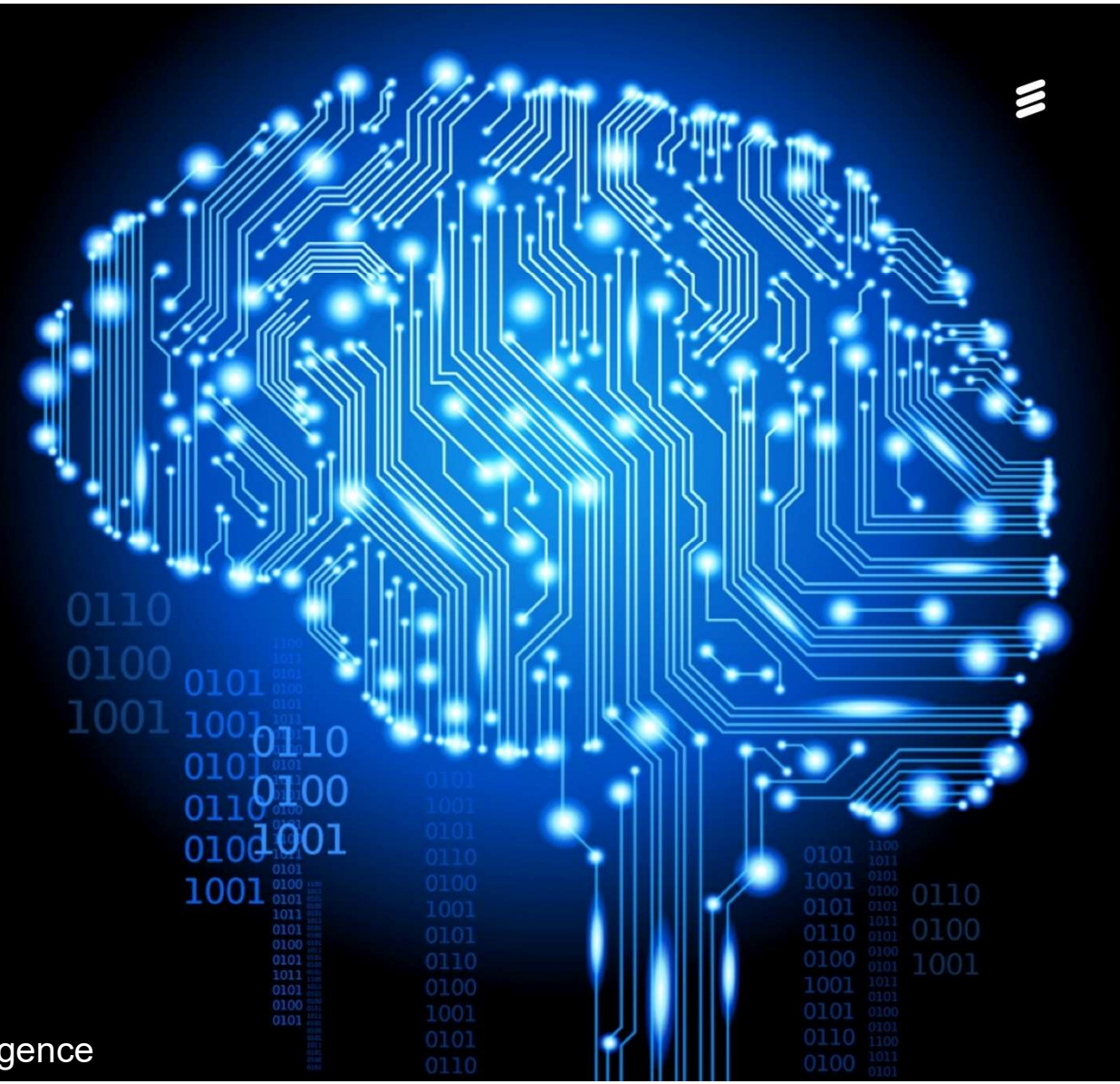
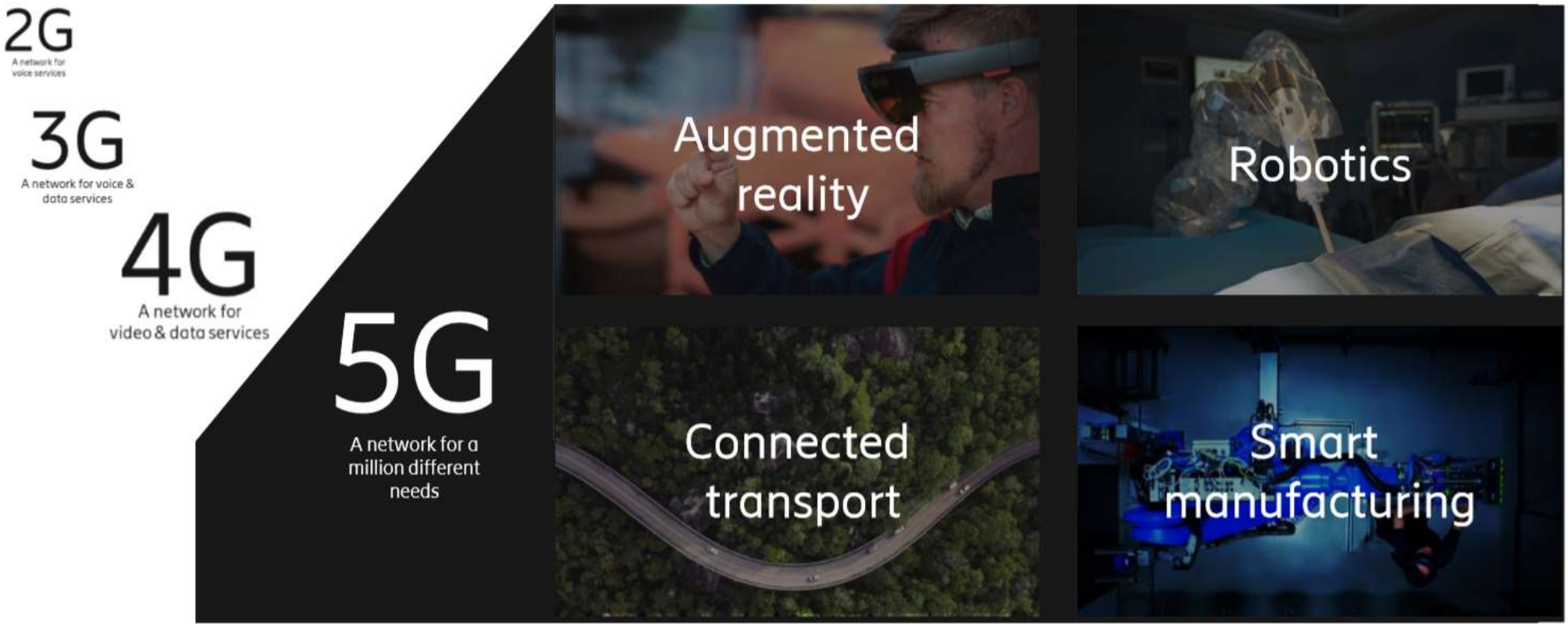
AI for Zero-touch systems

wth a focus on trustworthiness

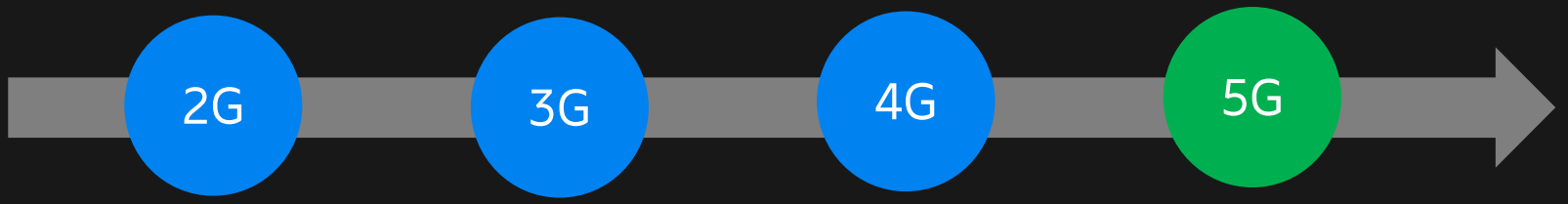


Dr. Aneta Vulgarakis Feljan, Sector Manager
Ericsson Research, Research Area Artificial Intelligence

