

AI Planning: From Shakey Foundations to a Chatty Future

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AAAI PLAN-FM Bridge

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In the beginning ...



Image created by AI

Shakey the Robot project: 1966-1972

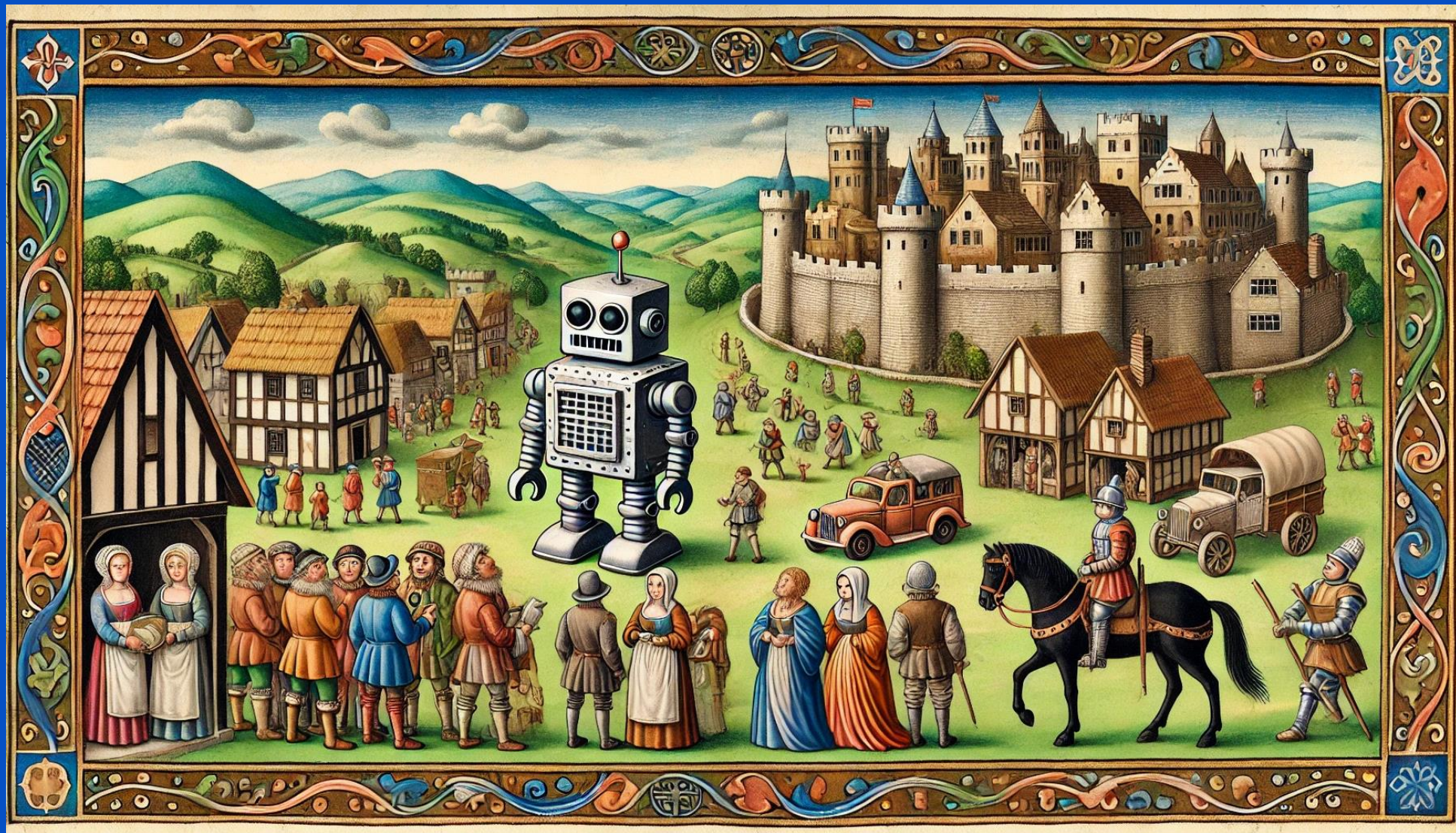
The birth of AI Planning

- STRIPS: **ST**anford **R**esearch **I**nstitute **P**roblem **S**olver
- A*
- Macro Learning: Triangle Tables
- Blocks World!



