



2019
Annual **INCOSE**
international workshop
Torrance, CA, USA
January 26 - 29, 2019

Challenge Team

Augmented Intelligence in Systems Engineering



What is Augmented Intelligence?

- How normal human intelligence is supplemented through the use of technology, such as artificial intelligence (AI) and machine learning (ML)
- An approach that promotes “team play” of human and machine intelligence, where performance of team is greater than the AI or human individually



Augmented Intelligence (AUI) in SE Challenge Team Charter

- Charter
 - Effectively pair human and machine intelligence to improve systems engineering
 - Goal: Further the understanding of how computational approaches, such as artificial intelligence, machine learning, and data science, can collaborate with human systems engineers to measurably improve the system engineering effort. The challenge team will seek out approaches that enhance human capabilities in systems engineering.
 - Chartered Feb 2018
 - <http://www.omgwiki.org/MBSE/doku.php?id=mbse:augmented>
- Activities
 - Conceptual Model of Augmented Intelligence
 - Presentations (GVSETS, GLRC, NMWS)
 - White Paper (GVSETS)
 - Poster Boards Discussions (MIT LL)



Human vs AI Competitions



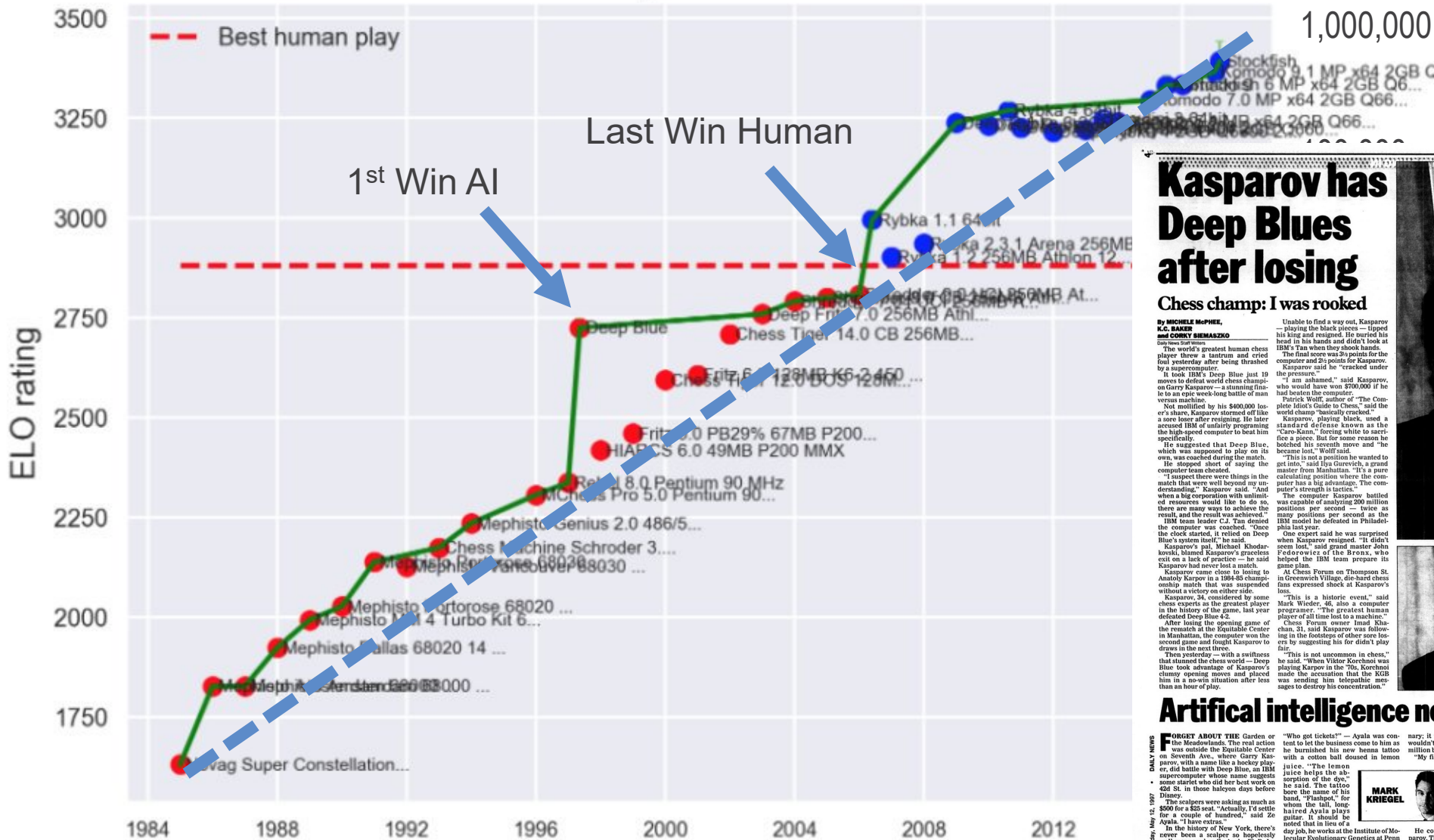
What is Toronto?



