Towards a Companion System Incorporating Human Planning Behavior

A Qualitative Analysis of Human Strategies

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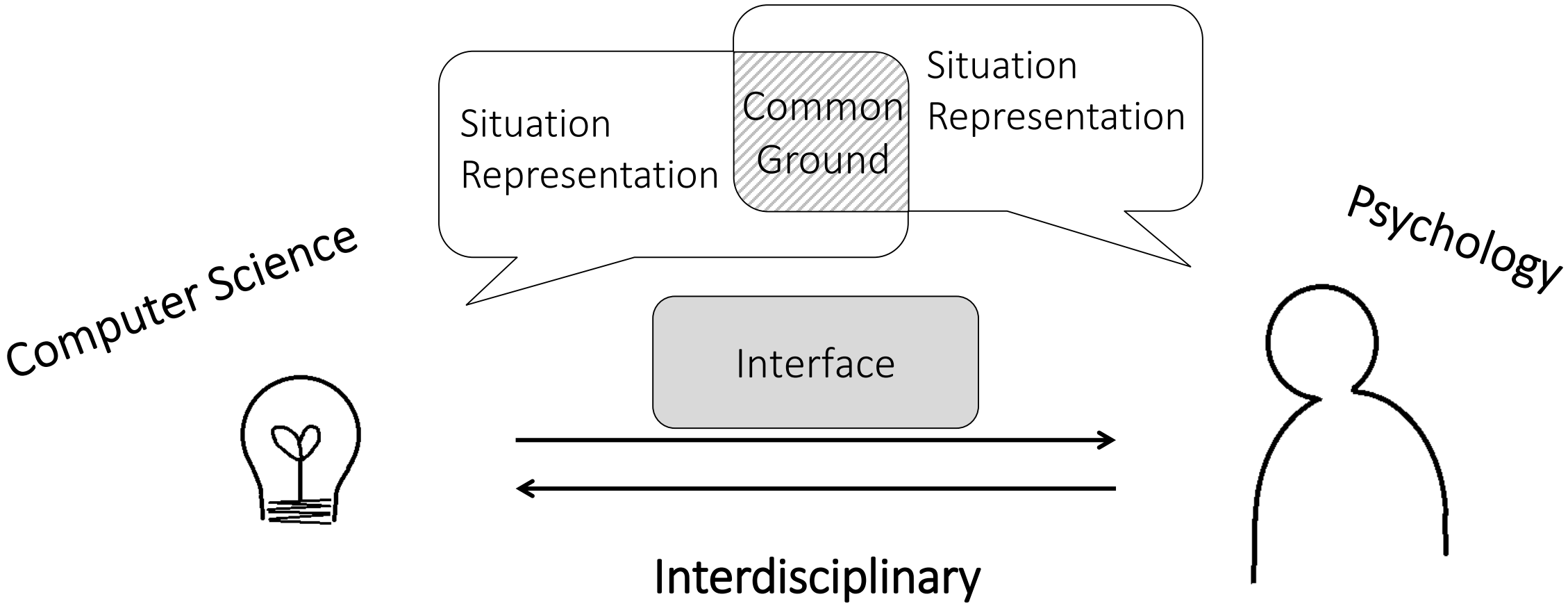
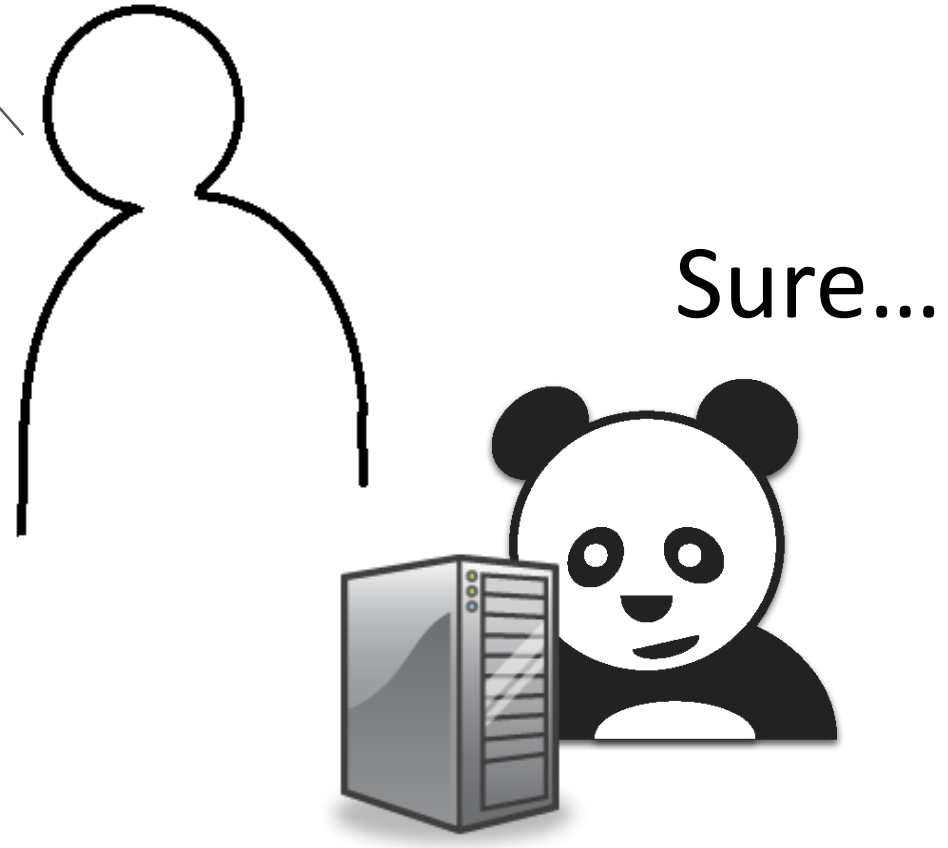
Computer Science and Psychology



Building up a home theater

PANDA, can you help me build up a home theater?