Helen Chan Wolf





The Middle Ages

Image created by AI

AI Planning Research Contributions



Methodologies

State-space planning
Plan-space planning
Case-based Planning
HTNs
SAT planning
Path planning
Resource allocation



Problem Enrichments

Multi-agent planning
Continuous planning
Temporal planning
Probabilistic planning
Nondeterministic planning
MDPs/POMDPs
Plan optimization

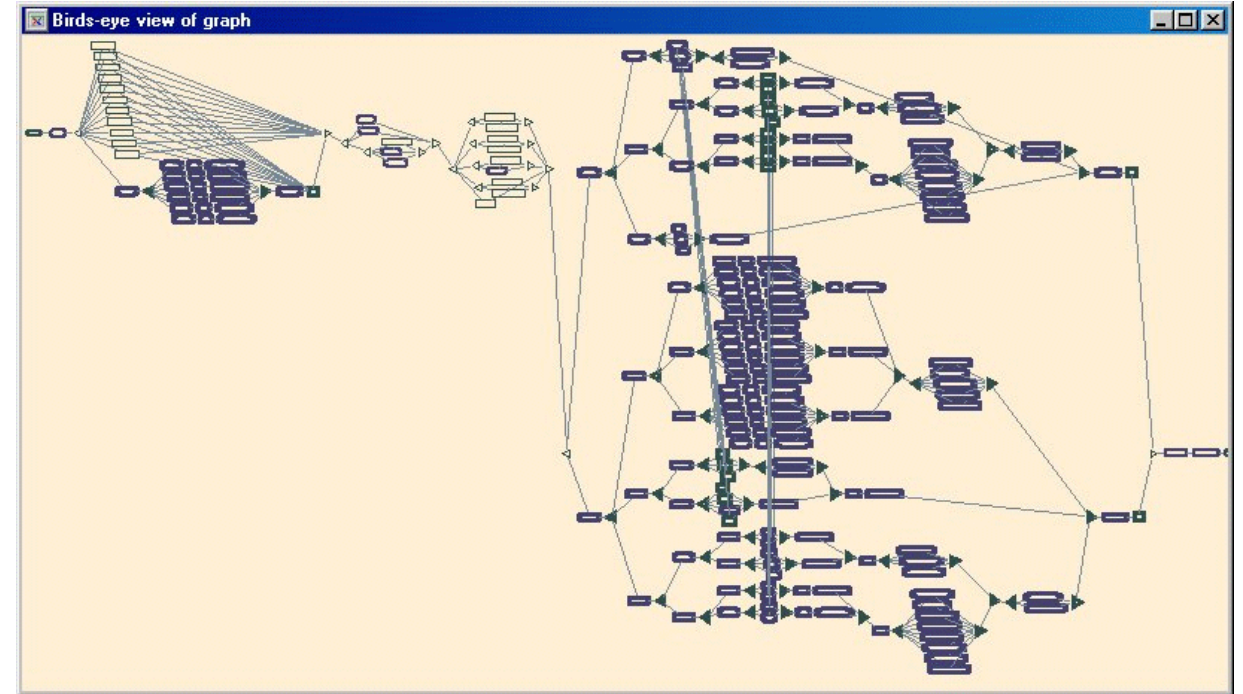
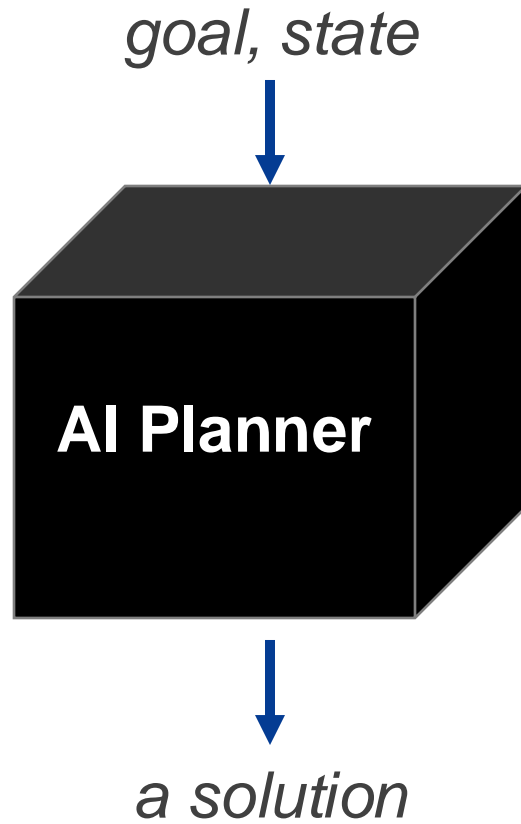


Ancillary Problems

Knowledge acquisition
Explanations for plans
Mixed-initiative planning
PDDL
Model learning
Learning search control
Plan recognition
Privacy-preserving planning

And Much More!

