

Video courtesy of Dr. Kaijen Hsiao, <http://people.csail.mit.edu/kjhsiao/wrtpomdps/>

# Successful Grasp Experiments

All videos 50x

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# BELIEF STATE

HOW ROBOTS MAKE SENSE OF A  
WORLD THEY DON'T UNDERSTAND

Anthony Morelli

# DECISION MAKING (HUMAN)



# DECISION MAKING (HUMAN)

- Compare to previous experience



# DECISION MAKING (HUMAN)

- Compare to previous experience
- Consider possible consequences



# DECISION MAKING (HUMAN)

- Compare to previous experience
- Consider possible consequences
- Consider gaps in knowledge



# DECISION MAKING (HUMAN)

- Compare to previous experience
- Consider possible consequences
- Consider gaps in knowledge
- Make intuitive predictions



# DECISION MAKING (COMPUTER)

- Compare to previous experience
- Consider possible consequences
- Consider gaps in knowledge
- Make intuitive predictions



# DECISION MAKING (COMPUTER)

- **Compare to previous experience**
- Consider possible consequences
- Consider gaps in knowledge
- Make intuitive predictions



# WHAT WE KNOW

- Effective decision making requires intuition
  - Consequences
  - Likelihood of correctness
- Computers are bad at intuition
- They are *incredible* at analysis of past results and observations
- Use math/data to make up for gaps in intuition and prediction

# BELIEF STATE

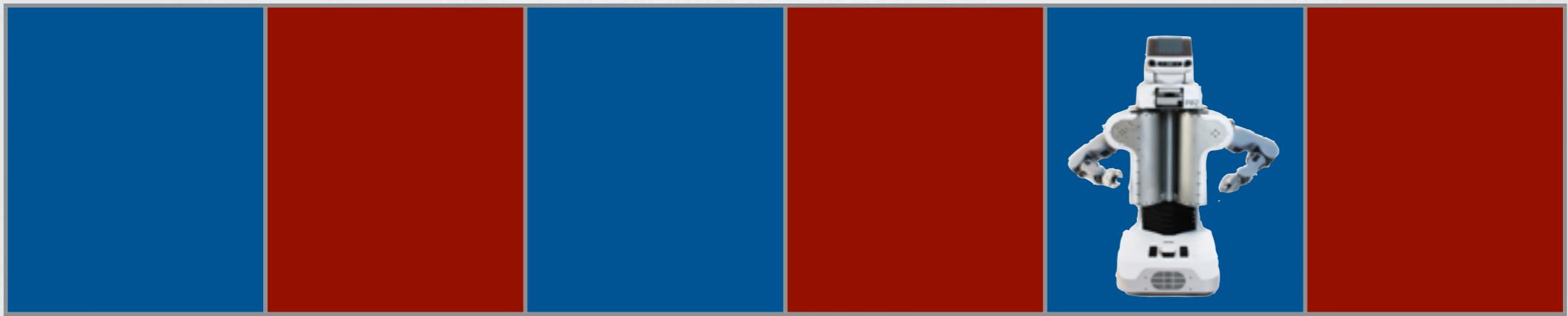
- Knowledge = “Belief”
- Accumulated current knowledge = “Belief State”
- Use new information to improve belief
- Account for quality of information
- Use probability to reflect confidence in any particular piece of information or intuition