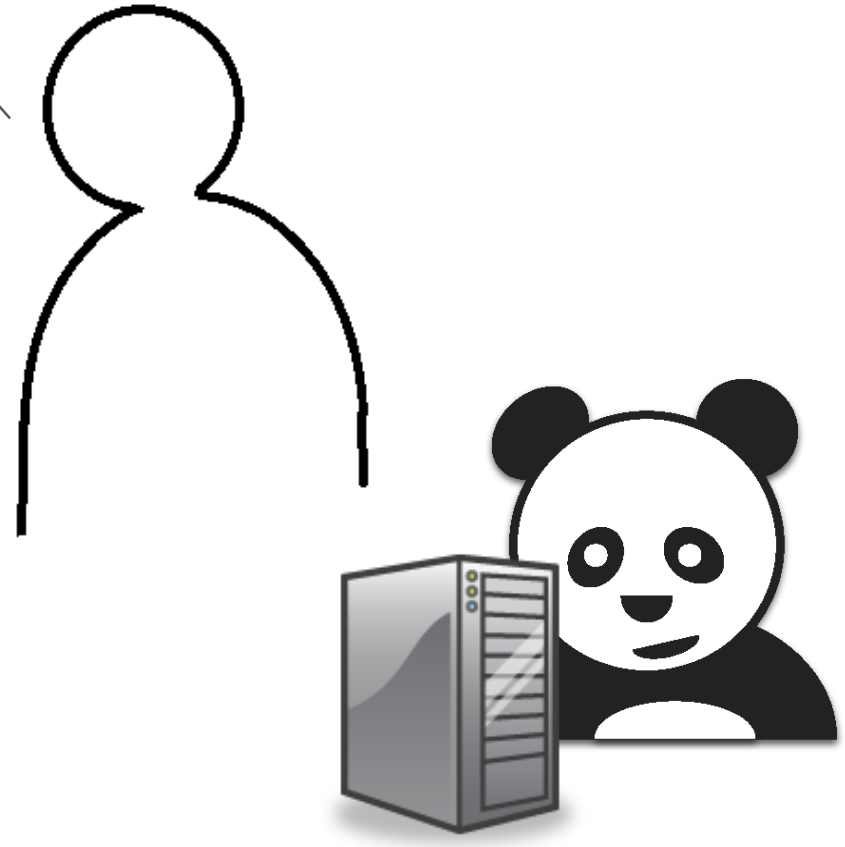
PANDA, can you help me build up a home theater?

Challenges…

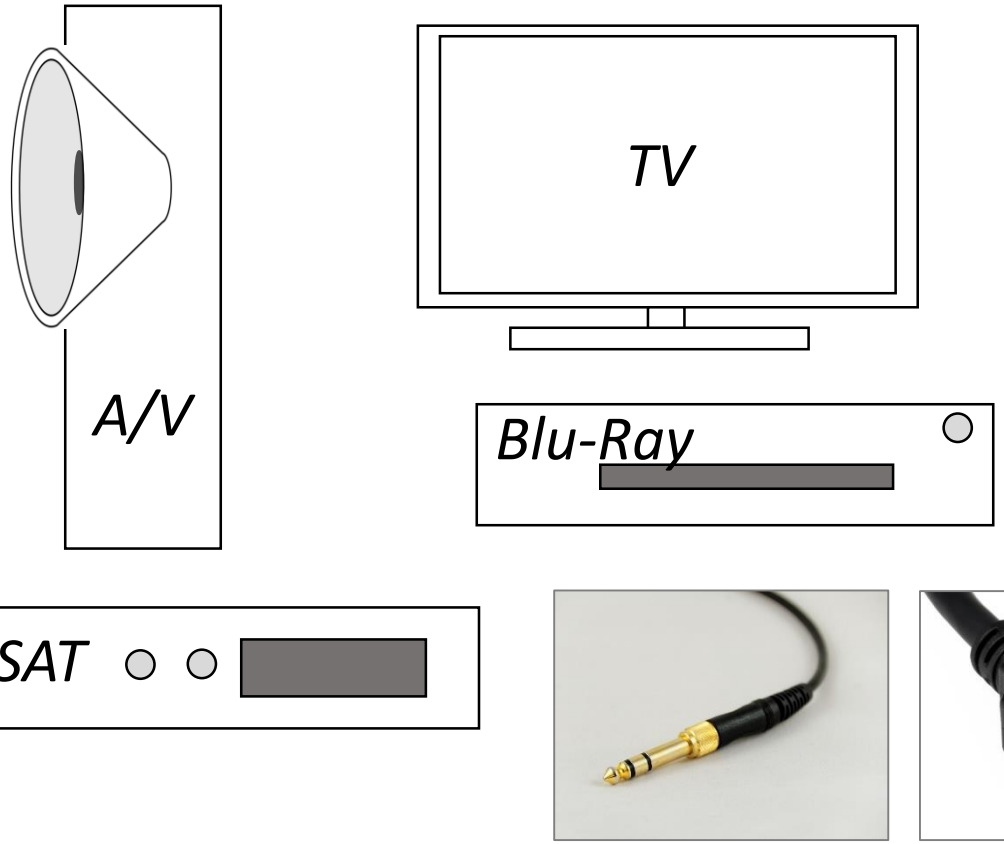
Which planning decisions should be made by the user and which ones by the AI planning component?

In which order should a plan be presented?

How to react to the user?



