User Study 02 - RL Audio Notebook

Please click the folliwng two links to read the explanatory statrement and answer the pre-study questionnaire.

Explanatory Statement: https://drive.google.com/file/d/1-8npbW1wg_ABzBnnGa1dgEgCaYjDED8o/view?usp=sharing

Pre-study Questionnaire: https://forms.gle/GAU8xzekWKkTMDLVA (Participant ID Required)

Setup

Imports & Args

Before starting this Notebook...

1. Enable JupyterLab Dark. Under "settings" --> theme --> **"JupyterLab Dark"**
2. Sub the line of code below with the path on your device to: **./../RL_audio/notebooks**

In [1]:
```
# %cd /home/liamroy/Documents/PHD/repos/RL_audio/notebooks

%cd /Users/liamroy/Documents/Studies/Monash_31194990/PHD/repo



# %cd <add your path here and comment out the others>
```

```
/Users/liamroy/Documents/Studies/Monash_31194990/PHD/repos/RL_audio/notebooks
```

In [2]:
```
PWD = %pwd
```

In [3]:
```
# You will need to install:
# numpy, pygame, termcolor, openpyxl, nbconvert-webpdf
```

```python

# IMPORTS
import os
import shutil
import time
import numpy as np
import random
import argparse
import linecache

from scripts import audio_control
from scripts import ucb1_algorithm as ucb1
from scripts import misc_helpers as mischelp

import sys

from termcolor import colored, cprint
# Termcolor guide: https://pypi.org/project/termcolor/


#
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#  ARGUMENTS & PARSER (Save this code for scripts
working with CLI)

# argParser = argparse.ArgumentParser()

# # Enter any valid integer value
# argParser.add_argument("-b", "--budg", required=False,
help="select the budget value (dtype=int)")
```

```
# # Enter a valid parameter discritization integer (must
match sound library size)
# argParser.add_argument("-d", "--disc", required=False,
help="select discritization size (dtype=int)")

# # Enter true if you would like to see hidden print
log, including Q-tables
# argParser.add_argument("-p", "--prnt", required=False,
help="show hidden print log (dtype=bool)")

# # To load and save, simply enter in the base filename
such as "lastsave" or "set_A", system takes care of rest
# argParser.add_argument("-s", "--save", required=False,
help="filename to save Q-table on exit (dtype=str)")
# argParser.add_argument("-l", "--load", required=False,
help="load Q-table from filename (dtype=str)")
```

Initializations

In [4]:

```
# Parameter discritization
param_disc = 3

state_descriptions = ["Stuck       \t- robot needs your
help", "Successful \t- robot has completed it's task",
"Progressing \t- robot is working and doesn't need
help", "None of the above"]
num_of_states = len(state_descriptions) - 1 # Adding a
minus 1 since the last state in "state_descriptions" is
"none of the above"
state_range = np.arange(num_of_states)


# CREATE SOUND LIBRARY A
```

```
# For library A, setup the array using libA
library_A = "libA"

# Create an array of size (N x N x N) where N = number
of discretized regions
# number of discretized regions for each param --> i.e.
if equals 3 then (0, 1, 2)
# ** must align with the discretization for selected
sound library
sound_obj_array_A = np.ndarray((param_disc, param_disc,
param_disc),dtype=object)

for param_1_range in range(param_disc):
        for param_2_range in range(param_disc):
                for param_3_range in range(param_disc):
                        sound_obj_array_A[param_1_range,
param_2_range, param_3_range] =
audio_control.audio_object(param_1=param_1_range,
param_2=param_2_range, param_3=param_3_range,
sound_library=library_A)



# CREATE SOUND LIBRARY B
# For library B, setup the array using libB
library_B = "libB"

# Create an array of size (N x N x N) where N = number
of discretized regions
# number of discretized regions for each param --> i.e.
if equals 3 then (0, 1, 2)
# ** must align with the discretization for selected
sound library
sound_obj_array_B = np.ndarray((param_disc, param_disc,
```

```
param_disc),dtype=object)

for param_1_range in range(param_disc):
        for param_2_range in range(param_disc):
                for param_3_range in range(param_disc):
                        sound_obj_array_B[param_1_range,
param_2_range, param_3_range] =
audio_control.audio_object(param_1=param_1_range,
param_2=param_2_range, param_3=param_3_range,
sound_library=library_B)
```

MAIN STUDY

Welcome to this study's **Jupyter notebook**. In this work, we are developing strategies for improving human-robot interaction with nonverbal sounds (***beeps & boops***).

This study is best completed with **headphones**. Ensure your volume is on.

While a robot is working on a task, it can have many different internal states...

If the robot gets stuck behind an obstacle, the robot's internal state is: **Stuck**

Similarly, if the robot was able to reach it's goal, the robot's internal state is: **Successful**

If the robot is actively working on the task but has neither gotten stuck nor completed the task, the robot's internal state is: **Progressing**

In this notebook, you will be asked to run through **3 sections**. In each of these sections, a virtual robot will play a sound. Once you listen to the sound, you will be asked to select which robot state you think the virtual robot is in. You will have the options: **Stuck**, **Successful**, **Progressing** and **Not Sure**

In addition to each answer, you will also self-score how confident you are in your response, on a scale from 1 to 10.

This process will repeat several times as a learning algorithm is processing in the background. **If you have any questions, ask your study moderator**. Have fun!

SECTION 1

Start by entering your user ID.

Click on the first cell below & hit 'shift + enter'...

In [5]:
```
current_user_ID_str =
mischelp.get_user_ID(parent_dir=PWD,
num_of_states=num_of_states)
```

```
--------------------------------------------------------------------------
--------------------------------------------------------------------------

Great job! You are user: 00

Click on the next cell below and hit 'shift + enter' to continue

--------------------------------------------------------------------------
--------------------------------------------------------------------------
```

Our first robot is named Jackal.


Jackal Robot

Let's listen to **Jackal** make a few sounds to express itself.

For each sound, you will asked to select which robot state you think the robot is in.

Click on the cell below & hit 'shift + enter'...

In [6]:
```
mischelp.get_user_accuracy(sound_obj_array=sound_obj_arra
```

```
 lib_str=library_A, sect_str="sect1",
user_ID_str=current_user_ID_str,
num_of_states=num_of_states,


states_array=np.ndarray(num_of_states, dtype=object),
state_descriptions=state_descriptions,
param_disc=param_disc, load_file="pilotset", seed=70)
```

```
------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above

------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above

--------------------------------------------------------------------------------
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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above




--------------------------------------------------------------------------------
--------------------------------------------------------------------------------

Great job!
Click on the next cell below and hit 'shift + enter' to continue

--------------------------------------------------------------------------------
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```

Our next robot is named the Spot.

Let's listen to **Spot** make a few sounds to express itself.

You will notice **Spot** sounds slightly different to **Jackal**. For each sound, you will asked to select which robot state you think the robot is in.

Click on the cell below & hit 'shift + enter'...

In [7]:
```
mischelp.get_user_accuracy(sound_obj_array=sound_obj_arra
  lib_str=library_B, sect_str="sect1",
user_ID_str=current_user_ID_str,
num_of_states=num_of_states,


states_array=np.ndarray(num_of_states, dtype=object),
state_descriptions=state_descriptions,
param_disc=param_disc, load_file="pilotset", seed=51)
```

```
------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above

------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above

--------------------------------------------------------------------------------
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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above




--------------------------------------------------------------------------------
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Great job!
Click on the next cell below and hit 'shift + enter' to continue

--------------------------------------------------------------------------------
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```

Section 2

In section 2, we'll be listening to **Jackal** again.

 Jackal Robot

Similar to before, **Jackal** make a few sounds to express itself, and you will asked to select which robot state you think the robot is in.

This process will repeat several times as a learning algorithm is processing in the background.

Section 2X

Click on the cell below & hit 'shift + enter'...

