

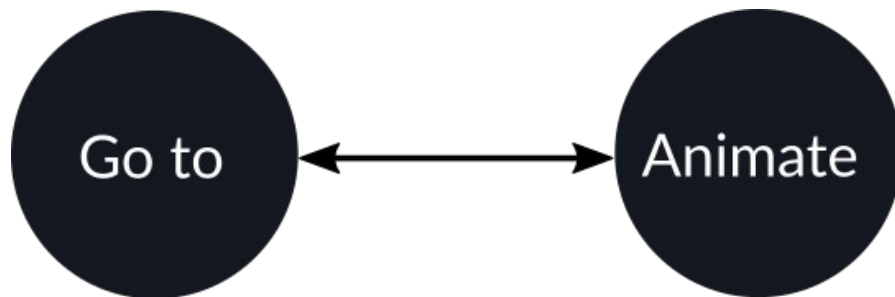


Games AI

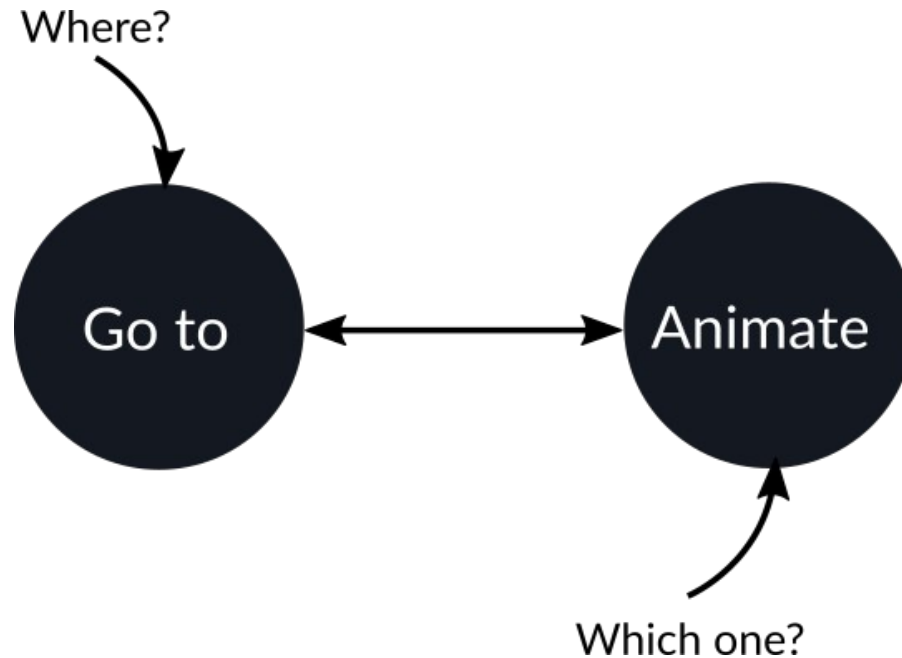
Lecture 12.1

GOAP

- Most agent AI can be boiled down to the following tasks:

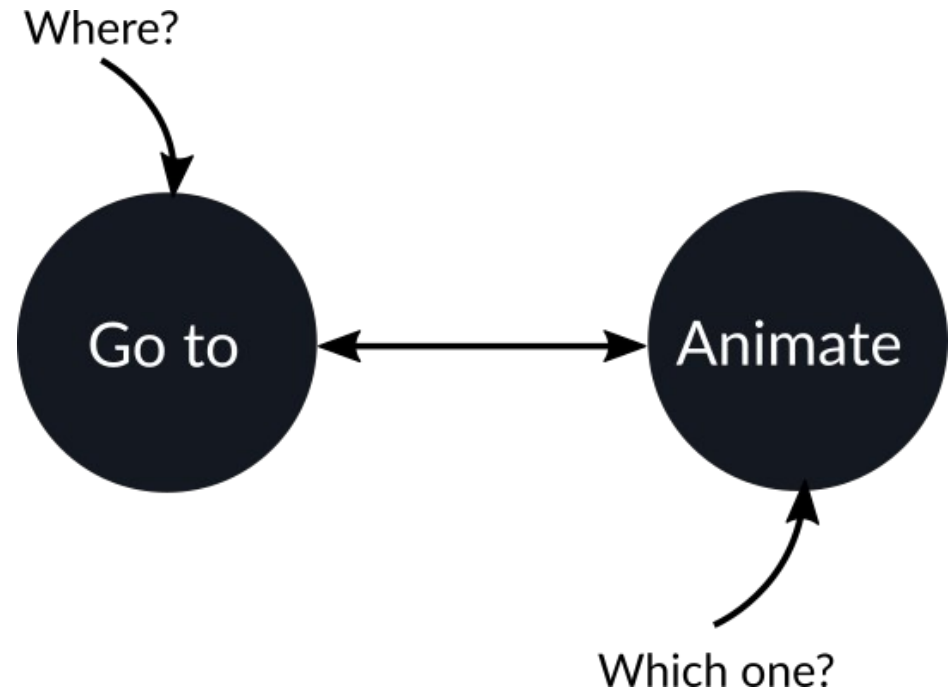


- This needs to be specified with parameters



- **Managing increasing complexity** is the challenge
 - Bigger FSMs
 - Larger FSM states
- All to tell the agent where to go and what animation to play

- This is supposed to be **AI**
 - Surely it should be deciding for itself!