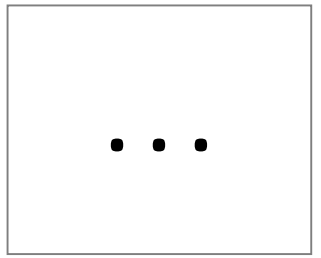
Ill-defined real-world tasks



Undefined Problem Space

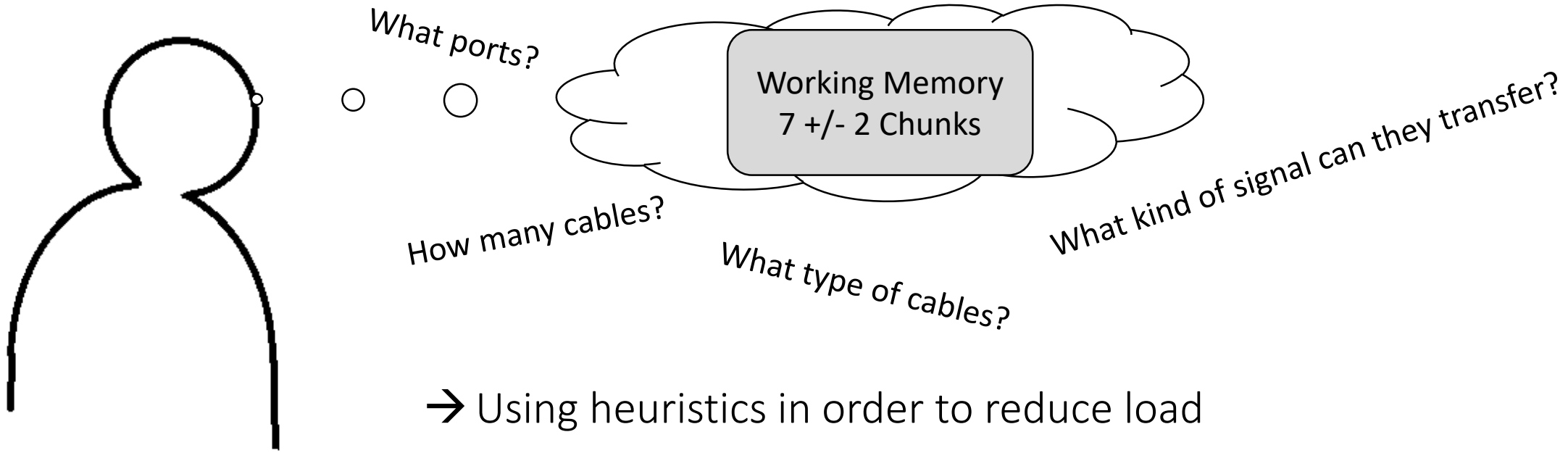
- Initial State?
- Goal State?
- What moves can be made?