In [8]:

```
# SECTION 2X



time_step_2X_str =
ucb1.ucb1_algor(num_of_states=num_of_states,
state_descriptions=state_descriptions,
param_disc=param_disc,
sound_obj_array=sound_obj_array_A,


current_user_ID_str=current_user_ID_str,
sect_str="_sect2X", load_file=None, budget=50,
delta_Q_thresh=2.0, conv_thresh=3, printer=True)
```

```
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------------------------------------------------------------------

Time Step: 00
state_idx_set: {0, 1, 2}
current_state_index: 0

New Param INDICES (not direct values):
P1: 1 (Beats per Minute - BPM)
P2: 1 (Beeps per Loop - BPL)
P3: 1 (Amplitude of Pitch Change)

------------------------------------------------------------------------
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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



-----------------------------------------------------------------

(Hidden):
Uncertainty_signal (U):  0.0
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 10.0
New action value (Q):    0.0
Q-table after update for state 0:

[[[10. 10. 10.]
  [10. 10. 10.]
  [10. 10. 10.]]

 [[10. 10. 10.]
  [10.  0. 10.]
  [10. 10. 10.]]

 [[10. 10. 10.]
  [10. 10. 10.]
  [10. 10. 10.]]]


-----------------------------------------------------------------

(Hidden):
Uncertainty_signal (U):  0.0
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 10.0
New action value (Q):    0.0
Q-table after update for state 1:

[[[10. 10. 10.]
  [10. 10. 10.]
  [10. 10. 10.]]

 [[10. 10. 10.]
  [10.  0. 10.]
  [10. 10. 10.]]

 [[10. 10. 10.]
  [10. 10. 10.]
  [10. 10. 10.]]]


-----------------------------------------------------------------

(Hidden):
Uncertainty_signal (U):  0.0
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 10.0
New action value (Q):    0.0
Q-table after update for state 2:

[[[10. 10. 10.]
  [10. 10. 10.]
  [10. 10. 10.]]

 [[10. 10. 10.]
  [10.  0. 10.]
  [10. 10. 10.]]

 [[10. 10. 10.]
  [10. 10. 10.]
  [10. 10. 10.]]]
in_a_row_st0 back to zero

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Time Step: 01
state_idx_set: {0, 1, 2}
current_state_index: 0

New Param INDICES (not direct values):
P1: 0 (Beats per Minute - BPM)
P2: 2 (Beeps per Loop - BPL)
P3: 0 (Amplitude of Pitch Change)

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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.41627730557884884
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 9.583722694421152
New action value (Q):    0.41627730557884884
Q-table after update for state 0:

[[[10.         10.         10.        ]
  [10.         10.         10.        ]
  [ 0.41627731 10.         10.        ]]

 [[10.         10.         10.        ]
  [10.          0.         10.        ]
  [10.         10.         10.        ]]

 [[10.         10.         10.        ]
  [10.         10.         10.        ]
  [10.         10.         10.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.41627730557884884
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 9.583722694421152
New action value (Q):    0.41627730557884884
Q-table after update for state 1:

[[[10.         10.         10.        ]
  [10.         10.         10.        ]
  [ 0.41627731 10.         10.        ]]

 [[10.         10.         10.        ]
  [10.          0.         10.        ]
  [10.         10.         10.        ]]

 [[10.         10.         10.        ]
  [10.         10.         10.        ]
  [10.         10.         10.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.41627730557884884
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 9.583722694421152
New action value (Q):    0.41627730557884884
Q-table after update for state 2:

[[[10.         10.         10.        ]
  [10.         10.         10.        ]
  [ 0.41627731 10.         10.        ]]

 [[10.         10.         10.        ]
  [10.          0.         10.        ]
  [10.         10.         10.        ]]

 [[10.         10.         10.        ]
  [10.         10.         10.        ]
  [10.         10.         10.        ]]]
in_a_row_st0 back to zero

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Time Step: 02
state_idx_set: {0, 1, 2}
current_state_index: 2

New Param INDICES (not direct values):
P1: 2 (Beats per Minute - BPM)
P2: 1 (Beeps per Loop - BPL)
P3: 1 (Amplitude of Pitch Change)

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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 2 --> state: Progressing   - robot is working and doesn't need
help

To replay the sound: Leave the input empty and hit 'enter'...
Score your confidence in this response from [0 to 10] or type 'back' to go
back:
```

```
You entered: 2



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.5240735369841025
Reward_signal (R):       -2.0
N value for state 0 is 1
Delta_Q for state 0 is: 11.475926463015897
New action value (Q):    -1.4759264630158975
Q-table after update for state 0:

[[[10.         10.         10.        ]
  [10.         10.         10.        ]
  [ 0.41627731 10.         10.        ]]

 [[10.         10.         10.        ]
  [10.          0.         10.        ]
  [10.         10.         10.        ]]

 [[10.         10.         10.        ]
  [10.         -1.47592646 10.        ]
  [10.         10.         10.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.5240735369841025
Reward_signal (R):       -2.0
N value for state 1 is 1
Delta_Q for state 1 is: 11.475926463015897
New action value (Q):    -1.4759264630158975
Q-table after update for state 1:

[[[10.         10.         10.        ]
  [10.         10.         10.        ]
  [ 0.41627731 10.         10.        ]]

 [[10.         10.         10.        ]
  [10.          0.         10.        ]
  [10.         10.         10.        ]]

 [[10.         10.         10.        ]
  [10.         -1.47592646 10.        ]
  [10.         10.         10.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.5240735369841025
Reward_signal (R):       2.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 7.475926463015897
New action value (Q):    2.5240735369841025
Q-table after update for state 2:

[[[10.         10.         10.        ]
  [10.         10.         10.        ]
  [ 0.41627731 10.         10.        ]]

 [[10.         10.         10.        ]
  [10.          0.         10.        ]
  [10.         10.         10.        ]]

 [[10.         10.         10.        ]
  [10.          2.52407354 10.        ]
  [10.         10.         10.        ]]]
in_a_row_st1 back to zero

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------------------------------------------------------------------

Time Step: 03
state_idx_set: {0, 1, 2}
current_state_index: 1

New Param INDICES (not direct values):
P1: 0 (Beats per Minute - BPM)
P2: 1 (Beeps per Loop - BPL)
P3: 0 (Amplitude of Pitch Change)

------------------------------------------------------------------------
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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
---------------------------------------------------------------------------
KeyboardInterrupt                         Traceback (most recent call last)
Cell In[8], line 4
      1 # SECTION 2X
----> 4 time_step_2X_str = ucb1.ucb1_algor(num_of_states=num_of_states, sta
te_descriptions=state_descriptions, param_disc=param_disc, sound_obj_array=
sound_obj_array_A,
      5                                   current_user_ID_str=current_user_ID_
str, sect_str="_sect2X", load_file=None, budget=50, delta_Q_thresh=2.0, con
v_thresh=3, printer=True)

File ~/Documents/Studies/Monash_31194990/PHD/repos/RL_audio/notebooks/script
ts/ucb1_algorithm.py:129, in ucb1_algor(num_of_states, state_descriptions,
 param_disc, sound_obj_array, current_user_ID_str, sect_str, load_file, tim
e_step, budget, delta_Q_thresh, conv_thresh, printer)
    126 time_step += 1
    128 # Play the desired mp3 file & probe user for perceived state & conf
idence in their response
--> 129 probed_state_index, probed_confidence = sound_obj_array[param_1_idx
, param_2_idx, param_3_idx].probe(state_descriptions)
    131 # Update N for audio obj
    132 sound_obj_array[param_1_idx, param_2_idx, param_3_idx].update()

File ~/Documents/Studies/Monash_31194990/PHD/repos/RL_audio/notebooks/script
ts/audio_control.py:89, in audio_object.probe(self, all_states, mixer_volum
e)
     87  print("To replay the sound: leave the input empty and hit '
enter'...")
     88          cprint(
     89          probed_state_index = int(input())
     90  print()
     92 except ValueError:

File ~/miniforge3/envs/phd/lib/python3.9/site-packages/ipykernel/kernelbas
e.py:1177, in Kernel.raw_input(self, prompt)
   1173 if not self._allow_stdin:
   1174     raise StdinNotImplementedError(
   1175         "raw_input was called, but this frontend does not support i
nput requests."
   1176     )
-> 1177 return self._input_request(
   1178     str(prompt),
   1179     self._parent_ident["shell"],
   1180     self.get_parent("shell"),
   1181     password=False,
   1182 )

File ~/miniforge3/envs/phd/lib/python3.9/site-packages/ipykernel/kernelbas
e.py:1219, in Kernel._input_request(self, prompt, ident, parent, password)
   1216             break
   1217 except KeyboardInterrupt:
   1218     # re-raise KeyboardInterrupt, to truncate traceback
-> 1219     raise KeyboardInterrupt("Interrupted by user") from None
   1220 except Exception:
   1221     self.log.warning("Invalid Message:", exc_info=True)
```

```
KeyboardInterrupt: Interrupted by user
```

Section 2O

Click on the cell below & hit 'shift + enter'...