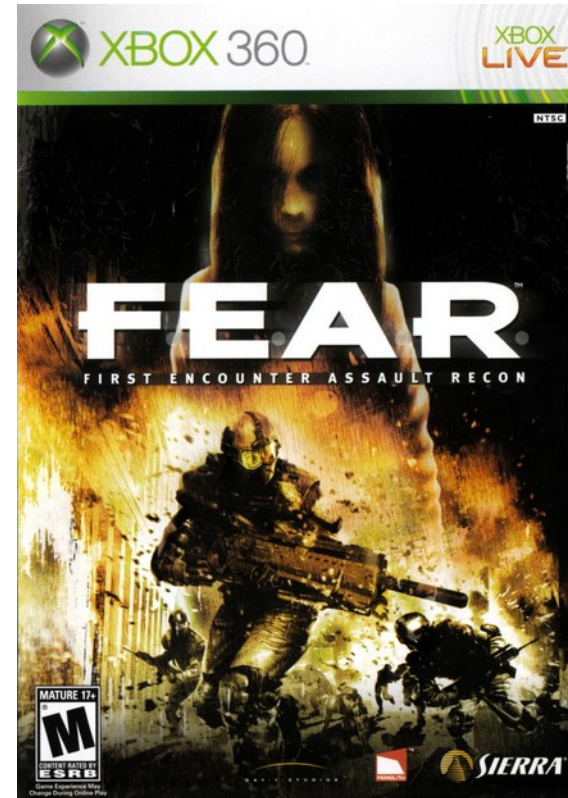
- F.E.A.R:
 - Rather than hard-code this in the FSM
 - Decide using a **planner**
 - Goal
 - Oriented
 - Action
 - Planning



- Smarter, easier-to-build AI
 - Actions are decoupled from one another
 - Selected when appropriate to satisfy a goal

Introduction

- Games using GOAP
- F.E.A.R., Monolith Productions, 2005
 - Jeff Orkin





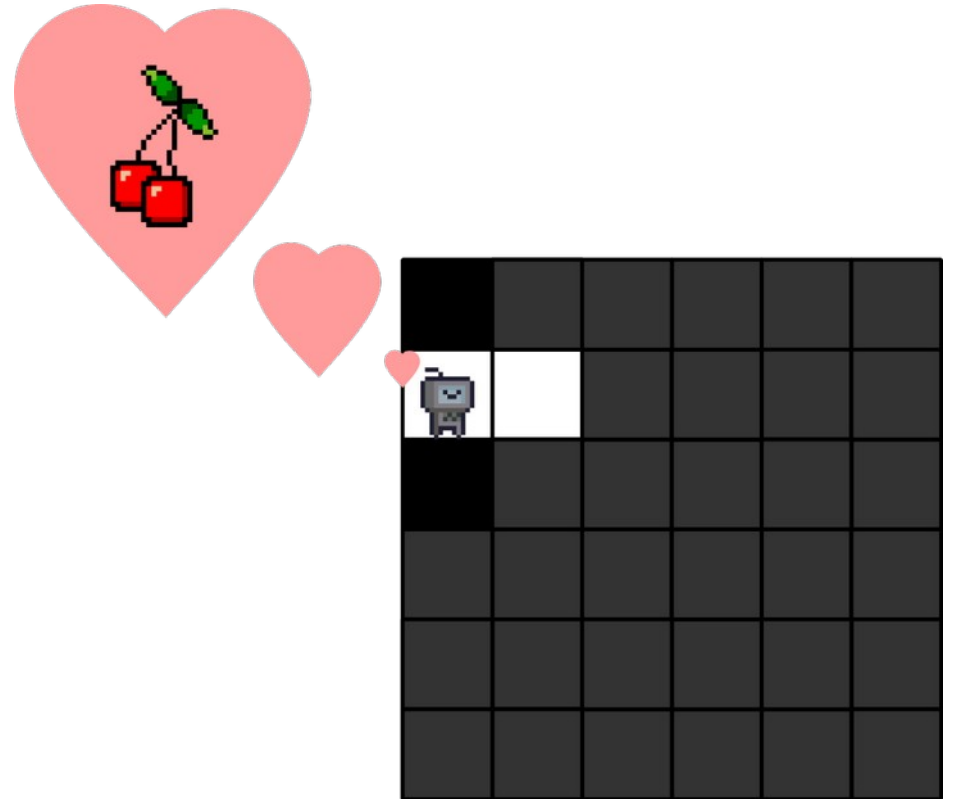
Planning



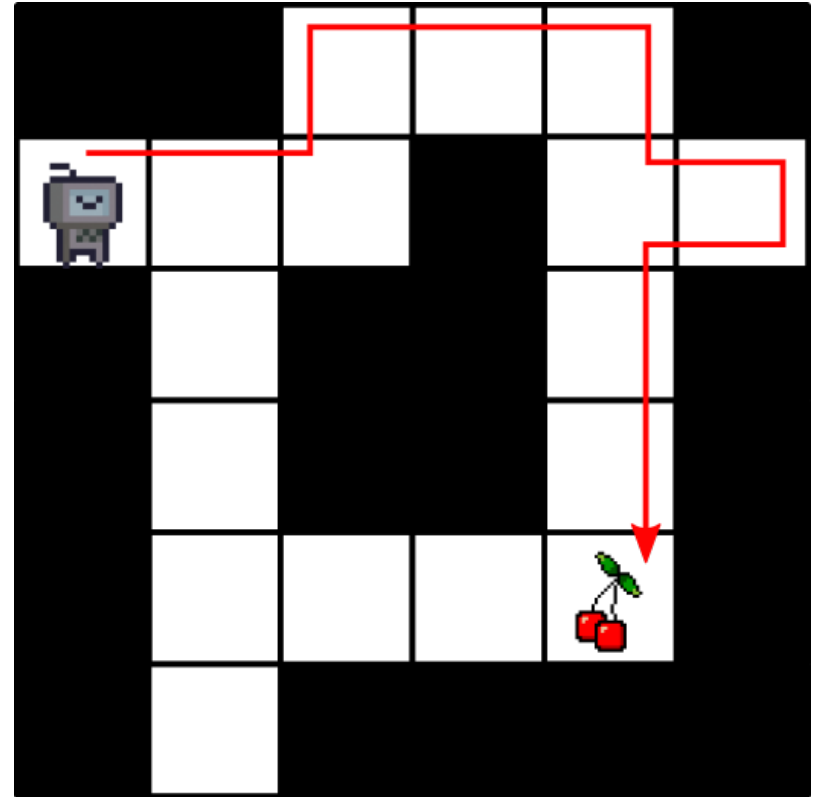
- Planning
 - Use a **model** to decide a **sequence of actions** to achieve a **goal**