Lesson #1: People Matter



*Sample plan generated via
SIPE-2 HTN planner*

Advisable Planner

Mixed-initiative planner that helps users find solutions

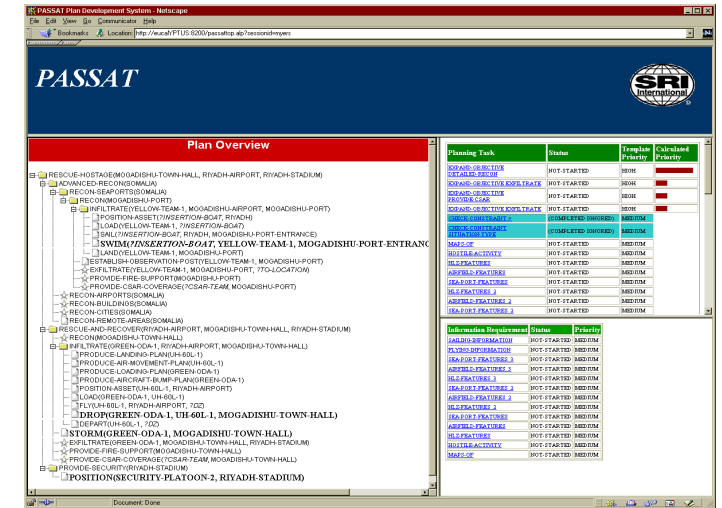
- **Advice** enables users to guide automation in a natural, intuitive manner
- **Plan sketching** as a means to quickly outline skeletal solutions, with system filling in details around it and identifying potential problems
- **Generation of qualitatively different options** supports rapid navigation of rich solution spaces
- **Plan summarization** capabilities that highlight key features of a solution

K. Myers. *Planning with Conflicting Advice*. AIPS 2000.

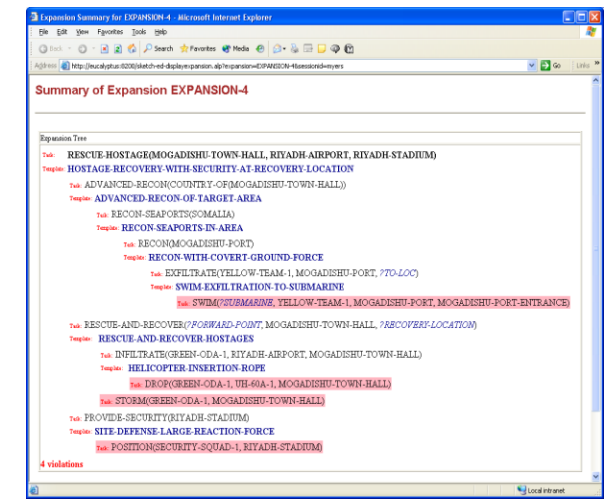
K. Myers, D. Morley. *Human Directability of Agents*. KCAP 2000.

K. Myers, T. Lee. *Generating Qualitatively Different Plans through Metatheory Analysis*. AAAI 1999.

K. Myers, P. Jarvis, W. Tyson, M. Wolverton. *A Mixed-initiative Framework for Robust Plan Sketching*. ICAPS 2003.



Exploratory mixed-initiative planning



Plan sketching

You can't please everyone



Users



“If humans are involved it isn't AI!”

AI Program Committees

Problem solved!

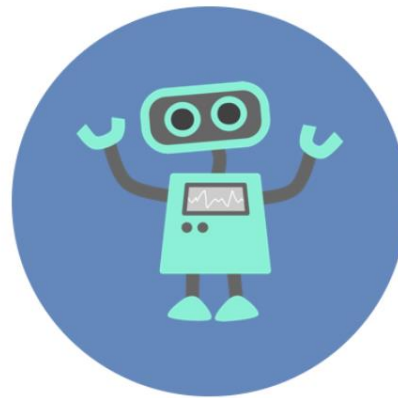


YOCHAN LAB

Arizona State University



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<https://yochan-lab.github.io/home/>

Lesson #2: Building good planning models is hard

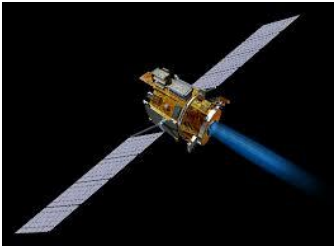


- Lack of explicit domain documentation
- Knowledge elicitation is hard
- KR is hard
 - Qualification problem: no potato in the tailpipe
 - Exceptions: Penguins don't fly
- Much planning needs commonsense reasoning
 - What does “CLOSE” mean?