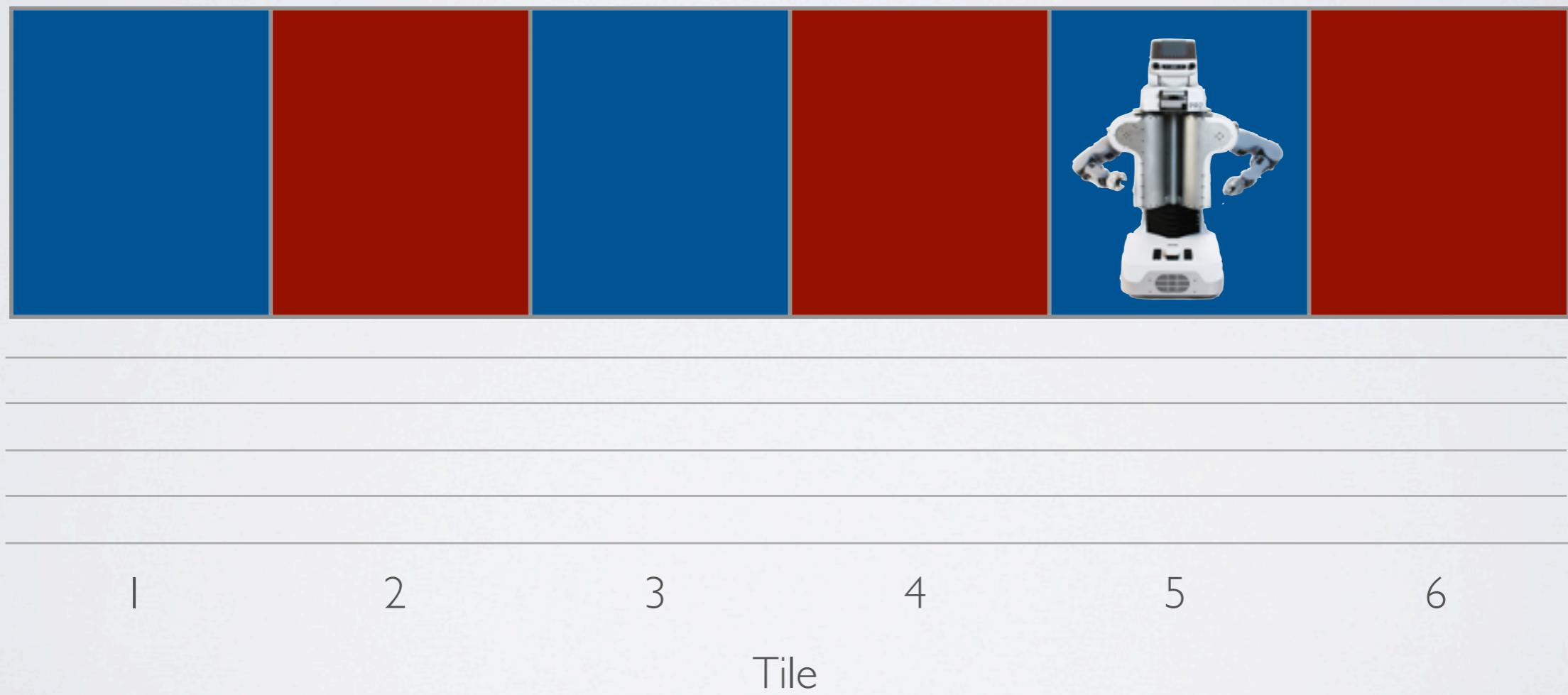
# BELIEF STATE IN ROBOTICS

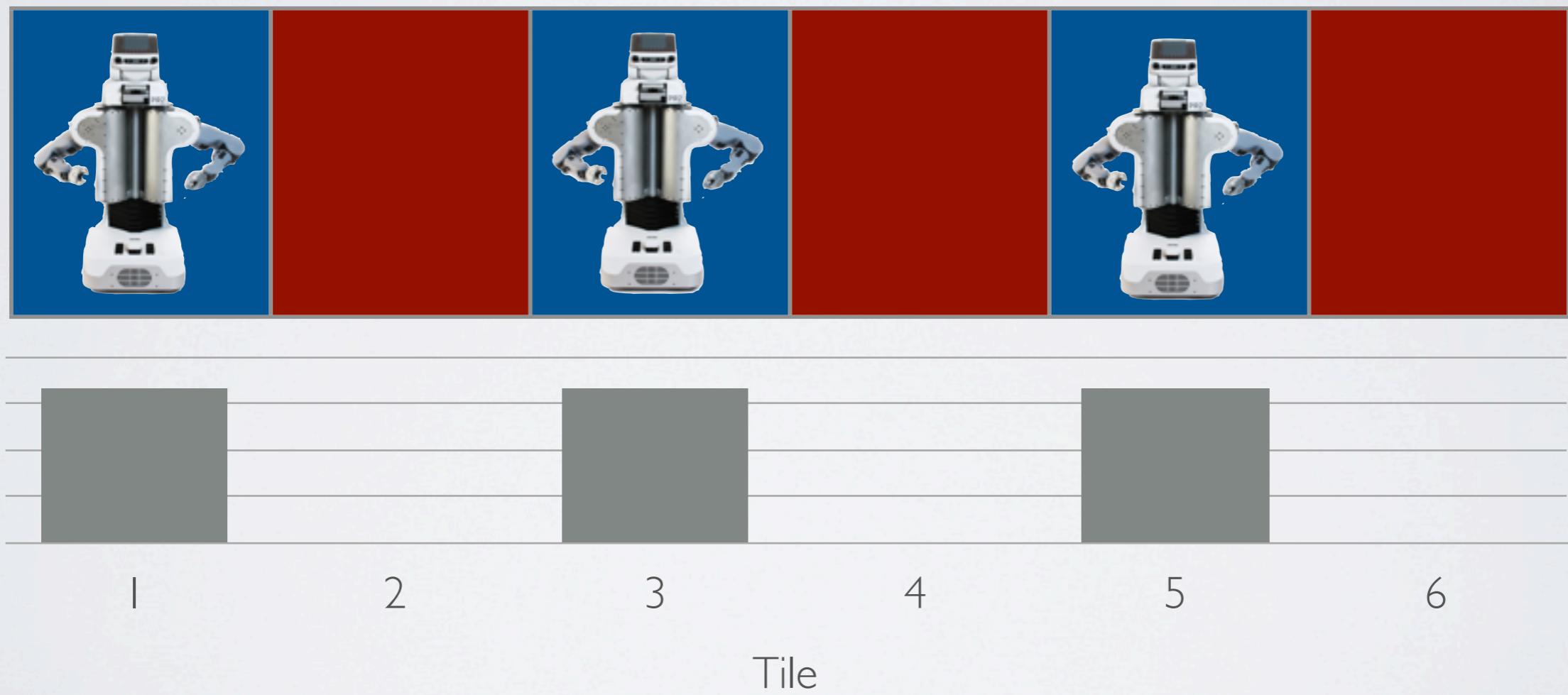
- Observations are often faulty
- Deal with the real world, which is inconsistent
- Interact in real time