In [11]:

```
# SECTION 2O



time_step_20_str =
ucb1.ucb1_algor(num_of_states=num_of_states,
state_descriptions=state_descriptions,
param_disc=param_disc,
sound_obj_array=sound_obj_array_A,


current_user_ID_str=current_user_ID_str,
sect_str="_sect2O", load_file="pilotset", budget=50,
delta_Q_thresh=2.0, conv_thresh=3, printer=True)
```

```
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------------------------------------------------------------------

Time Step: 00
state_idx_set: {0, 1, 2}
current_state_index: 2

New Param INDICES (not direct values):
P1: 1 (Beats per Minute - BPM)
P2: 0 (Beeps per Loop - BPL)
P3: 1 (Amplitude of Pitch Change)

------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 2 --> state: Progressing   - robot is working and doesn't need
help

To replay the sound: Leave the input empty and hit 'enter'...
Score your confidence in this response from [0 to 10] or type 'back' to go
back:
```

```
You entered: 2



-----------------------------------------------------------------

(Hidden):
Uncertainty_signal (U):  0.0
Reward_signal (R):       -2.0
N value for state 0 is 1
Delta_Q for state 0 is: 1.0
New action value (Q):    -2.0
Q-table after update for state 0:

[[[ 1. -1. -3.]
  [ 2.  0. -3.]
  [ 3.  2. -3.]]

 [[ 2. -2. -3.]
  [ 2.  0. -3.]
  [ 4.  2. -3.]]

 [[ 2. -1. -3.]
  [ 3.  0. -3.]
  [ 5.  3. -3.]]]


-----------------------------------------------------------------

(Hidden):
Uncertainty_signal (U):  0.0
Reward_signal (R):       -2.0
N value for state 1 is 1
Delta_Q for state 1 is: 2.0
New action value (Q):    -2.0
Q-table after update for state 1:

[[[-3.  0.  2.]
  [-3.  1.  3.]
  [-3.  0.  2.]]

 [[-3. -2.  4.]
  [-3.  1.  5.]
  [-3.  0.  3.]]

 [[-3.  0.  2.]
  [-3.  1.  3.]
  [-3.  0.  2.]]]


-----------------------------------------------------------------

(Hidden):
Uncertainty_signal (U):  0.0
Reward_signal (R):       2.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 3.0
New action value (Q):    2.0
Q-table after update for state 2:

[[[ 0.  3.  0.]
  [-3.  2. -3.]
  [-3.  1. -3.]]

 [[ 0.  2.  0.]
  [-3.  3. -3.]
  [-3.  1. -3.]]

 [[ 0.  4.  0.]
  [-3.  2. -3.]
  [-3.  1. -3.]]]
in_a_row_st1 back to zero

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------------------------------------------------------------------

Time Step: 01
state_idx_set: {0, 1, 2}
current_state_index: 2

New Param INDICES (not direct values):
P1: 2 (Beats per Minute - BPM)
P2: 0 (Beeps per Loop - BPL)
P3: 1 (Amplitude of Pitch Change)

------------------------------------------------------------------------
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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.41627730557884884
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 1.416277305578849
New action value (Q):    0.41627730557884884
Q-table after update for state 0:

[[[ 1.         -1.          -3.        ]
  [ 2.          0.          -3.        ]
  [ 3.          2.          -3.        ]]

 [[ 2.         -2.          -3.        ]
  [ 2.          0.          -3.        ]
  [ 4.          2.          -3.        ]]

 [[ 2.          0.41627731 -3.        ]
  [ 3.          0.          -3.        ]
  [ 5.          3.          -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.41627730557884884
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 0.41627730557884884
New action value (Q):    0.41627730557884884
Q-table after update for state 1:

[[[-3.          0.          2.        ]
  [-3.          1.          3.        ]
  [-3.          0.          2.        ]]

 [[-3.         -2.          4.        ]
  [-3.          1.          5.        ]
  [-3.          0.          3.        ]]

 [[-3.          0.41627731  2.        ]
  [-3.          1.          3.        ]
  [-3.          0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.41627730557884884
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 3.583722694421151
New action value (Q):    0.41627730557884884
Q-table after update for state 2:

[[[ 0.          3.           0.        ]
  [-3.          2.          -3.        ]
  [-3.          1.          -3.        ]]

 [[ 0.          2.           0.        ]
  [-3.          3.          -3.        ]
  [-3.          1.          -3.        ]]

 [[ 0.          0.41627731  0.        ]
  [-3.          2.          -3.        ]
  [-3.          1.          -3.        ]]]
in_a_row_st1 back to zero

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------------------------------------------------------------------

Time Step: 02
state_idx_set: {0, 1, 2}
current_state_index: 2

New Param INDICES (not direct values):
P1: 1 (Beats per Minute - BPM)
P2: 1 (Beeps per Loop - BPL)
P3: 1 (Amplitude of Pitch Change)

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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.5240735369841025
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 0.5240735369841025
New action value (Q):    0.5240735369841025
Q-table after update for state 0:

[[[ 1.         -1.         -3.        ]
  [ 2.          0.         -3.        ]
  [ 3.          2.         -3.        ]]

 [[ 2.         -2.         -3.        ]
  [ 2.          0.52407354 -3.        ]
  [ 4.          2.         -3.        ]]

 [[ 2.          0.41627731 -3.        ]
  [ 3.          0.         -3.        ]
  [ 5.          3.         -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.5240735369841025
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 0.47592646301589747
New action value (Q):    0.5240735369841025
Q-table after update for state 1:

[[[-3.          0.          2.        ]
  [-3.          1.          3.        ]
  [-3.          0.          2.        ]]

 [[-3.         -2.          4.        ]
  [-3.          0.52407354  5.        ]
  [-3.          0.          3.        ]]

 [[-3.          0.41627731  2.        ]
  [-3.          1.          3.        ]
  [-3.          0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.5240735369841025
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 2.4759264630158975
New action value (Q):    0.5240735369841025
Q-table after update for state 2:

[[[ 0.          3.          0.        ]
  [-3.          2.         -3.        ]
  [-3.          1.         -3.        ]]

 [[ 0.          2.          0.        ]
  [-3.          0.52407354 -3.        ]
  [-3.          1.         -3.        ]]

 [[ 0.          0.41627731  0.        ]
  [-3.          2.         -3.        ]
  [-3.          1.         -3.        ]]]
in_a_row_st1 back to zero

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Time Step: 03
state_idx_set: {0, 1, 2}
current_state_index: 1

New Param INDICES (not direct values):
P1: 1 (Beats per Minute - BPM)
P2: 1 (Beeps per Loop - BPL)
P3: 2 (Amplitude of Pitch Change)

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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.5887050112577373
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 3.5887050112577374
New action value (Q):    0.5887050112577373
Q-table after update for state 0:

[[[ 1.         -1.         -3.        ]
  [ 2.          0.         -3.        ]
  [ 3.          2.         -3.        ]]

 [[ 2.         -2.         -3.        ]
  [ 2.          0.52407354  0.58870501]
  [ 4.          2.         -3.        ]]

 [[ 2.          0.41627731 -3.        ]
  [ 3.          0.         -3.        ]
  [ 5.          3.         -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.5887050112577373
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 4.411294988742263
New action value (Q):    0.5887050112577373
Q-table after update for state 1:

[[[-3.          0.          2.        ]
  [-3.          1.          3.        ]
  [-3.          0.          2.        ]]

 [[-3.         -2.          4.        ]
  [-3.          0.52407354  0.58870501]
  [-3.          0.          3.        ]]

 [[-3.          0.41627731  2.        ]
  [-3.          1.          3.        ]
  [-3.          0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.5887050112577373
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 3.5887050112577374
New action value (Q):    0.5887050112577373
Q-table after update for state 2:

[[[ 0.          3.           0.        ]
  [-3.          2.          -3.        ]
  [-3.          1.          -3.        ]]

 [[ 0.          2.           0.        ]
  [-3.          0.52407354   0.58870501]
  [-3.          1.          -3.        ]]

 [[ 0.          0.41627731   0.        ]
  [-3.          2.          -3.        ]
  [-3.          1.          -3.        ]]]
in_a_row_st1 back to zero

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------------------------------------------------------------------

Time Step: 04
state_idx_set: {0, 1, 2}
current_state_index: 2

New Param INDICES (not direct values):
P1: 0 (Beats per Minute - BPM)
P2: 0 (Beeps per Loop - BPL)
P3: 1 (Amplitude of Pitch Change)

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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.6343181205897598
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 1.63431812058976
New action value (Q):    0.6343181205897598
Q-table after update for state 0:

[[[ 1.          0.63431812 -3.        ]
  [ 2.          0.         -3.        ]
  [ 3.          2.         -3.        ]]

 [[ 2.         -2.         -3.        ]
  [ 2.          0.52407354  0.58870501]
  [ 4.          2.         -3.        ]]

 [[ 2.          0.41627731 -3.        ]
  [ 3.          0.         -3.        ]
  [ 5.          3.         -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.6343181205897598
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 0.6343181205897598
New action value (Q):    0.6343181205897598
Q-table after update for state 1:

[[[-3.          0.63431812  2.        ]
  [-3.          1.          3.        ]
  [-3.          0.          2.        ]]

