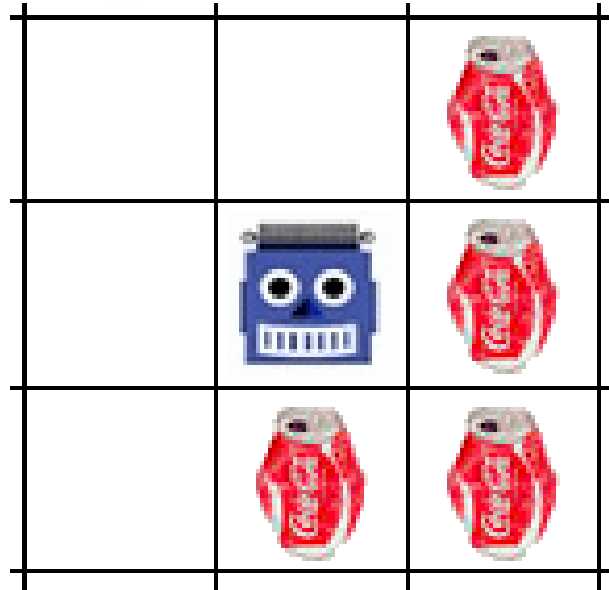
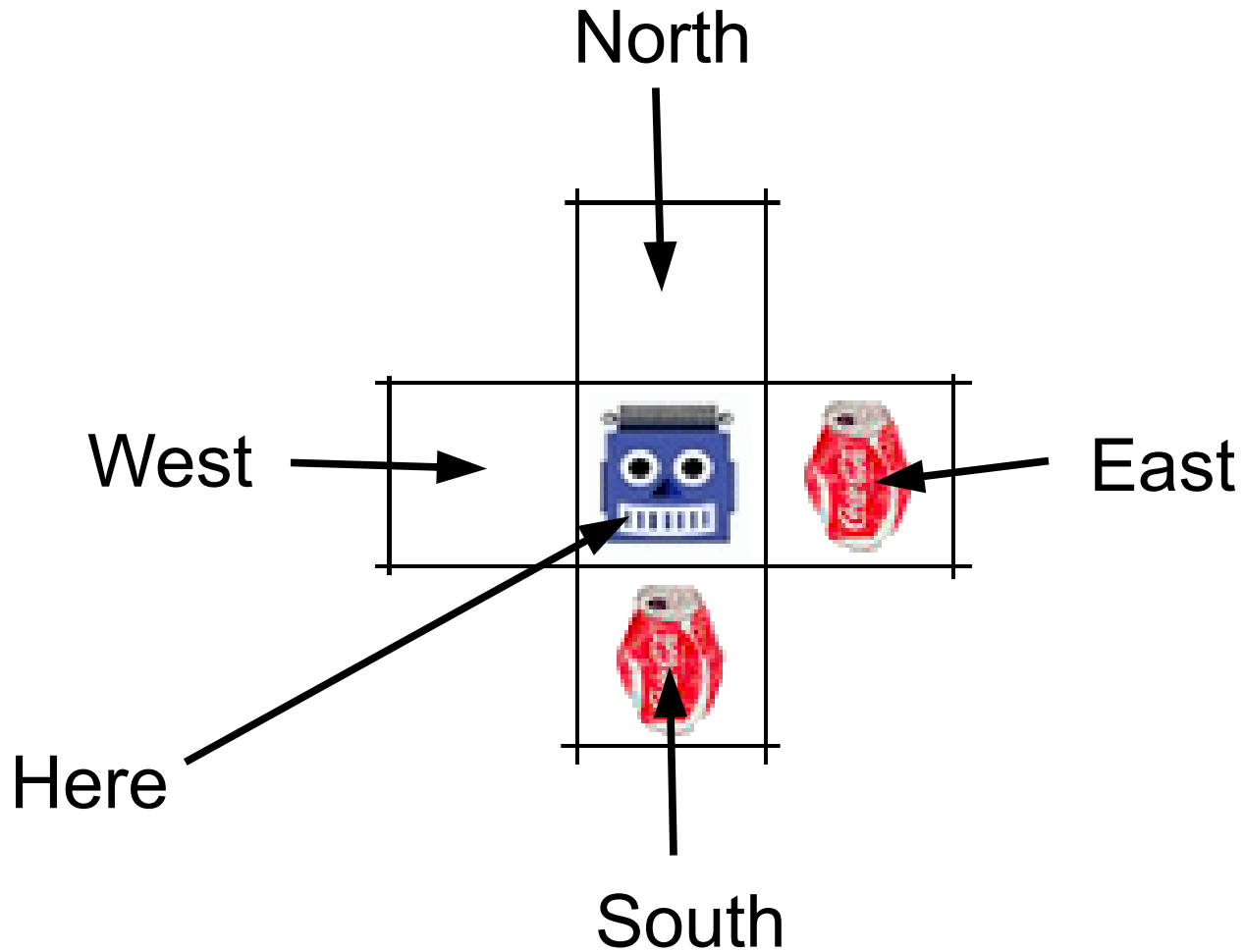


