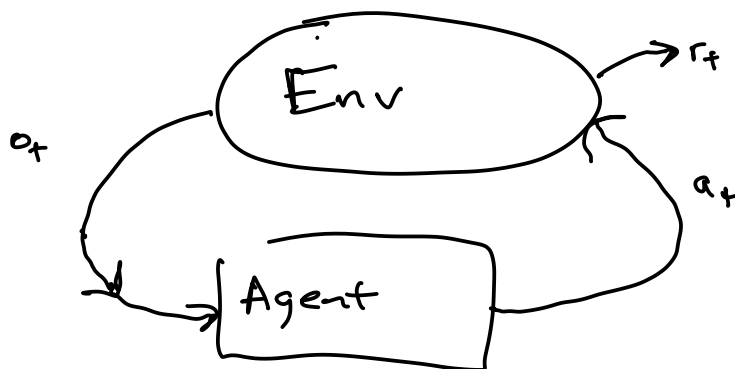


Decision Making under Uncertainty

Problems	Uncertainty	Decisions
Robotics	<u>position</u> <u>environment</u>	Where to go <i>distance to goal</i>
Aut. Defence	incoming threat state "intented target" my capability	When to fire
S.A.R.	Environment	
Aut. Driving	Obstacles, structure state physical state road signs driver "internal state"	
Airport Operation	Delays - <u>weather</u> , other vehicles	Plane take off order
Stock Markets	Economy ← Geopolitical Specific Business → Demand trends	Buy / sell <i>on time safety ROI</i>
Health	<u>Drug interaction</u>	Treatment <i>Life span Quality Year</i>
Robot Assist. Surg.	Model of tissues	
Public Policy	Public Response Difficult to predict weather	<div> Laws Climate Response </div> <i>Get re-elected</i>



How do we choose actions: minimize loss / maximize reward

Uncertainty

- Outcome Uncertainty ← can't reduce by learning
- Model Uncertainty ← uncertainty in dist.
- State Uncertainty ← uncertainty in state

outcomes
of
R.V.s

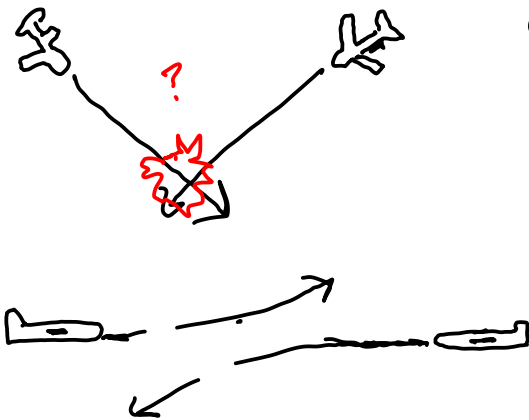
How do we create a good agent?

- Online ~~tree~~^{greedy} search
 - at each time, try each action in simulation
 - choose ~~a~~ that minimizes variance
 - "Greedy" "Myopic"
- Gradient search at every time step
 - [minimize cost at next time
 - "myopic/greedy"
- Q-learning - not myopic ★
- ~~compute~~ Compute a policy offline ★
 - Sampling a promising subset of actions
- Online Tree Search
- Hand Design

] RL
] Dynamic Programming
] ~~Online~~ Online Methods



ACAS



Change speeds
Change Altitude

TCAS 1970s
Hand designed

If $h_1 > h_2$ } $\frac{dh}{dt}$
1 → up
2 → down
↓ 1000 pages

Uncertainty

Pilots Listening?

New ACASX

Formulate as POMDP ← optimization

Dynamic Programming

↳ policy maps observations to good action