Chess: Human vs AI



Computer Chess



Kasparov has Deep Blues after losing

Chess champ: I was rooked

By MICHELE MOPPIER, K.C. BAKER and CORY SEMARZKO

The world's greatest human chess player threw a tantrum and cried last night after being crushed by a supercomputer.

It took IBM's Deep Blue just 19 moves to defeat world chess champion Garry Kasparov — a stunning finale to an epic week-long battle of man versus machine.

Not mollified by his \$400,000 loser's share, Kasparov stood off like a sore loser after resigning. He later accused IBM of unfairly programming the high-speed computer to beat him specifically.

He suggested that Deep Blue, which was supposed to play on its own, was coached during the match. He stopped short of saying the computer team cheated.

"I suspect there were things in the match that were well beyond my understanding," Kasparov said. "And when a big corporation with unlimited resources would like to do so, there are many ways to achieve the result, and the result was achieved."

The IBM team leader, C.J. Tan, denied the computer was coached. "Once the clock started, it relied on Deep Blue's system itself," he said.

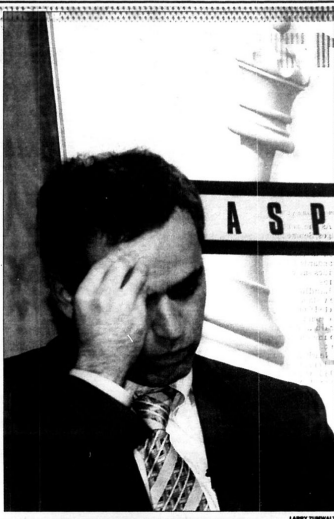
Kasparov's pal, Michael Khodarkovski, blamed Kasparov's greebles exit on a lack of practice — he said Kasparov had never lost a match.

Kasparov came close to losing to Anatoly Karpov in a 1984-85 championship match that was suspended without a victory on either side.

Kasparov, 34, considered by some chess experts as the greatest player in the history of the game, last year defeated Deep Blue 4-2.

After losing the opening game of the rematch at the Equitable Center in Manhattan, the computer won the second game and fought Kasparov to draws in the next three.

Then yesterday — with a swiftness that stunned the chess world — Deep Blue took advantage of Kasparov's clumsy opening moves and placed him in a no-win situation after less than an hour of play.



Unable to find a way out, Kasparov — playing the black pieces — tipped his king and resigned. He curled his head in his hands and didn't look at IBM's Tan when they shook hands.

The final score was 2½ points for the computer and 2½ points for Kasparov, Kasparov said he "cracked under the pressure."

"I am ashamed," said Kasparov, who would have won \$700,000 if he had beaten the computer.

Tarek Wotfi, author of "The Complete Idiot's Guide to Chess," said the world champ "basically cracked."