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Lesson #3: Planning in the real world is mostly scheduling



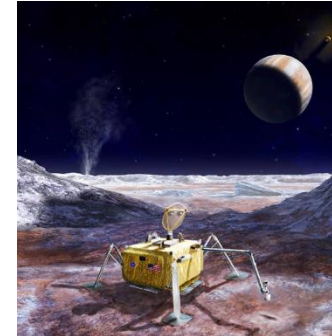
Remote Agent [Muscettola et al., 1998]

Report No. 7795

Dynamic Analysis and Replanning Tool (DART)
Final Functional Description



MAPGEN: Mars Exploration Rover
Mission [Ai-Chang et al. 2004]



Europa Lander Mission Concept
Matanuska Glacier Field Trials
Decision Theoretic Planning!

[Chien et al. 2022 ASTRA, Wagner et al. 2023 JAIS]
Robotics – Sampling Autonomy: [Bowkett et al. 2023 IEEE Aero]



Space Telescope Sciences Institute

SPIKE for Hubble Space Telescope [Johnston, Miller et al. Intelligent Scheduling 1993]

SPIKE used for all 4 “great observatories” Hubble, Spitzer, Chandra, Compton

SPIKE now in use for James Webb Space Telescope scheduling [Giuliano, Rager, Ferdous 2023]

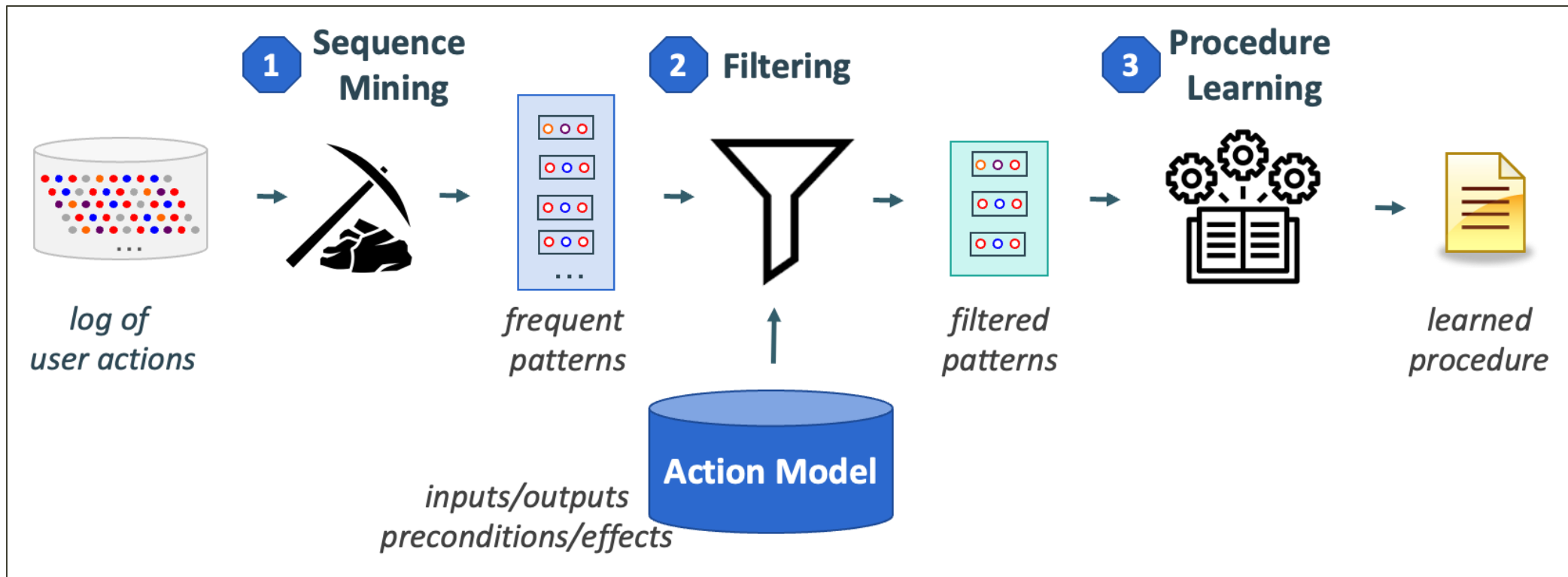
(All above)



ESA/Rosetta [Chien et al. 2021 JAIS],
Deep Space Network [Johnston et al, 2014 AIMag],
M2020/Perseverance [Verma et al. 2023 Sci Rob],
NISAR [Doubleday 2016 SPIE]
All above \$B mission deployments by JPL.

Lesson #4: A little planning can go a long way

Little p vs Big P



M. Gervasio, K. Myers, Learning Procedures by Augmenting Sequential Pattern Mining with Planning Knowledge, *Advances in Cognitive Systems*, Volume 10, 2023.

A Chatty Future

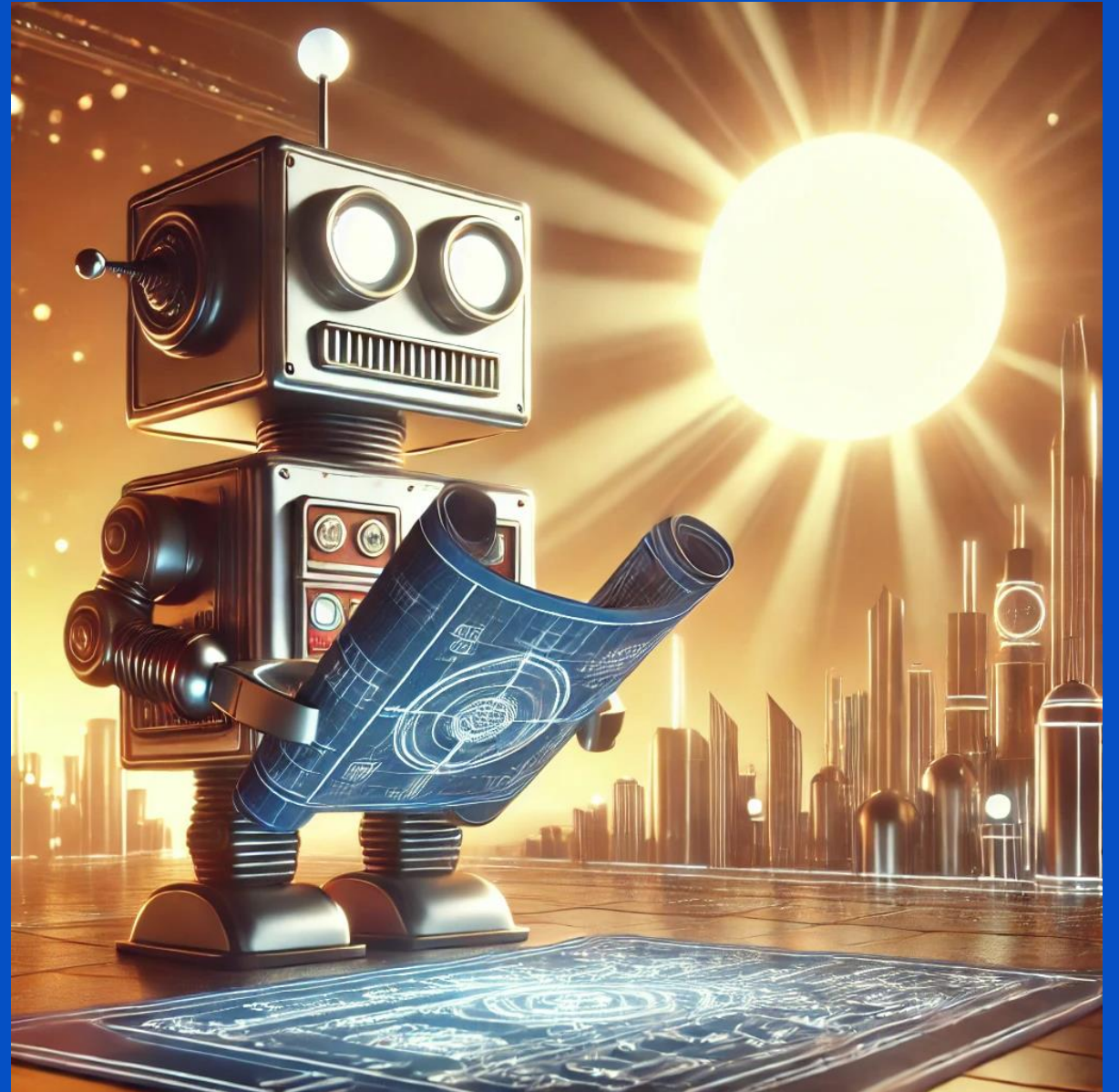


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Generative AI is Amazing but ...