New applications place higher demands on telecom networks



Tuning of Antenna Tilt … but not only



500	1000	1500	2000	Number of parameters per site
5	14	32	510	Average number of sites in mid-size city

Stolen with pride from Ali Imran, PhD, Director of AI4Networks Center, University of Oklahoma

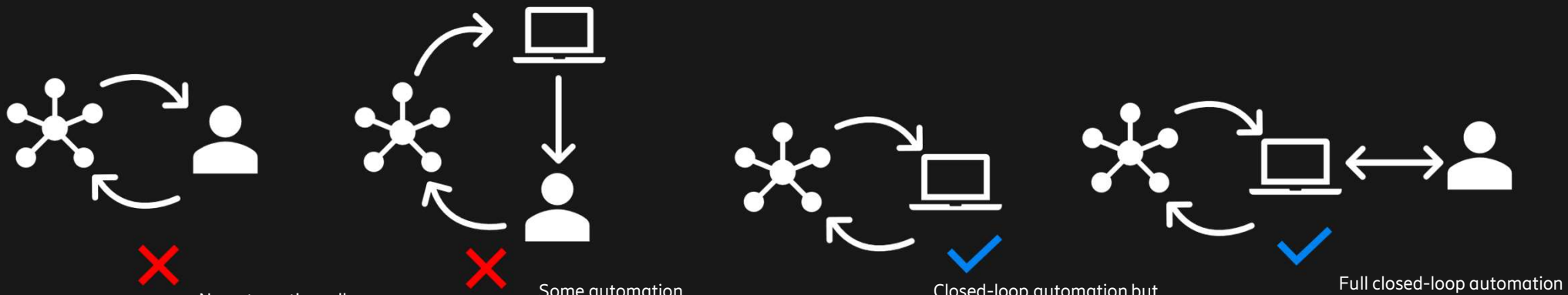
Zero-touch automation

"To have all operational processes and tasks (e.g. delivery, deployment, configuration, assurance, and optimization) executed automatically… ideally with 100% automation. "

*ETSI ZSM

Zero-touch == fully automated

- Closed-loop
- No humans in the actuation loop!



(0) No automation, all manual

(1) Some automation, but humans still in the actuation loop

(2) Closed-loop automation but lacks mechanisms for monitoring and influencing NWs in real-time

(3) Full closed-loop automation (no humans in the actuation loop) with real-time, intent-based, human-machine interaction

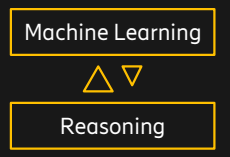
AI for zero-touch automation

Real-time

- Intelligent decision making on live data
- Network edge, IoT sensors and more

Machine Learning + Reasoning

- Extract high level knowledge from ML
- Inferencing, Planning
- Graph neural networks



Distributed Intelligence

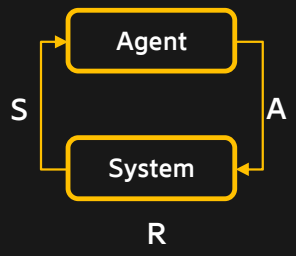
- From data center to network edge
- Distributed learning, Local vs. Global

Trustworthy AI

- Safety guarantees and verification
- Traceability of decisions, explainability

Beyond Games and Simulations

- Reinforcement Learning
- Simulators + Live systems



Human-Machine symbiosis

- Human Intelligence Augmentation
- Evolved Human-Machine interaction

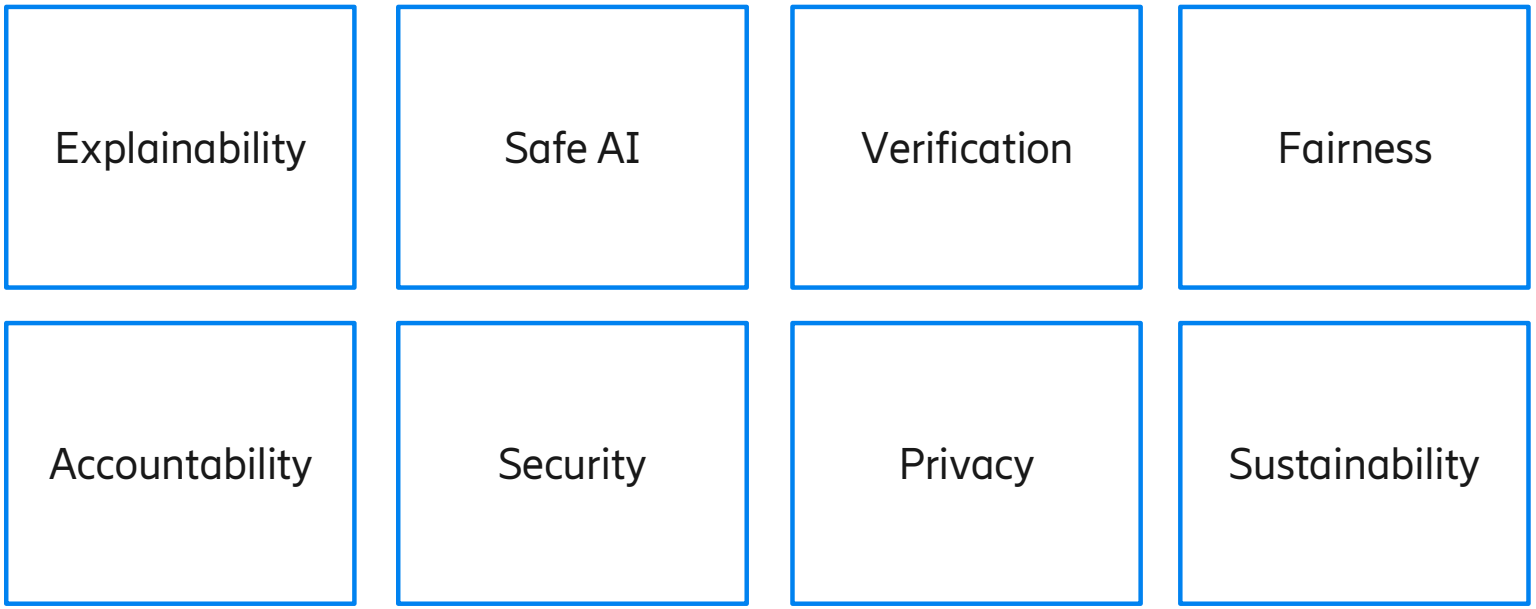
Trustworthy AI

Human Agency and Oversight	Transparency	Explainability	Accountability
Human autonomy is paramount	Usage transparency	Must explain outcomes	Traceable and auditable

