Basic Robot Behavior Tree Simulation

Nishanth Yeniebera

Python 3.10.12

Modules Used: py_trees[1], time[2], logging[3]

[1] https://py-trees.readthedocs.io/en/devel/

[2] https://docs.python.org/3/library/time.html

[3] https://docs.python.org/3/library/logging.html

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Objective:

Create a behavior tree that simulates (text-only in terminal) 1 robot moving a single part from a “part tray” to a “kit tray.” The goal is for the robot to move 3 parts from the “part tray” to the “kit tray.” Permitted actions and conditions are as listed:

1. Move robot towards part tray
2. Move robot towards kit tray
3. Pick up a part
4. Put down a part

Project Structure:

File Structure:

root/

create_tree.py: Tree is created here

main.py: Execution file for created behavior tree

behaviors/

Actions.py: Creates custom action node objects (*Pickup, PutDown)*

base.py: Initializes a basic condition *(Condition)* and action *(Action)* node objects. Logging functionality for debug is also set up.

Conditions.py: Creates custom condition node objects (*KitTrayFull, PartTraySufficient)*

Constants.py: Creates shared constants throughout the project

custom_blackboard.py: Creates a blackboard for project variables

Behavior Tree Structure:

(Italicized names are a reference to the node's "name" attribute)

rootSequence (Sequence)

- *sequenceA* (Sequence)

  - *PartTraySufficient* (Condition): Checks if "part tray" has enough parts initially.

  - *kitTrayFull* (Inverted Condition): Checks if "kit tray" has sufficient space before placing new parts

- *sequenceB* (Sequence)

  - *MoveToPartTray* (Action): Robot begins to travel until it reaches the "part tray"

  - *PickUpPart* (Action): Robot picks up a part from the tray (assuming it is at a tray)

  - *MoveToKitTray* (Action): Robot begins to travel until it reaches the "kit tray"

  - *PutPartDown* (Action): Robot sets down a part on the tray (assuming it is actively carrying one)

Variables:

Blackboard variables:

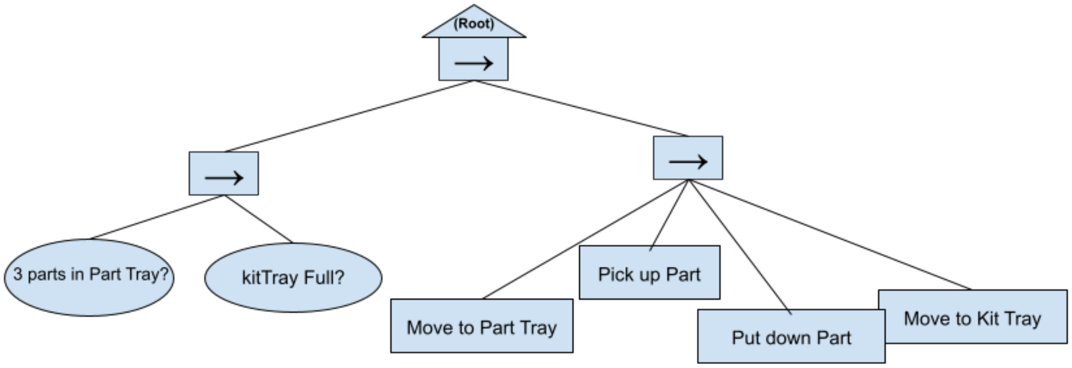
- *partTrayQty* (integer): Quantity of parts in “part tray”
- *kitTrayQty* (integer): Quantity of parts in “kit tray”
- *partsMoved* (integer): Quantity of parts moved
- *isSufficient* (boolean): Outcome of a check for “part tray” having the sufficient initial quantity of parts to complete goal

Constants:

- *DEBUG_PAUSE* (float): Time between debugging logs (and by multiple of 10 is time between ticks)
- *CARRYING_AMOUNT* (integer): Quantity robot is capable of carrying
- *GOAL_AMOUNT_MOVED* (integer): Goal quantity of parts to move
- *TRAY_MAX_PARTS* (integer): Maximum quantity of parts a tray may contain

Diagrams:

Behavior Tree Visualized:



XML Parsing

Instructions for XML Parsing:

1. Run the parse.py file using this command:

   python parse.py

2. An XML file will be generated and saved to the “exports” folder