Off by a few centuries!

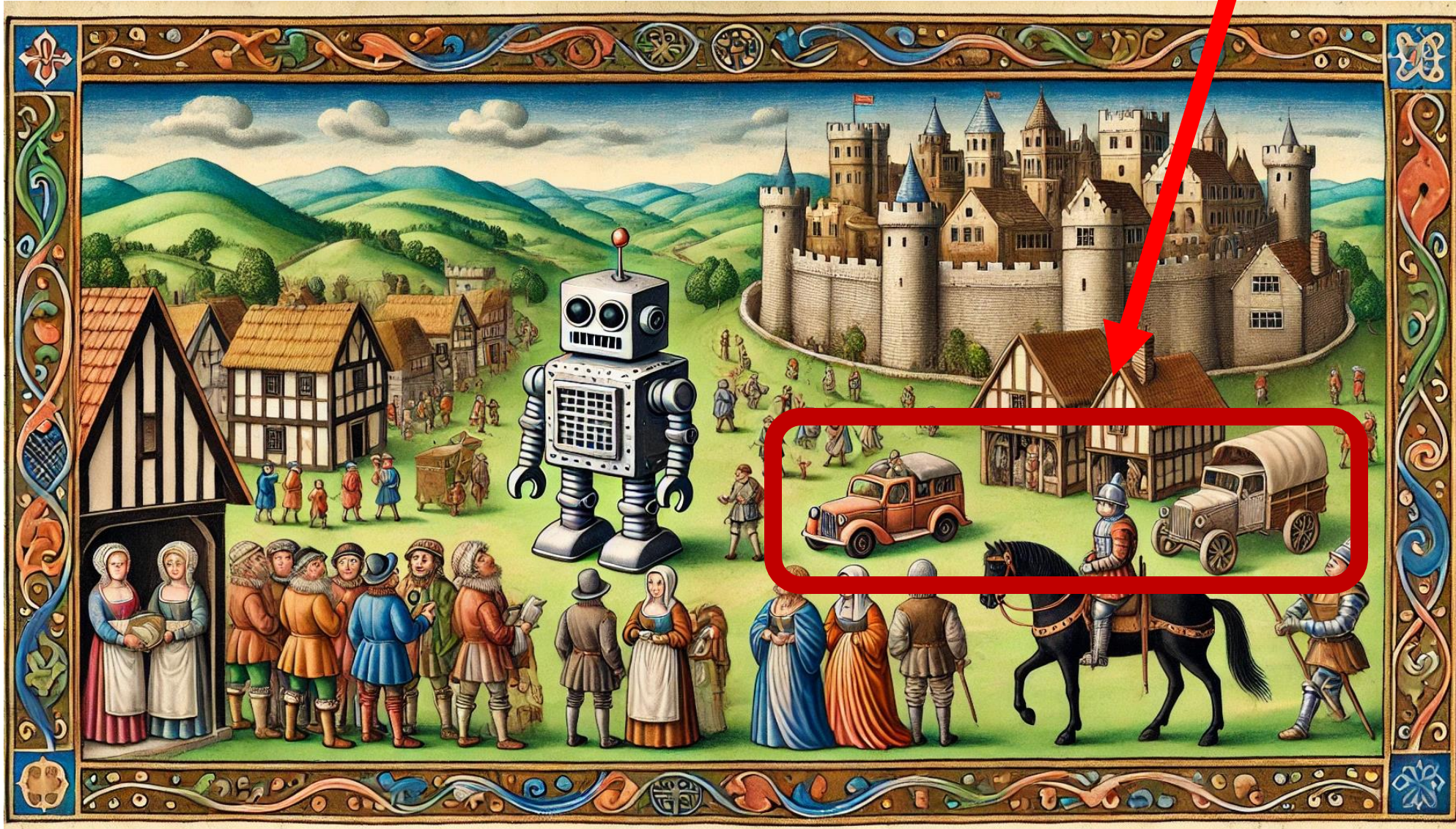