Dynamic and Uncertain Environment



Human Problem Solving

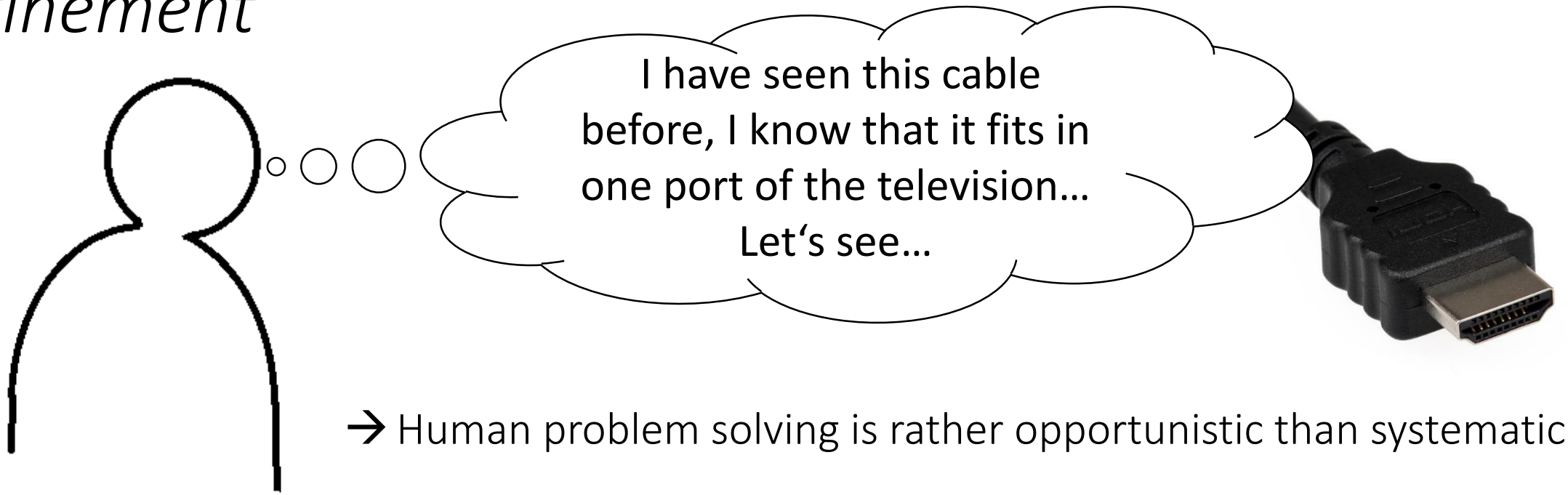
… with limited resources



→ Using heuristics in order to reduce load

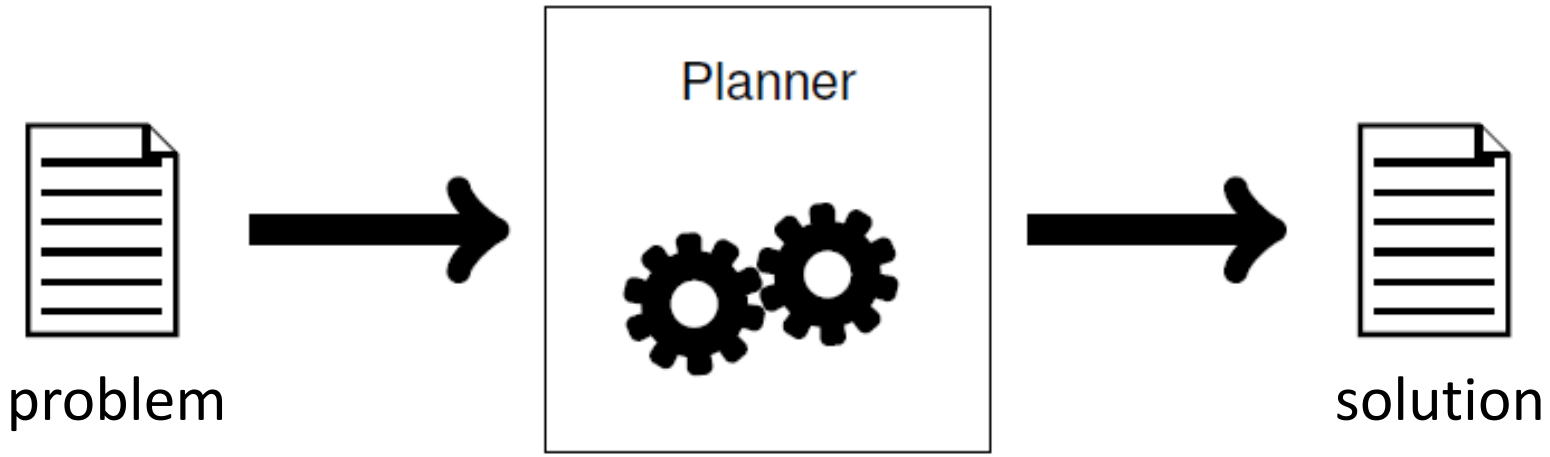
Human Problem Solving

Environmental cues trigger opportunities for plan refinement



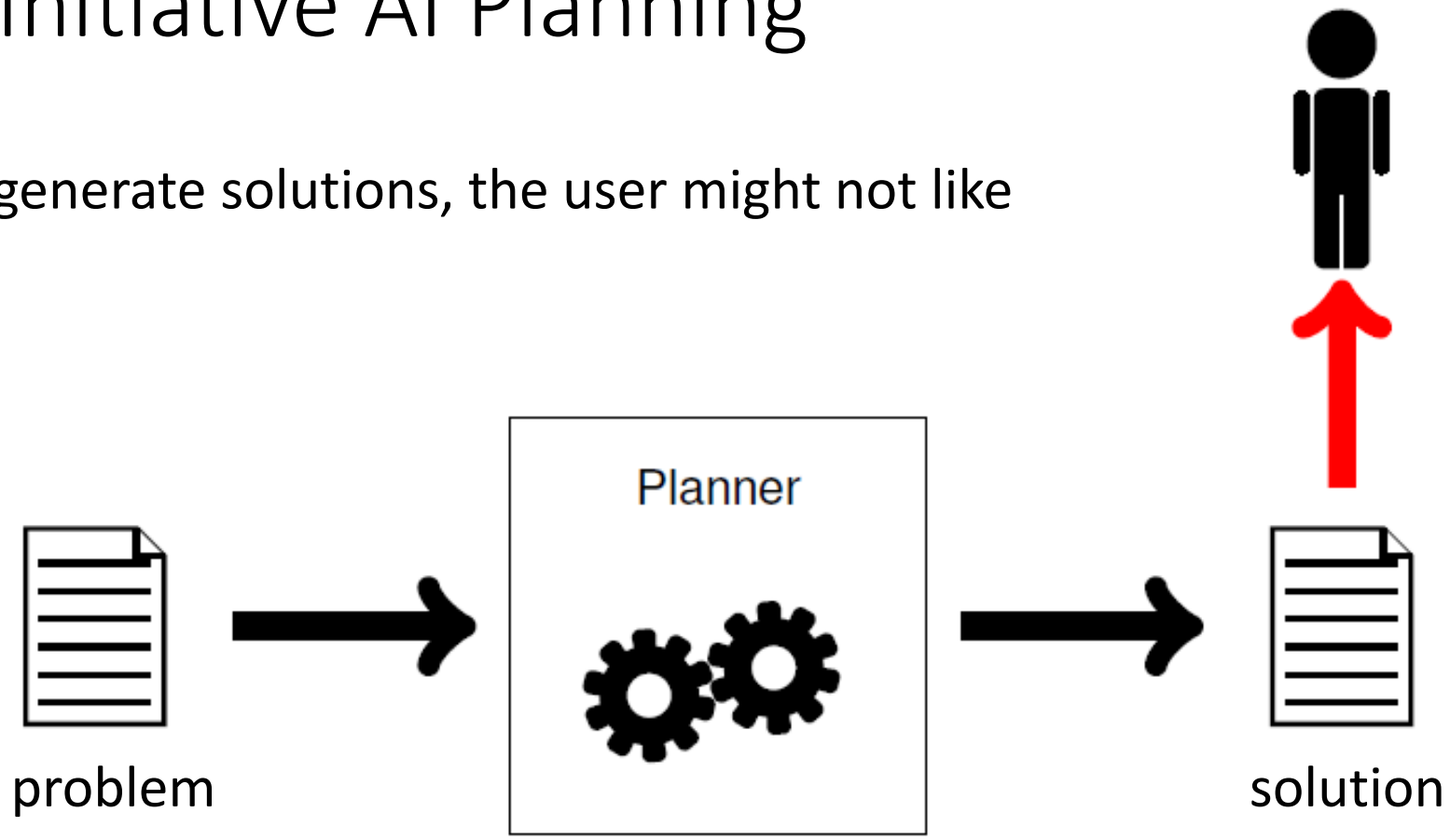
→ Human problem solving is rather opportunistic than systematic