Kasparov, playing black, used a standard defense known as the "Caro-Kann," forcing white to sacrifice a piece. But for some reason he botched his seventh move and "he became lost," Wotfi said.

"This is not a position he wanted to get into," said Ilya Gurevich, a grand master from Manhattan. "It's a pure calculating position where the computer has a big advantage. The computer's strength is tactics."

The computer Kasparov battled was capable of analyzing 200 million positions per second — twice as many positions per second as the IBM model he defeated in Philadelphia last year.

One expert said he was surprised when Kasparov resigned. "It didn't seem lost," said grand master John Fedorowicz of the Bronx, who helped the IBM team prepare its game plan.

At Chess Forum on Thompson St. in Greenwich Village, die-hard chess fans expressed shock at Kasparov's loss.

"This is a historic event," said Mark Wieder, 46, also a computer programmer. "The greatest human player of all time lost to a machine."

Chess Forum owner Imad Khashan, 31, said Kasparov was following in the footsteps of other sore losers by suggesting his forfeit play fair.

"This is not uncommon in chess," he said. "When Viktor Korchnoi was playing Karpov in the '70s, Korchnoi made the accusation that the KGB was sending him telepathic messages to destroy his concentration."



Artificial intelligence not black and white

FORGET ABOUT THE Garden or the Meadows. The real action was outside the Equitable Center on Seventh Ave., where Garry Kasparov, with a name like hockey player, did battle with Deep Blue, an IBM supercomputer whose name suggests some starlet who did her best work on 424 St. in those halcyon days before Disney.

The scalpers were asking as much as \$500 for a \$25 seat. "Actually, I'd settle for a couple of hundred," said Ze Magal, 71, have extra.

In the history of New York, there's never been a scalper so hopelessly well mannered as Ze Ayala, Ph.D. Instead of the usual hawker's cry —

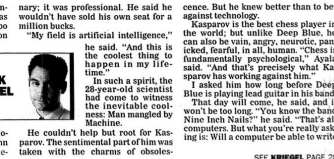
"Who got tickets?" — Ayala was content to let the business come to him as he furnished his new henna tattoo with a cotton ball doused in lemon juice.

"Then someone else helps the absorption of the dye," he said. The Latino bore the name of his band, "Blasphemy," for when the tall, long-haired Ayala plays guitar. It should be noted that he is not a musician.

He couldn't help but root for Kasparov. The sentimental part of him was taken with the charms of obsolescence. But he knew better than to bet against technology.

Kasparov is the best chess player in the world, but unlike Deep Blue, he can also be vain, angry, neurotic, panicked, fearful in all human. "Chess is fundamentally psychological," Ayala said. "And that's precisely what Kasparov is working against him."

In such a spirit, the 22-year-old scientist had come to witness "That day will come, he said, and it won't be too long. "You know the band Nine Inch Nails?" he said. "That's all computers. But what you're really asking is: Will a computer be able to write





Freestyle Chess

Rules: {}



Human

0..n



Machine

0..n



Centaur



Insights from Freestyle Tournament

Q: What makes for a great freestyle operator?