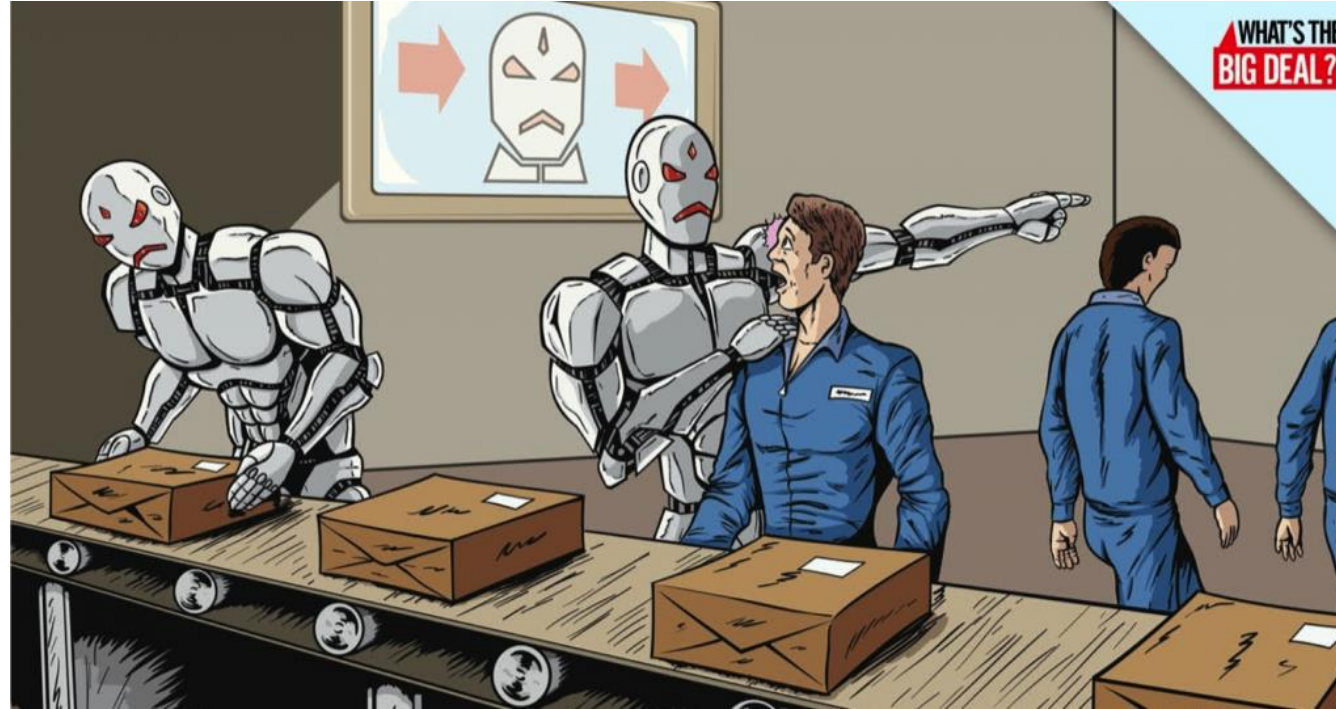


