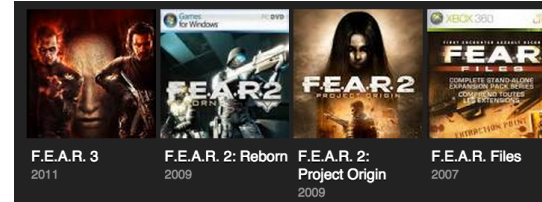
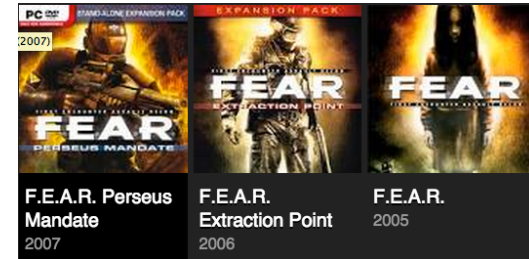


The AI of F.E.A.R.

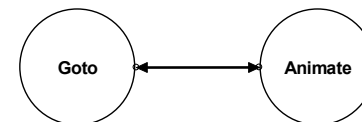


Jeff Orkin
Monolith Productions/
MIT Media Lab

[slightly edited by C. Rich]



FSM: 2 States!



FSM: Transition Logic

```
void StateAttack::Update()  
{  
    //...  
    if( Ammo == 0 )  
    {  
        pState = Reload(bCrouch);  
        return;  
    }  
    //...  
}
```

Shogo, 1998



No One Lives Forever, 2000



F.E.A.R., 2005



FSM vs Planning

FSM
- How

Planning
- What

FSM vs Planning

FSM
- How
- Procedural

Planning
- What
- Declarative

Motivation



Outline:

- STRIPS Planning Overview
- Planning in F.E.A.R.
- Beyond F.E.A.R.

What is Planning?

- Planning is a formalized process of searching for sequence of actions to satisfy a goal.
- Process is called “Plan Formulation.”

STRIPS Planning



...in a nutshell

STRIPS Planning

STRIPS =
STanford **R**esearch **I**nstitute
Problem **S**olver

STRIPS Planning

- STRIPS Goal:
Desired state of the world to reach.
- STRIPS Actions:
 - Preconditions
 - Effects

States



States: FSM



Attack



Search

States: Planning

Represented as a logical sentence:

$\text{AtLocation}(\text{Home}) \wedge \text{Wearing}(\text{Tie})$

Represented as a vector:

$(\text{AtLocation}, \text{Wearing}) = (\text{Home}, \text{Tie})$



States: Planning

Example: Lemonade Stand

$(\text{weather}, \#\text{lemons}, \$\$) =$

$(\text{☀️}, \text{🍋}, \text{🌳}) \text{ or}$

$(\text{☁️}, \text{🍋}, \text{💰})$

Desired (Goal, Final) State

Example: Lemonade Stand

(weather, #lemons, \$\$) =

(-- , -- , )

[slide added by C. Rich]

STRIPS Planning Example



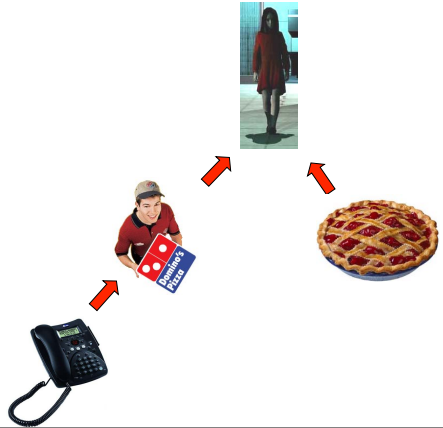
STRIPS Planning Example



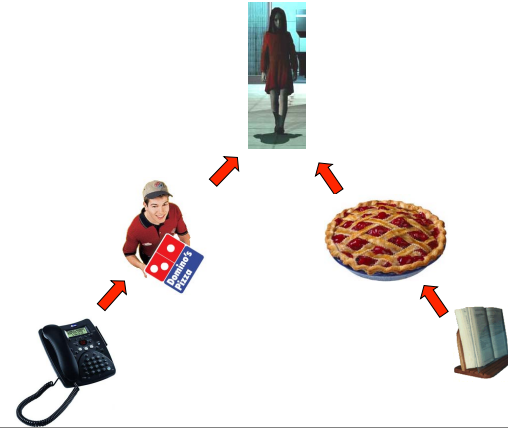
STRIPS Planning Example



STRIPS Planning Example



STRIPS Planning Example



STRIPS Planning Example

State: (phone#, recipe, hungry?)

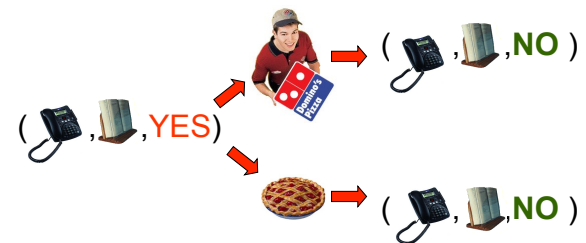
Goal: (-- , -- , **NO**)



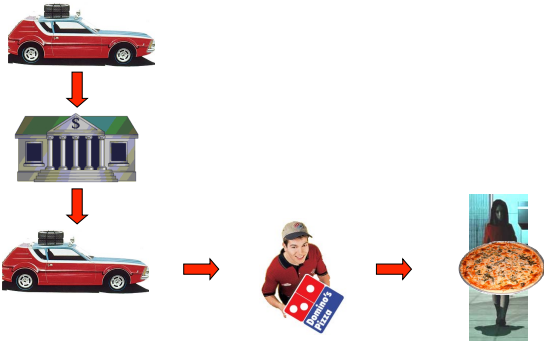
STRIPS Planning Example

State: (phone#, recipe, hungry?)

Goal: (-- , -- , **NO**)



STRIPS Planning Example




STRIPS Planning Example

State: (phone#, recipe, hungry?)



Action

Preconditions: ( , -- , --)

Effects:

Delete List: Hungry(**YES**)

Add List: Hungry(**NO**)

STRIPS Planning Example



STRIPS Planning Example



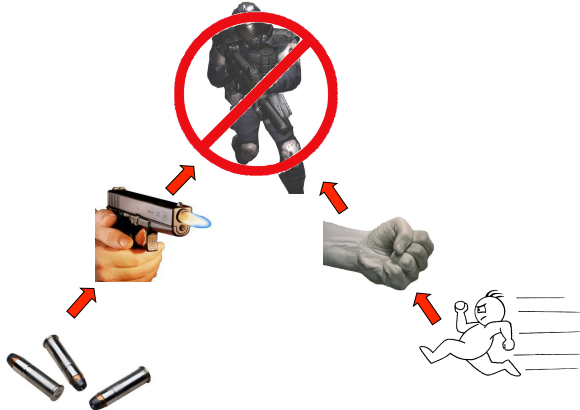
STRIPS Planning Example



STRIPS Planning Example



STRIPS Planning Example



Outline:

- STRIPS Planning Overview
- Planning in F.E.A.R.
- Beyond F.E.A.R.

Design Philosophy

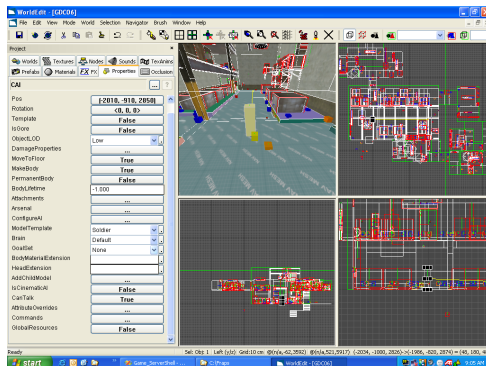
Designer's job is:
Create environments that allow AI to showcase their behaviors.

Designer's job is NOT:
Script behavior of individual AI.