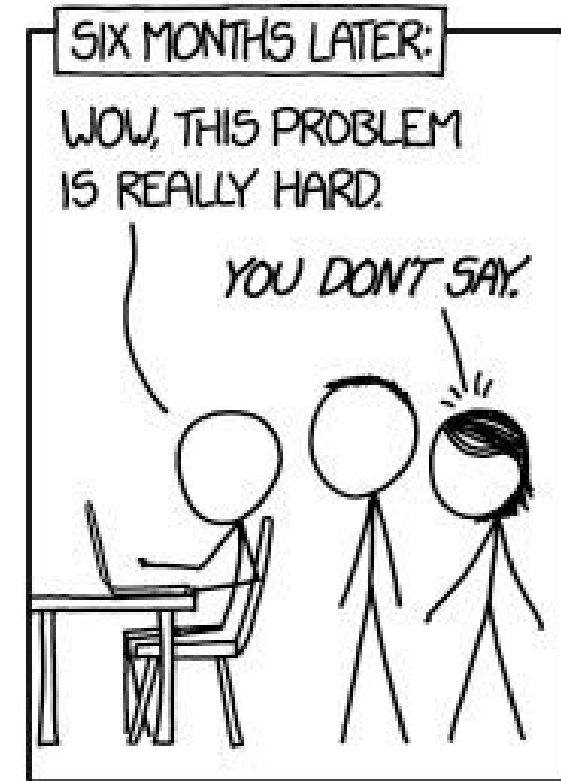
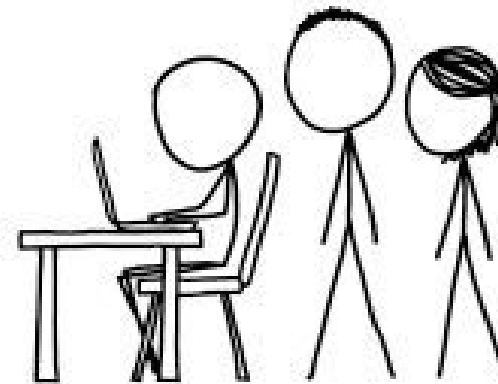
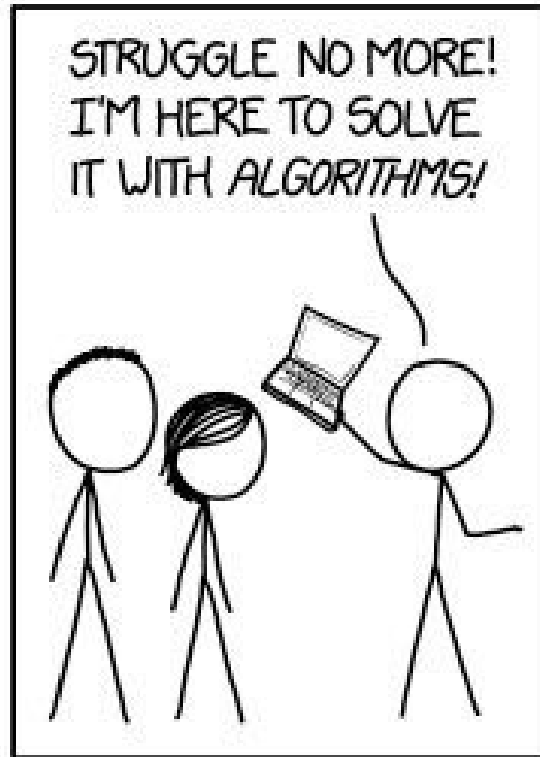
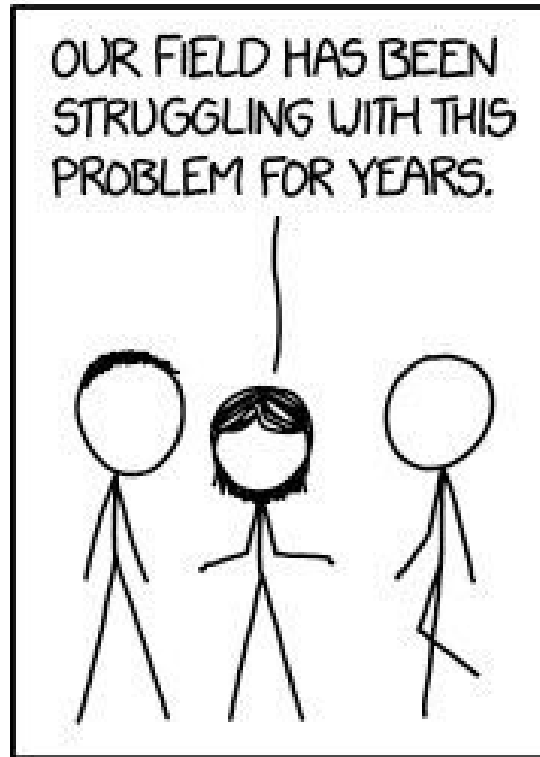
KASPAROV: Someone who can work out the most effective combination, bringing together human and machine skills. I reached the formulation that a weak human player plus machine plus a better process is superior, not only to a very powerful machine, but most remarkably, to a strong human player plus machine plus an inferior process.

