BLG435E, Artificial Intelligence, Fall 2017-2018

Assignment #3

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Q1) I selected question **a)** to be answered.

I selected the Sims as my favourite video game. The Sims is a life simulation game. In the game, the player can control only one character at a time but there are other characters in the game which can move and act according to their personalities and needs. The personalities of each character are determined at the beginning of the game.

The AI techniques used in this game can be listed as following: **path finding (searching)**, **decision making** and **controlling non played characters (NPC).**

P.S: I cannot decide that adjusting **social interactions** is an AI technique or not, so I indicated this topic as extra.

Path finding: The Sims uses **Hierarchical Pathfinding A* (HPA*)** which is adapted from A* algorithm. HPA* algorithm is working among groups of waypoints, instead of working with waypoint. HPA* does searching hierarchically by dividing the waypoints into regions. In the Sims, the regions are rooms. HPA* is run on a graph whose nodes' are rooms.

Decision making: There exists basic needs (hunger, comfort, hygiene, bladder, fun etc.) of a Sim (In the Sims, a person is called as Sim.) and there are some activities which supply Sim's needs and increase happiness. A Sim, which is not controlled by the player, makes decisions according to supply its needs and increase happiness. For making decisions, decision tree learning could be used.

- **Smart object paradigm:** In the Sims, objects have logic instead of a Sim. Objects offer options to a Sim that can serve.
- **Personalites:** Each Sim has a different personality and a Sim also can make decisions according to its personality.

Non-played characters are controlled from computer according to these aspects.

Extra: Social interactions: Sims have relationship levels and these levels allow Sims different interactions. These levels can be indicated by an automaton. The results of the interactions are coded in low-level rules. [1]

My suggestion to the Sims could be that babies and children can learn something with **reinforcement learning** and improve their characters from their experiences.

(○ indicates Park, □ indicates Theatre, △ indicates TV at decision tree.)

Θ2)a. The most appropriate (ideal) attribute for each step of the decision tree can be determined by calculating entropy and information gain. The attribute which has highest information gain value is selected as the most appropriate attribute for the step. Information gain for each attribute is calculated as following:

→ Firstly, entropy is calculated (p: positive examples, n: negative examples in a training set):

$$I\left(\frac{p}{p+n}, \frac{n}{p+n}\right) = \frac{-p}{p+n} \cdot \log_2 \frac{p}{p+n} - \frac{n}{p+n} \cdot \log_2 \frac{n}{p+n}$$

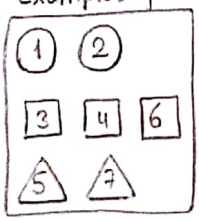
→ Then information gain is calculated according to following formula ("A" is an attribute, v is the subset number.):

$$IG(A) = I\left(\frac{p}{p+n}, \frac{n}{p+n}\right) - \sum_{i=1}^{v} \frac{p_i + n_i}{p+n} I\left(\frac{p_i}{p_i+n_i}, \frac{n_i}{p_i+n_i}\right)$$

→ The attribute which has the highest information gain (IG) is chosen.

- Entropy for the first step:

Examples

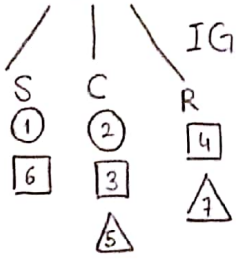


$$I\left(\frac{2}{7}, \frac{3}{7}, \frac{2}{7}\right) = \frac{-2}{7} \log_2 \frac{2}{7} - \frac{3}{7} \log_2 \frac{3}{7} - \frac{2}{7} \log_2 \frac{2}{7}$$

$$I\left(\frac{2}{7}, \frac{3}{7}, \frac{2}{7}\right) \cong 0,51 + 0,52 + 0,51$$

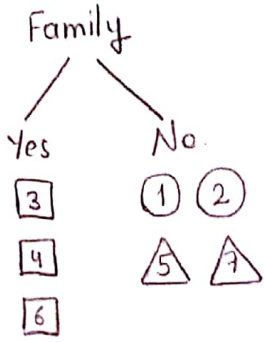
$$I\left(\frac{2}{7}, \frac{3}{7}, \frac{2}{7}\right) \cong 1,55$$

