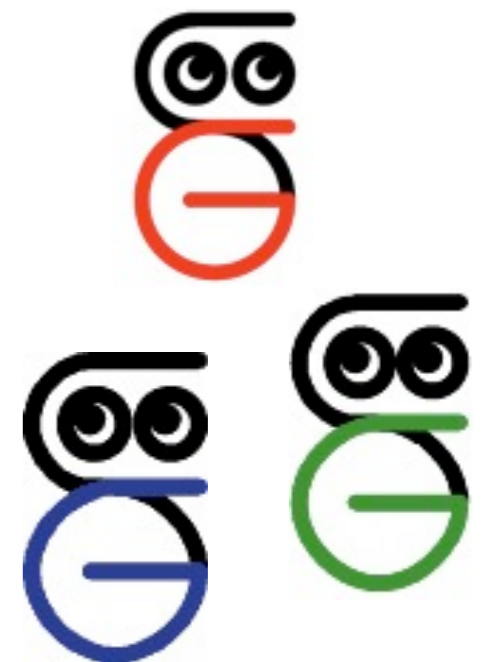


Smart Graphics: Methods: operator-based planning

Lecture „Smart Graphics”

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STRIPS

Stanford Research Institute Problem Solver (1972)

- Originally used for robot action planning
- Given a state and an action:
 - Can the action be executed?
 - What propositions are (in)valid after the action?
- Closed world assumption:
 - We know all true statements
 - All unknown statements are false
- Description of initial state and goal state
 - Sets of positive facts
- Set of STRIPS-operators with 3 parts:
 - Preconditions: what needs to hold, such that the op. can be ex.?
 - Add list: what holds after the op. is ex.?
 - Delete list: what doesn't hold after the op. is ex.?
- Planning problem: how to get from initial to goal state

Example STRIPS operator

- Operator name: Eat
 - Parameter: a person

Eat(person)	
Precond: Hungry(person)	Add: Full(person)
	Delete: Hungry(person)

- Can only be applied if person is hungry
- Removes the fact that person is hungry
- Adds the fact that person is full
- Remember: only positive facts!

Christmas evening

- Initial state
 - Hungry(children)
 - Want(children,gifts)

- Goal state
 - Happy(children)

Christmas Eve: Dysfunctional Family

- Initial state
 - Hungry(children)
 - Want(children,gifts)
- Goal state
 - Happy(children)
- How do we get from initial to goal state?

Eat(person)	
Precond: Hungry(person)	Add: Full(person)
	Delete: Hungry(person)

Receive(person,object)	
Precond: Want(person, object)	Add: Have(person,object)
	Delete: Want(person,object)

Play(person,object)	
Precond: Have(person, object) Full(person)	Add: Happy(person)
	Delete:

Dysfunctional Family: Solutions

Eat(person)	
Precond: Hungry(person)	Add: Full(person)
	Delete: Hungry(person)

Receive(person,object)	
Precond: Want(person, object)	Add: Have(person,object)
	Delete: Want(person,object)

play(person,object)	
Precond: Have(person, object) Full(person)	Add: Happy(person)
	Delete:

- Eat(children)
- Receive(children,gifts)
- Play(children,gifts)

or

- Receive(children,gifts)
- Eat(children)
- Play(children,gifts)

- Note:
 - Unknown facts are false
 - True facts remain true
 - Planning strategy?
- In this case:
 - Order of eat/gifts doesn't matter
 - Order of eat/play matters
 - Parents aren't happy
 - Parents don't eat
 - Parents don't play
 - ...??

Christmas evening (2nd try)

- Initial state
 - Hungry(children)
 - Hungry(parents)
 - Want(children,gifts)

- Goal state
 - Happy(children)
 - Happy(parents)

Christmas Eve: Musical Family

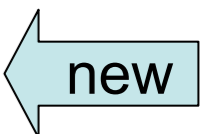
- Initial state
 - Hungry(children)
 - Hungry(parents)
 - Want(children,gifts)
- Goal state
 - Happy(children)
 - Happy(parents)

Eat(person)	
Precond: Hungry(person)	Add: Full(person)
	Delete: Hungry(person)

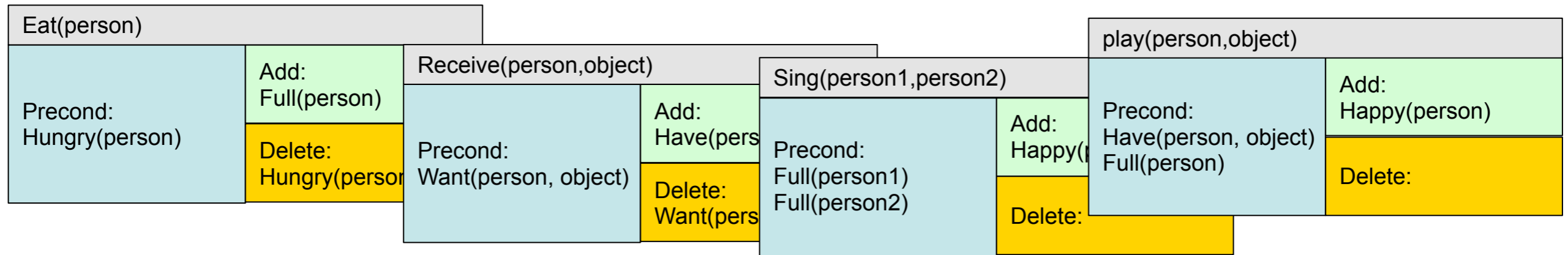
Receive(person,object)	
Precond: Want(person, object)	Add: Have(person,object)
	Delete: Want(person,object)