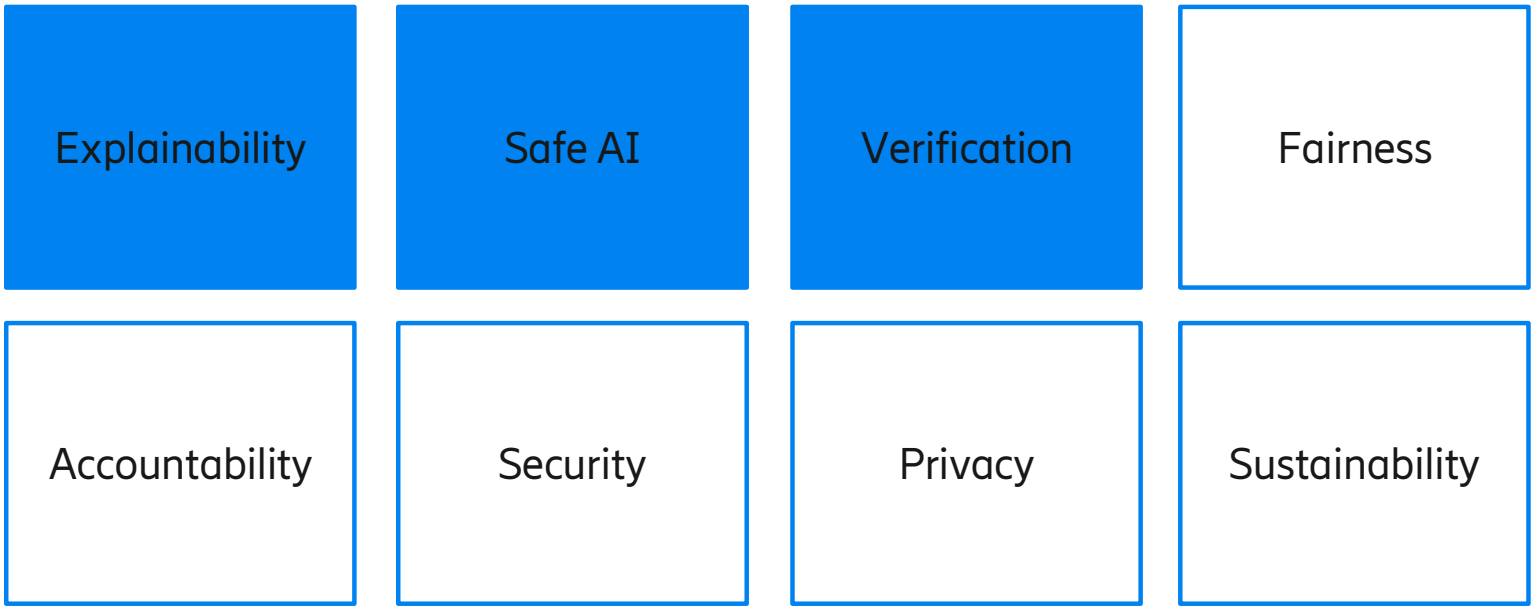
Diversity & Fairness	Technical Robustness and Safety	Privacy	Societal wellbeing
Unbiased and non-discriminatory	Resilient to attacks and uncertainty	Respects data privacy and user consent	Respect human rights and environmental wellbeing

EC Assessment List for Trustworthy Artificial Intelligence (ALTAI)

Technology pieces for Trustworthy AI



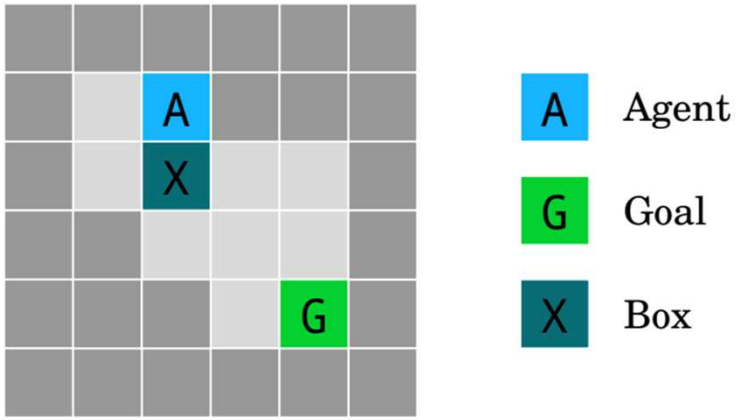
Technology pieces for Trustworthy AI

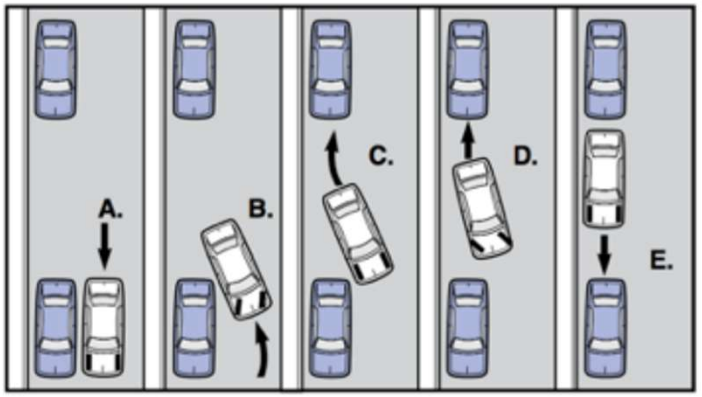


Safe AI

Safe AI

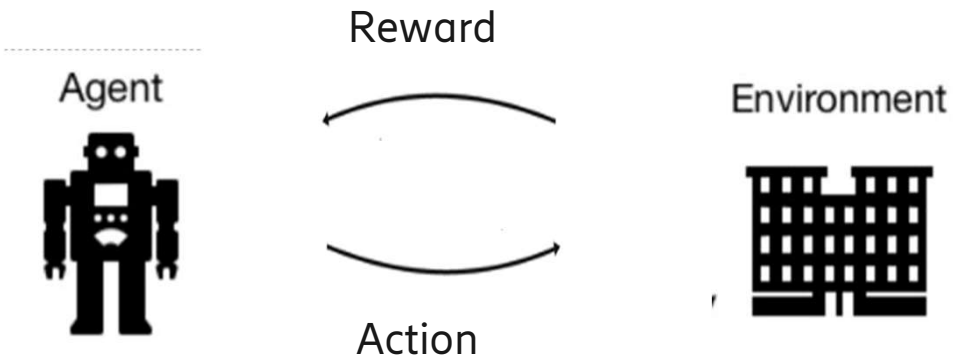
How can we get agents to minimize effects unrelated to their main objectives, especially those that are irreversible?





Intelligent agents

— Reinforcement learning (RL) has recently become a powerful solution for dealing with the general problem of optimal decision and control for agents that interact with an uncertain environment.