Weather



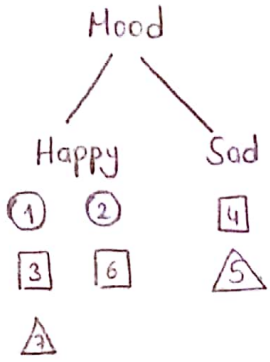
$$IG(\text{Weather}) = 1,55 - \left[\frac{2}{7} \cdot I\left(\frac{1}{2}, \frac{1}{2}, 0\right) + \frac{3}{7} I\left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right) + \frac{2}{7} \cdot I\left(0, \frac{1}{2}, \frac{1}{2}\right)\right]$$

$$IG(\text{Weather}) = 1,55 - \left[\frac{2}{7} \cdot 1 + \frac{3}{7} \cdot 1,58 + \frac{2}{7} \cdot 1\right] \cong 0,3$$



$$IG(Family) = 1,55 - \left[\frac{3}{7} \cdot I(0,1,0) + \frac{4}{7} \cdot I(1/2, 0, 1/2)\right]$$

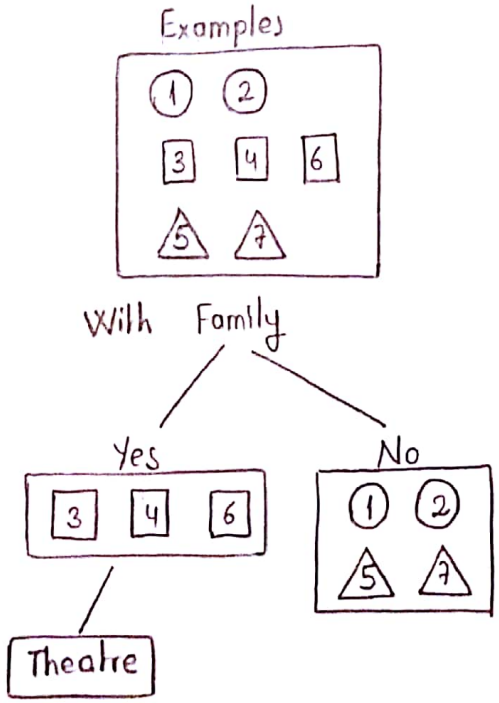
$$IG(Family) = 1,55 - \left[\frac{3}{7} \cdot 0 + \frac{4}{7} \cdot 1\right] \cong 0,98$$



$$IG(Mood) = 1,55 - \left[\frac{5}{7} \cdot I\left(\frac{2}{5}, \frac{2}{5}, \frac{1}{5}\right) + \frac{2}{7} I\left(0, \frac{1}{2}, \frac{1}{2}\right)\right]$$

$$IG(Mood) = 1,55 - \left[\frac{5}{7} \cdot 1,52 + \frac{2}{7} \cdot 1\right] \cong 0,18$$

For the first step: $IG(Family) \cong 0,98$, $IG(Weather) \cong 0,3$, $IG(Mood) \cong 0,18$ } Information gain of Family attribute is the highest, so this attribute is chosen as most appropriate attribute for this step.



$I(0,1,0) = 0$

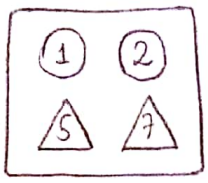
$IG = 0$

→ Entropy and information gain of "Yes" branch are zero. So, we would obtain the "Theatre" decision from this branch.

→ We will continue from "No" branch.

