CSCI 4202 – Introduction to Artificial Intelligence
Spring 2017 – Dr. Williams
Bagger Production System

Suppose that Robbie has been hired to bag groceries in a grocery store. Because he knows little about bagging groceries, he approaches his new job by creating Bagger, a rule-based production system that decides where each item should go.

After a little study, Robbie decides that Bagger should be designed to take four steps:

1. The check-order step: Bagger analyzes what the customer has selected, looking over the groceries to see whether any items are missing.
2. The bag-large-items step: Bagger bags the large items, taking care to put the big bottles in first.
3. The bag-medium-items step: Bagger bags the medium items, taking care to put frozen ones in freezer bags.
4. The bag-small-items step: Bagger bags the small items.

Now let us see how this knowledge can be captured in a rule-based production system. First, Bagger needs working memory. The working memory must contain assertions that capture information about the items to be bagged. Suppose that those items are the items in the following table:

Item	**Container type**	**Size**	**Frozen?**
Bread	plastic bag	medium	no
Glop	jar	small	no
Granola	cardboard box	large	no
Ice cream	cardboard carton	medium	yes
Potato chips	plastic bag	medium	no
Pepsi	bottle	large	no

Next, Bagger needs to know which step is the current step, which bag is the current bag, and which items already have been places in bags. In the following example, the first assertion identifies the current step as the check-order step, the second identifies the bag as Bag1, and the remainder indicate what items are yet to be bagged.

Initial Working Memory:

Step is check-order
Bag1 is a bag
Bread is to be bagged
Glop is to be bagged
Granola is to be bagged
Ice cream is to be bagged
Potato chips are to be bagged
Pepsi is to be bagged

Then we have the rules for the production system.

B1 If step is check-order
potato chips are to be bagged
there is no Pepsi to be bagged
then ask the customer whether he would like a bottle of Pepsi

B2 If step is check-order
delete step is check-order
add step is bag-large-items

B3 If step is bag-large-items
a large item is to be bagged
the large item is a bottle
the current bag contains < 6 large items
delete the large item to be bagged
add the large item is in the current bag

B4 If step is bag-large-items
a large item is to be bagged
the current bag contains < 6 large items
delete the large item to be bagged
add the large item is in the current bag

B5 If step is bag-large-items
a large item is to be bagged
an empty bag is available
delete the current bag is the current bag
add the empty bag is the current bag

B6 If step is bag-large-items
delete step is bag-large-items
add step is bag-medium-items

B7 If step is bag-medium-items
a medium item is frozen, but not in a freezer bag-large-items
delete the medium item is not in a freezer bag
add the medium item is in a freezer bag

B8 If step is bag-medium-items
a medium item is to be bagged
the current bag is empty or contains only medium items
the current bag contains no large items
the current bag contains < 12 medium items
delete the medium item is to be bagged
add the medium item is in the current bag

B9	If	step is bag-medium-items
		a medium item is to be bagged
		an empty bag is available
	delete	the current bag is the current bag
	add	the empty bag is the current bag
B10	If	step is bag-medium-items
	delete	step is bag-medium-items
	add	step is bag-small-items
B11	If	step is bag-small-items
		a small item is to be bagged
		the current bag contains no large items
		the current bag contains no medium items
		the current bag contains < 18 small items
	delete	the small item is to be bagged
	add	the small item is in the current bag
B12	If	step is bag-small-items
		a small item is to be bagged
		an empty bag is available
	delete	the current bag is the current bag
	add	the empty bag is the current bag
B13	If	step is bag-small-items
	delete	step is bag-small-items
	add	step is done

Solution:

For each step in the solution, we compute the conflict set. The conflict set contains all of the rule instances (with bindings) that are eligible to fire. For consistency, we list the rules instances in order of the rule number and then in order of the appearance of the bindings in working memory. We always select the first item from the conflict set. We execute that rule instance (with bindings) and briefly summarize its action.

Step	Conflict Set	Action
1	**B2()**	Change step to bag-large-items
2	**B3(item = Pepsi; bag = Bag1)** B4(item = Granola; bag = Bag1) B4(item = Pepsi; bag = Bag1) B5(item = Granola; bag = Bag2) B5(item = Pepsi; bag = Bag2) B6()	Put the Pepsi into Bag1
3	**B4(item = Granola; bag = Bag1)** B5(item = Granola; bag = Bag2) B6()	Put the Granola into Bag1
4	**B6()**	Change step to bag-medium-items
5	**B7(item = Ice cream)** B9(item = Bread; bag = Bag2) B9(item = Ice cream; bag = Bag2) B9(item = Potato chips; bag = Bag2) B10()	Put ice cream in a freezer bag
6	**B9(item = Bread; bag = Bag2)** B9(item = Ice cream (in freezer bag); bag = Bag2) B9(item = Potato chips; bag = Bag2) B10()	Make Bag2 the current bag
7	**B8(item = Bread; bag = Bag2)** B8(item = Ice cream (in freezer bag); bag = Bag2) B8(item = Potato chips; bag = Bag2) B9(item = Bread; bag = Bag3) B9(item = Ice cream (in freezer bag); bag = Bag3) B9(item = Potato chips; bag = Bag3) B10()	Put Bread in Bag2
8	**B8(item = Ice cream (in freezer bag); bag = Bag2)** B8(item = Potato chips; bag = Bag2) B9(item = Ice cream (in freezer bag); bag = Bag3) B9(item = Potato chips; bag = Bag3) B10()	Put Ice cream (in freezer bag) in Bag2
9	**B8(item = Potato chips; bag = Bag2)** B9(item = Potato chips; bag = Bag3)	Put Potato chips in Bag2

	B10()	
10	**B10()**	Change step to bag-small-items
11	**B12(item = Glop; bag = Bag3)** B13()	Make Bag3 the current bag
12	**B11(item = Glop; bag = Bag3)** B12(item = Glop; bag = Bag4) B13()	Put Glop in Bag3
13	B13()	Change step to done

After all rules have been used, everything is bagged:

Step is done
Bag1 contains Pepsi
Bag1 contains granola
Bag2 contains bread
Bag2 contains ice cream (in freezer bag)
Bag2 contains potato chips
Bag3 contains glop