Mixed-Initiative AI Planning



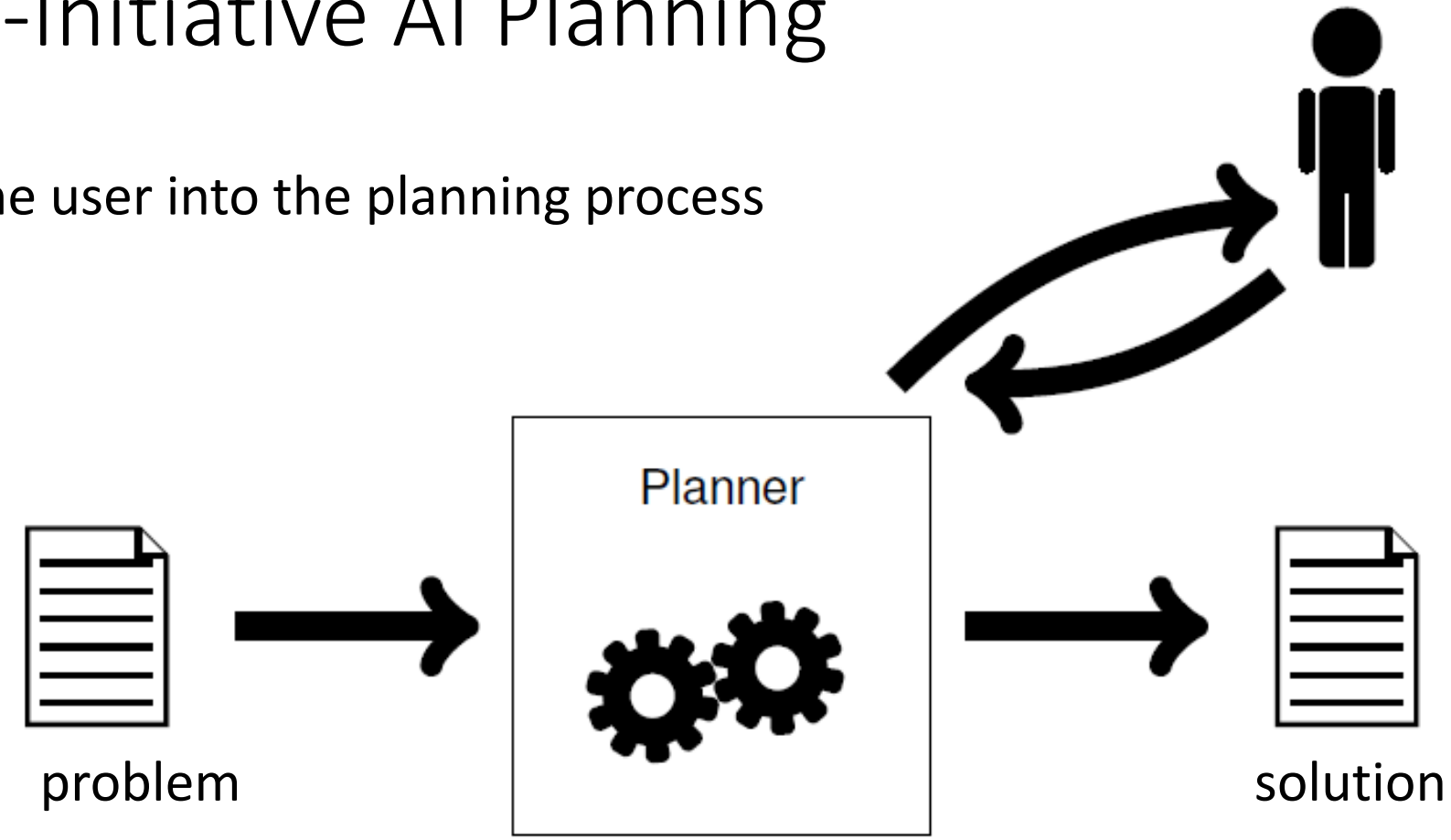
Mixed-Initiative AI Planning

Planner can generate solutions, the user might not like



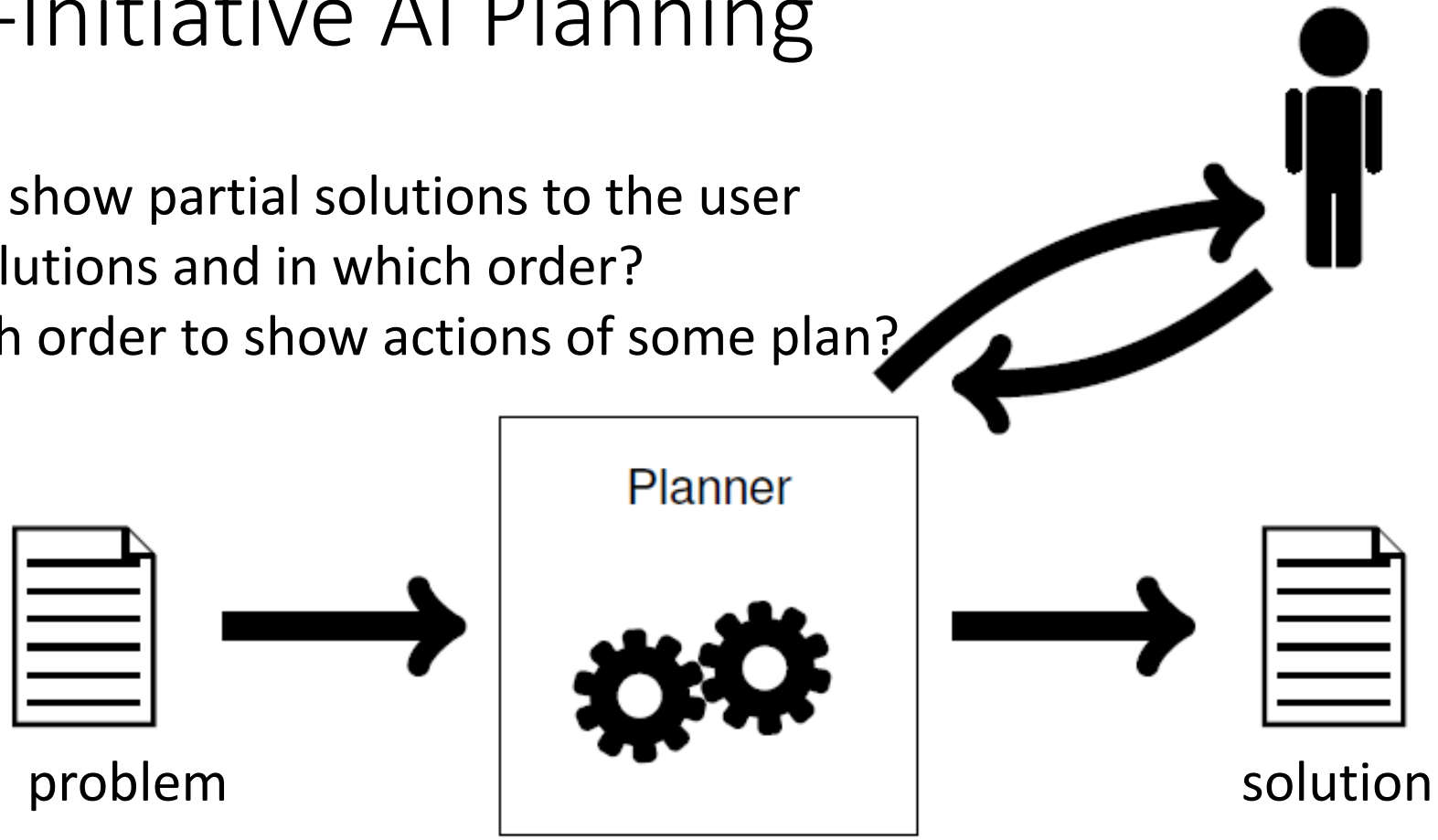
Mixed-Initiative AI Planning

Integrate the user into the planning process



Mixed-Initiative AI Planning

Planner can show partial solutions to the user
But what solutions and in which order?
And in which order to show actions of some plan?