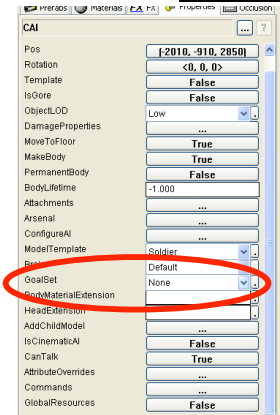
Planning Video #1



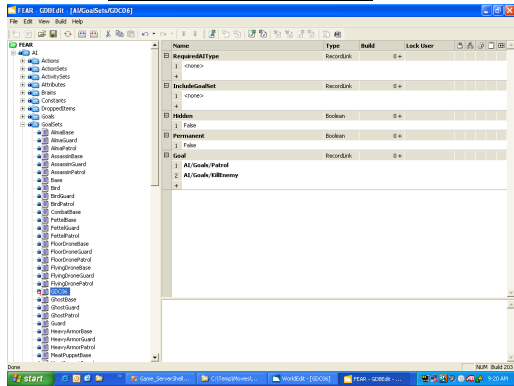
World Editor



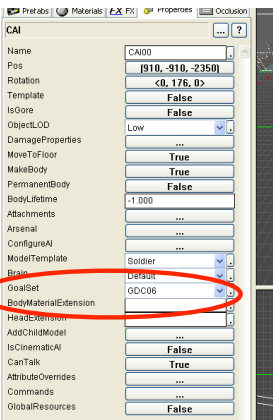
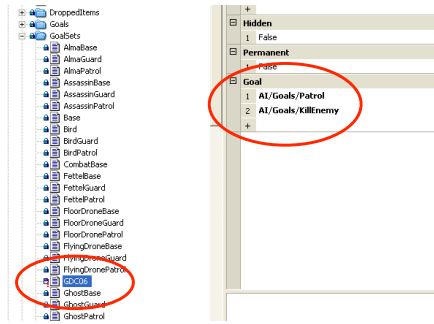
Goal Set



New Goal Set



New Goal Set



Planning Video #2



Planning Video #3



Planning Video #4



Action Sets

Soldier	Assassin	Rat
1 AI/Actions/Attack	1 AI/Actions/Attack	1 AI/Actions/Animate
2 AI/Actions/AttackCrouch	2 AI/Actions/InspectDisturbance	2 AI/Actions/Idle
3 AI/Actions/SuppressionFire	3 AI/Actions/LookAtDisturbance	3 AI/Actions/Idle
4 AI/Actions/SuppressionFireFromCover	4 AI/Actions/SurveyArea	4 AI/Actions/GoToNode
5 AI/Actions/AttackWithGrenade	5 AI/Actions/AttackMeleeUnlocked	4 AI/Actions/UseSmartObjectNode
6 AI/Actions/AttackFromCover	6 AI/Actions/TraverseLockedDoor	+
7 AI/Actions/BlindFireFromCover	7 AI/Actions/UseSmartObjectNodeMounted	
8 AI/Actions/AttackGrenadeFromCover	8 AI/Actions/MountNodeUnlocked	
9 AI/Actions/AttackFromView	9 AI/Actions/DismountNodeUnlocked	
10 AI/Actions/DrawWeapon	10 AI/Actions/TraverseLinkUnlocked	
11 AI/Actions/HolsterWeapon	11 AI/Actions/AttackFromAmbush	
12 AI/Actions/ReloadCrouch	12 AI/Actions/DodgeRollParanoid	
13 AI/Actions/ReloadCovered	13 AI/Actions/AttackLungeUnlocked	
14 AI/Actions/InspectDisturbance	14 AI/Actions/LopeToTargetUnlocked	
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		