 [[-3.         -2.          4.        ]
  [-3.          0.52407354  0.58870501]
  [-3.          0.          3.        ]]

 [[-3.          0.41627731  2.        ]
  [-3.          1.          3.        ]
  [-3.          0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.6343181205897598
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 2.36568187941024
New action value (Q):    0.6343181205897598
Q-table after update for state 2:

[[[ 0.          0.63431812  0.        ]
  [-3.          2.         -3.        ]
  [-3.          1.         -3.        ]]

 [[ 0.          2.          0.        ]
  [-3.          0.52407354  0.58870501]
  [-3.          1.         -3.        ]]

 [[ 0.          0.41627731  0.        ]
  [-3.          2.         -3.        ]
  [-3.          1.         -3.        ]]]
in_a_row_st1 back to zero

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Time Step: 05
state_idx_set: {0, 1, 2}
current_state_index: 2

New Param INDICES (not direct values):
P1: 0 (Beats per Minute - BPM)
P2: 1 (Beeps per Loop - BPL)
P3: 1 (Amplitude of Pitch Change)

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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.6692830995229252
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 0.6692830995229252
New action value (Q):    0.6692830995229252
Q-table after update for state 0:

[[[ 1.          0.63431812 -3.        ]
  [ 2.          0.6692831  -3.        ]
  [ 3.          2.         -3.        ]]

 [[ 2.         -2.         -3.        ]
  [ 2.          0.52407354  0.58870501]
  [ 4.          2.         -3.        ]]

 [[ 2.          0.41627731 -3.        ]
  [ 3.          0.         -3.        ]
  [ 5.          3.         -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.6692830995229252
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 0.3307169004770748
New action value (Q):    0.6692830995229252
Q-table after update for state 1:

[[[-3.          0.63431812  2.        ]
  [-3.          0.6692831   3.        ]
  [-3.          0.          2.        ]]

 [[-3.         -2.          4.        ]
  [-3.          0.52407354  0.58870501]
  [-3.          0.          3.        ]]

 [[-3.          0.41627731  2.        ]
  [-3.          1.          3.        ]
  [-3.          0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.6692830995229252
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 1.330716900477075
New action value (Q):    0.6692830995229252
Q-table after update for state 2:

[[[ 0.          0.63431812  0.        ]
  [-3.          0.6692831  -3.        ]
  [-3.          1.         -3.        ]]

 [[ 0.          2.          0.        ]
  [-3.          0.52407354  0.58870501]
  [-3.          1.         -3.        ]]

 [[ 0.          0.41627731  0.        ]
  [-3.          2.         -3.        ]
  [-3.          1.         -3.        ]]]
in_a_row_st1 back to zero

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Time Step: 06
state_idx_set: {0, 1, 2}
current_state_index: 1

New Param INDICES (not direct values):
P1: 1 (Beats per Minute - BPM)
P2: 0 (Beeps per Loop - BPL)
P3: 2 (Amplitude of Pitch Change)

------------------------------------------------------------------------
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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.6974794170897292
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 3.6974794170897294
New action value (Q):    0.6974794170897292
Q-table after update for state 0:

[[[ 1.          0.63431812 -3.        ]
  [ 2.          0.6692831  -3.        ]
  [ 3.          2.         -3.        ]]

 [[ 2.         -2.          0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 4.          2.         -3.        ]]

 [[ 2.          0.41627731 -3.        ]
  [ 3.          0.         -3.        ]
  [ 5.          3.         -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.6974794170897292
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 3.3025205829102706
New action value (Q):    0.6974794170897292
Q-table after update for state 1:

[[[-3.          0.63431812  2.        ]
  [-3.          0.6692831   3.        ]
  [-3.          0.          2.        ]]

 [[-3.         -2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [-3.          0.          3.        ]]

 [[-3.          0.41627731  2.        ]
  [-3.          1.          3.        ]
  [-3.          0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.6974794170897292
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 0.6974794170897292
New action value (Q):    0.6974794170897292
Q-table after update for state 2:

[[[ 0.          0.63431812  0.        ]
  [-3.          0.6692831  -3.        ]
  [-3.          1.         -3.        ]]

 [[ 0.          2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [-3.          1.         -3.        ]]

 [[ 0.          0.41627731  0.        ]
  [-3.          2.         -3.        ]
  [-3.          1.         -3.        ]]]
in_a_row_st1 back to zero

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Time Step: 07
state_idx_set: {0, 1, 2}
current_state_index: 1

New Param INDICES (not direct values):
P1: 0 (Beats per Minute - BPM)
P2: 1 (Beeps per Loop - BPL)
P3: 2 (Amplitude of Pitch Change)

------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



-----------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7210134433004415
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 3.7210134433004414
New action value (Q):    0.7210134433004415
Q-table after update for state 0:

[[[ 1.          0.63431812 -3.        ]
  [ 2.          0.6692831   0.72101344]
  [ 3.          2.         -3.        ]]

 [[ 2.         -2.          0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 4.          2.         -3.        ]]

 [[ 2.          0.41627731 -3.        ]
  [ 3.          0.         -3.        ]
  [ 5.          3.         -3.        ]]]


-----------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7210134433004415
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 2.2789865566995586
New action value (Q):    0.7210134433004415
Q-table after update for state 1:

[[[-3.          0.63431812  2.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          0.          2.        ]]

 [[-3.         -2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [-3.          0.          3.        ]]

 [[-3.          0.41627731  2.        ]
  [-3.          1.          3.        ]
  [-3.          0.          2.        ]]]


-----------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7210134433004415
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 3.7210134433004414
New action value (Q):    0.7210134433004415
Q-table after update for state 2:

[[[ 0.          0.63431812  0.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          1.         -3.        ]]

 [[ 0.          2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [-3.          1.         -3.        ]]

 [[ 0.          0.41627731  0.        ]
  [-3.          2.         -3.        ]
  [-3.          1.         -3.        ]]]
in_a_row_st1 back to zero

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Time Step: 08
state_idx_set: {0, 1, 2}
current_state_index: 1

New Param INDICES (not direct values):
P1: 1 (Beats per Minute - BPM)
P2: 2 (Beeps per Loop - BPL)
P3: 2 (Amplitude of Pitch Change)

------------------------------------------------------------------------
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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7411519036837556
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 3.7411519036837557
New action value (Q):    0.7411519036837556
Q-table after update for state 0:

[[[ 1.          0.63431812 -3.        ]
  [ 2.          0.6692831   0.72101344]
  [ 3.          2.         -3.        ]]

 [[ 2.         -2.          0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 4.          2.          0.7411519 ]]

 [[ 2.          0.41627731 -3.        ]
  [ 3.          0.         -3.        ]
  [ 5.          3.         -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7411519036837556
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 2.2588480963162443
New action value (Q):    0.7411519036837556
Q-table after update for state 1:

[[[-3.          0.63431812  2.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          0.          2.        ]]

 [[-3.         -2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [-3.          0.          0.7411519 ]]

 [[-3.          0.41627731  2.        ]
  [-3.          1.          3.        ]
  [-3.          0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7411519036837556
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 3.7411519036837557
New action value (Q):    0.7411519036837556
Q-table after update for state 2:

[[[ 0.          0.63431812  0.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          1.         -3.        ]]

 [[ 0.          2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [-3.          1.          0.7411519 ]]

 [[ 0.          0.41627731  0.        ]
  [-3.          2.         -3.        ]
  [-3.          1.         -3.        ]]]
in_a_row_st1 back to zero

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Time Step: 09
state_idx_set: {0, 1, 2}
current_state_index: 1

New Param INDICES (not direct values):
P1: 2 (Beats per Minute - BPM)
P2: 1 (Beeps per Loop - BPL)
P3: 2 (Amplitude of Pitch Change)

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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7587135646925732
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 3.7587135646925733
New action value (Q):    0.7587135646925732
Q-table after update for state 0:

[[[ 1.          0.63431812 -3.        ]
  [ 2.          0.6692831   0.72101344]
  [ 3.          2.         -3.        ]]