# BELIEF STATE IN ROBOTICS

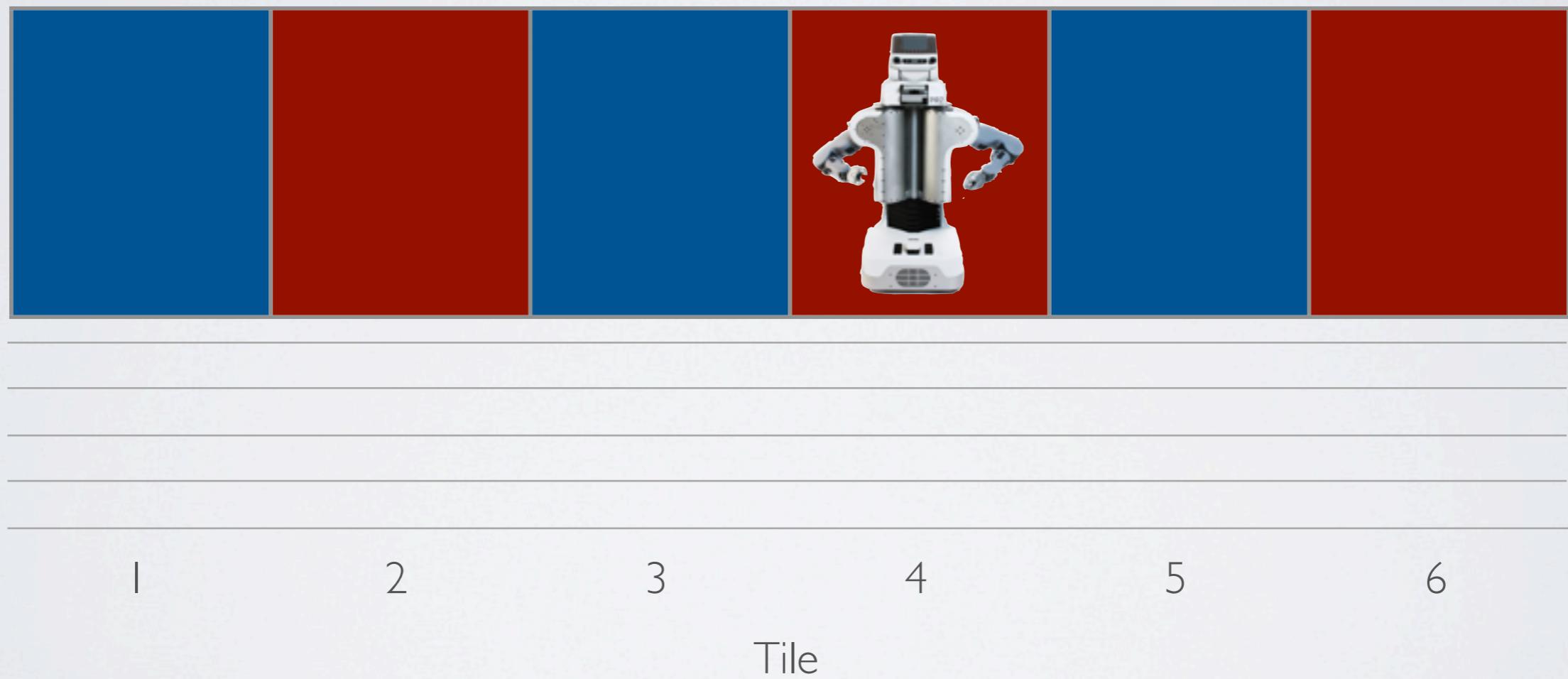
- Observations are often faulty
- Deal with the real world, which is inconsistent
- Interact in real time
- Using belief state makes the problems manageable
- Information isn't 100% right, but that's OK
- Use probability to reflect and track uncertainty