- FSM
 - Procedural
- Planning
 - Declarative

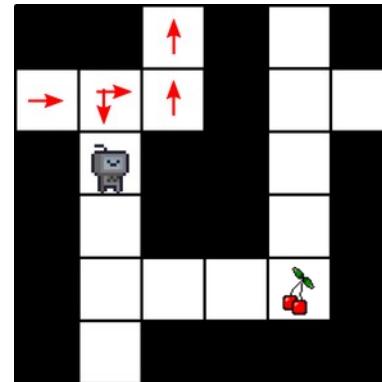
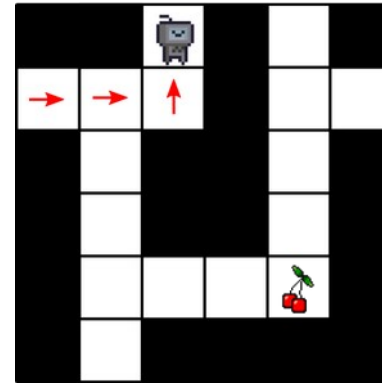
- Problem:
 - Find the cherries in the maze



- **Procedural**
 - Always follow left wall

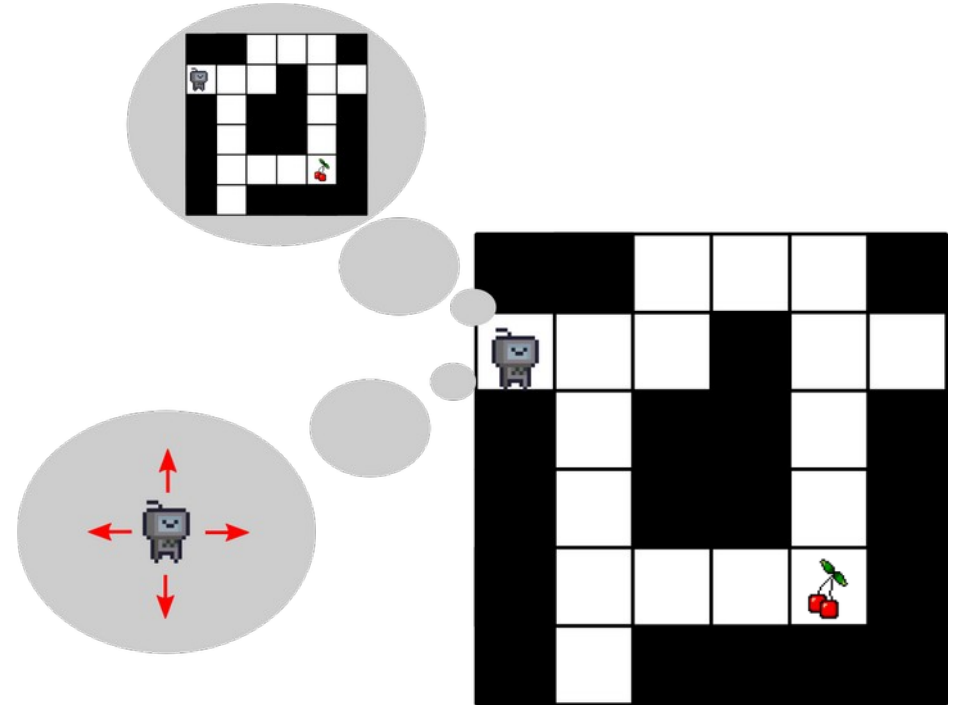


- **Procedural**
 - Always follow left wall
 - Leave chalk arrows and backtrack when reach a dead-end

