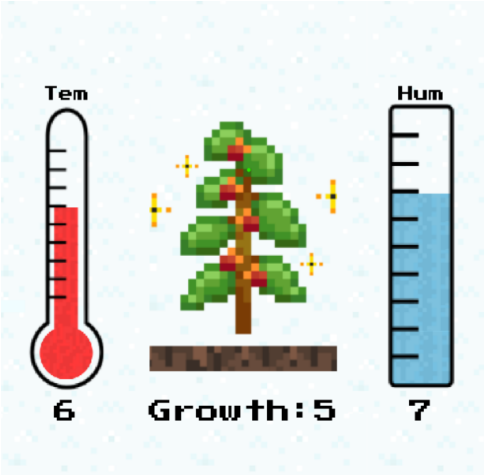
RL Formulation - Greenhouse management

Adele Caciolli (141793), Niccolò Petrilli (145457)



Problem

In the greenhouse, plants have $n = 5$ growth phases (germination, initial growth, advanced growth, maturation, harvest). The agent must manage temperature and humidity levels, either increasing them or leaving the conditions unchanged.

Objective

In the context of a single plant, the goal is to bring it to the harvest phase.

State

The state is composed by the information on the growth phase, temperature and humidity level.

- Growth: $[0\ (death), 1\ (germination), 2\ (initial\ growth), 3\ (advanced), 4\ (maturation), 5\ (harvest)]$
- Temperature: [0,1,2,3,4,5,6,7,8,9,10]
- Humidity: [0,1,2,3,4,5,6,7,8,9,10]

Action

- **0** : No action
- **1**: Increase temperature by one level.
- **2**: Increase humidity by one level

Natural deterioration is modeled as uncertainty for each action: when temperature or humidity levels remain unchanged, with probability $1 - p_t$ and $1 - p_h$, respectively, they may decrease by one.

Dynamics and range of growth

The Figure 1 shows the temperature and humidity levels for each stage of plant growth. Green indicates optimal levels that allow growth, yellow represents good levels, orange indicates poor levels, and red denotes very poor levels.

0	Death											
1	Germination	Temp	0	1	2	3	4	5	6	7	8	9	10
		Hum	0	1	2	3	4	5	6	7	8	9	10
2	Initial Growth	Temp	0	1	2	3	4	5	6	7	8	9	10
		Hum	0	1	2	3	4	5	6	7	8	9	10
3	Advanced Growth	Temp	0	1	2	3	4	5	6	7	8	9	10
		Hum	0	1	2	3	4	5	6	7	8	9	10
4	Maturation	Temp	0	1	2	3	4	5	6	7	8	9	10
		Hum	0	1	2	3	4	5	6	7	8	9	10
5	Harvest												

Figure 1: Range of Temperature ad Humidity

The dynamic depends on the state of temperature and humidity as follows:

- **Growth:** -2 if at least one condition is red (very poor)
- **Growth:** -1 if at least one condition is orange (poor)
- **Growth:** 0 if at least one condition is yellow (good)
- **Growth:** $+1$ if both conditions are green (optimal)

Reward

- r = +100 if growth = 5 (harvest)
- r = 0 else

In a case of analysis where weigths on action are taken, to minimize energy consumption, actions that involve increasing humidity and temperature are penalized:

- r = -6 if action = 1
- r = -5 if action = 2