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Will LLMs take my AI planning job?



Large Language Models Still Can't Plan (A Benchmark for LLMs on Planning and Reasoning about Change)

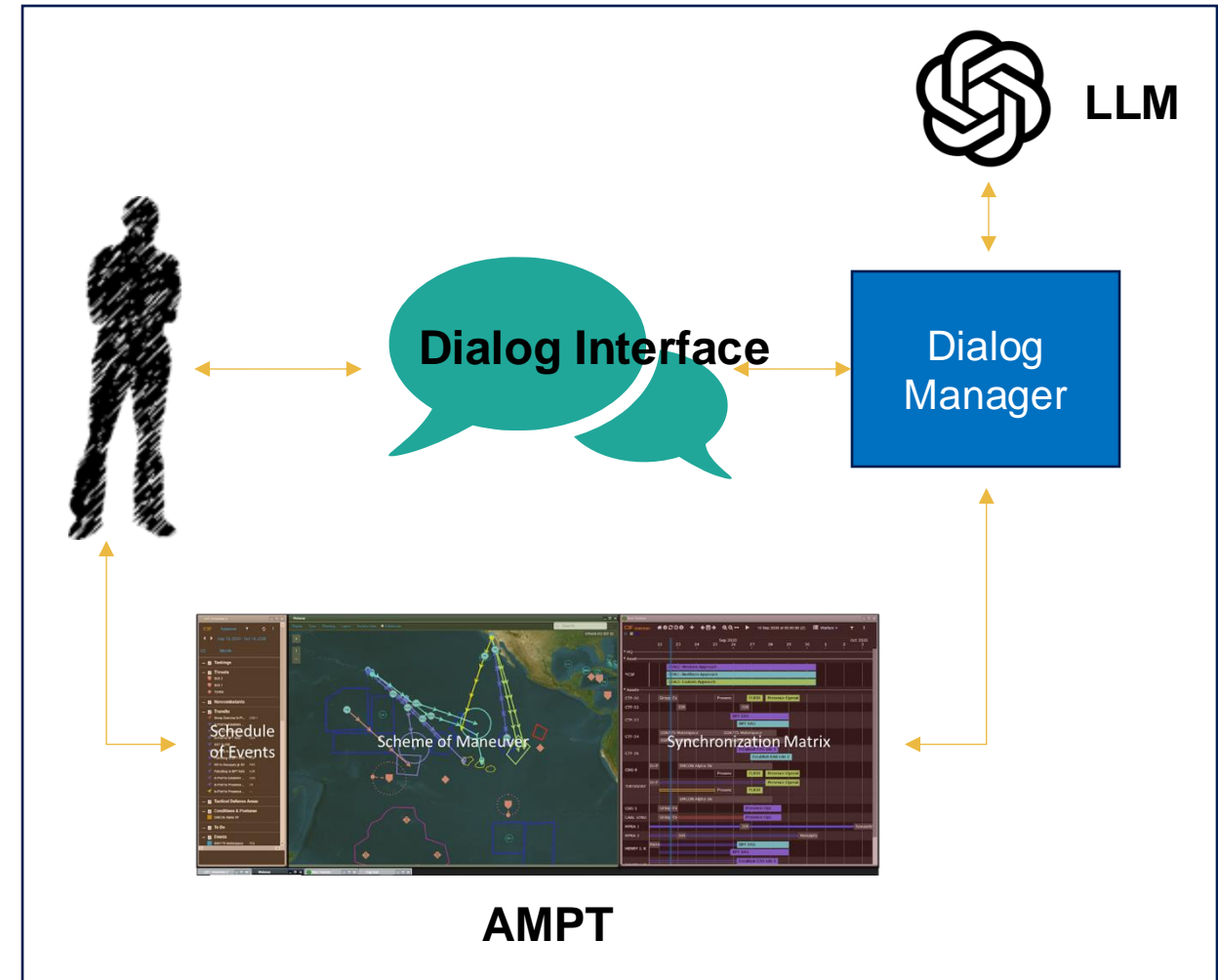
Karthik Valmeekam, Alberto Olmo, Sarath Sreedharan, Subbarao Kambhampati

Overcoming the interaction problem



LLMs can greatly facilitate interaction with planning tools

- Recognize what the user wants to do
- Know what information is needed from the user
- Ask follow-up/clarification questions as needed
- Convert natural language into formal, machine-understandable representations

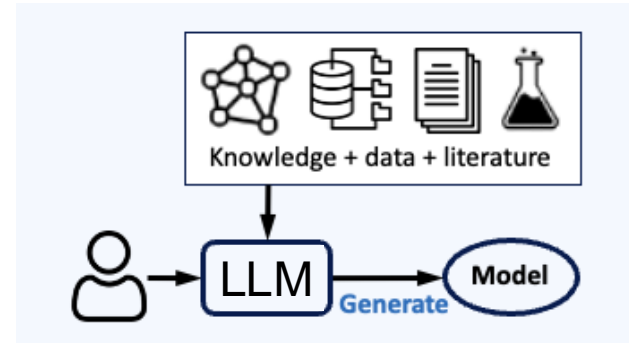


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More GenAI for planning



Building Planning Models



Synthesis vs Validation

AI-designed chips are so weird that 'humans cannot really understand them' — but they perform better than anything we've created

News By [Tim Danton](#) published February 20, 2025

<https://www.livescience.com/technology/computing/humans-cannot-really-understand-them-weird-ai-designed-chip-is-unlike-any-other-made-by-humans-and-performs-much-better>

Commonsense Reasoning

ChatGPT ▾

No, penguins cannot fly. Their wings have evolved into flippers, making them excellent swimmers instead. They use these flippers to glide through the water with incredible agility, but they are not built for flight in the air. Instead, penguins "fly" through the ocean!

Can penguins fly?



Thank you!