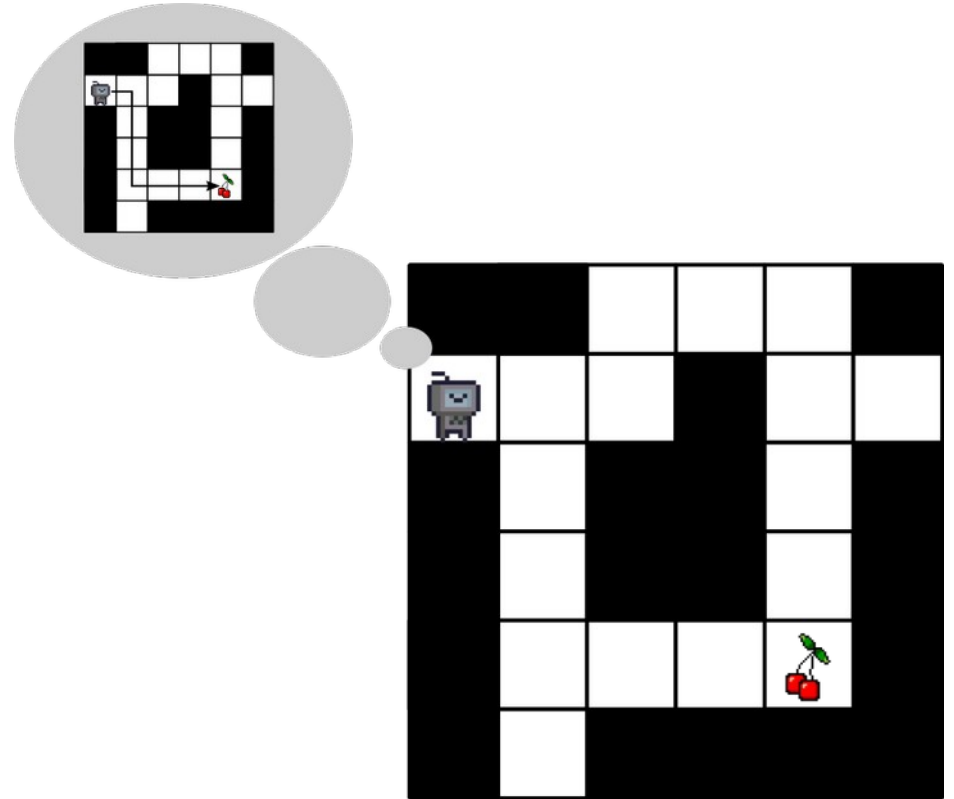


- **Declarative**

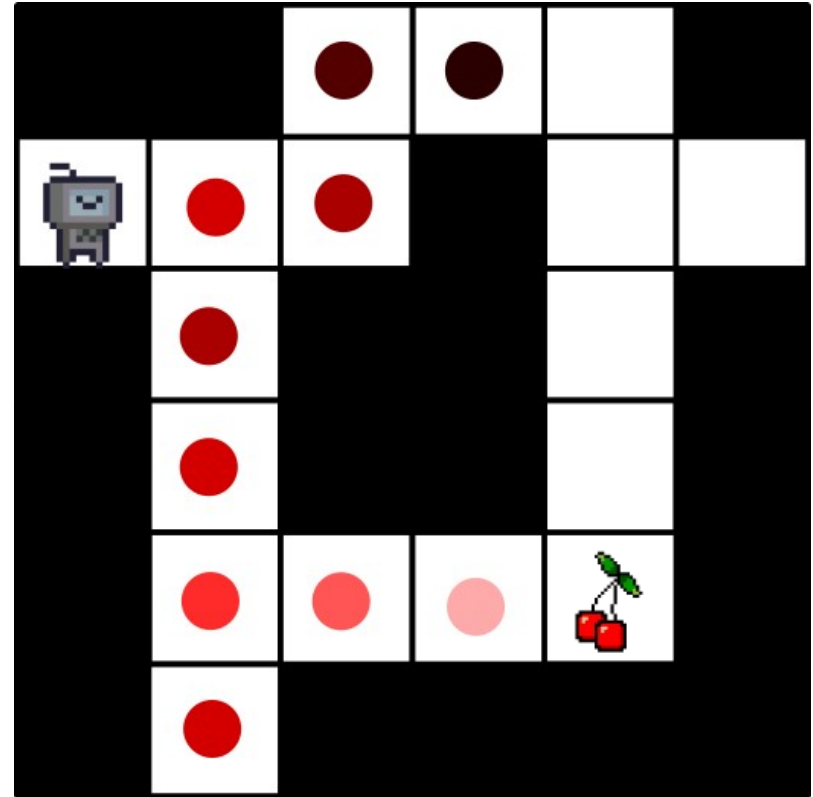
- Give a problem definition:
 - What is the map?
 - What are the ways you can move?
- Plan a path before moving



- A^*
 - Uses a **map** to plan a **sequence of moves** to get to a **target**



- A^*
 - Explores neighboring states/positions
 - Priorities which to explore by
 - Cost to reach
 - Heuristic



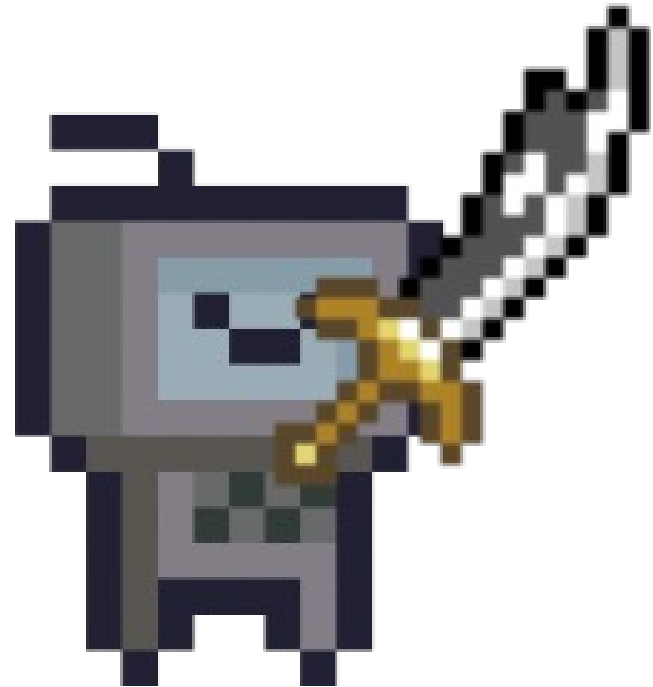
- Declarative approach:
 - You can solve any problem you can define in the declarative language
 - e.g. any map you can give to A^* it can find the shortest path (if it exists)

- Requirements for planning
 - Goal
 - Model
 - States
 - Actions

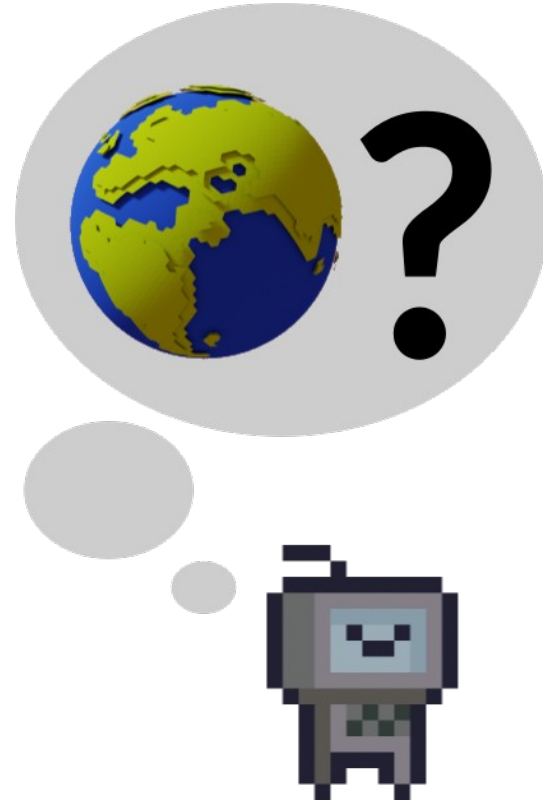
- State
 - How do we represent an agent's knowledge about the world?
 - **Goal:** What does the agent want to be true of the state?