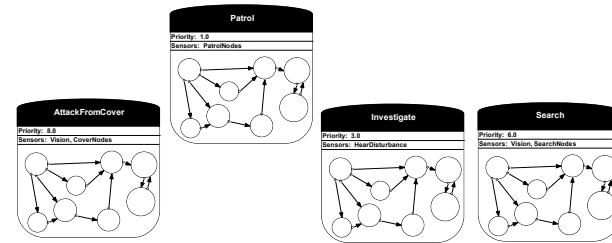
Benefits of Planning

1. Decoupling Goals & Actions
2. Layering Behaviors
3. Dynamic Problem Solving

Decoupling Goals & Actions



Decoupling Goals & Actions



Decoupling Goals & Actions



Decoupling Goals & Actions



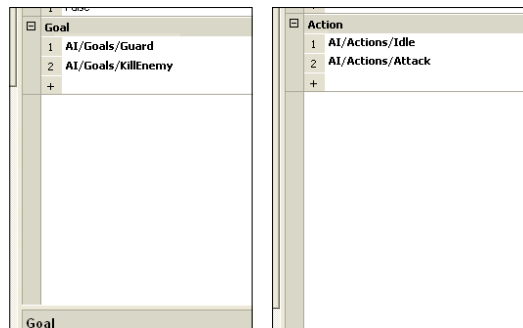
Benefits of Planning

1. Decoupling Goals & Actions
2. Layering Behaviors
3. Dynamic Problem Solving

Layering Behaviors



Layering Behaviors



Layering Behaviors



Layering Behaviors

Goal	Action
1 AI/Goals/Guard	1 AI/Actions/Idle
2 AI/Goals/KillEnemy	2 AI/Actions/Attack
3 AI/Goals/Dodge	3 AI/Actions/DodgeShuffle
+	4 AI/Actions/DodgeRoll
	+



Layering Behaviors



Layering Behaviors

Goal	Action
1 AI/Goals/Guard	1 AI/Actions/Idle
2 AI/Goals/KillEnemy	2 AI/Actions/Attack
3 AI/Goals/Dodge	3 AI/Actions/DodgeShuffle
+	4 AI/Actions/DodgeRoll
	5 AI/Actions/AttackMelee
	+



Layering Behaviors



Layering Behaviors

Goal	Action
1 AI/Goals/Guard	1 AI/Actions/Idle
2 AI/Goals/KillEnemy	2 AI/Actions/Attack
3 AI/Goals/Dodge	3 AI/Actions/DodgeShuffle
4 AI/Goals/Cover	4 AI/Actions/DodgeRoll
+	5 AI/Actions/AttackMelee
	6 AI/Actions/GotoNode
	7 AI/Actions/AttackFromCover
	+



Layering Behaviors

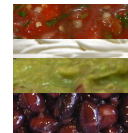


Layering Behaviors

Goal	Action
1 AI/Goals/Guard	1 AI/Actions/Idle
2 AI/Goals/KillEnemy	2 AI/Actions/Attack
3 AI/Goals/Dodge	3 AI/Actions/DodgeShuffle
4 AI/Goals/Cover	4 AI/Actions/DodgeRoll
+	5 AI/Actions/AttackMelee
	6 AI/Actions/GotoNode
	7 AI/Actions/AttackFromCover
	8 AI/Actions/DodgeCovered
	+

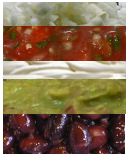


Layering Behaviors

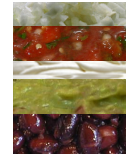


Layering Behaviors

Goal	Action
1 AI/Goals/Guard	1 AI/Actions/Idle
2 AI/Goals/KillEnemy	2 AI/Actions/Attack
3 AI/Goals/Dodge	3 AI/Actions/DodgeShuffle
4 AI/Goals/Cover	4 AI/Actions/DodgeRoll
	5 AI/Actions/AttackMelee
	6 AI/Actions/GotoNode
	7 AI/Actions/AttackFromCover
	8 AI/Actions/DodgeCovered
	9 AI/Actions/BlindFireFromCover



Layering Behaviors

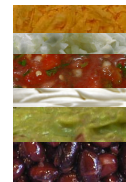


Layering Behaviors

Goal	Action
1 AI/Goals/Guard	1 AI/Actions/Idle
2 AI/Goals/KillEnemy	2 AI/Actions/Attack
3 AI/Goals/Dodge	3 AI/Actions/DodgeShuffle
4 AI/Goals/Cover	4 AI/Actions/DodgeRoll
5 AI/Goals/Ambush	5 AI/Actions/AttackMelee
	6 AI/Actions/GotoNode
	7 AI/Actions/AttackFromCover
	8 AI/Actions/DodgeCovered
	9 AI/Actions/BlindFireFromCover



