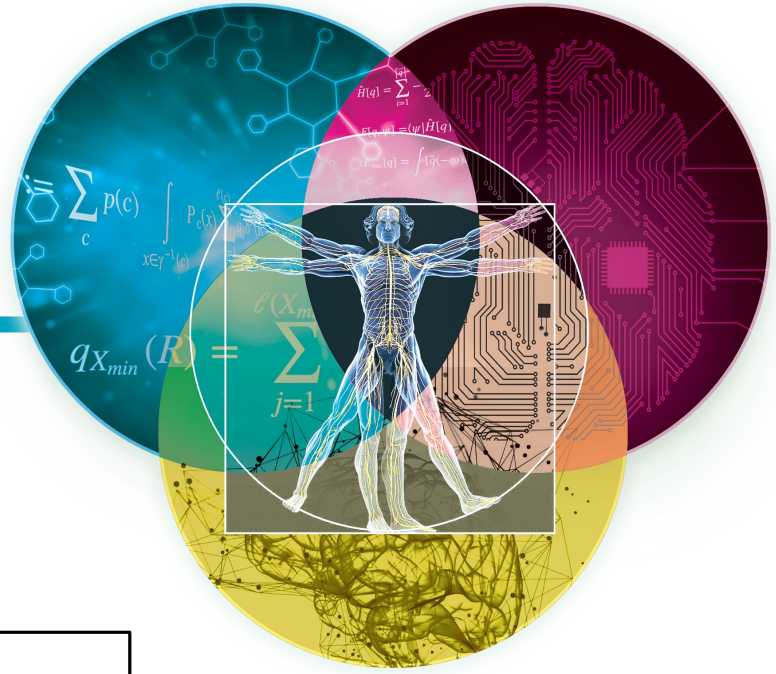
#2 – Data Analytics, *Hamilton Link & Curtis Johnson*

Science and technology that augment analysis and modeling of systems and their interactions.

#3 – Decision Science, *Karin Butler*

Exploring the optimization of decision-making at each process stage.

INTELLIGENCE SCIENCE | *FY20*



#1 – Human Systems Theory

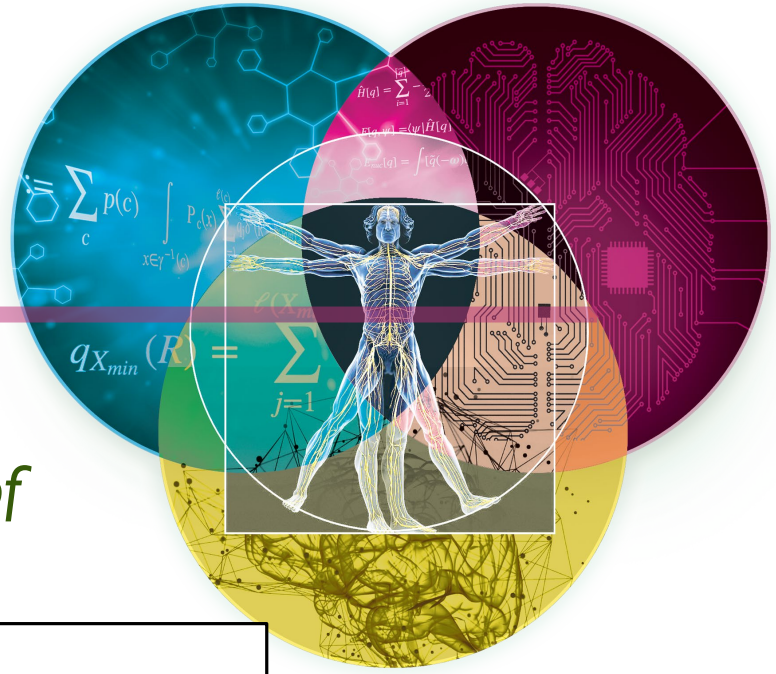
Asmeret Naugle

Building fundamental theory of social systems to advance our understanding of people and group decision making.

Example science questions:

- What causes **phase change** in social systems (affecting stability, etc.)?
- How do **different scales** (micro/macro) of complex social systems **interact**?
- How do social groups **evolve and adapt** given environmental and social context?
- What are the **limits of predictability** in human systems?
- How do social media and increased **connectivity** of society affect **stability**?

INTELLIGENCE SCIENCE | *FY20*



#2 – Data Analytics

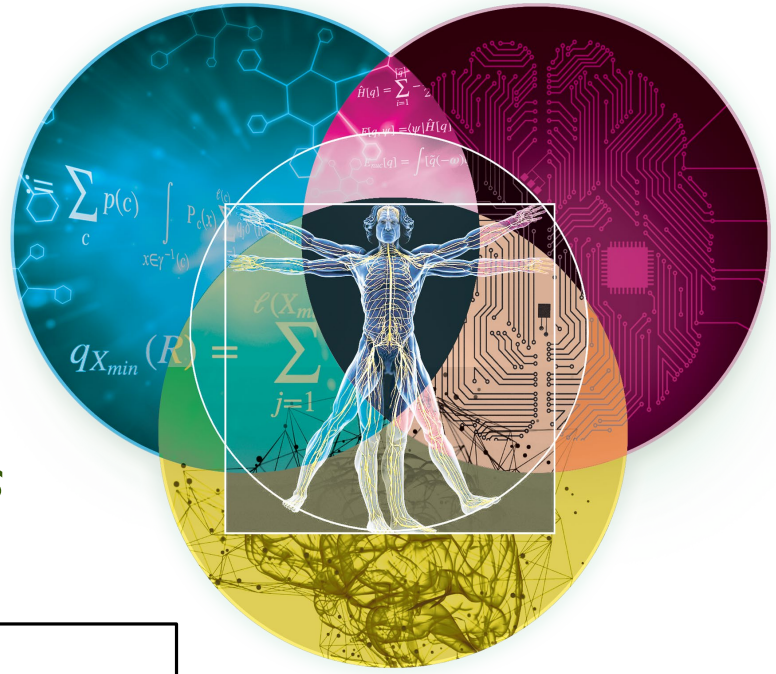
Hamilton Link & Curtis Johnson

Science and technology that augment analysis and modeling of systems and their interactions.

Example science questions:

- How do we produce concrete **evidence in support of** (or refuting) **people's assessments** of the available information?
- What measures of social and political movements or nation-state power structures **predict or anticipate national security developments**?
- How do we **indicate when** more information or **human attention** is needed?
- How do we **probe an adversarial system** to understand the current state of systems being engaged?
- How do we **operate within an adversary's "observe/orient/decide/act" loop** by getting them to tip their hand, running diagnostic actions, rapidly evaluating potential courses of action, and finding ways to change the rules of the game itself?

INTELLIGENCE SCIENCE | *FY20*



#3 – Decision Science

Karin Butler

Exploring the optimization of decision-making at each process stage.

Example science questions:

- What **new sources of information** can be successfully integrated into processes to understand, scope, and analyze national security problems? How can this be done?
- How can the results of automated analyses be **made meaningful** to human decision makers?
- How do human analyzers **integrate findings** with various levels of uncertainty and generalizability? Do uncertainty and generalizability have different effects for high consequence decisions? How do uncertainty and generalizability relate to **trust** in information?

THANK YOU!

Questions?