→ In the 2nd step of the decision tree, entropy is calculated as following:

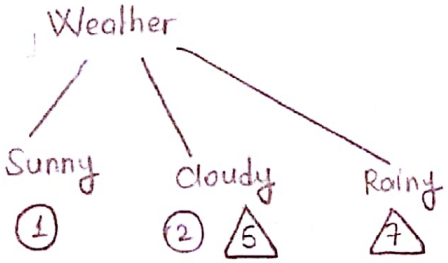
Examples



$$I\left(\frac{1}{2}, 0, \frac{1}{2}\right) = \frac{-1}{2}\cdot\log_2\frac{1}{2} - \frac{1}{2}\cdot\log_2\frac{1}{2}$$

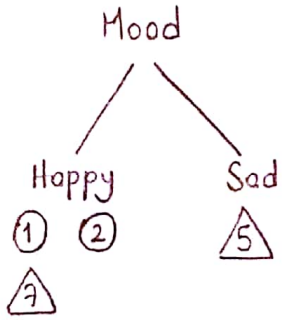
$$I\left(\frac{1}{2}, 0, \frac{1}{2}\right) = \frac{1}{2} + \frac{1}{2} = 1$$

Family attribute is selected at the 1st step. So, information gains of Mood and Weather attributes are calculated at the 2nd step.



$$IG(Weather) = 1 - \left[\frac{1}{4}\cdot I(1,0,0) + \frac{2}{4} I\left(\frac{1}{2}, 0, \frac{1}{2}\right) + \frac{1}{4}\cdot I(0,0,1)\right]$$

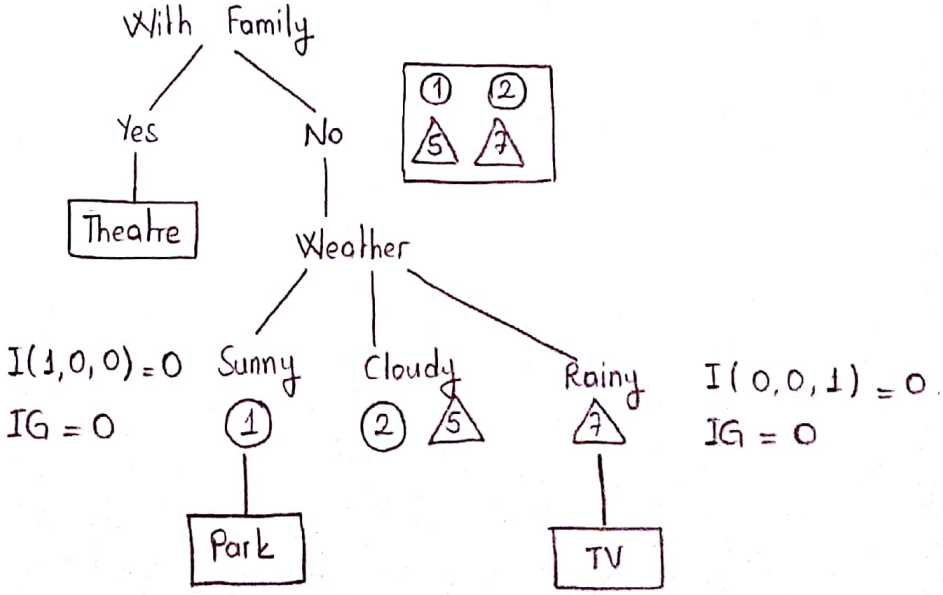
$$IG(Weather) = 1 - [0 + 2/4 \cdot 1 + 0] = 0,5$$



$$IG(Mood) = 1 - \left[\frac{3}{4}\cdot I\left(\frac{2}{3}, 0, \frac{1}{3}\right) + \frac{1}{4}\cdot I(0,0,1)\right]$$

$$IG(Mood) = 1 - \left[\frac{3}{4}\cdot 0,92 + \frac{1}{4}\cdot 0\right] \cong 0,31$$

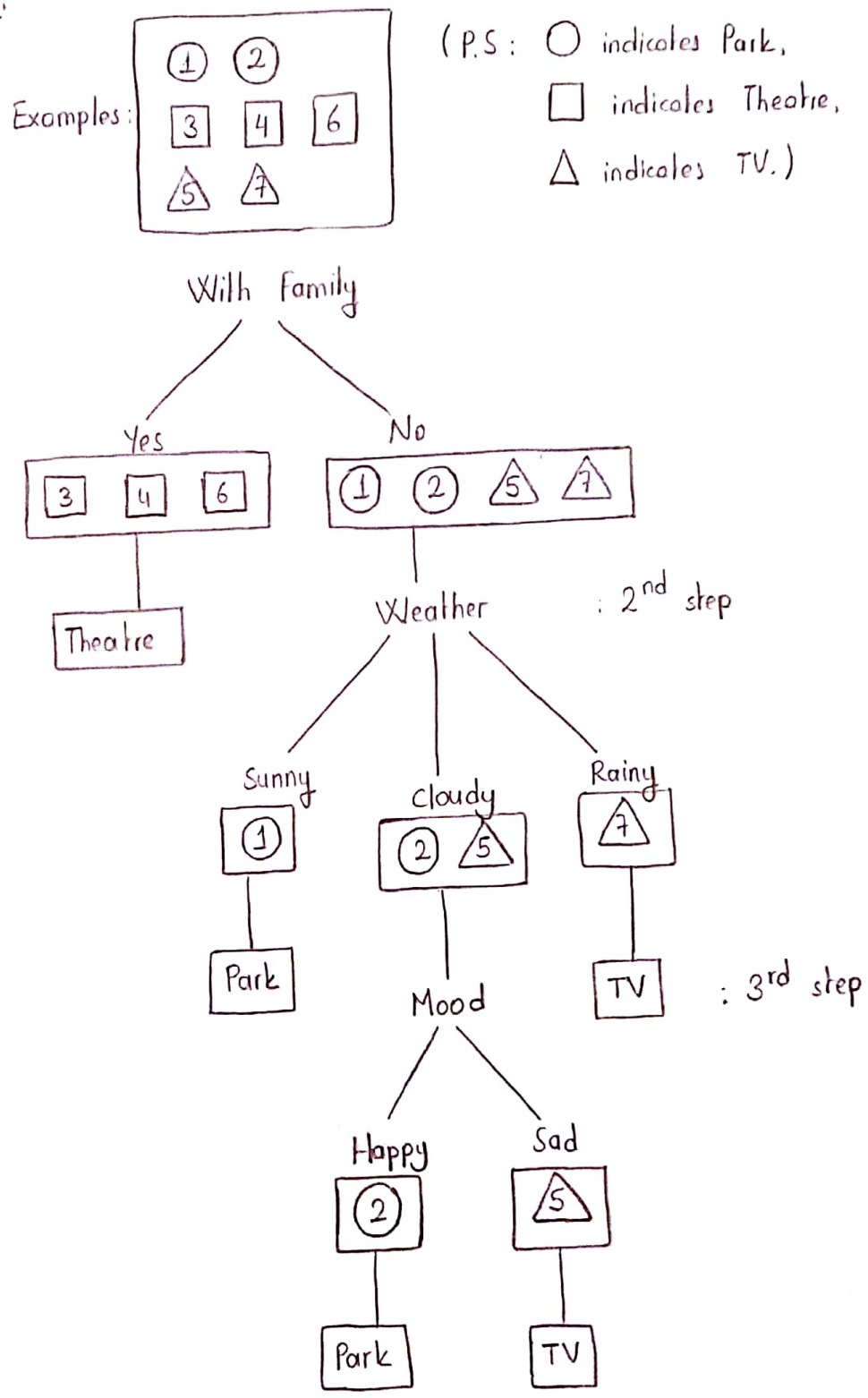
→ At the 2nd step: $IG(Weather) = 0,5$, $IG(Mood) \cong 0,31$ } Information gain of Weather attribute is higher than Mood attribute. Thus, Weather attribute is chosen in 2nd step.



→ Entropies and information gains are zero at "Sunny" and "Rainy" branches at the 2nd step. Thus, we can obtain decisions from these branches.

→ "Mood" attribute is the last attribute that was not used and we should proceed on "Cloudy" branch. So, we use "Mood" attribute on this branch.

The final decision tree:



b. With Family : No → Weather : Sunny → Park ✓

→ As we generalized our decisions with decision tree, we can obtain "Park" decision at the 2nd step.

REFERENCES

[1] Y. Bourse, *Artificial Intelligence in The Sims series.* 2012.