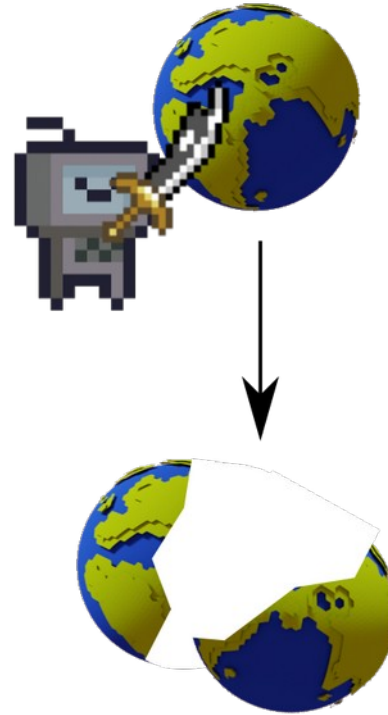
- Actions:
 - What actions can an agent perform?



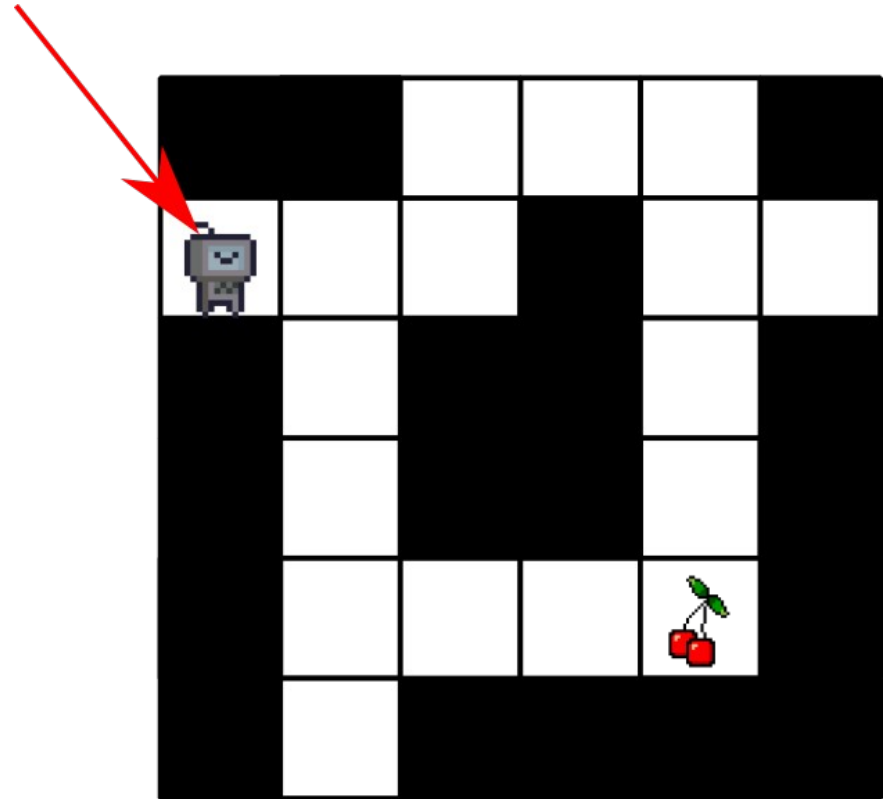
- Actions:
 - **Preconditions:** What needs to be true of the state to perform an action?



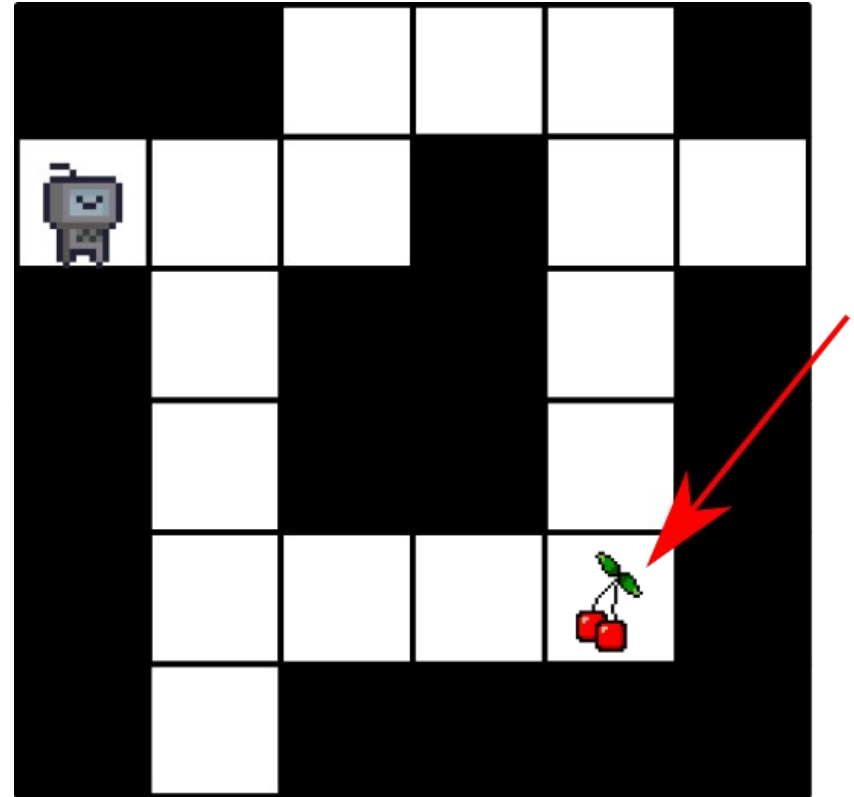
- Actions:
 - **Preconditions:** What needs to be true of the state to perform an action?
 - **Effects:** How does an action change the state?