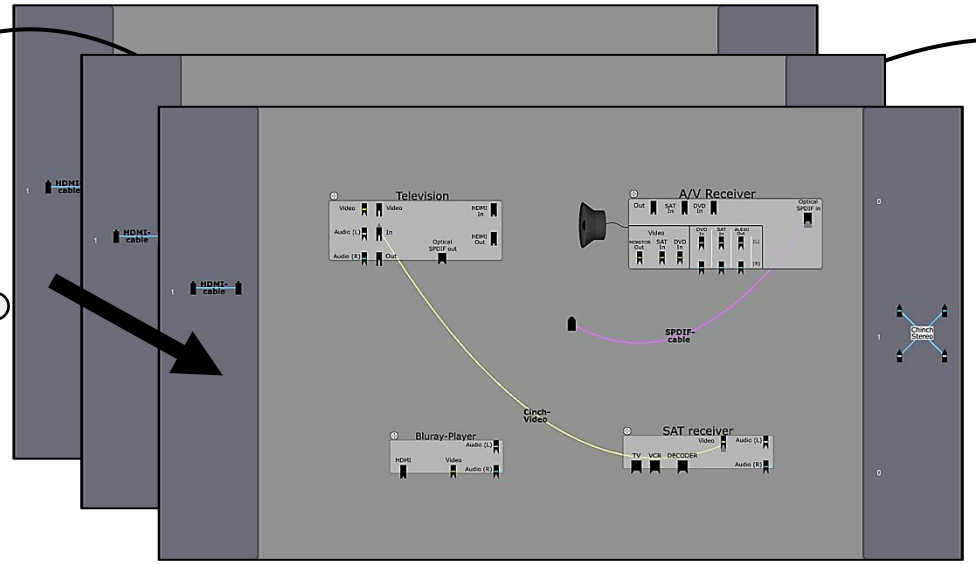


Difference in strategy use with varying knowledge

Group 1 (*n* = 23)

Standard Instructio

Additional strategical Instructions



Group 2 (*n* = 16)