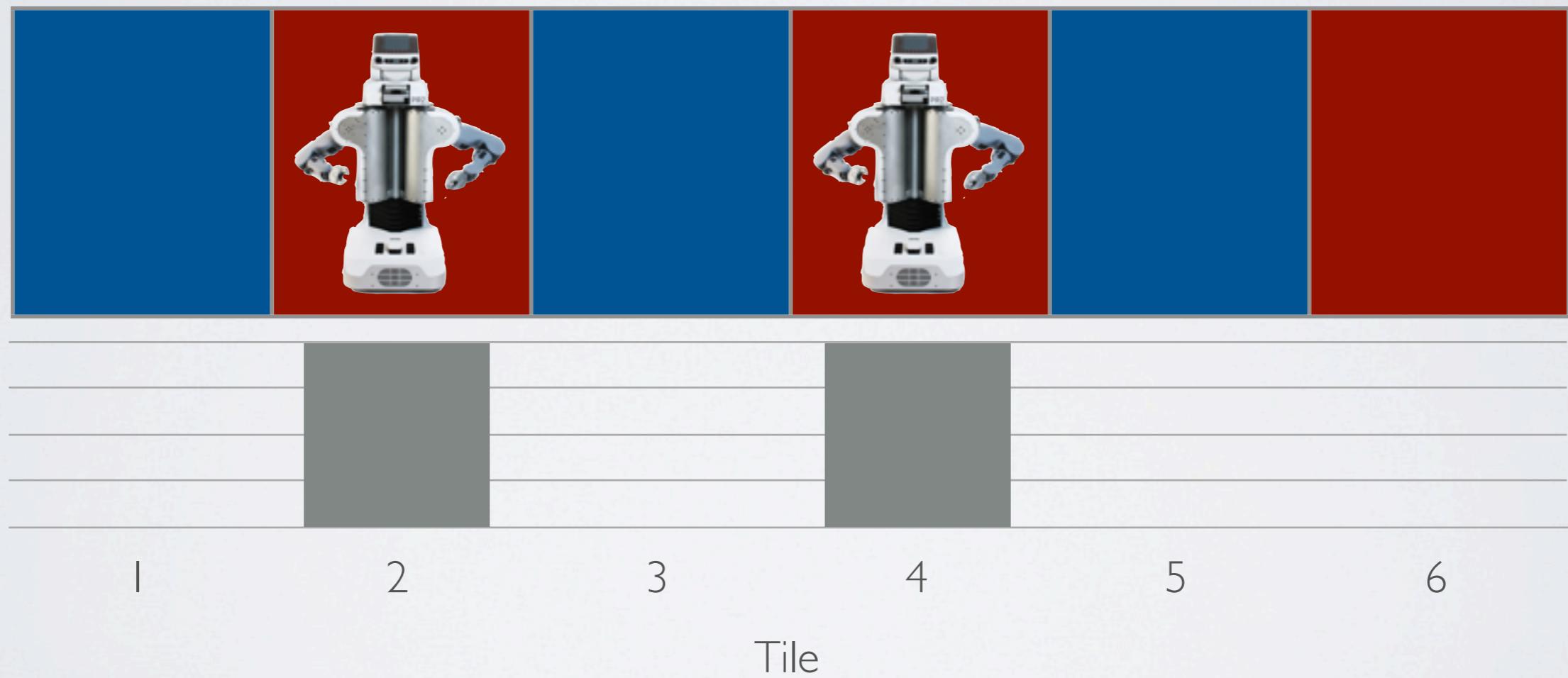


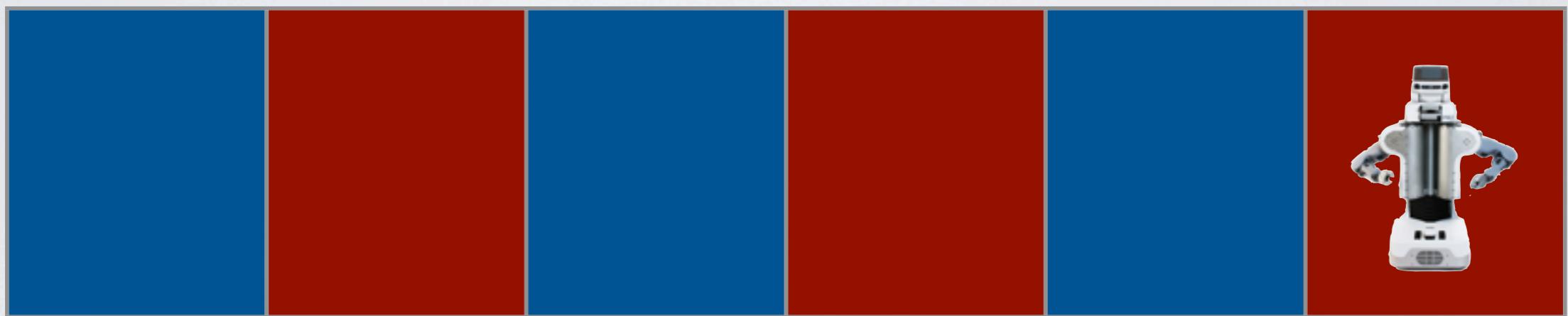


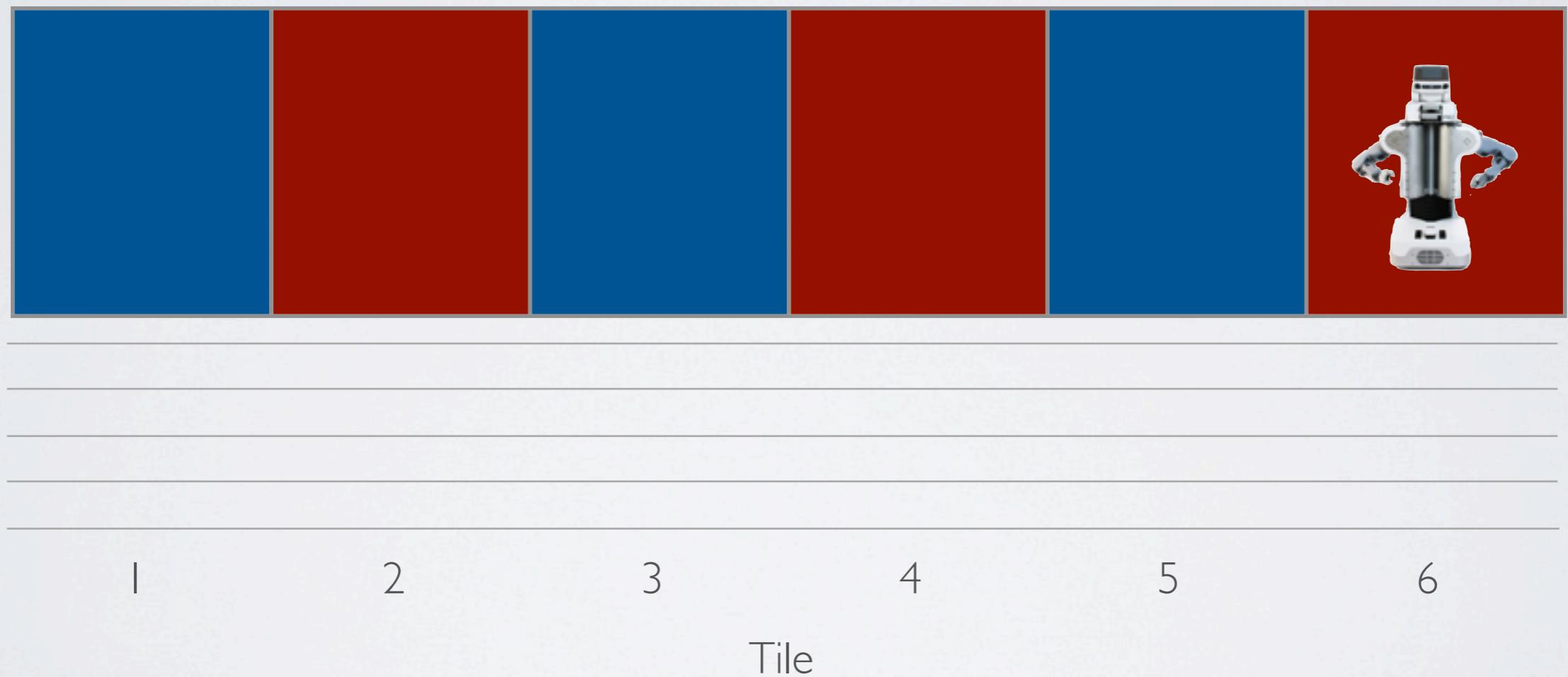


