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CS 6364

Quiz 1 (Take-Home)

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Due: September 2 2020 before Midnight (on eLearning)

Read section 2.4.7 from the Textbook and represent the Kitty world as:

1. Atomic representation.
2. Factored representation.
3. Structured representation.

A. Describe each of the representations (5 points for each representation)

1. Atomic representation – It is a black box representation of an indivisible state having no internal structure. For example, suppose in the kitty world, the kitty moves from a point A to point B via point C. Here we need not to deal with any other property of the kitty world and the state is reduced to focus only on the name of the different points.

   Kitty representation - From a numbered state of positions from 1 to 6, let us assume our kitty is at position '6' currently. In our case we would like our kitty to move to position '3' after passing from position '5' and position '4'.

2. Factored representation – It is a more expressive representation of a state consisting of a vector of attribute values. Each state can be split up into variables or attributes, each of which can either be real-valued, boolean or have a fixed set of values. For example, while the kitty moves from a point A to point B via point C, we might need to know some more details. These details may include knowing about defined kitty reactions, battery life of kitty robot on one-time charge, different sounds it can make, happiness level of kitty robot and so on.

Kitty representation - Let us assume the kitty can move from a numbered list of position from 1 to 6 and can have various happiness states like very happy, happy, sad, or curious. Initially, we place kitty at position '6' and a 'curious' happiness state. Next, we decide the goal of our kitty is to bring it to the position '3' and 'very happy' happiness state. We will utilize different states to decide on a utility value and take actions to reach our goal state.

3. Structured representation – It is the most expressive and complex representation of a state that includes objects, each of which have its own attributes and relationships to other objects. Here we go deeper in comparison than atomic and factored states to understand the relation among world states. For example, while moving kitty from point A to point B via point C, apart from the factored state knowledge, we might also want to know how the user interaction will affect the mood of the kitty, how the kitty robot will react if some obstruction is placed in the kitty's path, what will the robot do if its battery is very low and so on.

   Kitty representation - Let us assume the kitty can move from a numbered list of position from 1 to 6, can have various happiness states like very happy, happy, sad, or curious and can have three different battery remaining percentages – 5%, 40% and 80%. Initially, we place kitty at position '6', a 'curious' happiness state and '40%' battery level. Next, we decide the goal of our kitty is to bring it to the position '3', 'very happy' happiness state and '80%' battery level. We will utilize different states to decide on a utility value while making relations between the various states and take actions to reach our goal state.

B. Write the pseudo-code of a utility-based agent for each of these representations (5 points for each representation)

The different representations change with their level of complexity in the states, model and utilities, but all three representations will have the same pseudo code structure. However, following things will change for different representations in the pseudo code:

a. Variables (different states)
b. Model
c. Utilities

```
function UTILITY-BASED-AGENT (percept)
    returns an action
    static: state, a description of the current world state
            action, the most recent action, initially none
            model, a description of how the next state depends on current state and action
            utilities, a set of weighted outcomes for maximizing performance

state ← UPDATE-STATE (state, action, percept, model)
utility ← UTILITY-FUNCTION (state, utilities)
action ← UTILITY-ACTION [utility]
return action
```

Percepts considered: Clap, Pet, Bump

Actions considered: Walk, Purr, Meow, Blink, Stop, Start, Turn around, Charge Battery

1. Atomic representation

a. Variables considered:

- Position of Kitty: 1,2,3,4,5,6
  Current Position: 6

Assumption – An ideal kitty robot would like to reach in the center of room, i.e., position 3.

b. Model: Update-Kitty [State, Action, Percept]

- Position-1 <- UPDATE-KITTY [Position, Walk, [Clap]]
- Position <- UPDATE-KITTY [Position, Purr | Meow | Blink, [Pet]]
- Position <- UPDATE-KITTY [Position, Stop| Start | Turn around, [Bump]]

c. Utilities:

State	Utility measure (maximum = 10)	Action
position >3	Utility = 5	Walk
position = 3	Utility = 10	Purr, Blink, Stop

2. Factored representation

a. Variables considered:

- Position of Kitty: 1,2,3,4,5,6
  Current Position: 6

- Happiness of Kitty: Very Happy (VH), Happy(H), Sad(S), Curious(C)
  Current Happiness: Curious

Assumption: A idea kitty robot would like to be in position 3 and VH happiness level.

b. Model: Update-Kitty [State, Action, Percept]

- Happiness +1 <- UPDATE-KITTY [Happiness, Meow, [Clap, Clap]]
- Happiness +2 <- UPDATE-KITTY [Happiness, Purr, [Pet]]
- Happiness -1 <- UPDATE-KITTY [Happiness, Blink, [Bump]]
- Position-1 <- UPDATE-KITTY [Position, Walk, [Clap]]
- Position <- UPDATE-KITTY [Position, Purr | Meow | Blink, [Pet]]
- Position <- UPDATE-KITTY [Position, Stop| Start | Turn around, [Bump]]

c. Utilities:

State - Position	State - Happiness	Utility measure (maximum = 10)	Action
position >3	happiness < VH	Utility = 3	Walk
position = 3	happiness = VH	Utility = 10	Purr, Blink, Stop
position = 1 OR position = 6	-	Utility = 6	Blink, Meow, Turn around

3. Structured representation

a. Variables considered:

- **Position of Kitty**: 1,2,3,4,5,6
  Current Position: 6

- **Happiness of Kitty**: Very Happy (VH), Happy(H), Sad(S), Curious(C)
  Current Happiness: Curious

- **Battery remaining**: 5%, 40%, 80%
  Current battery level: 60%

Assumption – A ideal kitty robot would like to be in center of room, VH happiness state, and will have more than 80% battery remaining.

b. Model: Update-Kitty [State, Action, Percept]

- Happiness +1 <- UPDATE-KITTY [Happiness, Meow, [Clap, Clap]]
- Happiness +2 <- UPDATE-KITTY [Happiness, Purr, [Pet]]
- Happiness -1 <- UPDATE-KITTY [Happiness, Blink, [Bump]]
- Position-1 <- UPDATE-KITTY [Position, Walk, [Clap]]
- Position <- UPDATE-KITTY [Position, Purr | Meow | Blink, [Pet]]
- Position <- UPDATE-KITTY [Position, Stop| Start | Turn around, [Bump]]
- Battery remaining+35 <- UPDATE-KITTY [Battery remaining, Charge Battery, [Pet, Pet, Clap]]

c. Utilities:

State - Position	State - Happiness	State – Battery remaining	Utility measure (maximum = 10)	Action
position >3	-	battery > 5% and battery < 40%	Utility = 3	Walk
position >3	happiness < VH	battery < 5%	Utility = 10	Charge Back
position > 3	happiness > S	battery >= 40%	Utility = 4	Meow, Walk
position = 3	happiness = VH	battery < 60%	Utility = 5	Charge Back
position = 3	happiness = VH	battery > 80%	Utility = 10	Purr, Blink, Stop
position = 1 OR position = 6	-	-	Utility = 6	Bump, Turn around