 [[ 2.         -2.          0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 4.          2.          0.7411519 ]]

 [[ 2.          0.41627731 -3.        ]
  [ 3.          0.          0.75871356]
  [ 5.          3.         -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7587135646925732
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 2.2412864353074267
New action value (Q):    0.7587135646925732
Q-table after update for state 1:

[[[-3.          0.63431812  2.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          0.          2.        ]]

 [[-3.         -2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [-3.          0.          0.7411519 ]]

 [[-3.          0.41627731  2.        ]
  [-3.          1.          0.75871356]
  [-3.          0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7587135646925732
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 3.7587135646925733
New action value (Q):    0.7587135646925732
Q-table after update for state 2:

[[[ 0.          0.63431812  0.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          1.         -3.        ]]

 [[ 0.          2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [-3.          1.          0.7411519 ]]

 [[ 0.          0.41627731  0.        ]
  [-3.          2.          0.75871356]
  [-3.          1.         -3.        ]]]
in_a_row_st1 back to zero

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------------------------------------------------------------------

Time Step: 10
state_idx_set: {0, 1, 2}
current_state_index: 2

New Param INDICES (not direct values):
P1: 2 (Beats per Minute - BPM)
P2: 1 (Beeps per Loop - BPL)
P3: 1 (Amplitude of Pitch Change)

------------------------------------------------------------------------
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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7742569458516938
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 0.7742569458516938
New action value (Q):    0.7742569458516938
Q-table after update for state 0:

[[[ 1.          0.63431812 -3.        ]
  [ 2.          0.6692831   0.72101344]
  [ 3.          2.         -3.        ]]

 [[ 2.         -2.          0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 4.          2.          0.7411519 ]]

 [[ 2.          0.41627731 -3.        ]
  [ 3.          0.77425695  0.75871356]
  [ 5.          3.         -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7742569458516938
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 0.2257430541483062
New action value (Q):    0.7742569458516938
Q-table after update for state 1:

[[[-3.          0.63431812  2.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          0.          2.        ]]

 [[-3.         -2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [-3.          0.          0.7411519 ]]

 [[-3.          0.41627731  2.        ]
  [-3.          0.77425695  0.75871356]
  [-3.          0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7742569458516938
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 1.2257430541483063
New action value (Q):    0.7742569458516938
Q-table after update for state 2:

[[[ 0.          0.63431812  0.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          1.         -3.        ]]

 [[ 0.          2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [-3.          1.          0.7411519 ]]

 [[ 0.          0.41627731  0.        ]
  [-3.          0.77425695  0.75871356]
  [-3.          1.         -3.        ]]]
in_a_row_st1 back to zero

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------------------------------------------------------------------

Time Step: 11
state_idx_set: {0, 1, 2}
current_state_index: 0

New Param INDICES (not direct values):
P1: 2 (Beats per Minute - BPM)
P2: 2 (Beeps per Loop - BPL)
P3: 0 (Amplitude of Pitch Change)

------------------------------------------------------------------------
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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7881793339380322
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 4.211820666061968
New action value (Q):    0.7881793339380322
Q-table after update for state 0:

[[[ 1.          0.63431812 -3.        ]
  [ 2.          0.6692831   0.72101344]
  [ 3.          2.         -3.        ]]

 [[ 2.         -2.          0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 4.          2.          0.7411519 ]]

 [[ 2.          0.41627731 -3.        ]
  [ 3.          0.77425695  0.75871356]
  [ 0.78817933  3.         -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7881793339380322
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 3.7881793339380323
New action value (Q):    0.7881793339380322
Q-table after update for state 1:

[[[-3.          0.63431812  2.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          0.          2.        ]]

 [[-3.         -2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [-3.          0.          0.7411519 ]]

 [[-3.          0.41627731  2.        ]
  [-3.          0.77425695  0.75871356]
  [ 0.78817933  0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.7881793339380322
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 3.7881793339380323
New action value (Q):    0.7881793339380322
Q-table after update for state 2:

[[[ 0.          0.63431812  0.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          1.         -3.        ]]

 [[ 0.          2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [-3.          1.          0.7411519 ]]

 [[ 0.          0.41627731  0.        ]
  [-3.          0.77425695  0.75871356]
  [ 0.78817933  1.         -3.        ]]]
in_a_row_st0 back to zero

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------------------------------------------------------------------

Time Step: 12
state_idx_set: {0, 1, 2}
current_state_index: 0

New Param INDICES (not direct values):
P1: 1 (Beats per Minute - BPM)
P2: 2 (Beeps per Loop - BPL)
P3: 0 (Amplitude of Pitch Change)

------------------------------------------------------------------------
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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



-----------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8007729636828308
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 3.1992270363171693
New action value (Q):    0.8007729636828308
Q-table after update for state 0:

[[[ 1.          0.63431812 -3.        ]
  [ 2.          0.6692831   0.72101344]
  [ 3.          2.         -3.        ]]

 [[ 2.         -2.          0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 0.80077296  2.          0.7411519 ]]

 [[ 2.          0.41627731 -3.        ]
  [ 3.          0.77425695  0.75871356]
  [ 0.78817933  3.         -3.        ]]]


-----------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8007729636828308
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 3.8007729636828307
New action value (Q):    0.8007729636828308
Q-table after update for state 1:

[[[-3.          0.63431812  2.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          0.          2.        ]]

 [[-3.         -2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  0.          0.7411519 ]]

 [[-3.          0.41627731  2.        ]
  [-3.          0.77425695  0.75871356]
  [ 0.78817933  0.          2.        ]]]


-----------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8007729636828308
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 3.8007729636828307
New action value (Q):    0.8007729636828308
Q-table after update for state 2:

[[[ 0.          0.63431812  0.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          1.         -3.        ]]

 [[ 0.          2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  1.          0.7411519 ]]

 [[ 0.          0.41627731  0.        ]
  [-3.          0.77425695  0.75871356]
  [ 0.78817933  1.         -3.        ]]]
in_a_row_st0 back to zero

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------------------------------------------------------------------

Time Step: 13
state_idx_set: {0, 1, 2}
current_state_index: 0

New Param INDICES (not direct values):
P1: 2 (Beats per Minute - BPM)
P2: 1 (Beeps per Loop - BPL)
P3: 0 (Amplitude of Pitch Change)

------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8122587841345975
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 2.1877412158654024
New action value (Q):    0.8122587841345975
Q-table after update for state 0:

[[[ 1.          0.63431812 -3.        ]
  [ 2.          0.6692831   0.72101344]
  [ 3.          2.         -3.        ]]

 [[ 2.         -2.          0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 0.80077296  2.          0.7411519 ]]

 [[ 2.          0.41627731 -3.        ]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  3.         -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8122587841345975
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 3.8122587841345976
New action value (Q):    0.8122587841345975
Q-table after update for state 1:

[[[-3.          0.63431812  2.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          0.          2.        ]]

 [[-3.         -2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  0.          0.7411519 ]]

 [[-3.          0.41627731  2.        ]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8122587841345975
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 3.8122587841345976
New action value (Q):    0.8122587841345975
Q-table after update for state 2:

[[[ 0.          0.63431812  0.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          1.         -3.        ]]

 [[ 0.          2.          0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  1.          0.7411519 ]]

 [[ 0.          0.41627731  0.        ]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  1.         -3.        ]]]
in_a_row_st0 back to zero