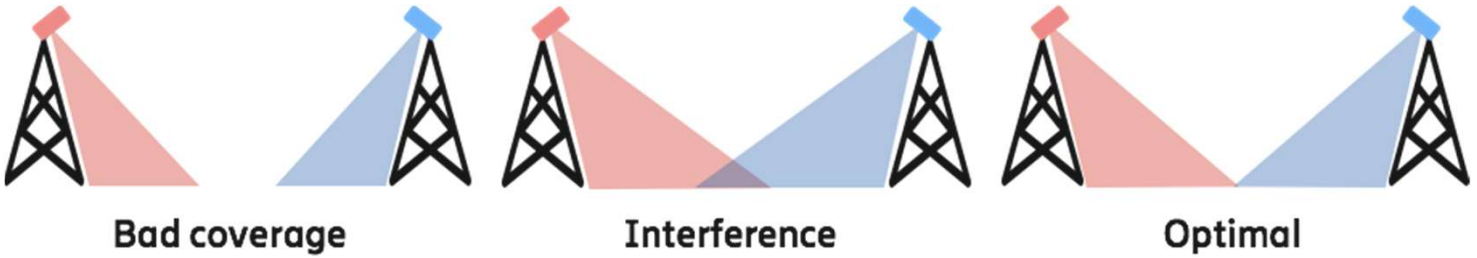
— Telecommunication systems are inherently stochastic and dynamic -> RL can be applied to domain specific use cases to make optimal decisions in order to improve performance

Use cases

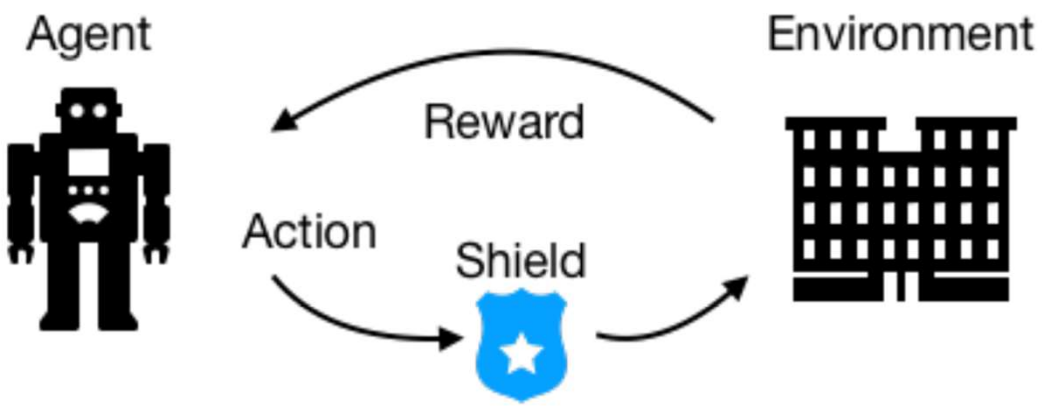
Design control policies in order to optimize network configuration parameters such as antenna tilts

Safe and Symbolic Reinforcement Learning

— When RL agents are deployed in an online learning setting, they perform exploration of the state-action space in the real world to arrive at an optimal policy.
  — However, this exploration needs to be safe, while also arriving at a policy that performs better than baselines.

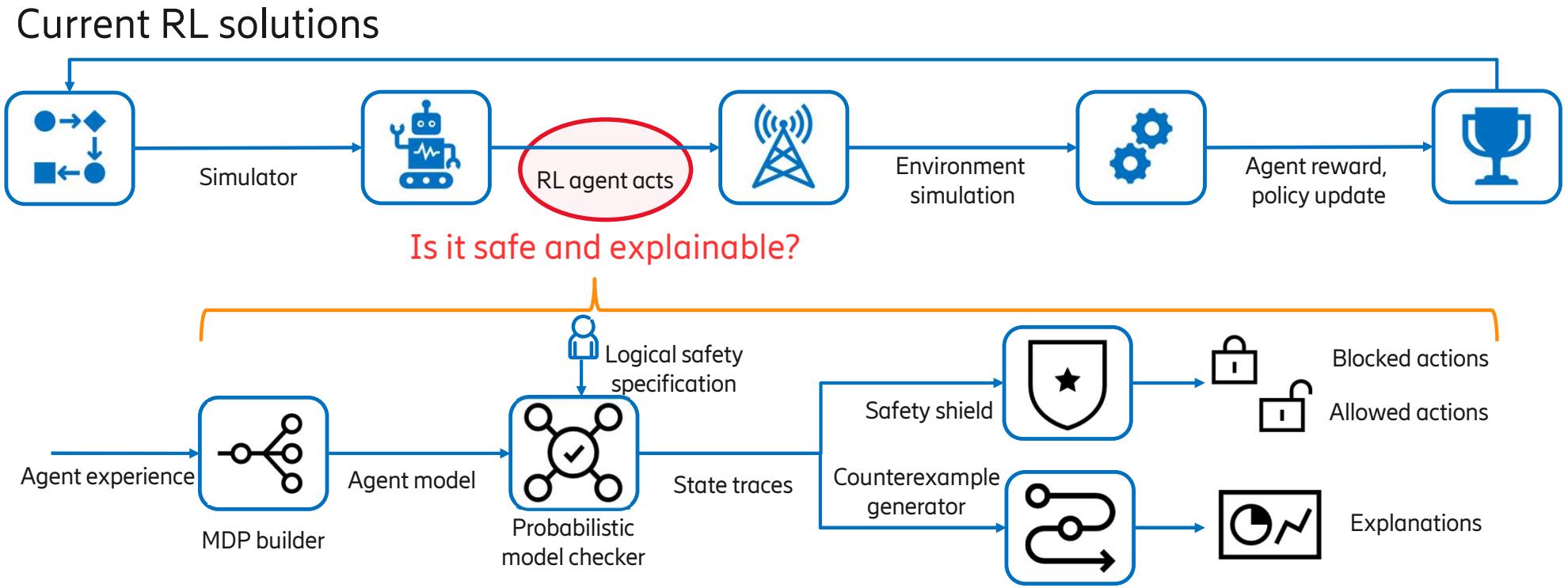


Safe and Symbolic RL

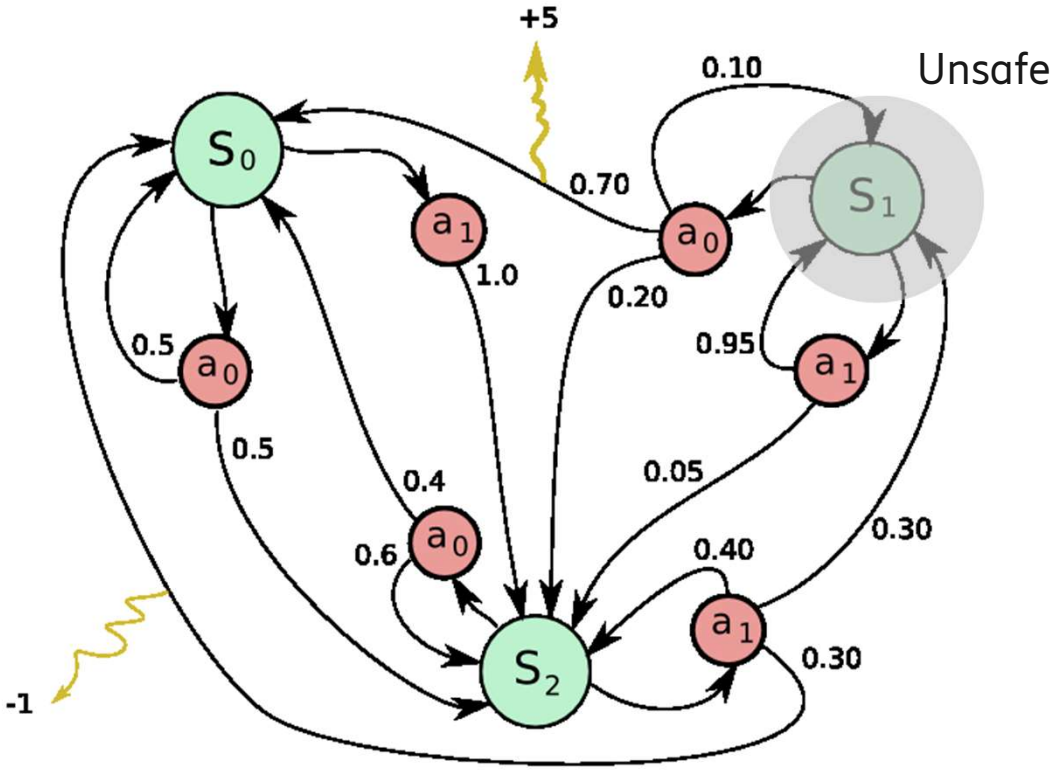


Model-based shielding to “block” unsafe actions towards the environment.

Safe and explainable RL process



MDPs to make state-action transitions explicit



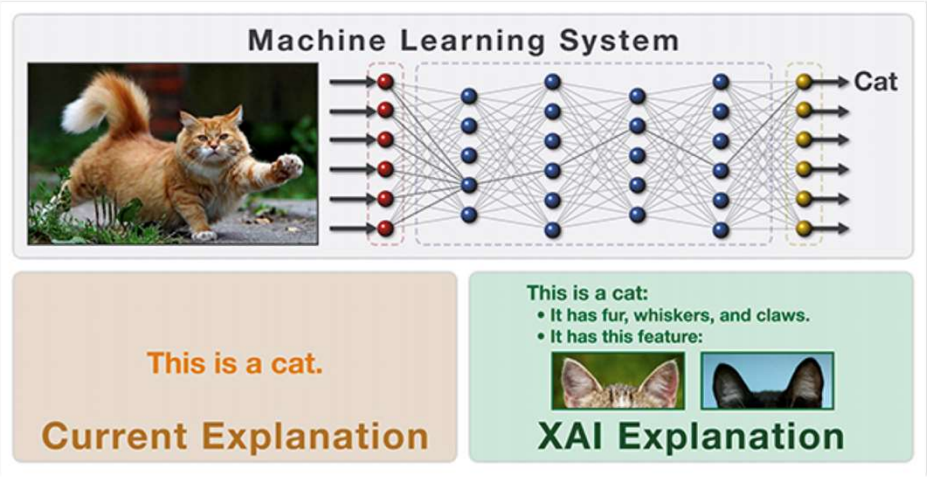
Explainable AI

Explainable Machine Learning

Google’s explanations service (based on Shap)

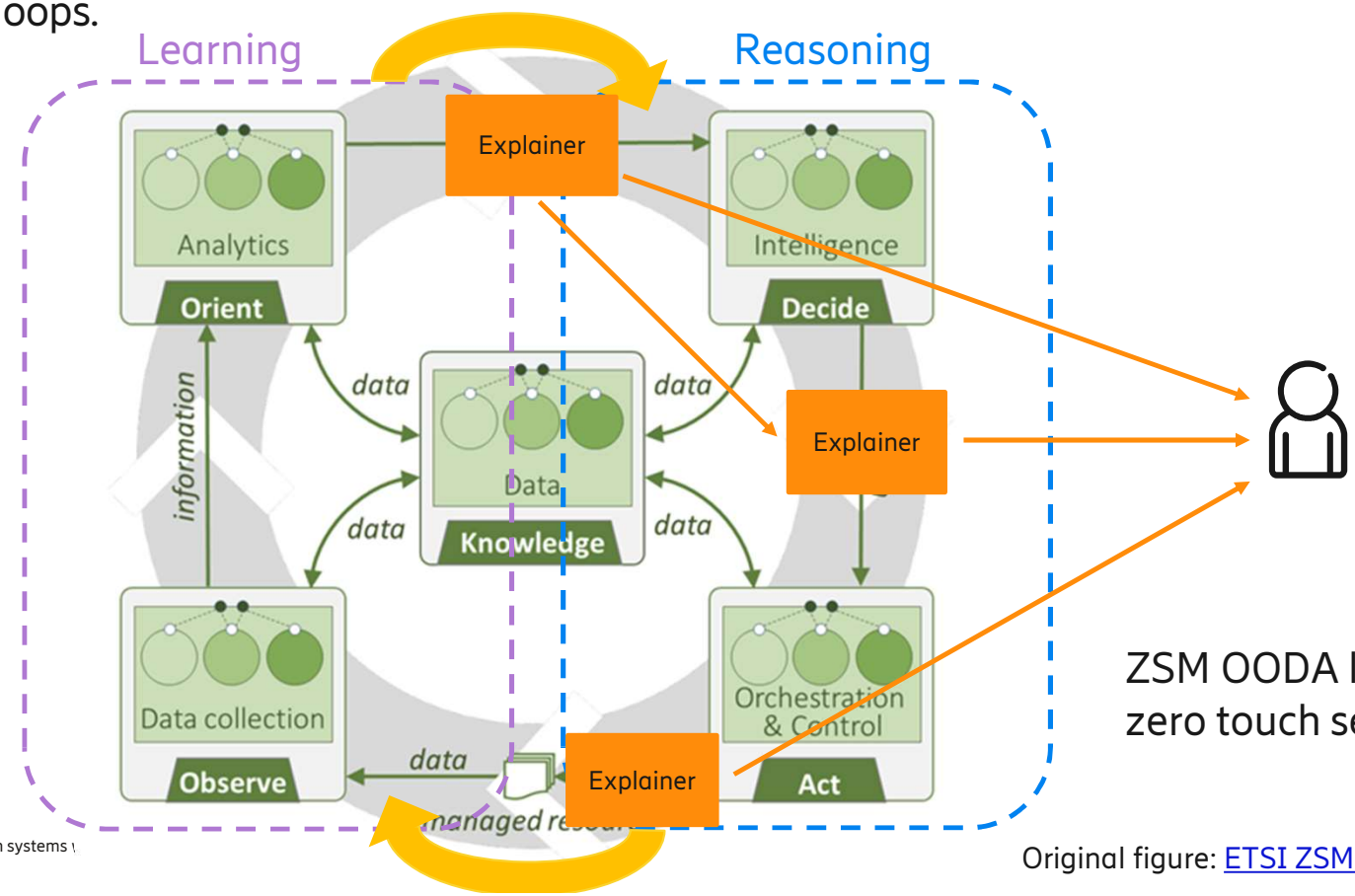
DARPA

Explainable AI



Explainable AI (XAI)

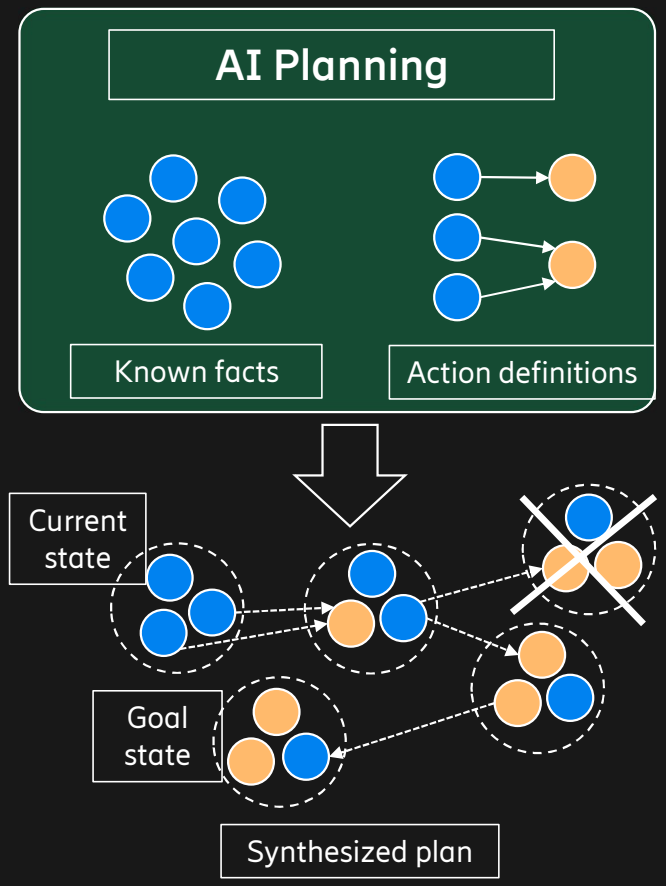
— Study of explainability in the larger intelligent agent context, or for AI agents in both the “Analyse” and "Decide" loops.