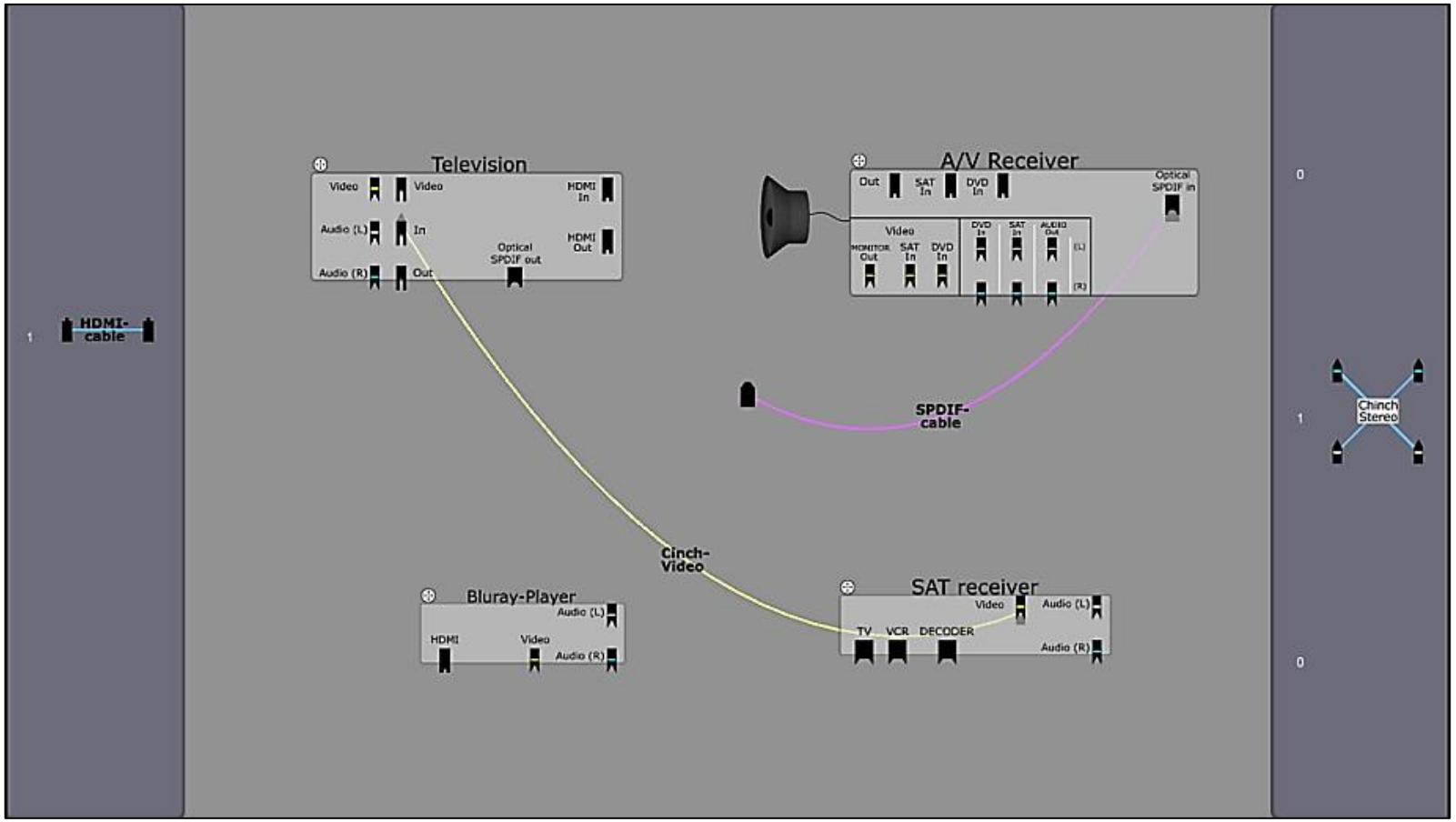
Standard Instructions

Home Theater Setup Task

Dependent variable: Observation of Actions

Control variable: Domain knowledge

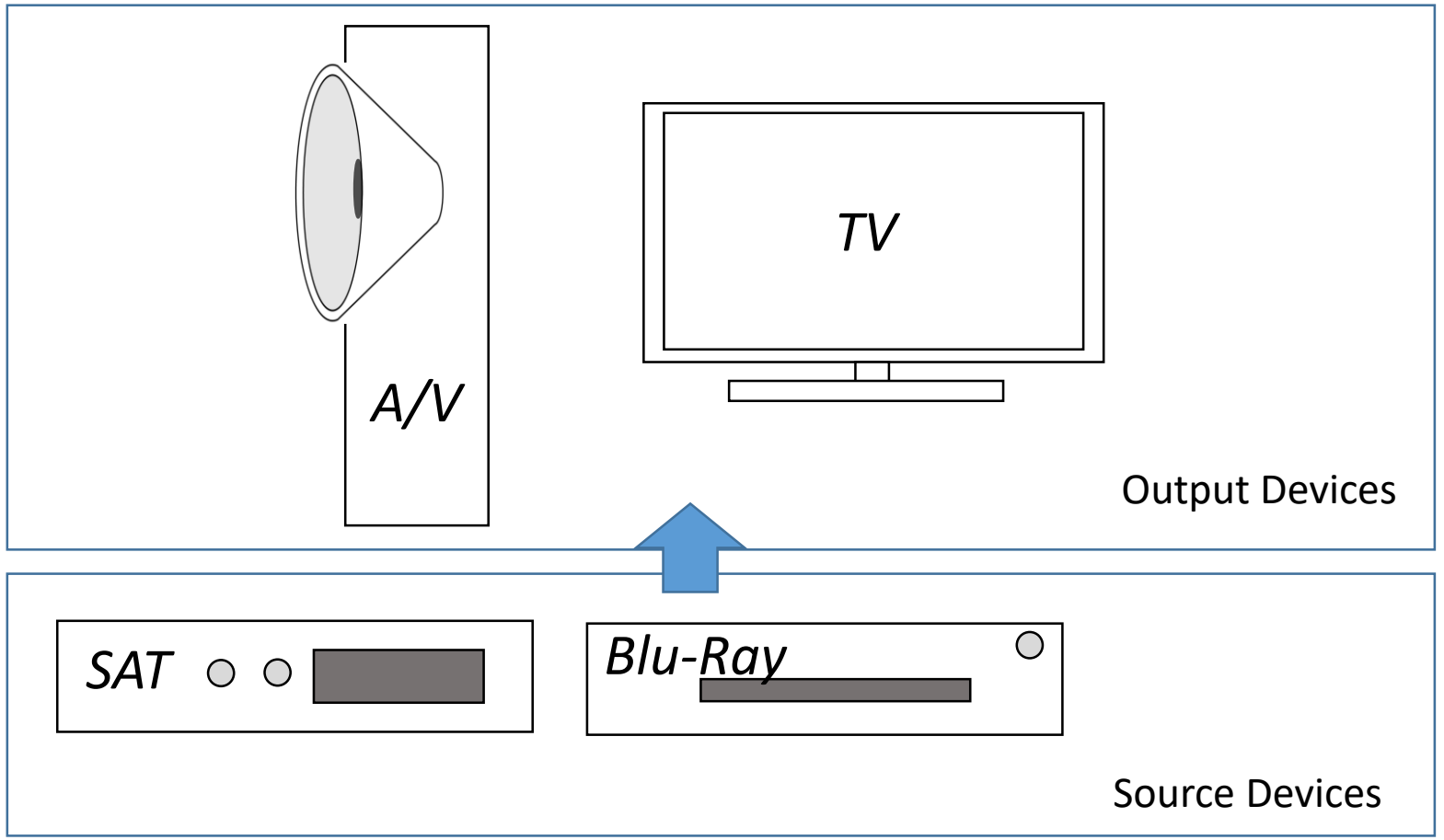
The task: Setting up a home theater



- Different Devices
- Different Cables / Adapters
- Different Ports
- Different Signal Types (Audio / Video)

Varying availability of cables to solve the tasks (Scenario A, B, C)

The instruction group



Follow the signal flow beginning from the source devices to output devices.

Example…

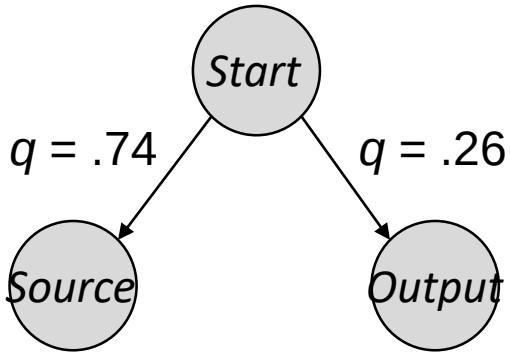
Results: Descriptives

Table 1: Percentage of correctly solved tasks for each group and scenario

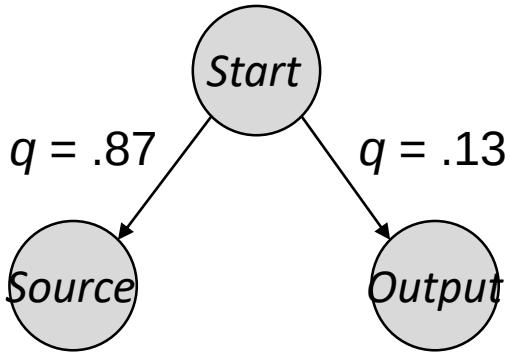
Group	Scenario		
	A	B	C
Instruction Group	.61	.48	.78
Control Group	.31	.25	.50
Sum	.49	.38	.67

Results: Strategy Use

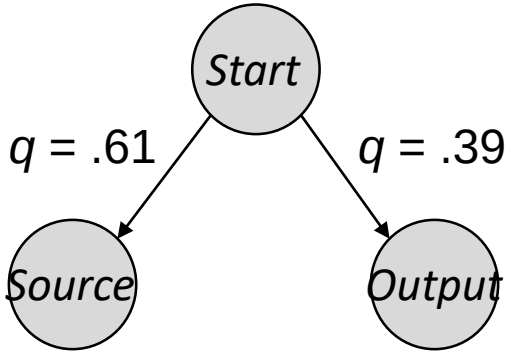
Did participants in the **instruction group** follow the strategy being proposed?