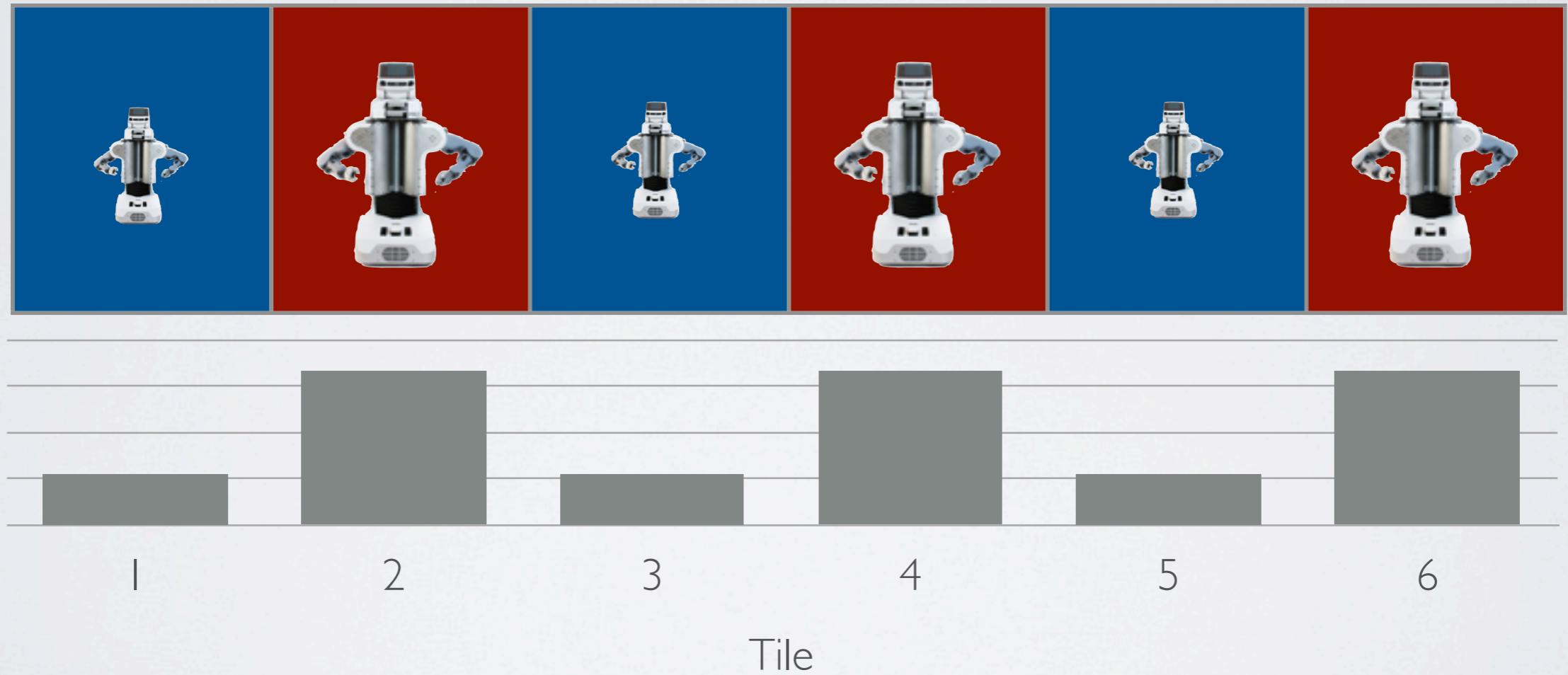


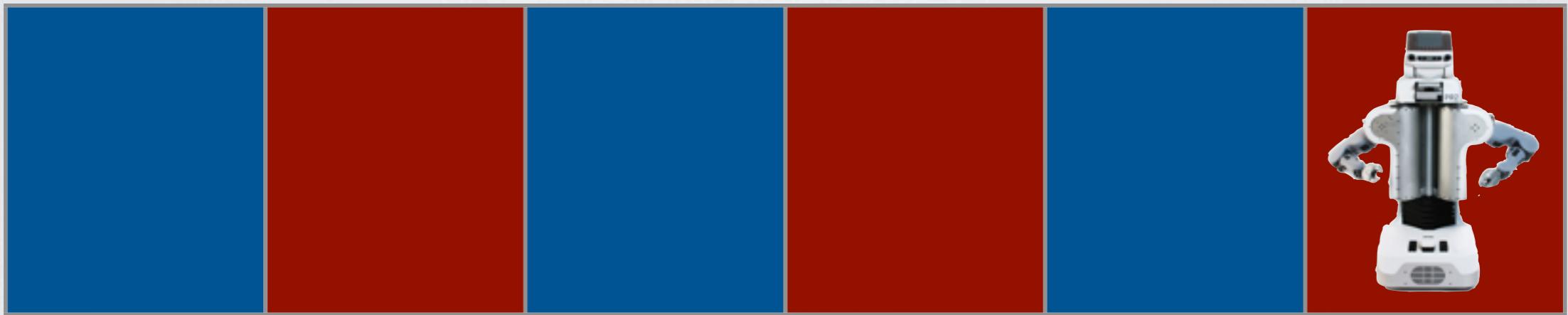


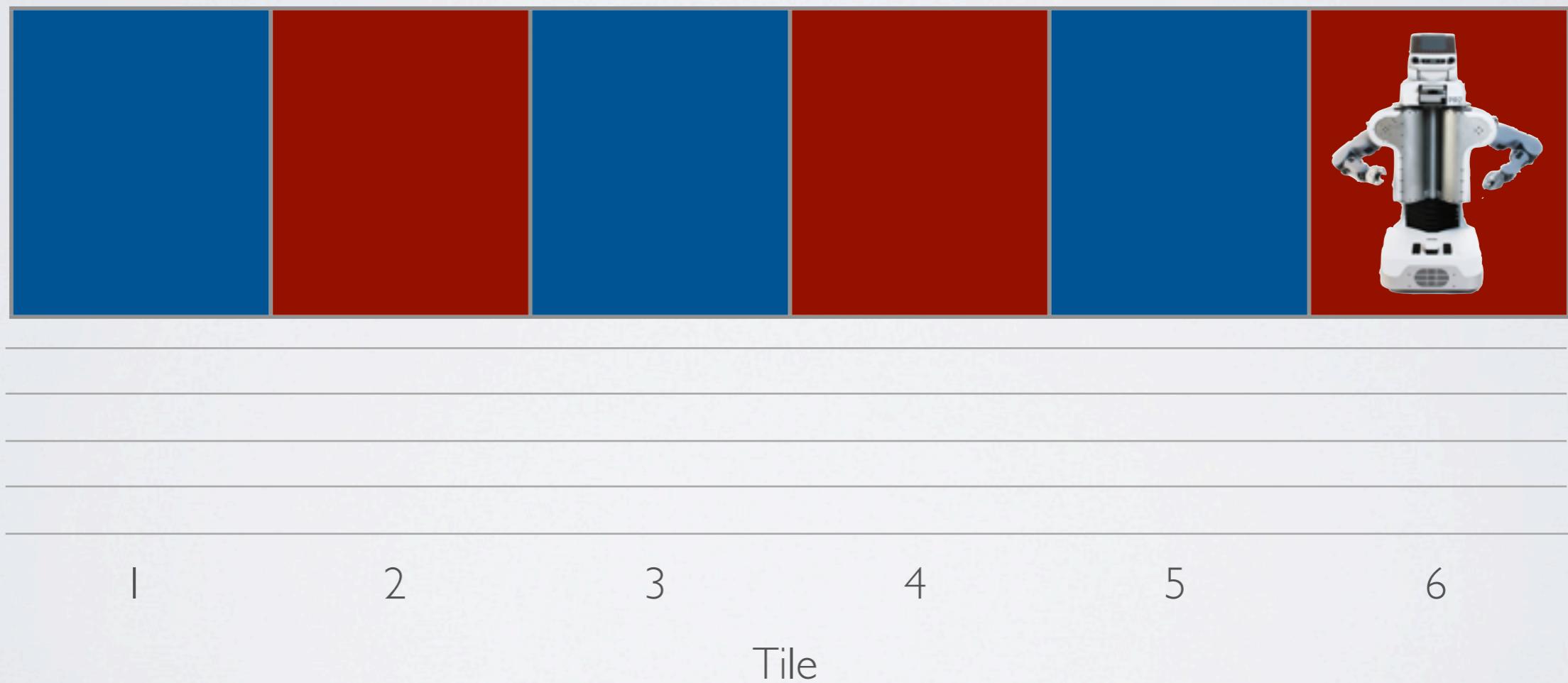