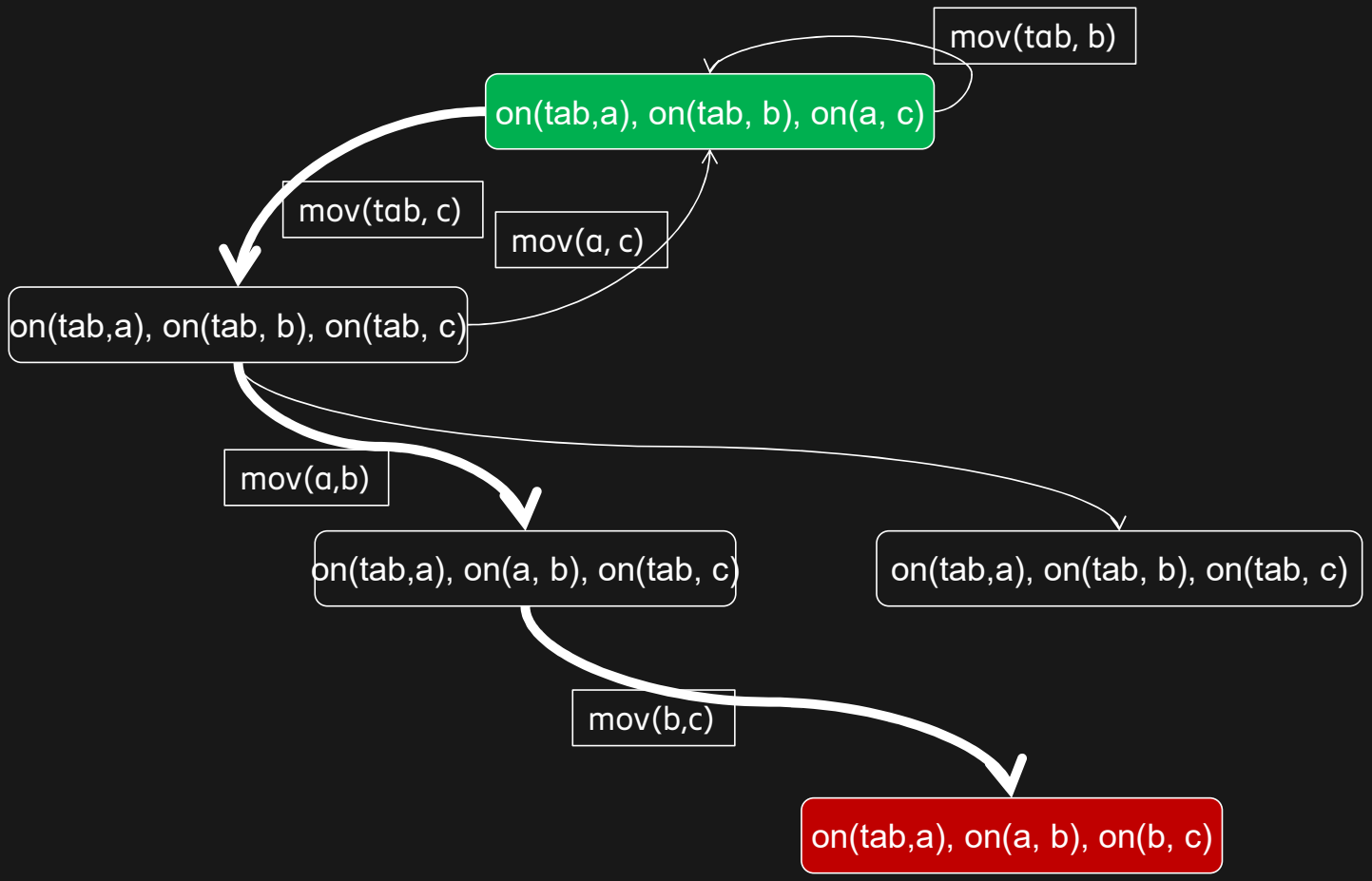
ZSM OODA loop for
zero touch service management