# Robby the Robot

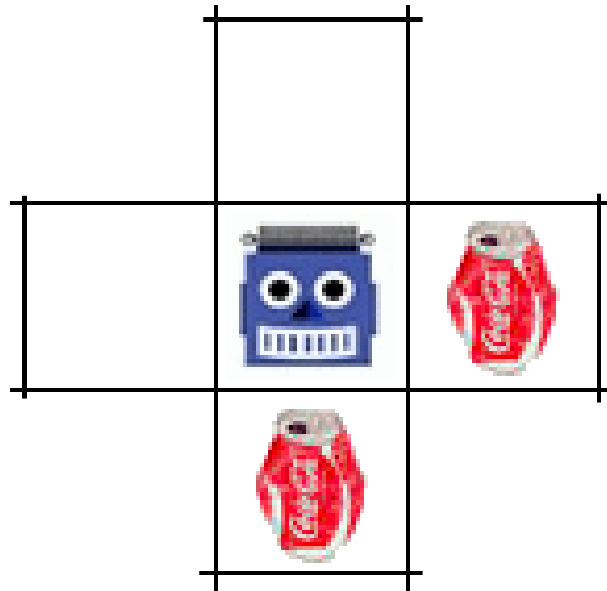


*Complexity: A Guided Tour*, by Melanie Mitchell, Oxford U. Press, 2009

# Robby the Robot



# Robby the Robot



*North*  
**Empty**

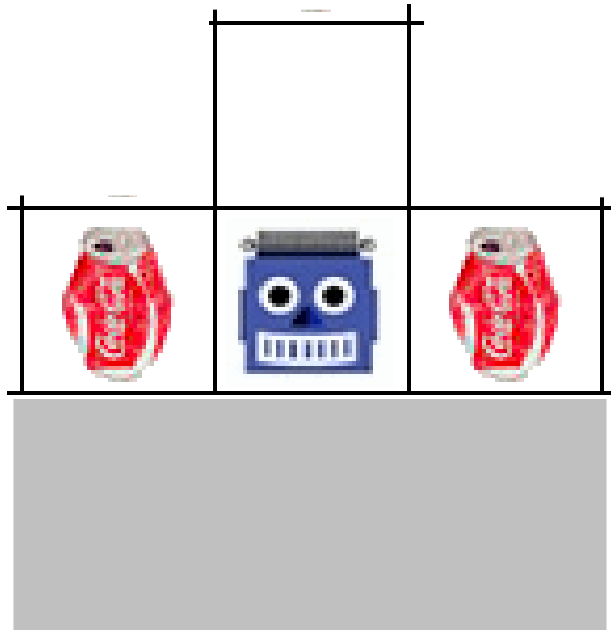
*South*  
**Can**

*East*  
**Can**

*West*  
**Empty**

*Here*  
**Empty**

# Robby the Robot



*North*  
**Empty**

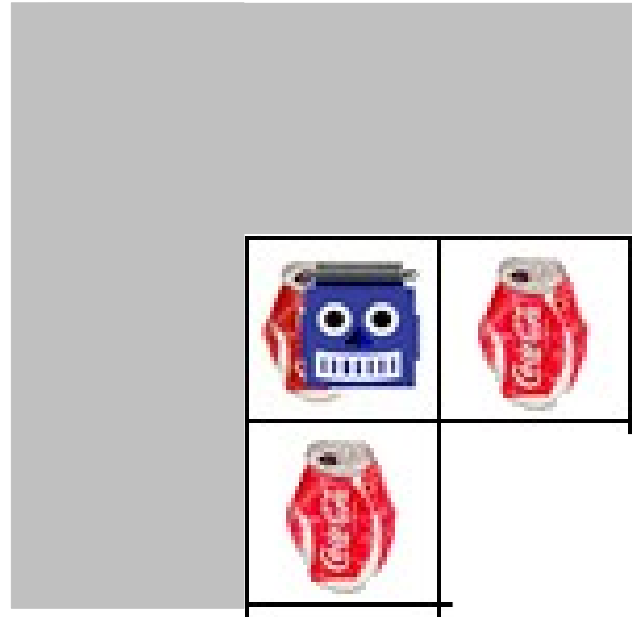
*South*  
**Wall**

*East*  
**Can**

*West*  
**Can**

*Here*  
**Empty**

# Robby the Robot



*North*  
**Wall**

*South*  
**Can**

*East*  
**Can**

*West*  
**Wall**

*Here*  
**Can**

Question:

How many possible **situations** are there?

$$3 \times 3 \times 3 \times 3 \times 3 = 3^5 = 243$$

# All Possible Situations

	<i>North</i>	<i>South</i>	<i>East</i>	<i>West</i>	<i>Here</i>	=	Code
#1	Empty	Empty	Empty	Empty	Empty	=	<b>EEEEEE</b>
#2	Empty	Empty	Empty	Empty	Can	=	<b>EEEECC</b>
#3	Empty	Empty	Empty	Empty	Wall	=	<b>EEEEWW</b>
#4	Empty	Empty	Empty	Can	Empty	=	<b>EEECEC</b>
#5	Empty	Empty	Empty	Can	Can	=	<b>EEECCC</b>
#6	Empty	Empty	Empty	Can	Wall	=	<b>EEECWW</b>
#7	Empty	Empty	Empty	Wall	Empty	=	<b>EEEWEE</b>
#8	Empty	Empty	Empty	Wall	Can	=	<b>EEEWCC</b>
							<i>... etc. ...</i>
#243	Wall	Wall	Wall	Wall	Wall	=	<b>WWWWW</b>

# Robot Actions

- Action Codes

**0** = Move North

**1** = Move South

**2** = Move East

**3** = Move West

**4** = Stay Put

**5** = Pick Up Can

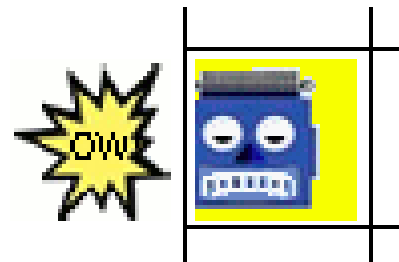