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------------------------------------------------------------------

Time Step: 14
state_idx_set: {0, 1, 2}
current_state_index: 2

New Param INDICES (not direct values):
P1: 1 (Beats per Minute - BPM)
P2: 0 (Beeps per Loop - BPL)
P3: 1 (Amplitude of Pitch Change)

------------------------------------------------------------------------
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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.5818129210818339
Reward_signal (R):       0.0
N value for state 0 is 2
Delta_Q for state 0 is: 1.581812921081834
New action value (Q):    -0.4181870789181661
Q-table after update for state 0:

[[[ 1.          0.63431812 -3.        ]
  [ 2.          0.6692831   0.72101344]
  [ 3.          2.         -3.        ]]

 [[ 2.         -0.41818708  0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 0.80077296  2.          0.7411519 ]]

 [[ 2.          0.41627731 -3.        ]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  3.         -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.5818129210818339
Reward_signal (R):       0.0
N value for state 1 is 2
Delta_Q for state 1 is: 1.581812921081834
New action value (Q):    -0.4181870789181661
Q-table after update for state 1:

[[[-3.          0.63431812  2.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          0.          2.        ]]

 [[-3.         -0.41818708  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  0.          0.7411519 ]]

 [[-3.          0.41627731  2.        ]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.5818129210818339
Reward_signal (R):       0.0
N value for state 2 is 2
```

```
Delta_Q for state 2 is: 0.4181870789181661
New action value (Q):    1.581812921081834
Q-table after update for state 2:

[[[ 0.          0.63431812  0.        ]
  [-3.          0.6692831   0.72101344]
  [-3.          1.         -3.        ]]

 [[ 0.          1.58181292  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  1.          0.7411519 ]]

 [[ 0.          0.41627731  0.        ]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  1.         -3.        ]]]
in_a_row_st1 back to zero

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Time Step: 15
state_idx_set: {0, 1, 2}
current_state_index: 1

New Param INDICES (not direct values):
P1: 0 (Beats per Minute - BPM)
P2: 0 (Beeps per Loop - BPL)
P3: 2 (Amplitude of Pitch Change)

----------------------------------------------------------------------
----------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8325546111576977
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 3.832554611157698
New action value (Q):    0.8325546111576977
Q-table after update for state 0:

[[[ 1.          0.63431812  0.83255461]
  [ 2.          0.6692831   0.72101344]
  [ 3.          2.         -3.        ]]

 [[ 2.         -0.41818708  0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 0.80077296  2.          0.7411519 ]]

 [[ 2.          0.41627731 -3.        ]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  3.         -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8325546111576977
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 1.1674453888423022
New action value (Q):    0.8325546111576977
Q-table after update for state 1:

[[[-3.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [-3.          0.          2.        ]]

 [[-3.         -0.41818708  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  0.          0.7411519 ]]

 [[-3.          0.41627731  2.        ]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.          2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8325546111576977
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 0.8325546111576977
New action value (Q):    0.8325546111576977
Q-table after update for state 2:

[[[ 0.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [-3.          1.         -3.        ]]

 [[ 0.          1.58181292  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  1.          0.7411519 ]]

 [[ 0.          0.41627731  0.        ]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  1.         -3.        ]]]
in_a_row_st1 back to zero

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------------------------------------------------------------------

Time Step: 16
state_idx_set: {0, 1, 2}
current_state_index: 0

New Param INDICES (not direct values):
P1: 2 (Beats per Minute - BPM)
P2: 2 (Beeps per Loop - BPL)
P3: 1 (Amplitude of Pitch Change)

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Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8416075902783042
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 2.1583924097216958
New action value (Q):    0.8416075902783042
Q-table after update for state 0:

[[[ 1.          0.63431812  0.83255461]
  [ 2.          0.6692831   0.72101344]
  [ 3.          2.         -3.        ]]

 [[ 2.         -0.41818708  0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 0.80077296  2.          0.7411519 ]]

 [[ 2.          0.41627731 -3.        ]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759 -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8416075902783042
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 0.8416075902783042
New action value (Q):    0.8416075902783042
Q-table after update for state 1:

[[[-3.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [-3.          0.          2.        ]]

 [[-3.         -0.41818708  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  0.          0.7411519 ]]

 [[-3.          0.41627731  2.        ]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759  2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8416075902783042
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 0.15839240972169577
New action value (Q):    0.8416075902783042
Q-table after update for state 2:

[[[ 0.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [-3.          1.         -3.        ]]

 [[ 0.          1.58181292  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  1.          0.7411519 ]]

 [[ 0.          0.41627731  0.        ]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759 -3.        ]]]
in_a_row_st0 back to zero

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------------------------------------------------------------------

Time Step: 17
state_idx_set: {0, 1, 2}
current_state_index: 1

New Param INDICES (not direct values):
P1: 2 (Beats per Minute - BPM)
P2: 0 (Beeps per Loop - BPL)
P3: 2 (Amplitude of Pitch Change)

------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



-----------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.85005466852082
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 3.85005466852082
New action value (Q):    0.85005466852082
Q-table after update for state 0:

[[[ 1.          0.63431812  0.83255461]
  [ 2.          0.6692831   0.72101344]
  [ 3.          2.         -3.        ]]

 [[ 2.         -0.41818708  0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 0.80077296  2.          0.7411519 ]]

 [[ 2.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759 -3.        ]]]


-----------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.85005466852082
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 1.1499453314791799
New action value (Q):    0.85005466852082
Q-table after update for state 1:

[[[-3.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [-3.          0.          2.        ]]

 [[-3.         -0.41818708  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  0.          0.7411519 ]]

 [[-3.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759  2.        ]]]


-----------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.85005466852082
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 0.85005466852082
New action value (Q):    0.85005466852082
Q-table after update for state 2:

[[[ 0.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [-3.          1.         -3.        ]]

 [[ 0.          1.58181292  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  1.          0.7411519 ]]

 [[ 0.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759 -3.        ]]]
in_a_row_st1 back to zero

------------------------------------------------------------------
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------------------------------------------------------------------

Time Step: 18
state_idx_set: {0, 1, 2}
current_state_index: 2

New Param INDICES (not direct values):
P1: 1 (Beats per Minute - BPM)
P2: 0 (Beeps per Loop - BPL)
P3: 1 (Amplitude of Pitch Change)

------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.49534827639806794
Reward_signal (R):       0.0
N value for state 0 is 3
Delta_Q for state 0 is: 0.6347439693707899
New action value (Q):    0.21655689045262383
Q-table after update for state 0:

[[[ 1.          0.63431812  0.83255461]
  [ 2.          0.6692831   0.72101344]
  [ 3.          2.         -3.        ]]

 [[ 2.          0.21655689  0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 0.80077296  2.          0.7411519 ]]

 [[ 2.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759 -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.49534827639806794
Reward_signal (R):       0.0
N value for state 1 is 3
Delta_Q for state 1 is: 0.6347439693707899
New action value (Q):    0.21655689045262383
Q-table after update for state 1:

[[[-3.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [-3.          0.          2.        ]]

 [[-3.          0.21655689  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  0.          0.7411519 ]]

 [[-3.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759  2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.49534827639806794
Reward_signal (R):       0.0
N value for state 2 is 3
```

```
Delta_Q for state 2 is: 0.0319226972958766
New action value (Q):    1.5498902237859573