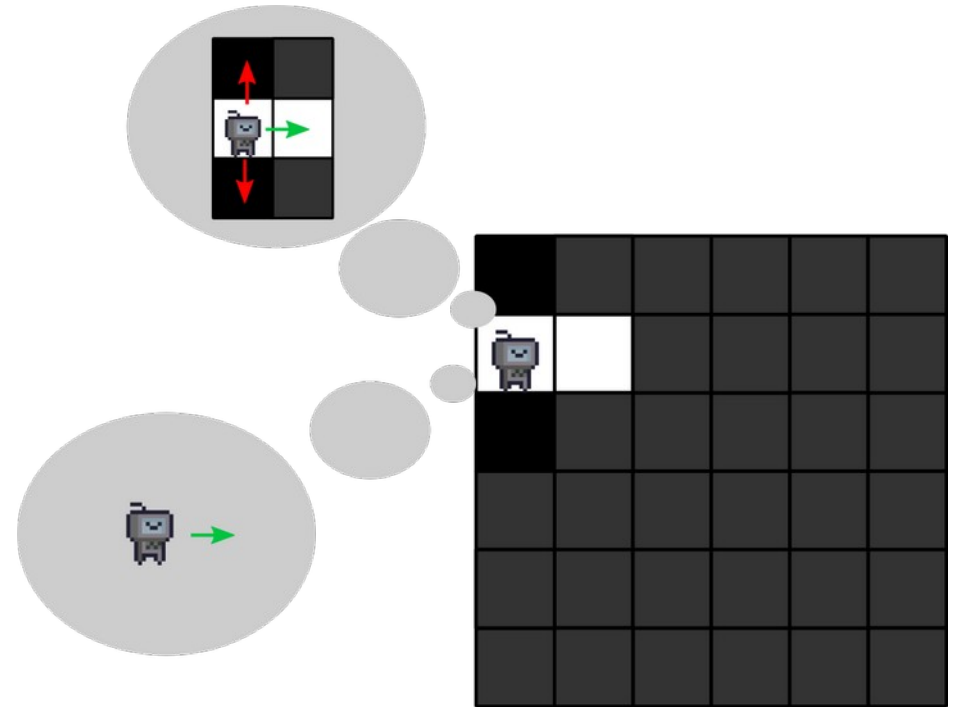
- **A* State**
 - Position of agent



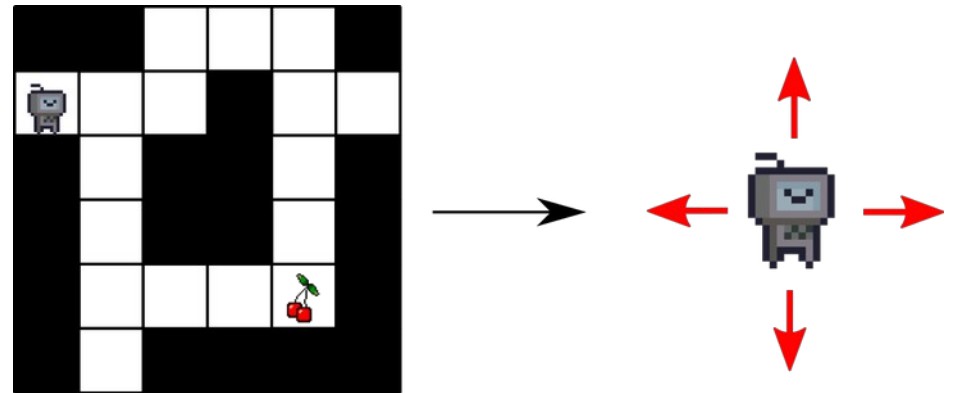
- **A* Goal**
 - Agent at target



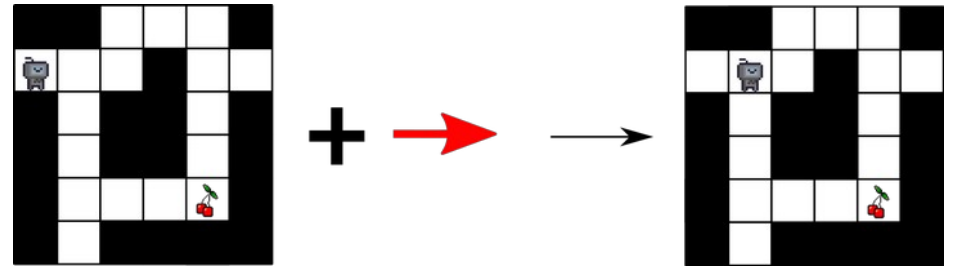
- **A* Actions**
 - **Precondition:** The tile is walkable
 - **Effect:** The agent moves to the tile



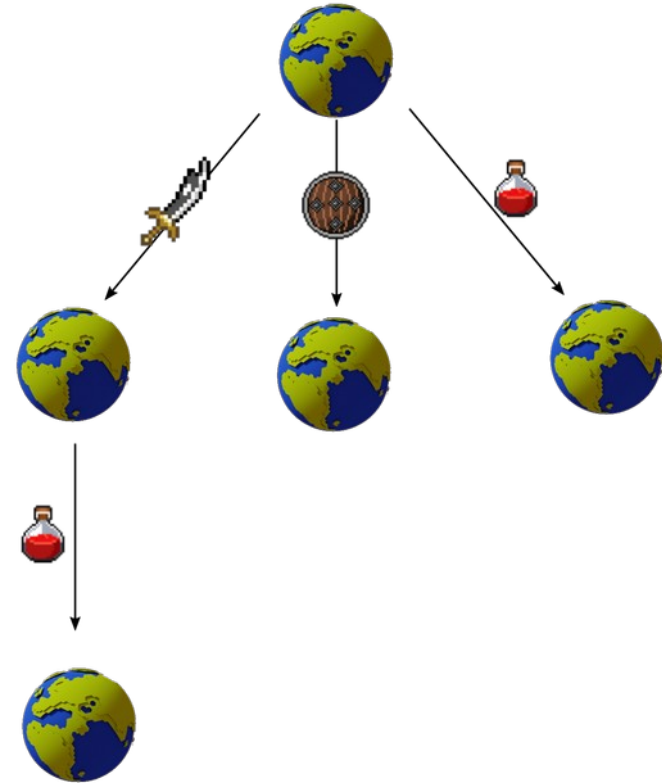
- Planning as Search
 - What actions can we perform?



- Planning as Search
 - What actions can we perform?
 - What state do they take us to?



- Planning as Search
 - What actions can we perform?
 - What state do they take us to?
 - Construct a tree of action sequences



- Summary
 - Represent agents knowledge as **state**
 - Define (declarative)
 - Goal
 - Actions
 - Preconditions
 - Effects



- GOAP is based on STRIPS
 - **ST**anford **R**esearch **I**nstitute **P**roblem **S**olver
 - Goals
 - Desired state of world
 - Actions
 - Preconditions
 - Effects






- State is a set of variables that define the world (model)

- State:
 - Have sword?
 - Have shield?
 - Have potion?
 - Healthy?
 - Enemy alive?