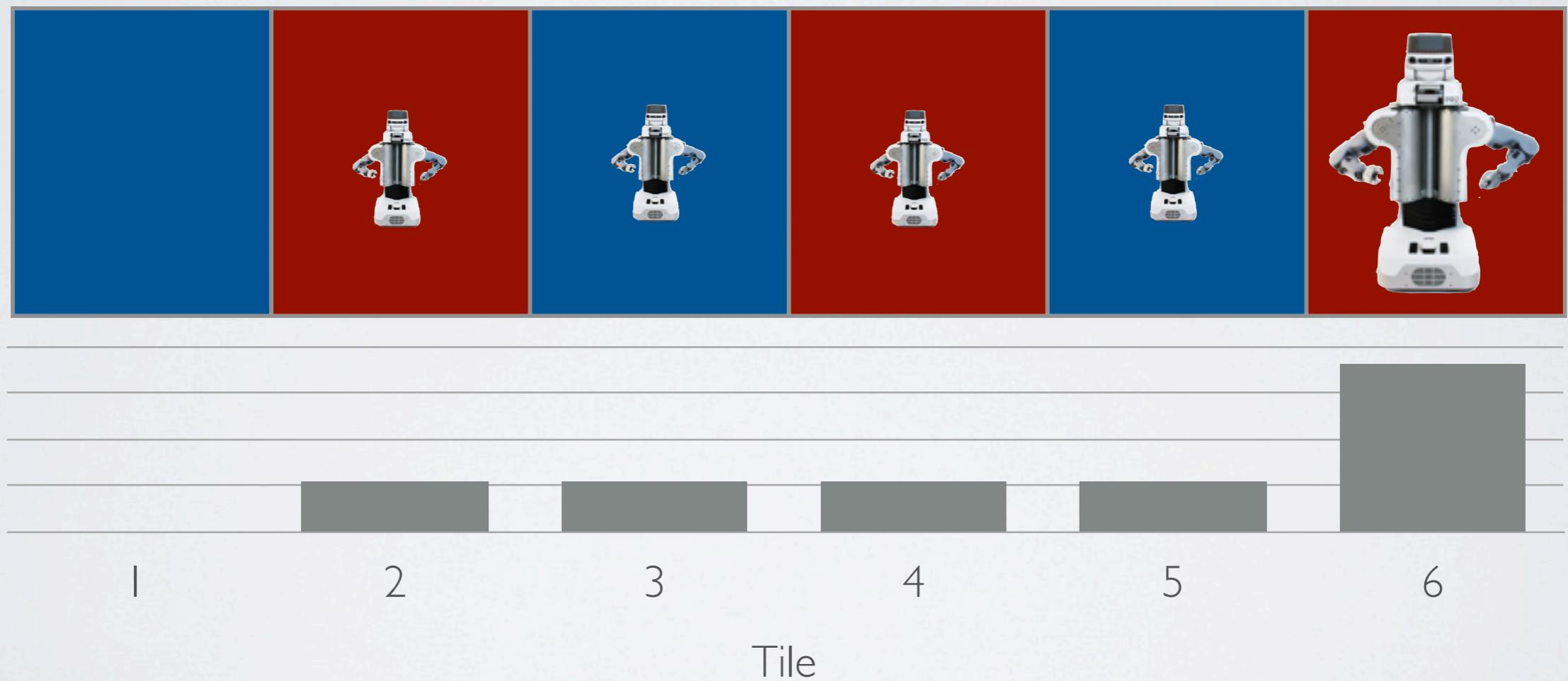








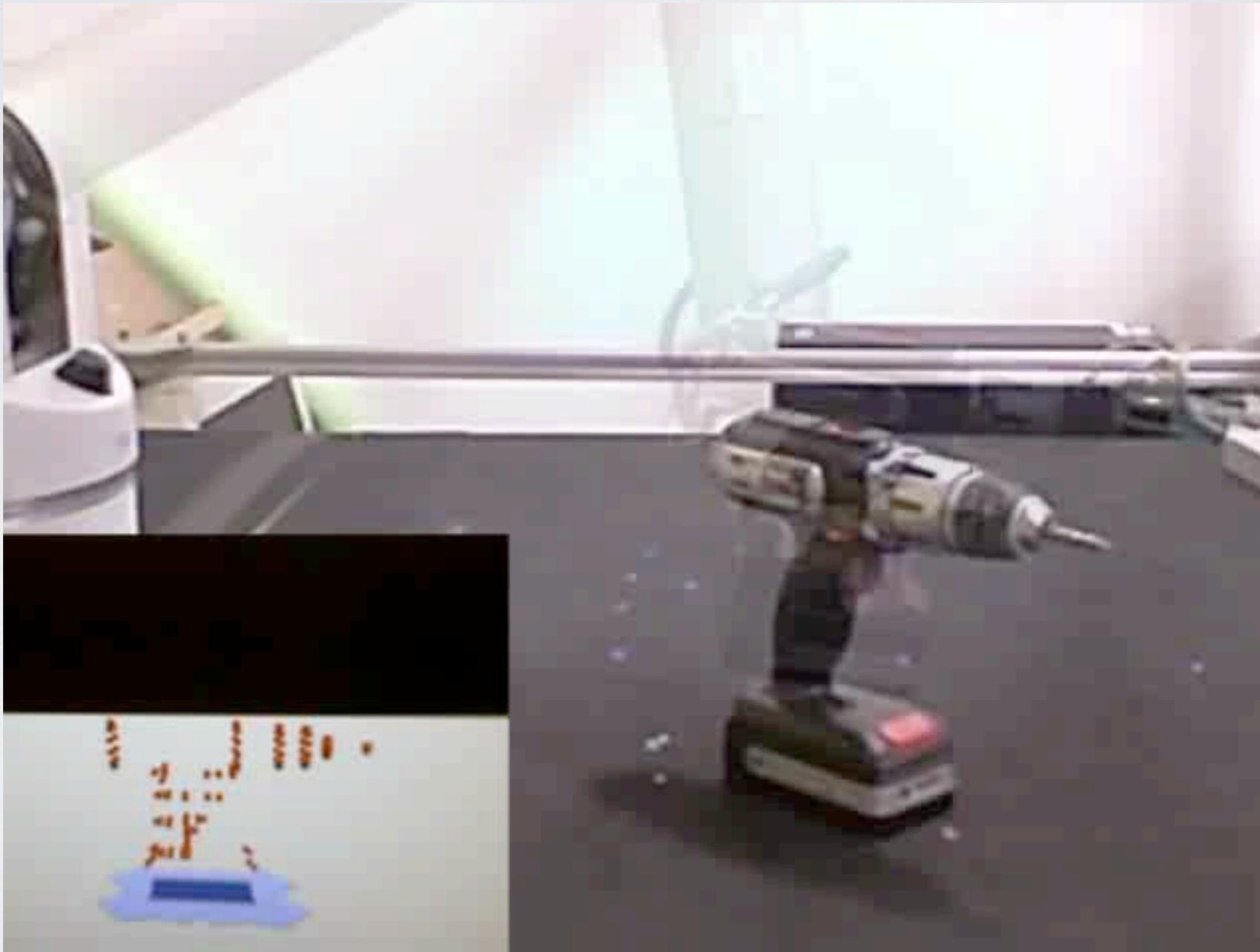




# GRASPING AND BELIEF STATES

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# BELIEF STATES

- Track what you know, and if you think it's correct
- Even if your model of the world is wrong, making many observations can improve your model
- Learn from failure, and take your time!