Kasperov's Law:

Weak Player + AI + Good Relationship
Outperforms

Strong Player + AI + Inferior Relationship

AI in Systems Engineering

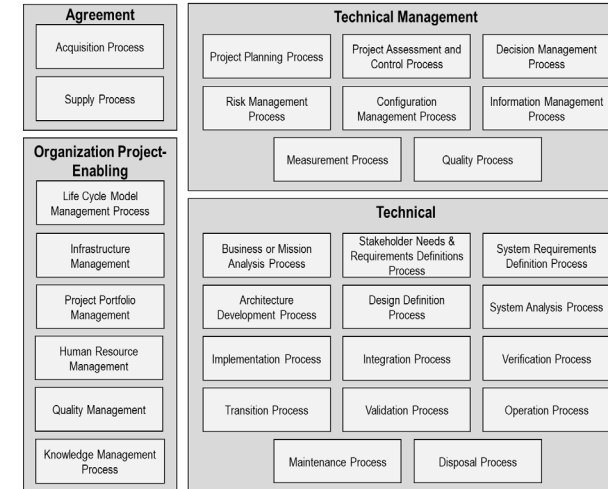
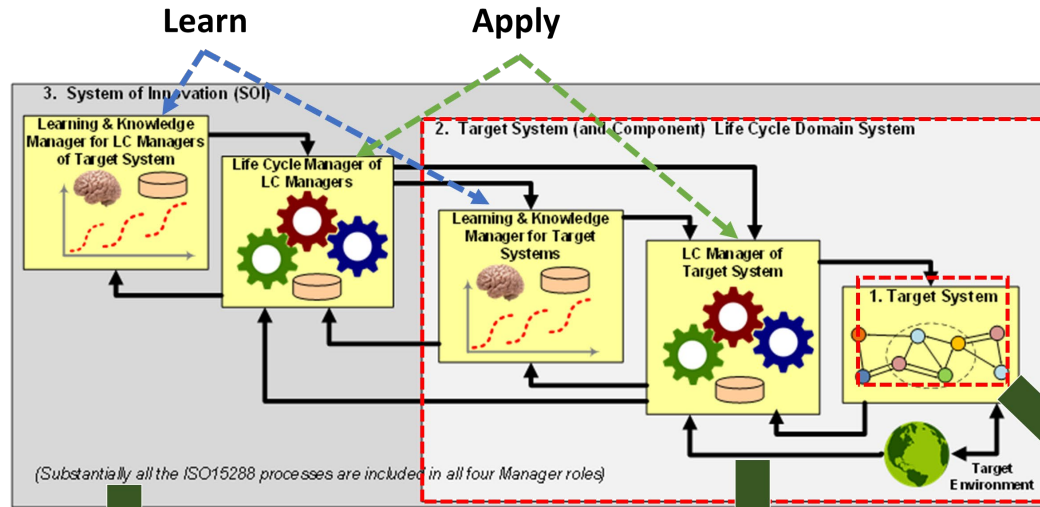


XKCD: Here to Help, <https://xkcd.com/1831/>



Conceptual Model

The ISO/IEC 15288 processes and lifecycle stages



System 3: AI as a **co-manager** for cross-domain efficiency, effectiveness and innovation for System 2

Trust Relationship: AI will enhance understanding and discovery to better communicate, collaborate, and share critical information about engineering processes in timely manner .

System 2: AI as a **collaborator** in the system lifecycle processes for System 1

Trust Relationship: Models & AI will provide unbiased insights into patterns expressed by data, and assist the engineering team in applying learned patterns, in a manner that improves the technical and operational aspects of systems engineering.