- State tracks knowledge about the world
 - Starting state
 - What facts do we know?

Start:

	true
	false
	true
	true
	true

- State tracks knowledge about the world
 - Starting state
 - What facts do we know?
 - Action effects
 - What changes?

Reckless attack:









false



false

- State tracks knowledge about the world
 - Starting state
 - What facts do we know?
 - Action effects
 - What changes?
 - Goals
 - What do we want to be true?

Goal:

















true



false

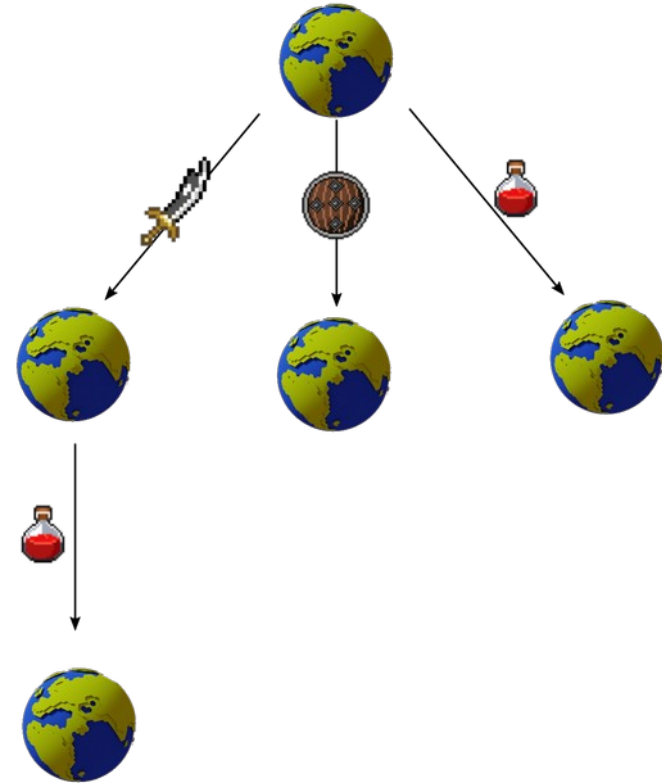
- Action prerequisites and effects are described in terms of the variables in the state

Prerequisites			Effects		
Attack:	Defend:	Potion:	Attack:	Defend:	Potion:
 true	---	---	 ---	---	---
 ---	true	---	 ---	---	---
 ---	---	true	 ---	---	false
 true	true	---	 false	---	true
 true	---	false	 false	---	---

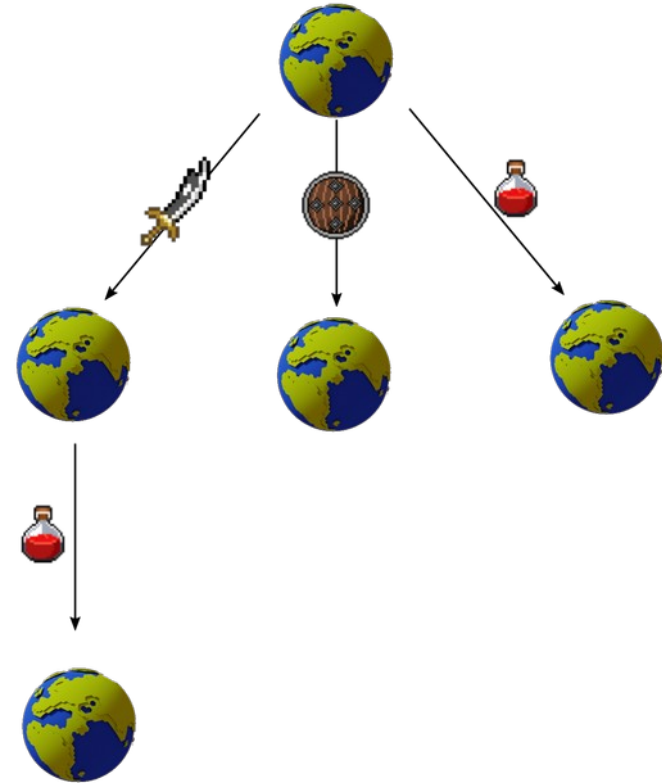




- How do we plan? **Tree search**
 - **Initial State:** Starting state
 - **State-Action mapping:** from action preconditions
 - **Transition Model:** from action effects
 - **Goal Test:** Goal satisfied?
 - **Cost function:** each action can be assigned a cost



- How do we plan? A^*
 - **Cost function:** action cost
 - **Heuristic:** distance from goal in # different variables





- Each agent has a GoalSet, e.g.
 - Patrol
 - Kill Enemy
- New goals can easily be added to this set

- Agents have different actions available
 - Attempt to accomplish goals in very different ways