**6** = Move at Random

- Rewards / Punishments

**+10** Successfully picked up a can

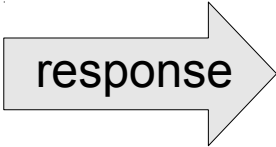
**-1** Tried to pick up a can that wasn't there

**-5** Crashed into a wall





# One Possible Control Strategy

Situation Code			Action Code	
#1	<b>EEEEEE</b>		<b>3</b>	(Move West)
#2	<b>EEEEEC</b>		<b>4</b>	(Stay Put)
#3	<b>EEEEEW</b>		<b>6</b>	(Move at Random)
#4	<b>EEECE</b>		<b>6</b>	(Move at Random)
#5	<b>EEEC</b>		<b>0</b>	(Move North)
#6	<b>EEECW</b>		<b>5</b>	(Pick Up Can)
#7	<b>EEWE</b>		<b>2</b>	(Move East)
#8	<b>EEWC</b>		<b>1</b>	(Move South)
	<b>...</b>		<b>...</b>	
#243	<b>WWWW</b>		<b>5</b>	(Pick Up Can)

**Genome: 34660521 ... 5**

243 digits long

Question:

How many possible **strategies** are there?

$$7 \times 7 \times 7 \times \dots \times 7 \quad (243 \text{ times})$$

$$= 7^{243}$$

# That's a lot of strategies!

$$7^{243} =$$

22,846,712,859,873,746,480,447,821,666,592,  
346,426,694,132,333,435,558,998,983,412,854,  
961,114,186,622,574,870,902,442,510,049,863,  
025,667,206,258,127,311,451,949,520,409,822,  
391,138,243,055,993,672,121,915,936,570,990,  
365,106,665,813,437,806,284,123,385,754,752,  
042,992,343

# How to Evaluate a Strategy's Fitness?

- Just try it out!
- Cleaning Session:
  - Scatter cans around at random (50% can density)
  - Have Robby follow strategy for 200 time steps
  - Score = total reward received
- Strategy Fitness:
  - Average score over **100 cleaning sessions**