Scenario A



Scenario B

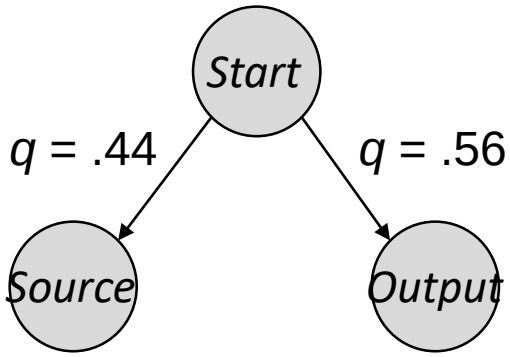


Scenario C

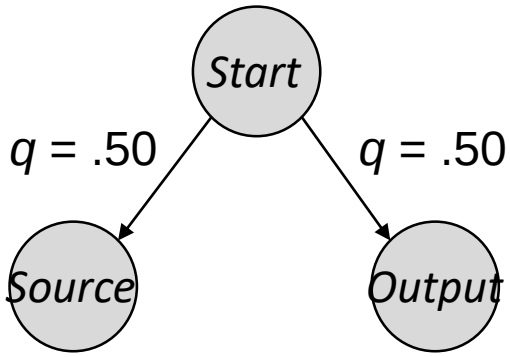
Yes, participants in the instruction group started with a source device

Results: Strategy Use

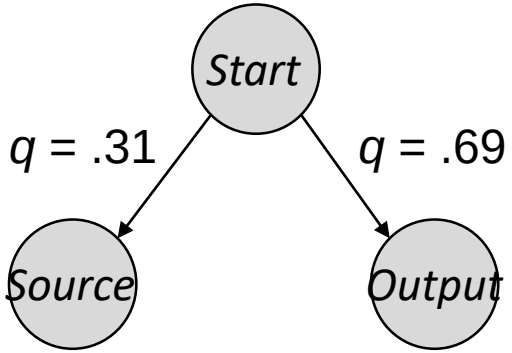
What about the **control group**?



Scenario A



Scenario B

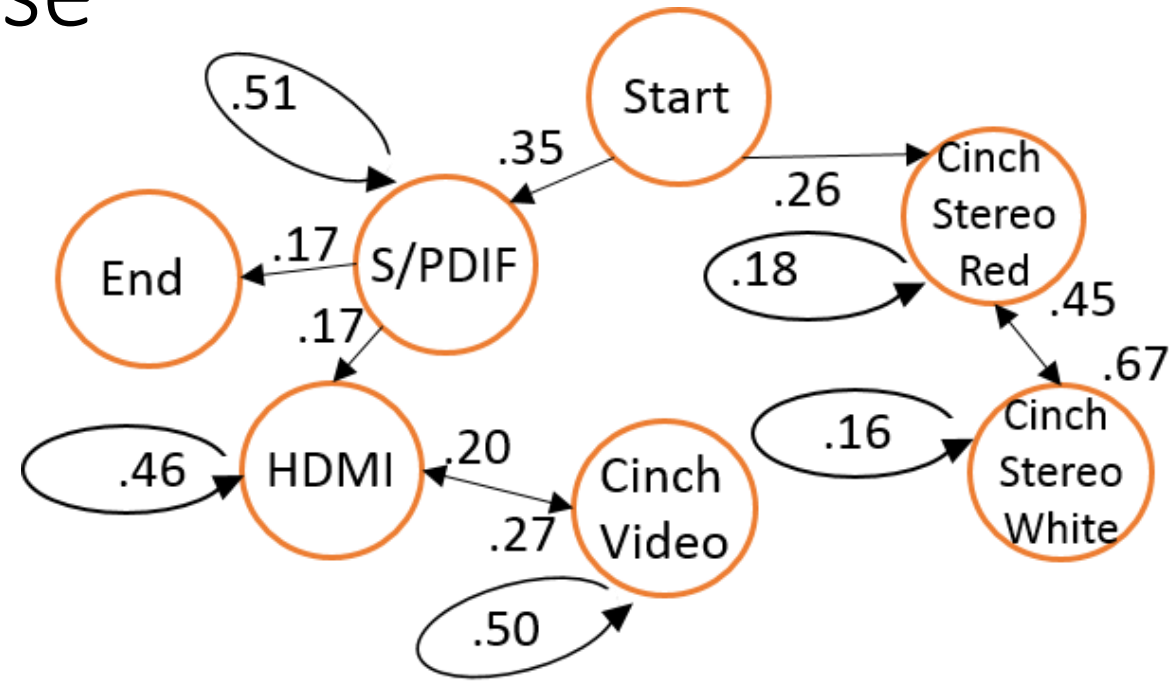


Scenario C

Participants in the control group seem to start randomly…

Results: Strategy Use

Parameter: Cable



State diagram of cable usage in scenario C.

Higher values for reusing the same cable again than using another one for most cables

Results: Strategy Use

The role of knowledge

Knowledge test (before):

- 85% knew HDMI cable
- 23% knew S/PDIF cable

Overall, the HDMI cable was used most directly after the start state in scenarios A & B ($q > .25$ VS. $q < .15$)

In scenario C, S/PDIF was used after the start state with $q = .35$ / $q = .44$. (It was known from scenario B by then)

Summary

- People tend to reuse the same cable with a higher probability than using another cable
- Parameter of decomposition: People decompose problems cable-wise instead of device-wise
- Influence of instruction: Higher strategy use in instruction group
- Influence of knowledge: People use cables they already know first
- Behavior is rather opportunistic

Limitations

- Homogeneous sample
- Small sample size (*N* = 39; low statistical power)
- Scenarios in fixed order, not randomized (possible order effects)
- Exploratory study: data-driven interpretations & post-hoc explanations
- Limited generalizability

Implications for AI Planner

If there are many possibilities to modify a given plan and the user needs to choose: How to present the options?

- rank them according to how well certain options are known to the user
- group options together according to how well the options are known and only show a representative of a group

Implications for AI Planner

If the planner solves a certain sub problem automatically: which solution should it preferably generate?

A solution that uses concepts (like the involved hardware) that is known to the user (Gives raise to new plan metrics).

Further Implications…

- plan explanations: why was a certain action chosen by the planner?
- plan linearization: in which order should the required actions be presented to the user?

For the details please take a look in the paper! :)