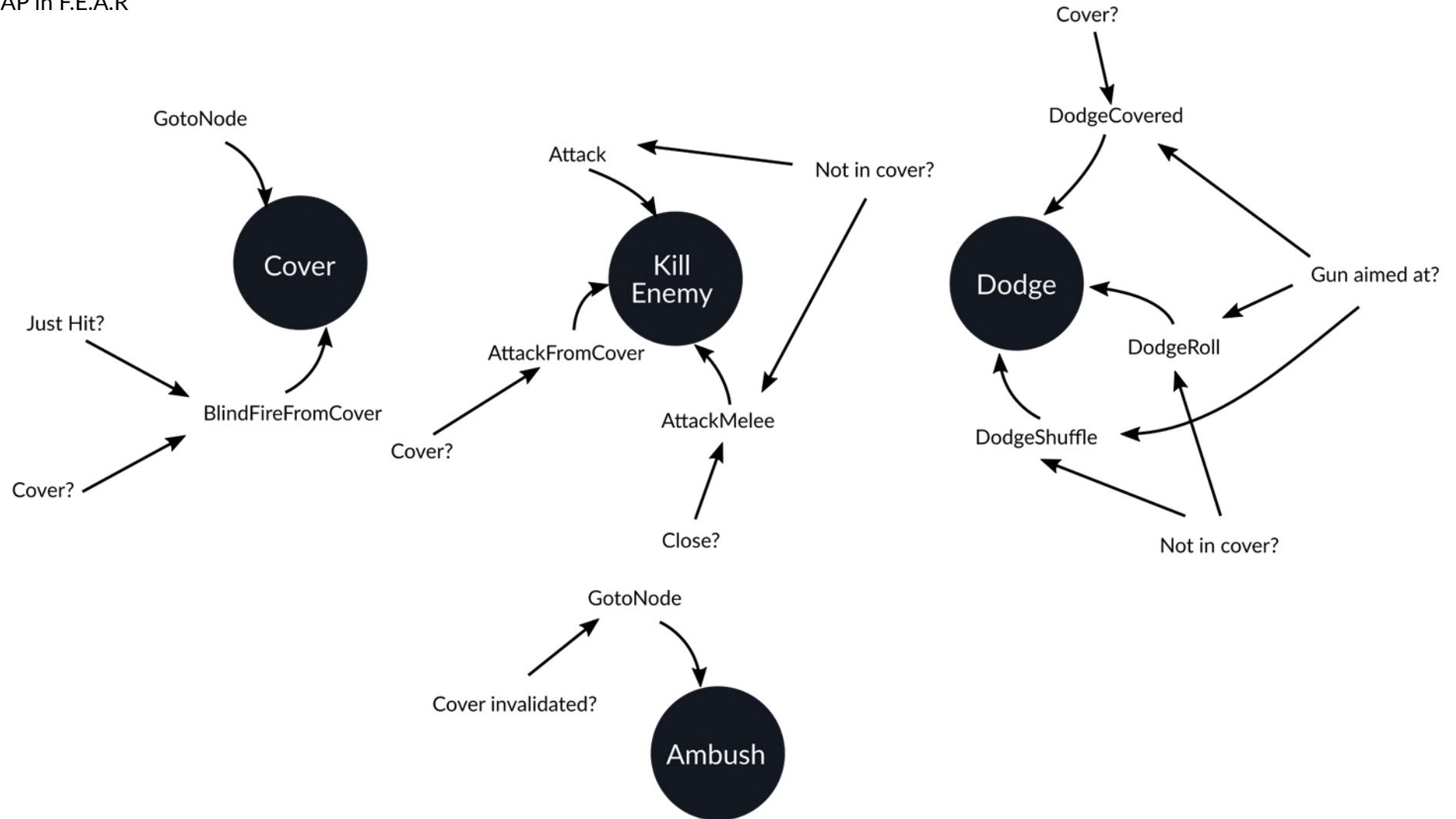


Action	
1	AI/Actions/Attack
2	AI/Actions/AttackCrouch
3	AI/Actions/SuppressionFire
4	AI/Actions/SuppressionFireFromCover
5	AI/Actions/FlushOutWithGrenade
6	AI/Actions/AttackFromCover
7	AI/Actions/BlindFireFromCover
8	AI/Actions/AttackGrenadeFromCover
9	AI/Actions/AttackFromView
10	AI/Actions/DrawWeapon
11	AI/Actions/HolsterWeapon
12	AI/Actions/ReloadCrouch
13	AI/Actions/ReloadCovered
14	AI/Actions/InspectDisturbance
15	AI/Actions/LookAtDisturbance
16	AI/Actions/SurveyArea
17	AI/Actions/DodgeRoll
18	AI/Actions/DodgeShuffle
19	AI/Actions/DodgeCovered
20	AI/Actions/Uncover
21	AI/Actions/AttackMelee

Action	
1	AI/Actions/Attack
2	AI/Actions/InspectDisturbance
3	AI/Actions/LookAtDisturbance
4	AI/Actions/SurveyArea
5	AI/Actions/AttackMeleeUncloaked
6	AI/Actions/TraverseBlockedDoor
7	AI/Actions/UseSmartObjectNodeMounted
8	AI/Actions/MountNodeUncloaked
9	AI/Actions/DismountNodeUncloaked
10	AI/Actions/TraverseLinkUncloaked
11	AI/Actions/AttackFromAmbush
12	AI/Actions/DodgeRollParanoid
13	AI/Actions/AttackLungeUncloaked
14	AI/Actions/LopeToTargetUncloaked
+	

Action	
1	AI/Actions/Animate
2	AI/Actions/Idle
3	AI/Actions/GotoNode
4	AI/Actions/UseSmartObjectNode
+	

GOAP in F.E.A.R



- Procedural Preconditions
 - Preconditions that you evaluate when you need them, rather than always keeping up to date
- Procedural Effects
 - Let acting system apply changes to world state model

- The world changes around the agents
 - Player actions
 - Other agents
- Plans must be validated / replanned
 - Plans are validated when created
 - Actions are validated before being performed
 - If an action is no longer possible, the agent replans

- Cooperation
 - Enemies in F.E.A.R. have no knowledge of each others' existence
 - Cooperative behavior comes from agents being assigned goals that line up nicely

- Squads
 - **Squad manager** periodically assigns units to squads based on proximity
 - Squad manager assigns squad behaviors
 - Units have goal to follow squad behavior
 - But their own goals, e.g. Dodge might sometimes take priority

- Simple Squad Behaviors
 - Get-to-Cover
 - All squad members get to cover
 - Advance-cover
 - One squad member provides covering fire while others advance to closer cover
 - Orderly-Advance
 - Advance in a line
 - Search
 - Split into pairs who cover each other and search rooms

- Jeff Orkin's Goal-Oriented Action Planning (GOAP) page
<http://alumni.media.mit.edu/~jorkin/goap.html>
- Jeff Orkin. 2006. 3 States and a Plan. GDC
http://alumni.media.mit.edu/~jorkin/gdc2006_orkin_jeff_fear.pdf
- Building the AI of F.E.A.R. with Goal Oriented Action Planning | AI 101
<https://youtu.be/PaOLBOuyswI>
- Goal-Oriented Action Planning: Ten Years of AI Programming
<https://youtu.be/gm7K68663rA>