System 1: AI **embedded** in target system / target environment

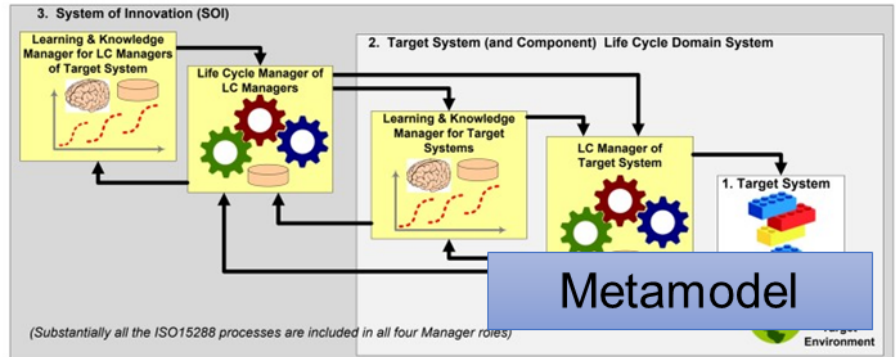
Trust Relationship: AI will perform reliably and predictably under anticipated conditions, and will gracefully degrade when unable to perform tasks.

Source: INCOSE Agile Working Group

Activities



Conceptual Model for Augmented MBSE



Source: INCOSE Agile Working Group

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Human Centered Design: Rules of Algorithm

The Algorithm should have:

Agency

Reflect the information, goals, and constraints that the decision-maker tends to weigh when arriving at a decision

Perspective

Analyze from a position of domain and institutional knowledge, and an understanding of the process that generated it

Relevancy

Anticipate the realities of the environment in which it is to be used

Objectivity

Avoid biased predictors

Transparency

Be transparent, peer-reviewed or audited to unwanted biases have not inadvertently crept in

Candor

Effectively present measures of confidence and messages (ideally expressed in intuitive language) explaining why a certain algorithmic indication is what it is



Algorithmic Design

Why artificial intelligence needs human-centered design - Deloitte Review, issue 22

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ISO 15288 and SE Processes

ISO/IEC/IEEE 15288: "Systems and Software Engineering-System Life Cycle Processes"



Establishes a common framework for describing the life cycle of a designed system

Defines a set of processes and associated terminology from an engineering viewpoint

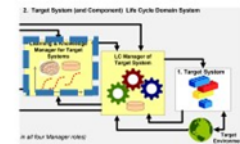
SE Processes

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System 2 – Learn Maintenance Procedures



ISO15288: Tech Process : Maintenance

Apply
User: compare sensor sets parameters (coverage, size, weight, cost, reliability) → isolation %



<https://www.phmtechnology.com/made/what-made-does/case-studies/design-for-cbm.html>

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Challenge Team Goals

Goal 1: Develop a conceptual framework for Aul

Goal 2: Develop history of how we collaborate / interact with models

Goal 3: Define what is “under control of model”

Goal 4: Define what Aul means in a SE process

Goal 5: How to introduce learned information to SE process

Goal 6: Develop an example

Goal 7: Case Studies

Goal 8: Current State of Art



Research Questions

- Model Interactions
 - How do humans interact with models and model-generated information?
 - How do humans interact with each other using models?
 - What cognitive challenges exist for model-informed decision-making?
 - What are essential human roles in model-centric environments?
 - How can interactivity of humans and models be made more effective?
- Trust
 - How to maintain trust relationships in a Digital Engineering environment with Model to Model interactions?

Posterboard Presentation, Human-Machine Collaboration
for National Security Workshop, MIT Lincoln Labs



Invitation to Upcoming Workshop

- 26-29 January 2019 INCOSE International Workshop
 - Working session Monday 28 January, 11-12pm
- Open Discussion
 - Topics
 - Knowledge Representation
 - Learning and Applying Knowledge
 - Teaming Relationships
 - Communication and Visualization
 - Trust
 - Measures of Performance
 - ...