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

Before starting this Notebook...

1. **Sub the line of code specifying PWD path** on your device to: ./../RL_audio/notebooks
2. **Install the required packages** (below) to run the notebook
3. **Enable JupyterLab Dark**. Under "Settings" --> Theme --> "JupyterLab Dark" (*Optional but recommended*)

In [1]:

```
%cd /home/liamroy/Documents/PHD/repos/RL_audio/notebooks

# %cd /Users/liamroy/Documents/Studies/Monash_31194990/PHD/repos/RL_audio/no

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

```
/home/liamroy/Documents/PHD/repos/RL_audio/notebooks
```

In [2]:

```
PWD = %pwd
```

Packages

Please install the following:

pygame (see this webpage ~ https://www.pygame.org/wiki/GettingStarted)
jupyterlab, numpy, termcolor, openpyxl, nbconvert-webpdf

Either use:
--> sudo apt-get install <package_name>
--> python3 -m pip install <package_name>
--> conda install -c conda-forge <package_name>

Example using conda:
--> conda install -c conda-forge <package_name>

jupyterlab or notebook
numpy
termcolor
openpyxl
nbconvert-webpdf

Imports

In [4]:

```
#  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
# 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/


#  ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
#  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 bu

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

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

# # To load and save, simply enter in the base filename such as "lastsave" c
# argParser.add_argument("-s", "--save", required=False, help="filename to s
# argParser.add_argument("-l", "--load", required=False, help="load Q-table
```

Initializations

In [5]:

```
# Parameter discritization
param_disc = 3

state_descriptions = ["Stuck      \t- robot is in trouble and needs your hel
                      "Accomplished \t- robot has successfully completed it'
                      "Progressing \t- robot is working and doesn't need hel
                      "None of the above"]


num_of_states = len(state_descriptions) - 1 # Adding a minus 1 since the las
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 region
# number of discretized regions for each param --> i.e. if equals 3 then (0,
# ** must align with the discretization for selected sound library
sound_obj_array_A = np.ndarray((param_disc, param_disc, param_disc),dtype=ob

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, para


# 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 region
# number of discretized regions for each param --> i.e. if equals 3 then (0,
# ** must align with the discretization for selected sound library
sound_obj_array_B = np.ndarray((param_disc, param_disc, param_disc),dtype=ob

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, para
```

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: **Accomplished**

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**, **Accomplished**, **Progressing** and **None of the above**.

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 1A

Start by entering your user ID.
Click on the first cell below & hit 'shift + enter'...

In [6]:
```
current_user_ID_str = mischelp.get_user_ID(parent_dir=PWD, num_of_states=num
```

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

Great job! You are user: 00

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

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

Our first robot is named Jackal.

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 [7]:
```
mischelp.get_user_accuracy(sound_obj_array=sound_obj_array_A, lib_str=librar
                           states_array=np.ndarray(num_of_states, dtype=obje
------------------------------------------------------------------------
------------------------------------------------------------------------

Robot sound is playing....

What state is the robot in: 

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]: 

Please enter the first letter of the state...

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

Robot sound is playing....

What state is the robot in: 

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]: 

You entered: n
None of the above

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

Robot sound is playing....

What state is the robot in: 

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]: 
```

```
You entered: n
None of the above

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

Robot sound is playing....

What state is the robot in: 

[S]: Stuck                - robot is in trouble and needs your help
[A]: Accomplished         - robot has successfully completed it's task
[P]: Progressing          - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]: 

You entered: n
None of the above




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

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

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

Jackal Robot

SECTION 1B

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 [8]: mischelp.get_user_accuracy(sound_obj_array=sound_obj_array_B, lib_str=librar
                                   states_array=np.ndarray(num_of_states, dtype=obje
```

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

Robot sound is playing....

What state is the robot in: 

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]: 

You entered: n
None of the above

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

Robot sound is playing....

What state is the robot in: 

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]: 
```

```
You entered: n
None of the above

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

Robot sound is playing....

What state is the robot in: 

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]: 

You entered: n
None of the above




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

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

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

Spot Robot

Section 2

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

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 [ ]:

```
# SECTION 2X


ucb1.ucb1_algor(num_of_states=num_of_states, state_descriptions=state_descri
                sound_obj_array=sound_obj_array_A, current_user_ID_str=curre
                delta_Q_thresh=2.0, conv_thresh=3, printer=None, mixer_volum


sect3_load_str = current_user_ID_str + "_sect2X_final"
```

Jackal Robot

Section 2O

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

In [9]:

```
# SECTION 2O
```

```
ucb1.ucb1_algor(num_of_states=num_of_states, state_descriptions=state_descri
                sound_obj_array=sound_obj_array_A, current_user_ID_str=curre
                delta_Q_thresh=2.0, conv_thresh=3, printer=None, mixer_volum


sect3_load_str = current_user_ID_str + "_sect20_final"
```

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

Robot sound is playing....

What state is the robot in:

[S]: Stuck                - robot is in trouble and needs your help
[A]: Accomplished         - robot has successfully completed it's task
[P]: Progressing          - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]:

You entered: s
Stuck           - robot is in trouble and needs your 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 change your response:

You entered: 9

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

Robot sound is playing....

What state is the robot in:

[S]: Stuck                - robot is in trouble and needs your help
[A]: Accomplished         - robot has successfully completed it's task
[P]: Progressing          - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]:
```

```
You entered: s
Stuck           - robot is in trouble and needs your 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 change your response:

You entered: 9

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

Robot sound is playing....

What state is the robot in:

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]:

You entered: p
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 change your response:

You entered: 9

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

Robot sound is playing....

What state is the robot in:

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]:
```

```
You entered: a
Accomplished    - robot has successfully completed it's task

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 change your response:

You entered: 9

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

Robot sound is playing....

What state is the robot in:

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]:

You entered: a
Accomplished    - robot has successfully completed it's task

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 change your response:

You entered: 9

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

Robot sound is playing....

What state is the robot in:

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]:
```

```
You entered: p
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 change your response:

You entered: 9

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

Robot sound is playing....

What state is the robot in:

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]:

You entered: a
Accomplished    - robot has successfully completed it's task

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 change your response:

You entered: 9

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

Robot sound is playing....

What state is the robot in:

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]:
```

```
You entered: p
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 change your response:

You entered: 9

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

Robot sound is playing....

What state is the robot in:

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]:

You entered: a
Accomplished    - robot has successfully completed it's task

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 change your response:

You entered: 9

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

Robot sound is playing....

What state is the robot in:

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]:
```

```
You entered: s
Stuck           - robot is in trouble and needs your 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 change your response: 

You entered: 9

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

Robot sound is playing....

What state is the robot in: 

[S]: Stuck              - robot is in trouble and needs your help
[A]: Accomplished       - robot has successfully completed it's task
[P]: Progressing        - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]: 

You entered: s
Stuck           - robot is in trouble and needs your 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 change your response: 

You entered: 9



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

Great job! The system terminated successfully at itter: 11.
Click on the next cell below and hit 'shift + enter' to continue

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

Jackal Robot

Section 3A

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 [ ]: mischelp.get_user_accuracy(sound_obj_array=sound_obj_array_A, lib_str=librar
                                   states_array=np.ndarray(num_of_states, dtype=obje
```

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

Robot sound is playing....

What state is the robot in: 

[S]: Stuck                  - robot is in trouble and needs your help
[A]: Accomplished           - robot has successfully completed it's task
[P]: Progressing            - robot is working and doesn't need help
[N]: None of the above


To replay the sound: leave the input empty and hit 'enter'...
Select a state by entering its first letter [S - A - P - N]: 

You entered: a
Accomplished     - robot has successfully completed it's task

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 change your response: 
```

Jackal Robot

Section 3B

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_array_B, lib_str=librar
                                   states_array=np.ndarray(num_of_states, dtype=obje
```

Spot Robot

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 [ ]:

```
file_path_name = "user_data/user_" + current_user_ID_str + "/final_output"

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

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., -
                                                                  [[2., -1.,
                                                                  [[2., -1.,

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


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
```