Original figure: ETSI ZSM closed loop architecture

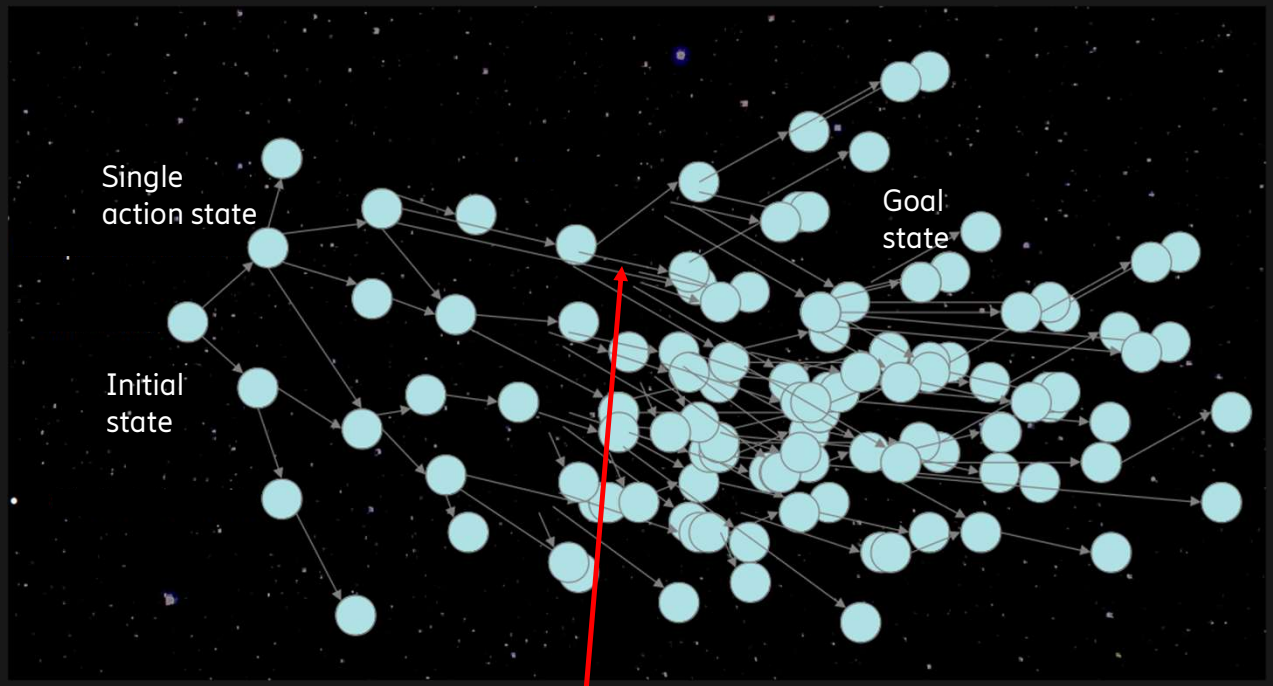
Explainable AI Planning



Explainable AI Planning

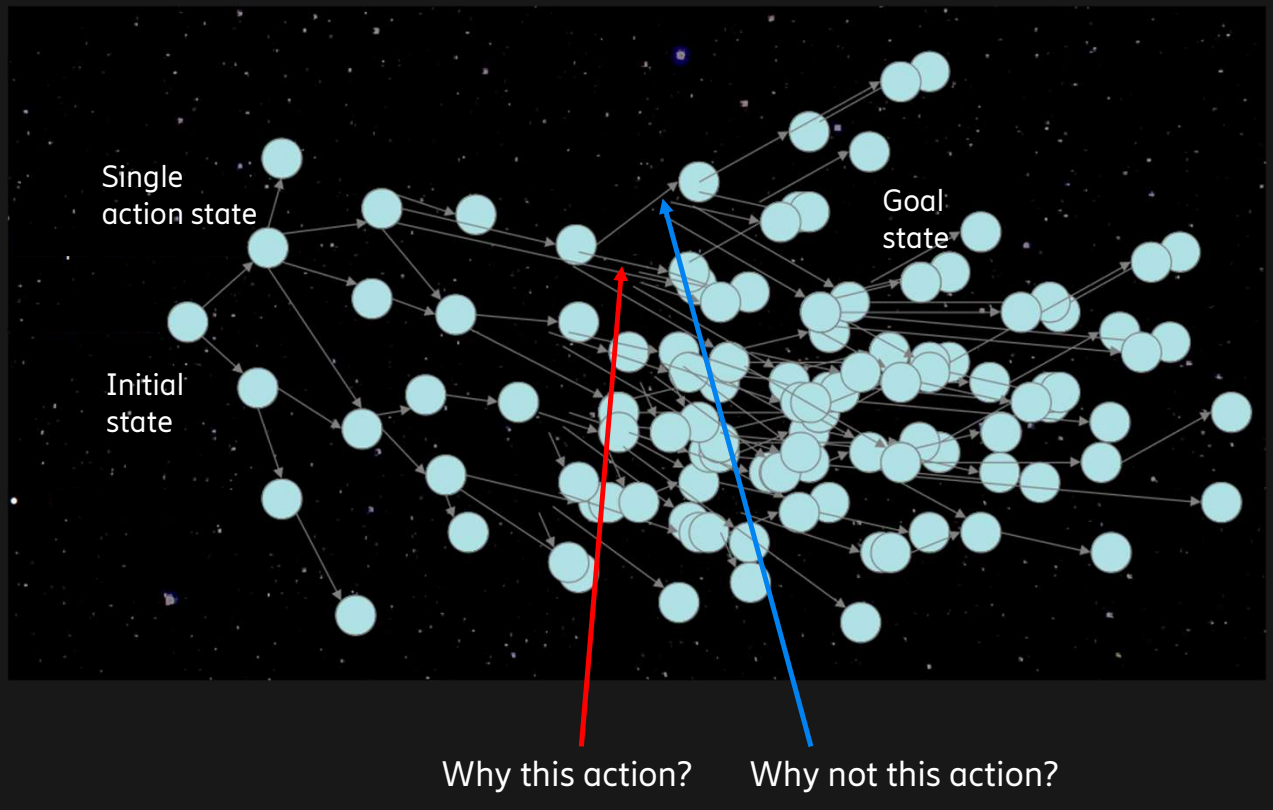


Explainable AI Planning



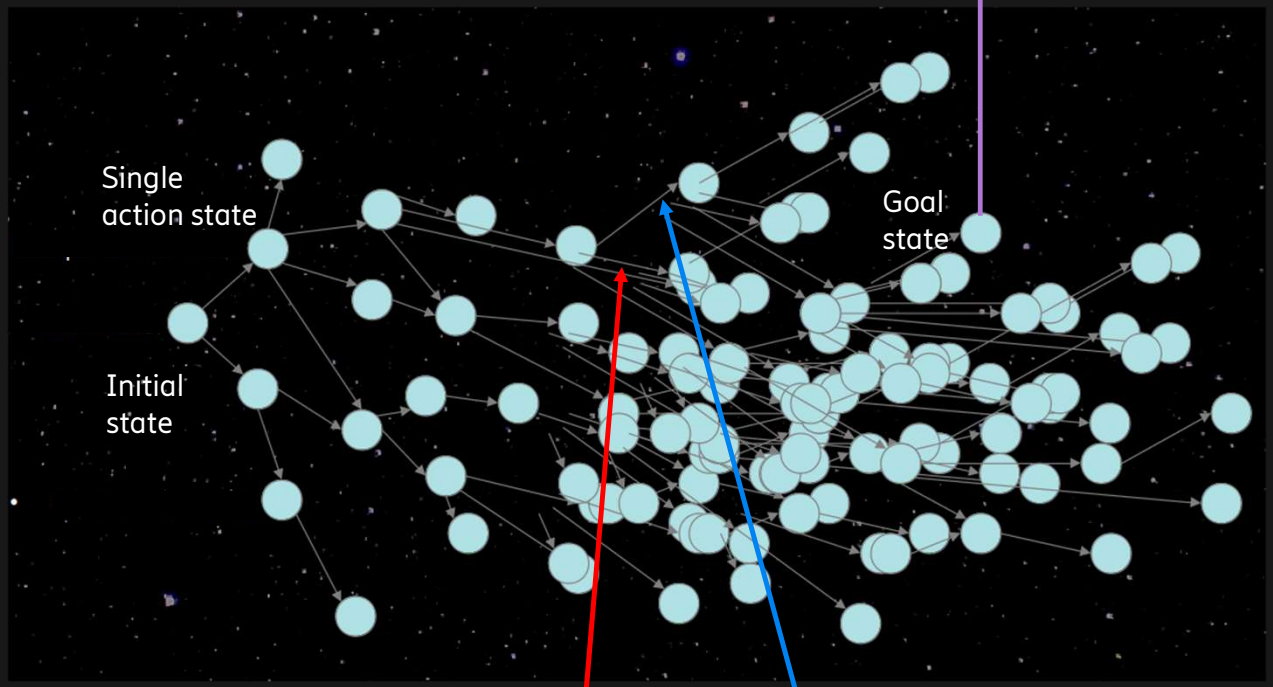
Why action A at step n ?

Explainable AI Planning



Why action A at step n ?
Why not action B at step n?