Q-table after update for state 2:

[[[ 0.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [-3.          1.         -3.        ]]

 [[ 0.          1.54989022  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  1.          0.7411519 ]]

 [[ 0.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759 -3.        ]]]
in_a_row_st1 back to zero

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------------------------------------------------------------------

Time Step: 19
state_idx_set: {0, 1, 2}
current_state_index: 0

New Param INDICES (not direct values):
P1: 0 (Beats per Minute - BPM)
P2: 2 (Beeps per Loop - BPL)
P3: 0 (Amplitude of Pitch Change)

------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8654091913011427
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 2.1345908086988574
New action value (Q):    0.8654091913011427
Q-table after update for state 0:

[[[ 1.          0.63431812  0.83255461]
  [ 2.          0.6692831   0.72101344]
  [ 0.86540919  2.         -3.        ]]

 [[ 2.          0.21655689  0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 0.80077296  2.          0.7411519 ]]

 [[ 2.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759 -3.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8654091913011427
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 3.8654091913011426
New action value (Q):    0.8654091913011427
Q-table after update for state 1:

[[[-3.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [ 0.86540919  0.          2.        ]]

 [[-3.          0.21655689  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  0.          0.7411519 ]]

 [[-3.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759  2.        ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8654091913011427
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 3.8654091913011426
New action value (Q):    0.8654091913011427
Q-table after update for state 2:

[[[ 0.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [ 0.86540919  1.         -3.        ]]

 [[ 0.          1.54989022  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  1.          0.7411519 ]]

 [[ 0.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759 -3.        ]]]
in_a_row_st0 back to zero

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------------------------------------------------------------------

Time Step: 20
state_idx_set: {0, 1, 2}
current_state_index: 1

New Param INDICES (not direct values):
P1: 2 (Beats per Minute - BPM)
P2: 2 (Beeps per Loop - BPL)
P3: 2 (Amplitude of Pitch Change)

------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8724279967027971
Reward_signal (R):       0.0
N value for state 0 is 1
Delta_Q for state 0 is: 3.8724279967027972
New action value (Q):    0.8724279967027971
Q-table after update for state 0:

[[[ 1.          0.63431812  0.83255461]
  [ 2.          0.6692831   0.72101344]
  [ 0.86540919  2.         -3.        ]]

 [[ 2.          0.21655689  0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 0.80077296  2.          0.7411519 ]]

 [[ 2.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759  0.872428  ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8724279967027971
Reward_signal (R):       0.0
N value for state 1 is 1
Delta_Q for state 1 is: 1.1275720032972028
New action value (Q):    0.8724279967027971
Q-table after update for state 1:

[[[-3.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [ 0.86540919  0.          2.        ]]

 [[-3.          0.21655689  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  0.          0.7411519 ]]

 [[-3.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759  0.872428  ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.8724279967027971
Reward_signal (R):       0.0
N value for state 2 is 1
```

```
Delta_Q for state 2 is: 3.8724279967027972
New action value (Q):    0.8724279967027971
Q-table after update for state 2:

[[[ 0.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [ 0.86540919  1.         -3.        ]]

 [[ 0.          1.54989022  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  1.          0.7411519 ]]

 [[ 0.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759  0.872428  ]]]
in_a_row_st1 back to zero

------------------------------------------------------------------
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------------------------------------------------------------------


Time Step: 21
state_idx_set: {0, 1, 2}
current_state_index: 2

New Param INDICES (not direct values):
P1: 1 (Beats per Minute - BPM)
P2: 0 (Beeps per Loop - BPL)
P3: 1 (Amplitude of Pitch Change)

------------------------------------------------------------------------
------------------------------------------------------------------------


Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
You entered: 3 --> state: None of the above



------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.43953401840459944
Reward_signal (R):       0.0
N value for state 0 is 4
Delta_Q for state 0 is: 0.3853947957914434
New action value (Q):    0.6019516862440673
Q-table after update for state 0:

[[[ 1.          0.63431812  0.83255461]
  [ 2.          0.6692831   0.72101344]
  [ 0.86540919  2.         -3.        ]]

 [[ 2.          0.60195169  0.69747942]
  [ 2.          0.52407354  0.58870501]
  [ 0.80077296  2.          0.7411519 ]]

 [[ 2.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759  0.872428  ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.43953401840459944
Reward_signal (R):       0.0
N value for state 1 is 4
Delta_Q for state 1 is: 0.3853947957914434
New action value (Q):    0.6019516862440673
Q-table after update for state 1:

[[[-3.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [ 0.86540919  0.          2.        ]]

 [[-3.          0.60195169  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  0.          0.7411519 ]]

 [[-3.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759  0.872428  ]]]


------------------------------------------------------------------


(Hidden):
Uncertainty_signal (U):  0.43953401840459944
Reward_signal (R):       0.0
N value for state 2 is 4
```

```
Delta_Q for state 2 is: 0.052061462458110164
New action value (Q):    1.6019516862440675
Q-table after update for state 2:

[[[ 0.          0.63431812  0.83255461]
  [-3.          0.6692831   0.72101344]
  [ 0.86540919  1.         -3.        ]]

 [[ 0.          1.60195169  0.69747942]
  [-3.          0.52407354  0.58870501]
  [ 0.80077296  1.          0.7411519 ]]

 [[ 0.          0.41627731  0.85005467]
  [ 0.81225878  0.77425695  0.75871356]
  [ 0.78817933  0.84160759  0.872428  ]]]
in_a_row_st1 back to zero

------------------------------------------------------------------
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------------------------------------------------------------------

Time Step: 22
state_idx_set: {0, 1, 2}
current_state_index: 1

New Param INDICES (not direct values):
P1: 0 (Beats per Minute - BPM)
P2: 2 (Beeps per Loop - BPL)
P3: 2 (Amplitude of Pitch Change)

------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in:

[0]: Stuck              - robot needs your help
[1]: Successful         - robot has completed it's task
[2]: Progressing        - robot is working and doesn't need help
[3]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state between [0 to 3]:
```

```
---------------------------------------------------------------------------
KeyboardInterrupt                         Traceback (most recent call last)
Cell In[11], line 4
      1 # SECTION 20
----> 4 time_step_20_str = ucb1.ucb1_algor(num_of_states=num_of_states, sta
te_descriptions=state_descriptions, param_disc=param_disc, sound_obj_array=
sound_obj_array_A,
      5                                   current_user_ID_str=current_user_ID_
str, sect_str="_sect20", load_file="pilotset", budget=50, delta_Q_thresh=2.
0, conv_thresh=3, printer=True)

File ~/Documents/Studies/Monash_31194990/PHD/repos/RL_audio/notebooks/script
ts/ucb1_algorithm.py:129, in ucb1_algor(num_of_states, state_descriptions,
 param_disc, sound_obj_array, current_user_ID_str, sect_str, load_file, tim
e_step, budget, delta_Q_thresh, conv_thresh, printer)
    126 time_step += 1
    128 # Play the desired mp3 file & probe user for perceived state & conf
idence in their response
--> 129 probed_state_index, probed_confidence = sound_obj_array[param_1_idx
, param_2_idx, param_3_idx].probe(state_descriptions)
    131 # Update N for audio obj
    132 sound_obj_array[param_1_idx, param_2_idx, param_3_idx].update()

File ~/Documents/Studies/Monash_31194990/PHD/repos/RL_audio/notebooks/script
ts/audio_control.py:89, in audio_object.probe(self, all_states, mixer_volum
e)
     87  print("To replay the sound: leave the input empty and hit '
enter'...")
     88          cprint(
     89          probed_state_index = int(input())
     90  print()
     92 except ValueError:

File ~/miniforge3/envs/phd/lib/python3.9/site-packages/ipykernel/kernelbas
e.py:1177, in Kernel.raw_input(self, prompt)
   1173 if not self._allow_stdin:
   1174     raise StdinNotImplementedError(
   1175         "raw_input was called, but this frontend does not support i
nput requests."
   1176     )
-> 1177 return self._input_request(
   1178     str(prompt),
   1179     self._parent_ident["shell"],
   1180     self.get_parent("shell"),
   1181     password=False,
   1182 )

File ~/miniforge3/envs/phd/lib/python3.9/site-packages/ipykernel/kernelbas
e.py:1219, in Kernel._input_request(self, prompt, ident, parent, password)
   1216             break
   1217 except KeyboardInterrupt:
   1218     # re-raise KeyboardInterrupt, to truncate traceback
-> 1219     raise KeyboardInterrupt("Interrupted by user") from None
   1220 except Exception:
   1221     self.log.warning("Invalid Message:", exc_info=True)
```

```
KeyboardInterrupt: Interrupted by user
```