Layering Behaviors



Layering Behaviors

Kill Enemy

Attack Ranged

Layering Behaviors

Kill Enemy

Attack Ranged

Attack Melee

Layering Behaviors

Kill Enemy

Dodge

Attack Ranged

Attack Melee

Dodge Shuffle

Dodge Roll

Layering Behaviors

Kill Enemy

Dodge

Cover

Dodge Covered

Attack Ranged

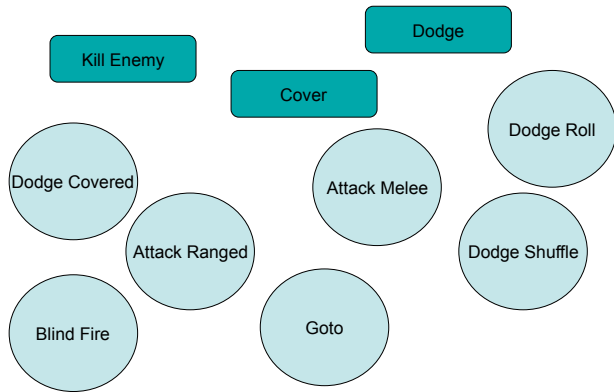
Attack Melee

Dodge Shuffle

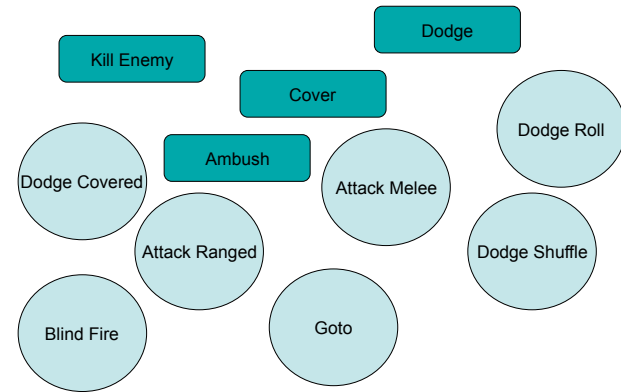
Dodge Roll

Goto

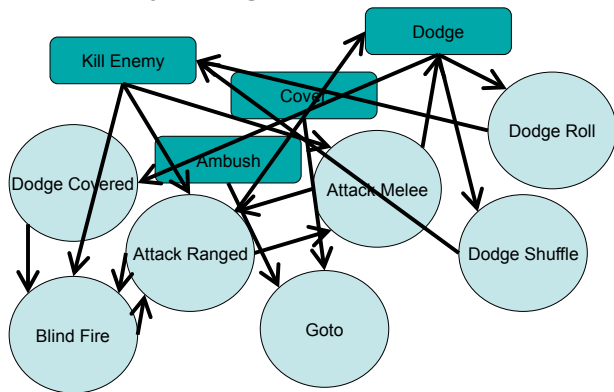
Layering Behaviors



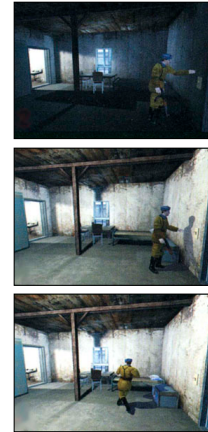
Layering Behaviors



Layering Behaviors



Layering Behaviors



Benefits of Planning

1. Decoupling Goals & Actions
2. Layering Behaviors
3. **Dynamic Problem Solving**

Dynamic Problem Solving



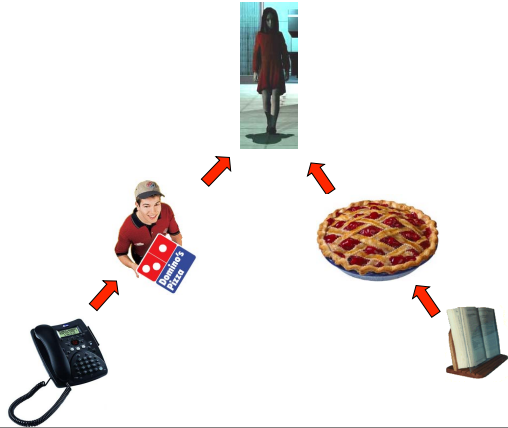
Dynamic Problem Solving



Planning Algorithm

[Slide added by C. Rich]

Cost Per Action



Cost Per Action



Cost Per Action



Cost Per Action



Cost Per Action

A*	Navigation	Planning
Nodes:	NavMesh Polys	World States
Edges:	NavMesh Poly Edges	Actions
Goal:	NavMesh Poly	World State

Summary

- Goals and actions as *data* (vs. code)
 - easier development
 - additivity
 - actions specified as [add/delete lists](#)
- AI planner *automatically* strings together actions (vs. manually coded FSM's)
 - flexibility, “problem solving”
 - search using [backward chaining](#)

[Slide added by C. Rich]