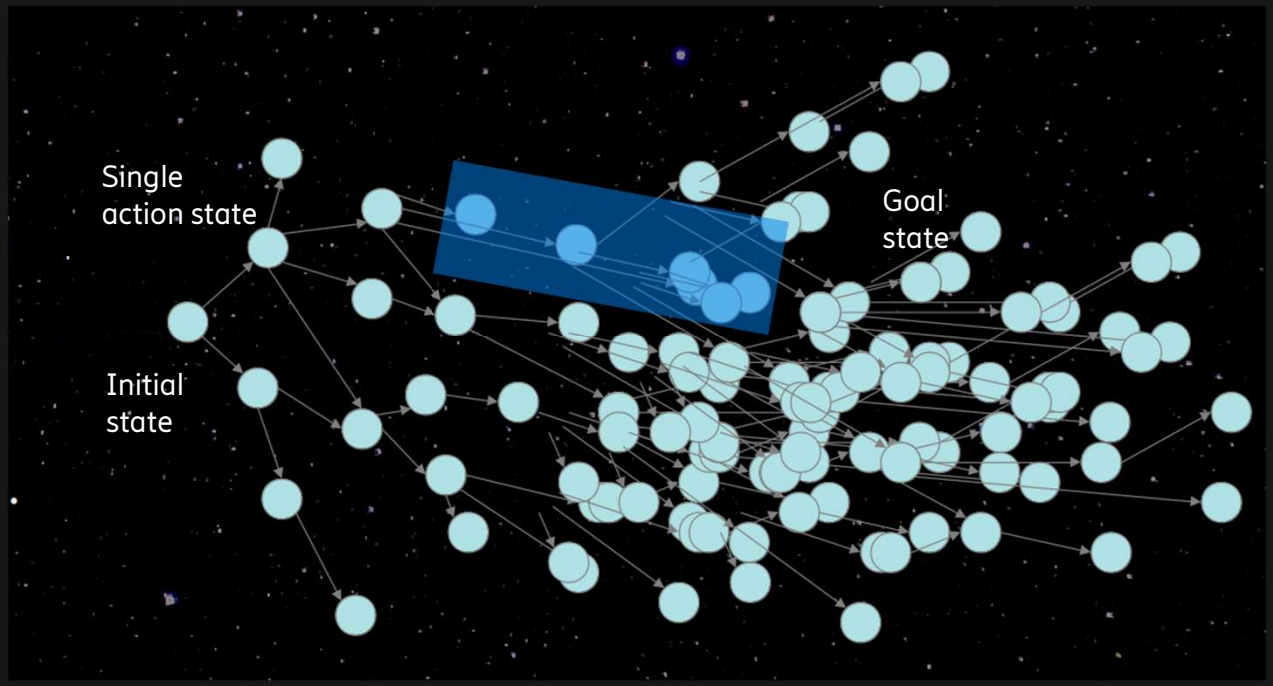
Explainable AI Planning



Contrastive

Why action A at step n ?
Why not action B at step n?
Why this goal or sub-intent?

Explainable AI Planning



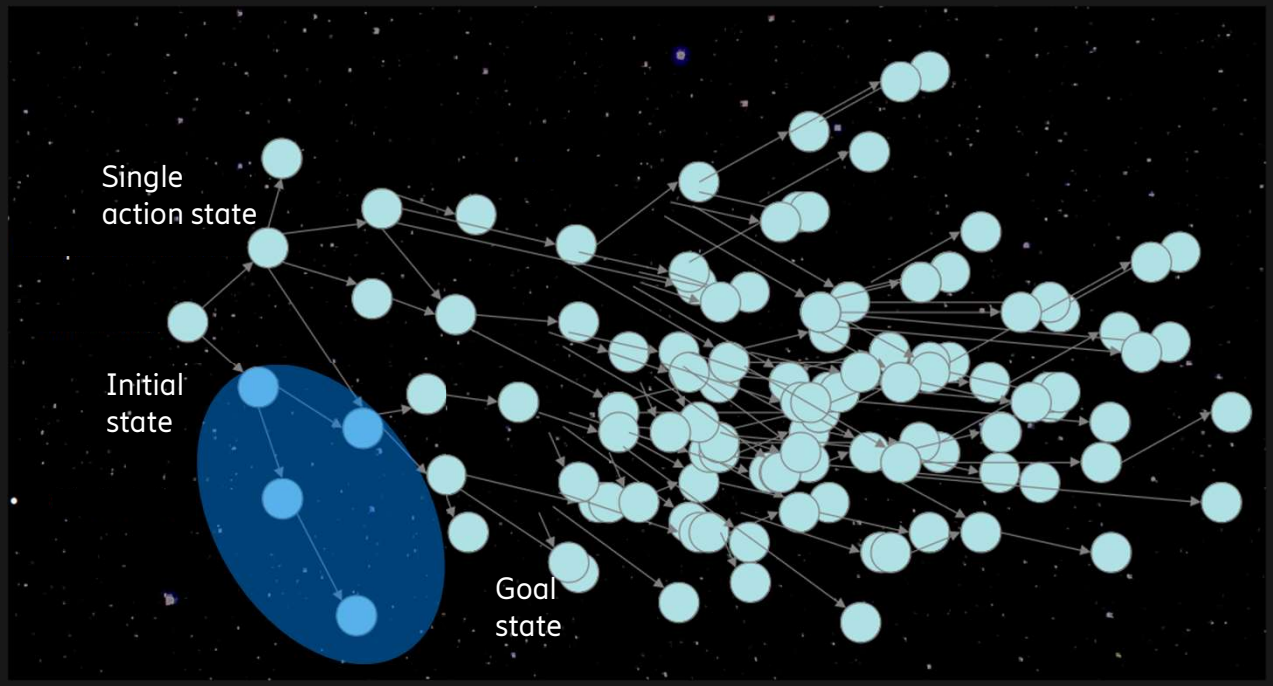
Contrastive

Why action A at step n ?
Why not action B at step n?
Why this goal or sub-intent?

State traces

What was the decision path?
State traces
Plan recognition
What facts support/attack?

Explainable AI Planning



Contrastive

Why action A at step n ?
Why not action B at step n?
Why this goal or sub-intent?

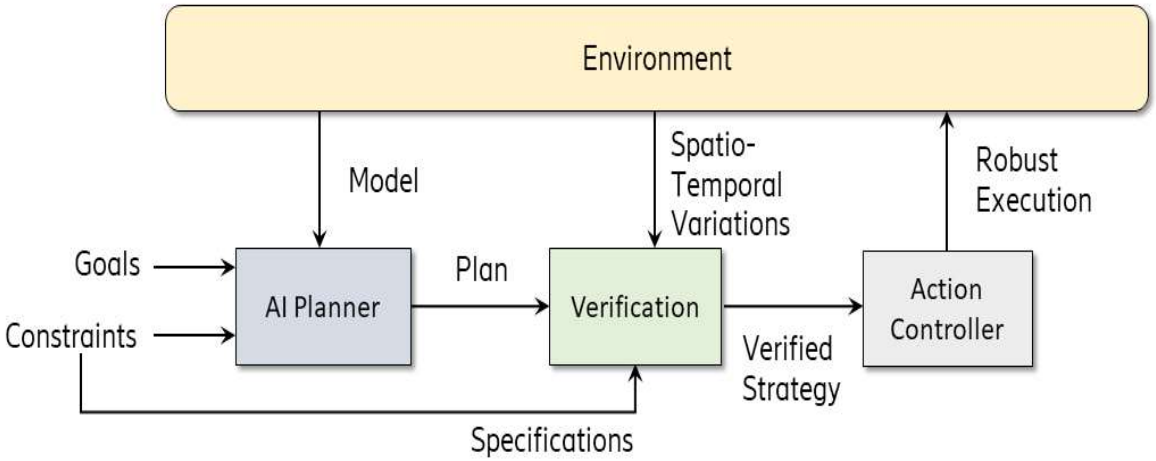
State traces

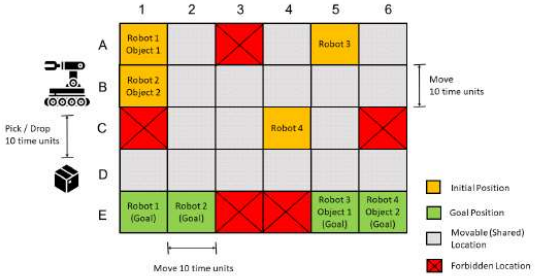
What was the decision path?
State traces
Plan recognition
What facts support/attack?

Explain unsolvability
Introspection in RL

Verification in AI

Verification in AI Planning





- **Problem:** How do we verify AI Planning systems to be conformant to specifications, despite spatio-temporal deviations in the deployment environment ?
- Demonstrated in an automated warehouse use case (SCOTT EU project).
- Paper "FlatPack: Flexible Temporal Planning with Verification and Controller Synthesis", Ajay Kattepur and Swarup Kumar Mohalik to *SAC'21, March 22-March 26, 2021, Gwangju, South Korea*

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