Section 3

We're nearly finished ~ **home stretch!**

Let's listen to **Jackal** express itself one last time.

For each sound, you will asked to select which robot state you think the robot is in.

Click on the cell below & hit 'shift + enter'...

In [12]:
```
sect3_load_str = current_user_ID_str + "_sect20_step" +
time_step_20_str



mischelp.get_user_accuracy(sound_obj_array=sound_obj_arra
 lib_str=library_A, sect_str="sect3",
user_ID_str=current_user_ID_str,
num_of_states=num_of_states,

states_array=np.ndarray(num_of_states, dtype=object),
state_descriptions=state_descriptions,
```

```
param_disc=param_disc, load_file=sect3_load_str,
seed=51)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[12], line 1
----> 1 sect3_load_str = current_user_ID_str + "_sect20_step" + time_step_2
0_str
      4 mischelp.get_user_accuracy(sound_obj_array=sound_obj_array_A, lib_s
tr=library_A, sect_str="sect3", user_ID_str=current_user_ID_str, num_of_sta
tes=num_of_states,
      5                              states_array=np.ndarray(num_of_states, d
type=object), state_descriptions=state_descriptions, param_disc=param_disc,
 load_file=sect3_load_str, seed=51)

NameError: name 'time_step_20_str' is not defined
```

 Jackal Robot

Lastly, let's listen to **Spot** express itself one last time.

You will notice **Spot** sounds slightly different to **Jackal**. For each sound, you will asked to select which robot state you think the robot is in.

Click on the cell below & hit 'shift + enter'...

In [ ]:
```
mischelp.get_user_accuracy(sound_obj_array=sound_obj_arra
 lib_str=library_B, sect_str="sect3",
user_ID_str=current_user_ID_str,
num_of_states=num_of_states,
```

```
states_array=np.ndarray(num_of_states, dtype=object),
state_descriptions=state_descriptions,
param_disc=param_disc, load_file=sect3_load_str,
seed=48)
```

Save the Output

Run the following code block to save the output of this Jupyter Notebook.

Click on the cell below & hit 'shift + enter'...

In [14]:
```
file_path_name = "user_data/user_" + current_user_ID_str
+ "/final_output"

cmd = "jupyter nbconvert --to webpdf --allow-chromium-
download study_notebook_V2.ipynb --output " +
file_path_name
if(os.system(cmd)):
        print("Error converting to .py")
        print(f"cmd: {cmd}")
```

```
Error converting to .py
cmd: jupyter nbconvert --to webpdf --allow-chromium-download study_notebook
_V2.ipynb --output user_data/user_00/final_output
```

```
[NbConvertApp] Converting notebook study_notebook_V2.ipynb to webpdf
Traceback (most recent call last):
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/nbconvert/exporters/webpdf.py", line 74, in _check_launch_reqs
    from pyppeteer import launch
ModuleNotFoundError: No module named 'pyppeteer'

The above exception was the direct cause of the following exception:

Traceback (most recent call last):
  File "/Users/liamroy/miniforge3/envs/phd/bin/jupyter-nbconvert", line 10, in <module>
    sys.exit(main())
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/jupyter_core/application.py", line 277, in launch_instance
    return super().launch_instance(argv=argv, **kwargs)
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/traitlets/config/application.py", line 1043, in launch_instance
    app.start()
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/nbconvert/nbconvertapp.py", line 418, in start
    self.convert_notebooks()
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/nbconvert/nbconvertapp.py", line 592, in convert_notebooks
    self.convert_single_notebook(notebook_filename)
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/nbconvert/nbconvertapp.py", line 555, in convert_single_notebook
    output, resources = self.export_single_notebook(
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/nbconvert/nbconvertapp.py", line 483, in export_single_notebook
    output, resources = self.exporter.from_filename(
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/nbconvert/exporters/templateexporter.py", line 383, in from_filename
    return super().from_filename(filename, resources, **kw)  # type:ignore
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/nbconvert/exporters/exporter.py", line 198, in from_filename
    return self.from_file(f, resources=resources, **kw)
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/nbconvert/exporters/templateexporter.py", line 389, in from_file
    return super().from_file(file_stream, resources, **kw)  # type:ignore
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/nbconvert/exporters/exporter.py", line 217, in from_file
    return self.from_notebook_node(
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/nbconvert/exporters/webpdf.py", line 156, in from_notebook_node
    self._check_launch_reqs()
  File "/Users/liamroy/miniforge3/envs/phd/lib/python3.9/site-packages/nbconvert/exporters/webpdf.py", line 77, in _check_launch_reqs
    raise RuntimeError(
RuntimeError: Pyppeteer is not installed to support Web PDF conversion. Please install `nbconvert[webpdf]` to enable.
```

Closing Survey

Please click the folliwng link to answer a short post-study questionnaire.

Pre-study Questionnaire: https://forms.gle/K6RnncY82vSVdyE38 (Participant ID Required)

Thank you for completing this Jupyter Notebook.

NOTES & DEBUG

This section is not part of the survey.

In [ ]:

```
# PILOTSET ARRAY VALUE SETTER

# State 0: Stuck - Pilot Set
manual_Qtable_state_0 = np.array([[[1., -1., -3.], [2., 0., -3.], [3., 2., -3.]],

[[2., -1., -3.], [2., 0., -3.], [4., 2., -3.]],

[[2., -1., -3.], [3., 0., -3.], [5., 3., -3.]]]) * 1.0

print("State 0: Stuck")
print(manual_Qtable_state_0.shape, "\n")
print(manual_Qtable_state_0, "\n")



# State 1: Successful - Pilot Set
manual_Qtable_state_1 = np.array([[[-3., 0., 2.], [-3., 1., 3.], [-3., 0., 2.]],

[[-3., 0., 4.], [-3., 1., 5.], [-3., 0., 3.]],

[[-3., 0., 2.], [-3., 1., 3.], [-3., 0., 2.]]]) * 1.0

print("State 1: Successful")
```

```
print(manual_Qtable_state_1.shape, "\n")
print(manual_Qtable_state_1, "\n")



# State 2: Progressing - Pilot Set
manual_Qtable_state_2 = np.array([[[0., 3., 0.], [-3.,
2., -3.], [-3., 1., -3.]],

[[0., 5., 0.], [-3., 3., -3.], [-3., 1., -3.]],

[[0., 4., 0.], [-3., 2., -3.], [-3., 1., -3.]]]) * 1.0

print("State 2: Successful")
print(manual_Qtable_state_2.shape, "\n")
print(manual_Qtable_state_2, "\n")



np.save("arrays/pilotset_st0.npy",
manual_Qtable_state_0)
np.save("arrays/pilotset_st1.npy",
manual_Qtable_state_1)
np.save("arrays/pilotset_st2.npy",
manual_Qtable_state_2)
```

Creating buttons and widgets: https://medium.com/@technologger/how-to-interact-with-jupyter-33a98686f24e

In [ ]:

In [ ]:
```
%whos
```