Sing(person1,person2)	
Precond: Full(person1) Full(person2)	Add: Happy(person2)
	Delete:

Play(person,object)	
Precond: Have(person, object) Full(person)	Add: Happy(person)
	Delete:



Musical Family: Solutions



- Eat(children) ↔
 - Eat(parents) ↔
 - Sing(children,parents) } ↔
 - Receive(children,gifts) } ↔
 - Play(children,gifts) } ↔
- Only partial order:
 - Children can eat before or after parents
 - Singing can be done before or after gifts
 - All eat before singing
 - Planning strategy?

But also this.... 8(

Eat(person)	
Precond: Hungry(person)	Add: Full(person)
	Delete: Hungry(person)

Sing(person1, person2)	
Precond: Full(person1) Full(person2)	Add: Happy(person2)
	Delete:

- Eat(children)
- Eat(parents)
- Sing(children, parents)
- Sing(parents, children)

- Not a correct model
 - Children can be happy without gifts
- Even worse:
 - ...
 - Sing(parents, children)
 - Receive(parents, gifts)
 - Play(parents, gifts)

Christmas evening (3rd try)

- Initial state
 - Hungry(children)
 - Hungry(parents)
 - Want(children,gifts)
 - In(dad,Lroom)
 - In(children,Lroom)
 - Full(santa)
- Goal state
 - Happy(children)
 - Happy(parents)
 - Believe(children,santa)

Plan your own Christmas Eve



Sing(person1, person2)	
Precond: Full(person1) Full(person2) Want(person1, gifts)	Add: Happy(person2)
	Delete:

Leave(person, room)	
Precond: In(person, room)	Add: Outs(person, room)
	Delete: In(person, room)

Enter(person, room)	
Precond: Outs(person, room)	Add: In(person, room)
	Delete: Outs(person, room)

Eat(person)	
Precond: Hungry(person)	Add: Full(person)
	Delete: Hungry(person)

Eat(person)	
Precond: Hungry(person)	Add: Full(person)
	Delete: Hungry(person)

Enter(person, room)	
Precond: Outs(person, room)	Add: In(person, room)
	Delete: Outs(person, room)

Receive(person, object, pers2)	
Precond: Want(person, object) Happy(pers2)	Add: Have(person, object)
	Delete: Want(person, object) Happy(pers2)

Change(person1, person2, room)	
Precond: Outs(person1, room) Full(person1)	Add: Outs(person2, room) Full(person2)
	Delete: Outs(person1, room)

Change(person1, person2, room)	
Precond: Outs(person1, room) Full(person1)	Add: Outs(person2, room) Full(person2)
	Delete: Outs(person1, room)

Sing(person1, person2)	
Precond: Full(person1) Full(person2) Want(person1, gifts)	Add: Happy(person2)
	Delete:

Leave(person, room)	
Precond: In(person, room)	Add: Outs(person, room)
	Delete: In(person, room)

See(person1, person2, room)	
Precond: in(pers1, room) In(pers2, room)	Add: Believe(pers1, pers2)
	Delete:

Play(person, object)	
Precond: Have(person, object) Full(person)	Add: Happy(person)
	Delete:

STRIPS backward planning

- Choose one fact from goal state
- See how it can be achieved
 - Fact is in the add list of operator
 - No other fact from goal state is in delete list
- Remove fact from goal, add preconditions
- Iterate until all goal facts are known to be true
- Backtrack if no choice is possible

- Good choice in step 1: fewer preconditions

Christmas Eve: Family with small children

- Eat(children)
- Eat(parents)
- Sing(children,parents)
- Leave(dad,Lroom)
- Change(dad,santa)
- Enter(santa,Lroom)
- See(children,santa)
- Sing(children,santa)
- Receive
(children,gifts,
santa)
- Leave(santa,Lroom)
- Change(santa,dad)
- Enter(dad,Lroom)
- Play(children,gifts)

Leave(person,room)	
Precond: In(person,room)	Add: Outs(person,room)
	Delete: In(person,room)

Eat(person)	
Precond: Hungry(person)	Add: Full(person)
	Delete: Hungry(person)

Enter(person,room)	
Precond: Outs(person,room)	Add: In(person,room)
	Delete: Outs(person,room)

Receive(person,object,pers2)	
Precond: Want(person,object) Happy(pers2)	Add: Have(person,object)
	Delete: Want(person,object) Happy(pers2)

Change(person1,person2,room)	
Precond: Outs(person1,room) Full(person1)	Add: Outs(person2,room) Full(person2)
	Delete: Outs(person1,room)

Sing(person1,person2)	
Precond: Full(person1) Full(person2) Want(person1,gifts)	Add: Happy(person2)
	Delete:

See(person1,person2,room)	
Precond: in(pers1,room) In(pers2,room)	Add: Believe(pers1,pers2)
	Delete:

Play(person,object)	
Precond: Have(person, object) Full(person)	Add: Happy(person)
	Delete:

