Let us try to create here, through different cells, all the necessary material to run a very first simulation. We need: user inputs for initial positions; user-given (only for now!) values of 'reward' probability amplitudes; a bunch of operations, a Qiskit extension, and a loop to run the code multiple times. If we are even able to create a visual representation which is updated at each time step, that would be so cool!

(We have to use ESC + M to write a text rather than a coding line in Jupyter). The following cell shouldn't change across time.

In [1]:

```
# Some resources on Python robot simulation can be found here: https://jyro.reac
```

In [2]:

```
from ibm_quantum_widgets import CircuitComposer
from qiskit import QuantumRegister, ClassicalRegister, QuantumCircuit, Aer, exec
import numpy as np
from numpy import pi
from ibm_quantum_widgets import draw_circuit
from qiskit.providers.aer import QasmSimulator
from qiskit.utils import QuantumInstance
from qiskit.visualization import plot_histogram, plot_state_qsphere
from qiskit import *
import random
import matplotlib.pyplot as plt
import pylab
import pandas as pd
from sklearn import preprocessing
import collections
from collections import Counter
```

In [3]:

```
# from: https://stackoverflow.com/questions/39298928/play-multiple-sounds-at-the

from pydub import AudioSegment
from pydub.playback import play
```

In [4]:

```
# 3d graph: Adapted from https://stackoverflow.com/questions/12423601/simplest-w

import sys
import matplotlib
import matplotlib.pyplot as plt
from matplotlib.ticker import MaxNLocator
from matplotlib import cm
from mpl_toolkits.mplot3d import Axes3D
import numpy
from numpy import array
from scipy import newaxis
```

In [5]:

```
# mlab.points3d(x, y, z, value)
```

In [6]:

```
from mayavi import mlab
mlab.options.offscreen = True
mlab.test_contour3d()
mlab.savefig('example.png')
mlab.draw()
mlab.show()

# now it works :)
```

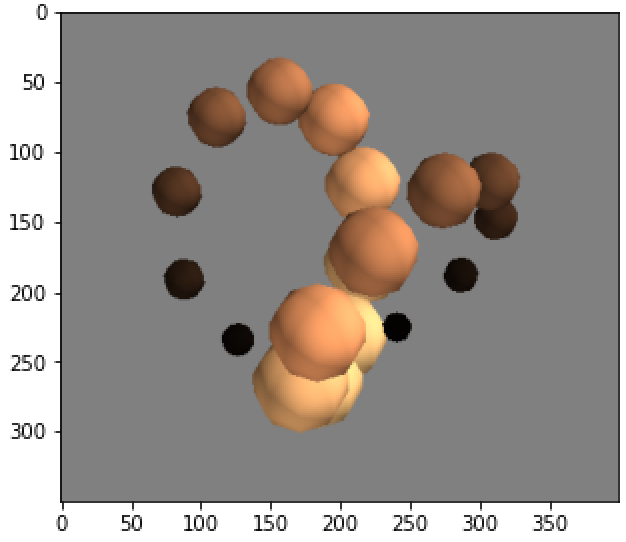
In [7]:

```
# example from https://stackoverflow.com/questions/67045944/embed-mayavi-into-a-

mlab.clf()

from mayavi import mlab
mlab.init_notebook()
import numpy as np

class Test:
    def __init__(self):
        self.fig = mlab.figure()
        self._add_data()

    def _add_data(self):
        pi = np.pi
        cos = np.cos
        sin = np.sin
        dphi, dtheta = pi / 250.0, pi / 250.0
        [phi, theta] = np.mgrid[0:pi + dphi * 1.5:dphi,
                                0:2 * pi + dtheta * 1.5:dtheta]
        m0 = 4; m1 = 3; m2 = 2; m3 = 3
        m4 = 6; m5 = 2; m6 = 6; m7 = 4
        r = sin(m0 * phi) ** m1 + cos(m2 * phi) ** m3 + \
            sin(m4 * theta) ** m5 + cos(m6 * theta) ** m7
        x = r * sin(phi) * cos(theta)
        y = r * cos(phi)
        z = r * sin(phi) * sin(theta)
        self.surf = mlab.mesh(x, y, z, figure=self.fig)

    def show(self):
        return self.surf

t=Test()
t.show()
```

```
Notebook initialized with ipy backend.
```

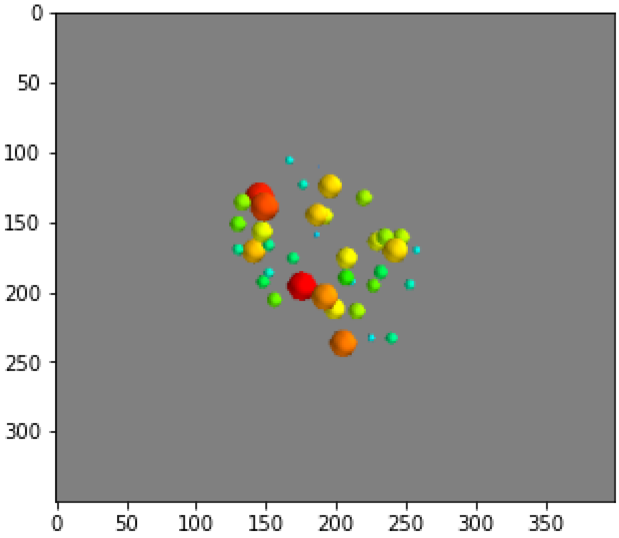
In [8]:

```
mlab.clf()

import numpy, pylab, mayavi, mayavi.mlab
import matplotlib.pyplot as plt

t = numpy.linspace(0, 4 * numpy.pi, 20)
cos,sin = numpy.cos, numpy.sin

x = sin(2 * t)
y = cos(t)
z = cos(2 * t)
s = 2 + sin(t)
mayavi.mlab.points3d(x, y, z, s, colormap="copper", scale_factor=.25)

arr = mayavi.mlab.screenshot()
fig = plt.figure(figsize=(5, 5))
pylab.imshow(arr)

plt.show()

```



In [9]:

```
 mlab.clf()

import numpy, pylab, mayavi, mayavi.mlab
import matplotlib.pyplot as plt

x, y, z, value = np.random.random((4, 40))
mlab.points3d(x, y, z, value)

arr = mayavi.mlab.screenshot()
fig = plt.figure(figsize=(5, 5))
pylab.imshow(arr)

plt.show()
```



Circuit components initialization. The specific qubits are on $|0\rangle$ by default. They will get a gate later on, according on attributes of classes. The following cell shouldn't change across time.

In [10]:

```
q = QuantumRegister(7, 'q'); # qubits # changed to 9, formerly 15
m3 = ClassicalRegister(1, 'c1'); # classical bits (separated is better)
m4 = ClassicalRegister(1, 'c2');
m5 = ClassicalRegister(1, 'c3');
m6 = ClassicalRegister(1, 'c4');

qc3 = QuantumCircuit(q, m3, m4, m5, m6); # to reach the target
qc4 = QuantumCircuit(q, m3, m4, m5, m6); # to get back to the nest
```

In [11]:

```
class Target:
    def __init__(self,name,x,y,z): # no indetermination in the target's positio
        self.name = name
        self.x = x
        self.y = y
        self.z = z
```

In [12]:

```
T = Target("T", 0.8, 0.8, 0.2) # deep in the ocean

# for getting back to the beginning
T2 = Target("T2", 0.2, 0.2, 1.0) # back to the ship
```

In [13]:

```
def reward(T, betax, betay, betaz):
    r = round(1 - ((T.x - betax)**2 + (T.y - betay)**2 + (T.z - betaz)**2)**0.5,
    # the closer the target, the less the distance, the higher the reward
    return r
```

Robot R_1: x-position $|q_0(t)\rangle = \alpha_1^x(t)|0\rangle + \beta_1^x(t)|1\rangle$; y-position $|q_1(t)\rangle = \alpha_1^y(t)|0\rangle + \beta_1^y(t)|1\rangle$; reward $|q_2(t)\rangle = \gamma_1(t)|0\rangle + \delta_1(t)|1\rangle$.

The class-initialization cells shouldn't change across time. However, cells with numerical values of class attributes should be updated.

In [14]:

```
class Robot:
  def __init__(self,name, alphax, betax, alphay, betay, alphaz, betaz, gamma, de
    self.name = name
    self.alphax = alphax
    self.betax = betax
    self.alphay = alphay
    self.betay = betay
    self.alphaz = alphaz
    self.betaz = betaz
    delta = reward(T, betax, betay, betaz)
    gamma = round(1 - delta, 2)
    self.gamma = gamma
    self.delta = delta
```

In [15]:

```
# manual intervention needed here to avoid circularity
reward(T, 0.2, 0.2, 0.7) # value of delta 0.2,0.2, 1.0
```

Out[15]:

```
0.02
```

In [16]:

```
# manual intervention needed here to avoid circularity
round(1 - reward(T, 0.2, 0.2, 0.7), 2) # value of gamma
```

Out[16]:

```
0.98
```

The following cell, and the other corresponding cells, should be updated by hand at each time:

In [17]:

```
# (name, alphax, betax, alphay, betay, gamma, delta)
R1 = Robot("R1",0.8, 0.2, 0.8, 0.2, 0.3, 0.7, 0.98, 0.02)
```

In [18]:

```
R1.gamma, R1.delta
```

Out[18]:

```
(0.98, 0.02)
```

Robot R_2: x-position $|q_3(t)\rangle = \alpha_2^x(t)|0\rangle + \beta_2^x(t)|1\rangle$; y-position $|q_4(t)\rangle = \alpha_2^y(t)|0\rangle + \beta_2^y(t)|1\rangle$; reward $|q_5(t)\rangle = \gamma_2(t)|0\rangle + \delta_2(t)|1\rangle$

In [19]:

```
reward(T, 0.2, 0.2, 0.6) # manual intervention needed here to avoid circularity
```

Out[19]:

```
0.06
```

In [20]:

```
round(1 - reward(T, 0.2, 0.2, 0.6), 2) # manual intervention needed here to avoi
```

Out[20]:

```
0.94
```

In [21]:

```
R2 = Robot("R2",0.8, 0.2, 0.8, 0.2, 0.4, 0.6, 0.94, 0.06) # update by hand this
```

In [22]:

```
R2.delta, R2.gamma, R2.alphax, R2.betax, R2.alphay, R2.betay, R2.alphaz, R2.beta
```

Out[22]:

```
(0.06, 0.94, 0.8, 0.2, 0.8, 0.2, 0.4, 0.6, 0.94, 0.06)
```

Robot R_3: x-position $|q_6(t)\rangle = \alpha_3^x(t)|0\rangle + \beta_3^x(t)|1\rangle$; y-position $|q_7(t)\rangle = \alpha_3^y(t)|0\rangle + \beta_3^y(t)|1\rangle$; reward $|q_8(t)\rangle = \gamma_3(t)|0\rangle + \delta_3(t)|1\rangle$

In [23]:

```
reward(T, 0.3, 0.1, 0.7) # manual intervention needed here to avoid circularity
```

Out[23]:

```
0.01
```

In [24]:

```
round(1 - reward(T, 0.3, 0.1, 0.7), 2) # manual intervention needed here to avoi
```

Out[24]:

```
0.99
```

In [25]:

```
R3 = Robot("R3", 0.7, 0.3, 0.9, 0.1, 0.3, 0.7, 0.99, 0.01) # to be updated by ha
R3.alphax, R3.betax, R3.alphay, R3.betay, R3.alphaz, R3.betaz, R3.gamma, R3.delt
```

Out[25]:

```
(0.7, 0.3, 0.9, 0.1, 0.3, 0.7, 0.99, 0.01)
```

In [26]:

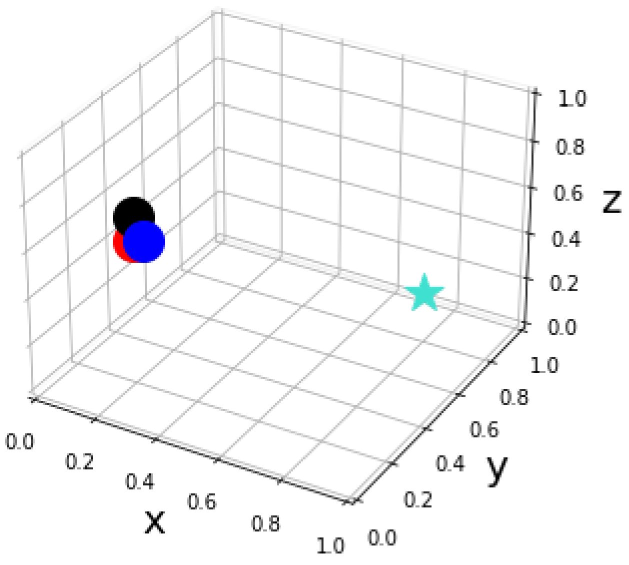
```
R3.gamma, R3.delta
```

Out[26]:

```
(0.99, 0.01)
```

In [27]:

```

fig = plt.figure()

ax = Axes3D(fig, auto_add_to_figure=False)
fig.add_axes(ax)

ax.set_xlim3d(0, 1)
ax.set_ylim3d(0, 1)
ax.set_zlim3d(0, 1)

ax.xaxis.pane.fill = False
ax.yaxis.pane.fill = False
ax.zaxis.pane.fill = False

ax.set_xlabel('x', fontsize=20)
ax.set_ylabel('y', fontsize=20)
ax.set_zlabel('z', fontsize=20) # r'\alpha'

ax.scatter3D(R1.betax, R1.betay, R1.betaz, s = 400, marker = 'o', color = 'black
ax.scatter3D(R2.betax, R2.betay, R2.betaz, s = 400, marker = 'o', color = 'red')
ax.scatter3D(R3.betax, R3.betay, R3.betaz, s = 400, marker = 'o', color = 'blue'
# ax.scatter3D(R4_[0], R4_[1], R4_[2], s = 400, marker = 'o', color = 'green')
ax.scatter3D(T.x, T.y, T.z, s = 400, marker = '*', color = 'turquoise')

plt.show()

# find how to automatically create trajectories: maybe LinePlot between R1, R2,
```



In [28]:

```
R1.delta, R2.delta, R3.delta
```

Out[28]:

```
(0.02, 0.06, 0.01)
```

In [29]:

```
R3.alphay, R3.betay
```

Out[29]:

```
(0.9, 0.1)
```

In [30]:

```
# Audio section :)
```

In [31]:

```
# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB2.mp3")
            print("cB2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#2.mp3")
            print("cC#2")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#2.mp3")
            print("cA#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD2.mp3")
            print("cD2")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#2.mp3")
            print("cD#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA2.mp3")
            print("cA2")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE2.mp3")
            print("cE2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#2.mp3")
            print("cG#2")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF2.mp3")
            print("cF2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG2.mp3")
            print("cG2")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#2.mp3")
        print("cF#2")

mixed_time1_ = audio1.overlay(audio2)          # combine , superimpose audio fi
mixed_time1  = mixed_time1_.overlay(audio3)          # further combine , superi

mixed_time1.export("notes_/mixed_time1.mp3", format='mp3') # export mixed  audi
play(mixed_time1)                             # play mixed audio file
# change this line at each time point, so in the end we can get a little piece

```

```
tA#
fA#
cA#
Could not import the PyAudio C module '_portaudio'.

Input #0, wav, from '/var/folders/tc/5k6bdv0s421bnc52mnnj7p_w0000gn/T/tmpqy_o_ibe.
wav':
  Duration: 00:00:07.34, bitrate: 1411 kb/s
  Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 44100 Hz, 2 channels, s1
6, 1411 kb/s
   7.25 M-A:  0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
   7.29 M-A: -0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
```

In [35]:

```
# NEW! ---> January 13, 2022
```

NEW LINES of code: if the initial reward is high for all the three robots, but not 0.99 yet: --> randomly shuffle one of the positions.

In [36]:

```
if (R1.delta and R2.delta and R3.delta) >= 0.8 and (R1.delta and R2.delta and R3
    print("ciao ciao")
    R1.alphax = round(np.random.uniform(0,0.2), 3) # slightly shuffle position c
    R1.betax = round(1 - R1.alphax, 3)
    #R1.alphay = round(np.random.uniform(0,0.2), 3) # slightly shuffle position
    #R1.betay = round(1 - R1.alphay, 3)
    print("the new x-positions for R1 are: ", R1.alphax, R1.betax)
```

In [37]:

```
R1.alphax, R1.betax, R1.alphay, R1.betay, R1.alphaz, R1.betaz
```

Out[37]:

```
(0.8, 0.2, 0.8, 0.2, 0.3, 0.7)
```

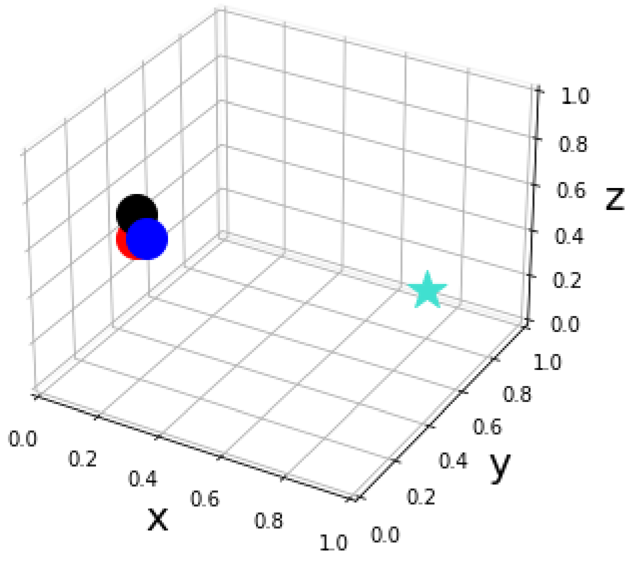
In [38]:

```
R1.delta = reward(T, R1.betax, R1.betay, R1.betaz)
print(R1.delta)

R2.delta = reward(T, R2.betax, R2.betay, R2.betaz)
print(R2.delta)

R3.delta = reward(T, R3.betax, R3.betay, R3.betaz)
print(R3.delta)
```

```
0.02
0.06
0.01
```

In [39]:

```python
fig = plt.figure()

ax = Axes3D(fig, auto_add_to_figure=False)
fig.add_axes(ax)

ax.set_xlim3d(0, 1)
ax.set_ylim3d(0, 1)
ax.set_zlim3d(0, 1)

ax.xaxis.pane.fill = False
ax.yaxis.pane.fill = False
ax.zaxis.pane.fill = False

ax.set_xlabel('x', fontsize=20)
ax.set_ylabel('y', fontsize=20)
ax.set_zlabel('z', fontsize=20) # r'\alpha'

ax.scatter3D(R1.betax, R1.betay, R1.betaz, s = 400, marker = 'o', color = 'black
ax.scatter3D(R2.betax, R2.betay, R2.betaz, s = 400, marker = 'o', color = 'red')
ax.scatter3D(R3.betax, R3.betay, R3.betaz, s = 400, marker = 'o', color = 'blue'
# ax.scatter3D(R4_[0], R4_[1], R4_[2], s = 400, marker = 'o', color = 'green')
ax.scatter3D(T.x, T.y, T.z, s = 400, marker = '*', color = 'turquoise')

plt.show()

# find how to automatically create trajectories: maybe LinePlot between R1, R2,
```



Rewards: here, they are an attribute of each class. This information should be provided by robots themselves according to their observations.

First check: if robots' positions are too far from the target, that is, initial positions guarantee a reward lower than a given threshold for all robots, then we have to change position. We can accomplish this by randomly moving robots (as in an exploration task), and evaluating again their rewards.

In [40]:

```
# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB2.mp3")
            print("cB2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#2.mp3")
            print("cC#2")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#2.mp3")
            print("cA#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD2.mp3")
            print("cD2")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#2.mp3")
            print("cD#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA2.mp3")
            print("cA2")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE2.mp3")
            print("cE2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#2.mp3")
            print("cG#2")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF2.mp3")
            print("cF2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG2.mp3")
            print("cG2")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#2.mp3")
        print("cF#2")

mixed_time2_ = audio1.overlay(audio2)          # combine , superimpose audio fi
mixed_time2  = mixed_time2_.overlay(audio3)          # further combine , superi

mixed_time2.export("notes_/mixed_time2.mp3", format='mp3') # export mixed  audi
play(mixed_time2)                             # play mixed audio file
# change this line at each time point, so in the end we can get a little piece

```

```
tA#
fA#
cA#
Could not import the PyAudio C module '_portaudio'.

Input #0, wav, from '/var/folders/tc/5k6bdv0s421bnc52mnnj7p_w0000gn/T/tmp8o5xzrvf.
wav':
  Duration: 00:00:07.34, bitrate: 1411 kb/s
  Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 44100 Hz, 2 channels, s1
6, 1411 kb/s
   7.28 M-A:  0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
```

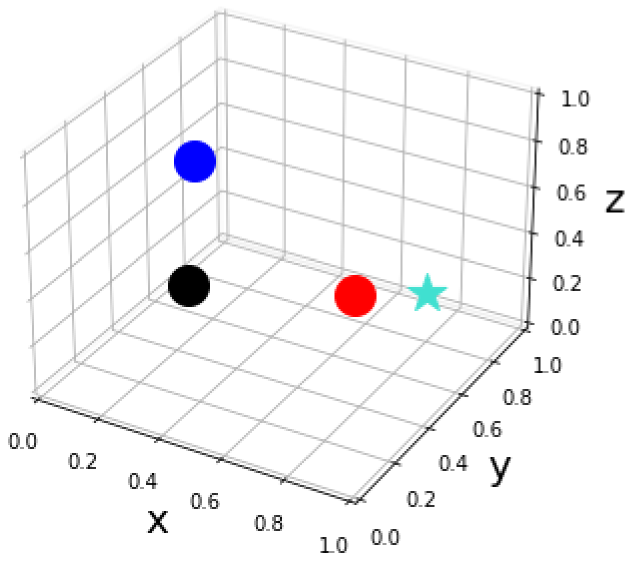
In [41]:

```
# threshold for initial reward
# random fluctuations

if (R1.delta <= 0.4) and (R2.delta <= 0.4) and (R3.delta <= 0.4):
    print("SOS")
    # R1
    R1.alphax = round(np.random.uniform(0,0.9), 3)
    R1.betax = round(1 - R1.alphax, 3)
    print("the new x-positions for R1 are: ", R1.alphax, R1.betax)
    R1.alphay = round(np.random.uniform(0,0.9), 3)
    R1.betay = round(1 - R1.alphay, 3)
    print("the new y-positions for R1 are: ", R1.alphay, R1.betay)
    R1.alphaz = round(np.random.uniform(0,0.9), 3)
    R1.betaz = round(1 - R1.alphaz, 3)
    print("the new z-positions for R1 are: ", R1.alphaz, R1.betaz)
    # R2
    R2.alphax = round(np.random.uniform(0,0.9), 3)
    R2.betax = round(1 - R2.alphax, 3)
    print("the new x-positions for R2 are: ", R2.alphax, R1.betax)
    R2.alphay = round(np.random.uniform(0,0.9), 3)
    R2.betay = round(1 - R2.alphay, 3)
    print("the new y-positions for R2 are: ", R2.alphay, R1.betay)
    R2.alphaz = round(np.random.uniform(0,0.9), 3)
    R2.betaz = round(1 - R2.alphaz, 3)
    print("the new z-positions for R2 are: ", R2.alphaz, R1.betaz)
    # R3
    R3.alphax = round(np.random.uniform(0,0.9), 3)
    R3.betax = round(1 - R3.alphax, 3)
    print("the new x-positions for R3 are: ", R3.alphax, R1.betax)
    R3.alphay = round(np.random.uniform(0,0.9), 3)
    R3.betay = round(1 - R3.alphay, 3)
    print("the new y-positions for R3 are: ", R3.alphay, R1.betay)
    R3.alphaz = round(np.random.uniform(0,0.9), 3)
    R3.betaz = round(1 - R3.alphaz, 3)
    print("the new y-positions for R3 are: ", R3.alphaz, R1.betaz)

R1.delta = reward(T, R1.betax, R1.betay, R1.betaz)
R1.gamma = 1 - R1.delta
R2.delta = reward(T, R2.betax, R2.betay, R2.betaz)
R2.gamma = 1 - R2.delta
R3.delta = reward(T, R3.betax, R3.betay, R3.betaz)
R3.gamma = 1 - R3.delta
print(R1.delta, R2.delta, R3.delta)
```

```
SOS
the new x-positions for R1 are:  0.776 0.224
the new y-positions for R1 are:  0.572 0.428
the new z-positions for R1 are:  0.736 0.264
the new x-positions for R2 are:  0.083 0.224
the new y-positions for R2 are:  0.85 0.428
the new z-positions for R2 are:  0.313 0.264
the new x-positions for R3 are:  0.854 0.224
the new y-positions for R3 are:  0.403 0.428
the new y-positions for R3 are:  0.333 0.264
0.31 0.18 0.17
```

In [42]:

```
fig = plt.figure()

ax = Axes3D(fig, auto_add_to_figure=False)
fig.add_axes(ax)

ax.set_xlim3d(0, 1)
ax.set_ylim3d(0, 1)
ax.set_zlim3d(0, 1)

ax.xaxis.pane.fill = False
ax.yaxis.pane.fill = False
ax.zaxis.pane.fill = False

ax.set_xlabel('x', fontsize=20)
ax.set_ylabel('y', fontsize=20)
ax.set_zlabel('z', fontsize=20) # r'\alpha'

ax.scatter3D(R1.betax, R1.betay, R1.betaz, s = 400, marker = 'o', color = 'black
ax.scatter3D(R2.betax, R2.betay, R2.betaz, s = 400, marker = 'o', color = 'red')
ax.scatter3D(R3.betax, R3.betay, R3.betaz, s = 400, marker = 'o', color = 'blue'
# ax.scatter3D(R4_[0], R4_[1], R4_[2], s = 400, marker = 'o', color = 'green')
ax.scatter3D(T.x, T.y, T.z, s = 400, marker = '*', color = 'turquoise')

plt.show()

# find how to automatically create trajectories: maybe LinePlot between R1, R2,
```



In [43]:

```python

# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB2.mp3")
            print("cB2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#2.mp3")
            print("cC#2")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#2.mp3")
            print("cA#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD2.mp3")
            print("cD2")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#2.mp3")
            print("cD#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA2.mp3")
            print("cA2")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE2.mp3")
            print("cE2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#2.mp3")
            print("cG#2")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF2.mp3")
            print("cF2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG2.mp3")
            print("cG2")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#2.mp3")
        print("cF#2")

mixed_time3_ = audio1.overlay(audio2)          # combine , superimpose audio fi
mixed_time3  = mixed_time3_.overlay(audio3)          # further combine , superi

mixed_time3.export("notes_/mixed_time3.mp3", format='mp3') # export mixed  audi
play(mixed_time3)                             # play mixed audio file
# change this line at each time point, so in the end we can get a little piece

```

```
tA#2
fF#
cC#
Could not import the PyAudio C module '_portaudio'.

Input #0, wav, from '/var/folders/tc/5k6bdv0s421bnc52mnnj7p_w0000gn/T/tmpf1jvh51c.
wav':
  Duration: 00:00:07.31, bitrate: 1411 kb/s
  Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 44100 Hz, 2 channels, s1
6, 1411 kb/s
   7.23 M-A:  0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
```

In [44]:

```
# January 22, 2022
```

I'm adding a check here as well.

NEW LINES of code: IF the initial reward is very high (greater than 0.8) for at least one of the three robots ("or"), THEN the other robots have to just reach it (with a pretty small fluctuation), without entering the circuit.

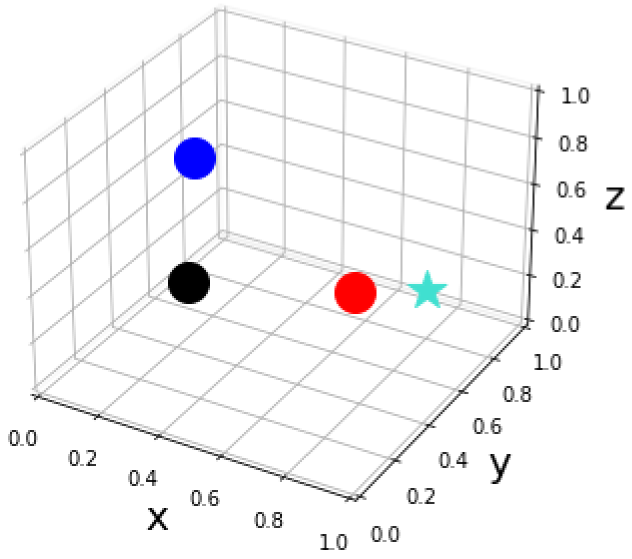
In [45]:

```
if((R1.delta >= 0.8) or (R2.delta >= 0.8) or (R3.delta >= 0.8)):
    print('yuk')
    if (R1.delta > R2.delta and R1.delta > R3.delta):
        print('quokka')
        R2.betax = round(R1.betax + np.random.uniform(0,0.1), 3) # Here and late
        R2.alphax = round(1 - R2.betax, 3)
        R2.betay = round(R1.betay + np.random.uniform(0,0.1), 3)
        R2.alphay = round(1 - R2.betay, 3)
        R2.betaz = round(R1.betaz + np.random.uniform(0,0.1), 3)
        R2.alphaz = round(1 - R2.betaz, 3)
        R3.betax = round(R1.betax + np.random.uniform(0,0.1), 3)
        R3.alphax = round(1 - R2.betax, 3)
        R3.betay = round(R1.betay + np.random.uniform(0,0.1), 3)
        R3.alphay = round(1 - R2.betay, 3)
        R3.betaz = round(R1.betay + np.random.uniform(0,0.1), 3)
        R3.alphaz = round(1 - R2.betaz, 3)
    if (R2.delta > R1.delta and R2.delta > R3.delta):
        print('quagga')
        R1.betax = round(R2.betax + np.random.uniform(0,0.1), 3)
        R1.alphax = round(1 - R1.betax, 3)
        R1.betay = round(R2.betay + np.random.uniform(0,0.1), 3)
        R1.alphay = round(1 - R1.betay, 3)
        R1.betaz = round(R2.betaz + np.random.uniform(0,0.1), 3)
        R1.alphaz = round(1 - R1.betaz, 3)
        R3.betax = round(R2.betax + np.random.uniform(0,0.1), 3)
        R3.alphax = round(1 - R3.betax, 3)
        R3.betay = round(R2.betay + np.random.uniform(0,0.1), 3)
        R3.alphay = round(1 - R3.betay, 3)
        R3.betaz = round(R2.betaz + np.random.uniform(0,0.1), 3)
        R3.alphaz = round(1 - R3.betaz, 3)
    if (R3.delta > R1.delta and R3.delta > R2.delta):
        print('quark')
        R1.betax = round(R3.betax + np.random.uniform(0,0.1), 3)
        R1.alphax = round(1 - R1.betax, 3)
        R1.betay = round(R3.betay + np.random.uniform(0,0.1), 3)
        R1.alphay = round(1 - R1.betay, 3)
        R1.betaz = round(R3.betaz + np.random.uniform(0,0.1), 3)
        R1.alphaz = round(1 - R1.betaz, 3)
        R2.betax = round(R3.betax + np.random.uniform(0,0.1), 3)
        R2.alphax = round(1 - R2.betax, 3)
        R2.betay = round(R3.betay + np.random.uniform(0,0.1), 3)
        R2.alphay = round(1 - R2.betay, 3)
        R2.betaz = round(R3.betaz + np.random.uniform(0,0.1), 3)
        R2.alphaz = round(1 - R2.betaz, 3)

R1.delta = reward(T, R1.betax, R1.betay, R1.betaz)
print(R1.delta)

R2.delta = reward(T, R2.betax, R2.betay, R2.betaz)
print(R2.delta)

R3.delta = reward(T, R3.betax, R3.betay, R3.betaz)
print(R2.delta)
```

```
0.31
0.18
0.18
```

In [46]:

```
fig = plt.figure()

ax = Axes3D(fig, auto_add_to_figure=False)
fig.add_axes(ax)

ax.set_xlim3d(0, 1)
ax.set_ylim3d(0, 1)
ax.set_zlim3d(0, 1)

ax.xaxis.pane.fill = False
ax.yaxis.pane.fill = False
ax.zaxis.pane.fill = False

ax.set_xlabel('x', fontsize=20)
ax.set_ylabel('y', fontsize=20)
ax.set_zlabel('z', fontsize=20) # r'\alpha'

ax.scatter3D(R1.betax, R1.betay, R1.betaz, s = 400, marker = 'o', color = 'black
ax.scatter3D(R2.betax, R2.betay, R2.betaz, s = 400, marker = 'o', color = 'red')
ax.scatter3D(R3.betax, R3.betay, R3.betaz, s = 400, marker = 'o', color = 'blue'
# ax.scatter3D(R4_[0], R4_[1], R4_[2], s = 400, marker = 'o', color = 'green')
ax.scatter3D(T.x, T.y, T.z, s = 400, marker = '*', color = 'turquoise')

plt.show()

# find how to automatically create trajectories: maybe LinePlot between R1, R2,
```



In [47]:

```python

# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB2.mp3")
            print("cB2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#2.mp3")
            print("cC#2")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#2.mp3")
            print("cA#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD2.mp3")
            print("cD2")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#2.mp3")
            print("cD#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA2.mp3")
            print("cA2")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE2.mp3")
            print("cE2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#2.mp3")
            print("cG#2")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF2.mp3")
            print("cF2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG2.mp3")
            print("cG2")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#2.mp3")
        print("cF#2")

mixed_time4_ = audio1.overlay(audio2)          # combine , superimpose audio fi
mixed_time4  = mixed_time4_.overlay(audio3)          # further combine , superi

mixed_time4.export("notes_/mixed_time4.mp3", format='mp3') # export mixed  audi
play(mixed_time4)                             # play mixed audio file
# change this line at each time point, so in the end we can get a little piece

```

```
tA#2
fF#
cC#
Could not import the PyAudio C module '_portaudio'.

Input #0, wav, from '/var/folders/tc/5k6bdv0s421bnc52mnnj7p_w0000gn/T/tmptpahic1a.
wav':
  Duration: 00:00:07.31, bitrate: 1411 kb/s
  Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 44100 Hz, 2 channels, s1
6, 1411 kb/s
   7.23 M-A:  0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
```

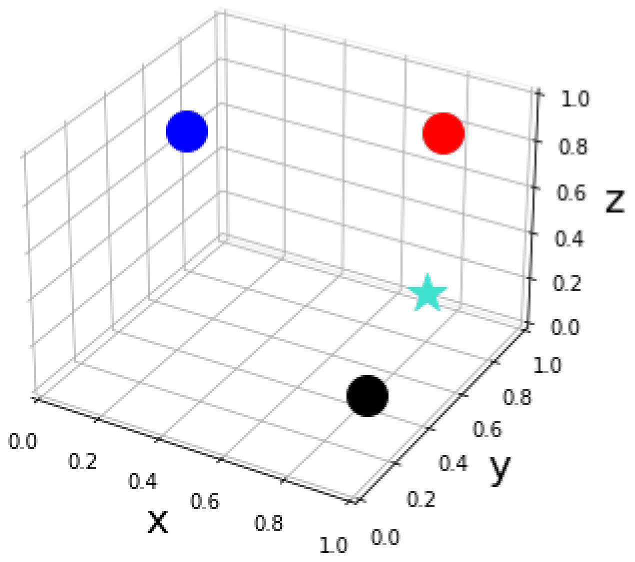
In [48]:

```python
# Another round of SOS re-shuffle

# threshold for initial reward
# random fluctuations

if (R1.delta <= 0.4) and (R2.delta <= 0.4) and (R3.delta <= 0.4):
    print("SOS")
    # R1
    R1.alphax = round(np.random.uniform(0,0.9), 3)
    R1.betax = round(1 - R1.alphax, 3)
    print("the new x-positions for R1 are: ", R1.alphax, R1.betax)
    R1.alphay = round(np.random.uniform(0,0.9), 3)
    R1.betay = round(1 - R1.alphay, 3)
    print("the new y-positions for R1 are: ", R1.alphay, R1.betay)
    R1.alphaz = round(np.random.uniform(0,0.9), 3)
    R1.betaz = round(1 - R1.alphaz, 3)
    print("the new z-positions for R1 are: ", R1.alphaz, R1.betaz)
    # R2
    R2.alphax = round(np.random.uniform(0,0.9), 3)
    R2.betax = round(1 - R2.alphax, 3)
    print("the new x-positions for R2 are: ", R2.alphax, R1.betax)
    R2.alphay = round(np.random.uniform(0,0.9), 3)
    R2.betay = round(1 - R2.alphay, 3)
    print("the new y-positions for R2 are: ", R2.alphay, R1.betay)
    R2.alphaz = round(np.random.uniform(0,0.9), 3)
    R2.betaz = round(1 - R2.alphaz, 3)
    print("the new y-positions for R2 are: ", R2.alphaz, R1.betaz)
    # R3
    R3.alphax = round(np.random.uniform(0,0.9), 3)
    R3.betax = round(1 - R3.alphax, 3)
    print("the new x-positions for R3 are: ", R3.alphax, R1.betax)
    R3.alphay = round(np.random.uniform(0,0.9), 3)
    R3.betay = round(1 - R3.alphay, 3)
    print("the new y-positions for R3 are: ", R3.alphay, R1.betay)
    R3.alphaz = round(np.random.uniform(0,0.9), 3)
    R3.betaz = round(1 - R3.alphaz, 3)
    print("the new z-positions for R3 are: ", R3.alphaz, R1.betaz)

R1.delta = reward(T, R1.betax, R1.betay, R1.betaz)
R1.gamma = 1 - R1.delta
R2.delta = reward(T, R2.betax, R2.betay, R2.betaz)
R2.gamma = 1 - R2.delta
R3.delta = reward(T, R3.betax, R3.betay, R3.betaz)
R3.gamma = 1 - R3.delta
print(R1.delta, R2.delta, R3.delta)
```

```
SOS
the new x-positions for R1 are:  0.055 0.945
the new y-positions for R1 are:  0.835 0.165
the new z-positions for R1 are:  0.728 0.272
the new x-positions for R2 are:  0.107 0.945
the new y-positions for R2 are:  0.312 0.165
the new y-positions for R2 are:  0.005 0.272
the new x-positions for R3 are:  0.807 0.945
the new y-positions for R3 are:  0.523 0.165
the new z-positions for R3 are:  0.119 0.272
0.34 0.19 0.03
```

In [49]:

```
fig = plt.figure()

ax = Axes3D(fig, auto_add_to_figure=False)
fig.add_axes(ax)

ax.set_xlim3d(0, 1)
ax.set_ylim3d(0, 1)
ax.set_zlim3d(0, 1)

ax.xaxis.pane.fill = False
ax.yaxis.pane.fill = False
ax.zaxis.pane.fill = False

ax.set_xlabel('x', fontsize=20)
ax.set_ylabel('y', fontsize=20)
ax.set_zlabel('z', fontsize=20) # r'\alpha'

ax.scatter3D(R1.betax, R1.betay, R1.betaz, s = 400, marker = 'o', color = 'black
ax.scatter3D(R2.betax, R2.betay, R2.betaz, s = 400, marker = 'o', color = 'red')
ax.scatter3D(R3.betax, R3.betay, R3.betaz, s = 400, marker = 'o', color = 'blue'
# ax.scatter3D(R4_[0], R4_[1], R4_[2], s = 400, marker = 'o', color = 'green')
ax.scatter3D(T.x, T.y, T.z, s = 400, marker = '*', color = 'turquoise')

plt.show()

# find how to automatically create trajectories: maybe LinePlot between R1, R2,
```



In [50]:

```
# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB2.mp3")
            print("cB2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#2.mp3")
            print("cC#2")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#2.mp3")
            print("cA#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD2.mp3")
            print("cD2")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#2.mp3")
            print("cD#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA2.mp3")
            print("cA2")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE2.mp3")
            print("cE2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#2.mp3")
            print("cG#2")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF2.mp3")
            print("cF2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG2.mp3")
            print("cG2")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#2.mp3")
        print("cF#2")

mixed_time5_ = audio1.overlay(audio2)          # combine , superimpose audio fi
mixed_time5  = mixed_time5_.overlay(audio3)          # further combine , superi

mixed_time5.export("notes_/mixed_time5.mp3", format='mp3') # export mixed  audi
play(mixed_time5)                                  # play mixed audio file
# change this line at each time point, so in the end we can get a little piece

```

```
tF#2
fF#
cA#
Could not import the PyAudio C module '_portaudio'.

Input #0, wav, from '/var/folders/tc/5k6bdv0s421bnc52mnnj7p_w0000gn/T/tmp6qjcf2hd.
wav':
  Duration: 00:00:07.34, bitrate: 1411 kb/s
  Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 44100 Hz, 2 channels, s1
6, 1411 kb/s
   7.28 M-A:  0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
```

We can now attempt to relate class attributes with quantum states. This passage should be automatically changed when class attributes change, in the loop! (while).

Let us suppose that R_1 received a signal from R_2, R_3 with the message: ``Where I am, what I found.'' That is: xy-position and reward information. Then, R_1 chooses to follow the more successful robot that has the more precise position localization.

Before all of that, we use an if: if R_2 already has a high reward, it remains where it is. If we had the same minimization function for all robots, thus, already at the second step all robots would converge toward the same point.

Now: initialization of qubits.

If the robot with the highest reward is R_3, then $R_1 \rightarrow R_3$ and $R_2 \rightarrow R_3$ while entering the gate. $q[0]$, $q[1]$, $q[2]$ takes positions (x and y) and reward of R_3 in this case. The output with $q[3]$, $q[4]$ ($q[2]$ remains the same) goes to new x, y of R_1 and of R_2.

GATE HERE!! GATE 1

In [51]:

```
R1.alphaz
```

Out[51]:

```
0.728
```

In [52]:

```
if (R1.delta > R2.delta) and (R1.delta > R3.delta):
    print("glu glu")
    if (R1.alphax < 0.3): # I have to customize state vectors according to prec
        print("bri")
        qc3.x(q[0])        # just using the NOT gate as a test
    if (R1.alphax == 0.5): # I have to customize state vectors according to pre
        qc3.h(q[0])
    if (R1.alphax >= 0.3) and (R2.alphax < 0.5):
        print('jungle!')
        qc3.ry(1.9106332, q[0])
    if (R1.alphax >= 0.6) and (R2.alphax < 0.7):
        print('ocean!')
        qc3.ry(1.2309594, q[0])
    if (R1.alphay <= 0.2): # else: the qubit sticks with the default value '0'
        print("cra cra")
        qc3.x(q[1])
    if (R1.alphay == 0.5): # I have to customize state vectors according to pre
        qc3.h(q[1])
    if (R1.alphay >= 0.3) and (R2.alphay < 0.5):
        print('jungle!')
        qc3.ry(1.9106332, q[1])
    if (R1.alphay >= 0.6) and (R2.alphay < 0.7):
        print('ocean!')
        qc3.ry(1.2309594, q[1])
    if (R1.alphaz <= 0.2): # else: the qubit sticks with the default value '0'
        qc3.x(q[2])
        print("augh")
    if (R1.alphaz == 0.5): # I have to customize state vectors according to pre
        print("ouch")
        qc3.h(q[2])
    if (R1.alphaz >= 0.3) and (R2.alphaz < 0.5):
        print('jungle!')
        qc3.ry(1.9106332, q[2])
    if (R1.alphaz >= 0.6) and (R2.alphaz < 0.7):
        print('ocean!')
        qc3.ry(1.2309594, q[2])
    if (R1.alphaz >= 0.2 and R1.alphax < 0.3):
        print("wolf")
        qc3.x(q[2])
    #if (R1.alphaz >= 0.7):
    #    print("wolf2") # leave the state as 0, default value
    if (R1.delta == 0.5):
        qc3.h(q[3])
    if (R1.delta == 0.6):
        qc3.h(q[3])
    if (R1.delta >= 0.7):
        qc3.x(q[3])
    if (R1.gamma >= 0.3) and (R2.gamma < 0.5):
        print('jungle!')
        qc3.ry(1.9106332, q[3])
    if (R1.gamma >= 0.6) and (R2.gamma < 0.7):
        print('ocean!')
        qc3.ry(1.2309594, q[3])
# February 13: IT WAS SUPPOSED TO BE (R2.delta > R1.delta) and (R2.delta > R3.d
# and R2 rather than R1; correct also in the other file!!! (for x-y)
#elif (R1.delta > R2.delta) and (R1.delta > R3.delta): # February 13: THAT MUST
elif (R2.delta > R1.delta) and (R2.delta > R3.delta): # February 13: THAT MUST
    print('dog')
    if (R2.alphax < 0.3): # I have to customize state vectors according to prec
```

```
        qc3.x(q[0])        # just using the NOT gate as a test
    if (R2.alphax == 0.5): # I have to customize state vectors according to pre
        qc3.h(q[0])
    if (R2.alphax >= 0.3) and (R1.alphax < 0.5):
        print('jungle!')
        qc3.ry(1.9106332, q[0])
    if (R2.alphax >= 0.6) and (R1.alphax < 0.7):
        print('ocean!')
        qc3.ry(1.2309594, q[0])
    if (R2.alphay <= 0.2): # else: the qubit sticks with the default value '0'
        qc3.x(q[1])
    if (R2.alphay == 0.5): # I have to customize state vectors according to pre
        qc3.h(q[1])
    if (R2.alphay >= 0.3) and (R1.alphay < 0.5):
        print('jungle!')
        qc3.ry(1.9106332, q[1])
    if (R2.alphay >= 0.6) and (R1.alphay < 0.7):
        print('ocean!')
        qc3.ry(1.2309594, q[1])
    if (R2.alphaz <= 0.2): # else: the qubit sticks with the default value '0'
        qc3.x(q[2])
    if (R2.alphay == 0.5): # I have to customize state vectors according to pre
        qc3.h(q[2])
    if (R2.alphaz >= 0.3) and (R1.alphaz < 0.5):
        print('jungle!')
        qc3.ry(1.9106332, q[2])
    if (R2.alphaz >= 0.6) and (R1.alphaz < 0.7):
        print('ocean!')
        qc3.ry(1.2309594, q[2])
    if (R1.alphaz >= 0.2 and R1.alphax < 0.3):
        print("wolf")
        qc3.x(q[2])
    if (R2.delta == 0.5):
        qc3.h(q[3])
    if (R2.delta == 0.6):
        qc3.h(q[3])
    if (R2.delta >= 0.7):
        qc3.x(q[3])
    if (R2.gamma >= 0.3) and (R1.gamma < 0.5):
        print('jungle!')
        qc3.ry(1.9106332, q[3])
    if (R2.gamma >= 0.6) and (R1.gamma < 0.7):
        print('ocean!')
        qc3.ry(1.2309594, q[3])
else: # February 13: REVISE ALL THIS SECTION!!!!
    print('cat') # I made some tests to check the IF conditions
    if (R3.alphax < 0.3):
        qc3.x(q[0])
    if (R3.alphax == 0.5):
        qc3.h(q[0])
    if (R3.alphax >= 0.3) and (R3.alphax < 0.5):
        print('jungle!')
        qc3.ry(1.9106332, q[0])
    if (R3.alphax >= 0.6) and (R3.alphax < 0.7):
        print('ocean!')
        qc3.ry(1.2309594, q[0])
    if (R3.alphay < 0.3):
        qc3.x(q[1])
    if (R3.alphay == 0.5):
        qc3.h(q[1])
    if (R3.alphay >= 0.3) and (R3.alphay < 0.5):
        print('jungle!')
        qc3.ry(1.9106332, q[1])
    if (R3.alphay >= 0.6) and (R3.alphay < 0.7):
        print('ocean!')
        qc3.ry(1.2309594, q[1])
    if (R3.alphaz < 0.3):
        qc3.x(q[2])
    if (R3.alphaz == 0.5):
        qc3.h(q[2])
    if (R3.alphaz >= 0.3) and (R3.alphaz < 0.5):
        print('jungle!')
        qc3.ry(1.9106332, q[2])
    if (R3.alphaz >= 0.6) and (R3.alphaz < 0.7):
        print('ocean!')
        qc3.ry(1.2309594, q[2])
    if (R3.delta == 0.5):
        qc3.h(q[3])
    if (R3.delta == 0.6):
        qc3.h(q[3])
    if (R3.delta >= 0.7):
        qc3.x(q[3])
    if (R3.gamma >= 0.3) and (R3.gamma < 0.5):
        print('jungle!')
        qc3.ry(1.9106332, q[3])
    if (R3.gamma >= 0.6) and (R3.gamma < 0.7):
        print('ocean!')
        qc3.ry(1.2309594, q[3])
```

```
glu glu
bri
jungle!
ocean!
jungle!
ocean!
wolf
```

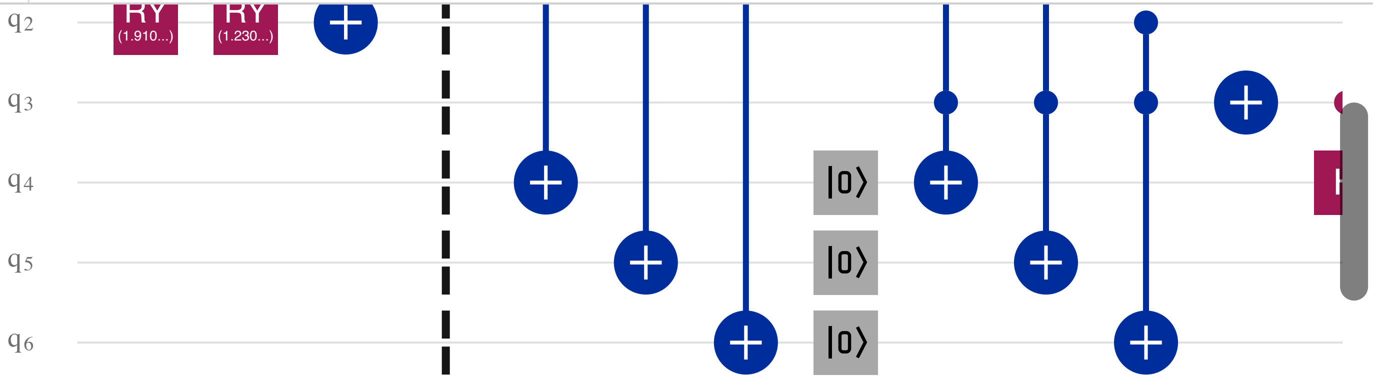
In [53]:

```
# qc3.x(q[1]), qc3.x(q[2]) # just to check
# qc3.h(q[2])
```

Numeration of qubits within IF instructions is slightly different than the initial one. In fact, some distinction across qubits was needed to clearly build the whole circuit later on. Thus, I decided to keep them apart.

In [54]:

```
# this is the core code, and it is unchanged across time

qc3.barrier(q[0], q[1], q[2], q[3], q[4], q[5], q[6])
qc3.ccx(q[0], q[1], q[4])
qc3.ccx(q[0], q[1], q[5])
qc3.ccx(q[0], q[1], q[6])
qc3.reset(q[4])
qc3.reset(q[5])
qc3.reset(q[6])
qc3.ccx(q[0], q[3], q[4])
qc3.ccx(q[1], q[3], q[5])
qc3.ccx(q[2], q[3], q[6])
qc3.x(q[3])
qc3.ch(q[3], q[4])
qc3.ch(q[3], q[5])
qc3.ch(q[3], q[6])
qc3.x(q[3])
qc3.barrier(q[0], q[1], q[2], q[3], q[4], q[5], q[6])
qc3.measure(q[3], m3[0])
qc3.measure(q[4], m4[0])
qc3.measure(q[5], m5[0])
qc3.measure(q[6], m6[0])

# visualization of the ciruit

draw_circuit(qc3)

# definition of quantum simulator

simulator = Aer.get_backend('qasm_simulator') # statevector_simulator # aer_simu
qc3 = transpile(qc3, simulator)
cc = collections.Counter()

# Run and get counts
result = simulator.run(qc3, shots=1024).result()
counts = result.get_counts(qc3)
counts2 = counts.most_frequent() # does not work if multiple states have the san
# decide something if multiple states have the same count --> e.g., ``choose the
counts3 = cc.most_common(2)
print(counts)
print(counts2)
print(counts3)
result = simulator.run(qc3, shots=10, memory=True).result()
memory = result.get_memory(qc3)
print(memory)
plot_histogram(counts, title='outcomes')
# TAKE the TWO more present outcomes
```



c11

c21

c31

In [45]:

```
# keep the two more present outcomes.
```

In [55]:

```
print(counts2) # order: R3, R2, R1. Add some uncertainty?
# export as an array
str = counts2
arr1 = str.split(' ') # to split the string and avoid empty spaces as array elen
print(arr1)
weight1 = 146  # AT HAND ONLY FOR NOW

arr2 = ['0','1','0', '0'] # 111 # 011
print(arr2)
weight2 = 135
# BY HAND ONLY FOR NOW


# an attempt, not so good, to automatize this passage:

print(memory)

data = Counter(memory)
data.most_common()   # Returns all unique items and their counts
data.most_common(3)

print(data.most_common())
print(data.most_common(1))
arrx1 = data.most_common(2)[0]
print(arrx1)
arrx2 = data.most_common(2)[1]
print(arrx2)


```

```
0 0 0 0
['0', '0', '0', '0']
['0', '1', '0', '0']
['0 1 1 0', '0 1 1 0', '1 1 1 0', '1 1 1 0', '0 0 1 0', '1 0 0 0', '0 0 1 0', '0 0
1 0', '1 0 0 0', '1 0 1 0']
[('0 0 1 0', 3), ('0 1 1 0', 2), ('1 1 1 0', 2), ('1 0 0 0', 2), ('1 0 1 0', 1)]
[('0 0 1 0', 3)]
('0 0 1 0', 3)
('0 1 1 0', 2)
```

In [56]:

```
# array 1
arr1
```

Out[56]:

```
['0', '0', '0', '0']
```

In [57]:

```
# array 2
arr2
```

Out[57]:

```
['0', '1', '0', '0']
```

Let us create a sort of weighted sum.

It not convenient to set up q[3], q[4], because we need coordinates attribution....

Now, we re-calculate the positions of the robots that entered the gate. To this aim, use their reward (which is unchanged yet).

In [58]:

```
# February 13: ADD THE z-COMPONENT IN WHAT FOLLOWS
```

Position for R_1:

In [59]:

```python
if (R1.delta > R2.delta) and (R1.delta > R3.delta):
    # if R1 didn't enter the gate, keep its position
    R1.alphax = R1.alphax
    R1.betax = R1.betax
    R1.alphay = R1.alphay
    R1.betay = R1.betay
    R1.alphaz = R1.alphaz
    R1.betaz = R1.betaz
else:
# change of January 28: I'm substituting [0] with [1] and vice versa, because t
# February 15: in the case with xyz, we have [2] first
    if (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight1 - weight2) > 50
        print("bla")
        R1.alphax = 0.3
        R1.betax = 0.7
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight2 - weight1) > 5
        print("gulp")
        R1.alphax = 0.7
        R1.betax = 0.3
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and (weight1 == weight2 or n
        print("stra-gulp")
        R1.alphax = 0.5 # change temporarily made on January 24: random generat
        R1.betax = 0.5 # same as above
    elif (arr1[2] == arr2[0]) and (arr1[2] == '1') and ((weight2 - weight1) > 8
        print("thunderstorm!")
        R1.alphax = 0
        R1.betax = 1
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight2 - weight1) > 2
        print("avalanche!")
        R1.alphax = 0.1
        R1.betax = 0.9
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight2 - weight1) > 2
        print("earthquake!")
        R1.alphax = 0.9
        R1.betax = 0.1
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight1 - weight2) > 2
        print("avalanche bis!")
        R1.alphax = 0.1 # the same also in this case
        R1.betax = 0.9 # the same also in this case
    # same = outcome 0  # January 23
    elif (arr1[2] == arr2[2]) and (arr1[2] == '0') and ((weight1 - weight2) > 5
        print("bla 2")
        R1.alphax = 0.7  # the opposite??
        R1.betax = 0.3  # the opposite??
    elif (arr1[2] == arr2[2]) and (arr1[2] == '0') and ((weight2 - weight1) > 5
        print("gulp 2")
        R1.alphax = 0.3  # the opposite??
        R1.betax = 0.7  # the opposite??
    elif (arr1[2] == arr2[2]) and (arr1[2] == '0') and (weight1 == weight2 or n
        print("stra-gulp 2")
        R1.alphax = 0.5 # change temporarily made on January 24: random generat
        R1.betax = 0.5 # change temporarily made on January 24: random generato
    # different outcomes
    elif arr1[2] != arr2[2]:  # January 23
        print("blue")
        if (arr1[2] != arr2[2]) and (weight1 == weight2 or np.absolute(weight1
            print("google 1")
            R1.alphax = 0.5 # change temporarily made on January 24: random gen
            R1.betax = 0.5 # change temporarily made on January 24: random gene
        if (arr1[2] == '1' and arr2[1] == '0') and (weight1 == weight2 or np.ab
            # include the case of a very small difference!
            print("uffdah")
            R1.alphax = 0.5
            R1.betax = 0.5
        if (arr1[2] == '1' and arr2[1] == '0'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("abc")
                R1.alphax = 0.3
                R1.betax = 0.7
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("bca")
                R1.alphax = 0.7
                R1.betax = 0.3
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("news")
                R1.alphax = 0.2 #
                R1.betax = 0.8 #
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("idea")
                R1.alphax = 0.8 #
                R1.betax = 0.2 #
            if ((weight1 - weight2) > 200 and (weight2 - weight1) >= 800): # no
                print("news")
                R1.alphax = 0.1 #
                R1.betax = 0.9 #
            if ((weight2 - weight1) > 200 and (weight2 - weight1) >= 800): # no
                print("idea")
                R1.alphax = 0.9 #
                R1.betax = 0.1 #
        if (arr1[2] == '0') and (arr2[2] == '1'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("bac")
                R1.alphax = 0.7
                R1.betax = 0.3
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("cba")
                R1.alphax = 0.3
                R1.betax = 0.7
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("brain")
                R1.alphax = 0.7 # 0.9
                R1.betax = 0.3 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("hand")
                R1.alphax = 0.3 # 0.1
                R1.betax = 0.7 # 0.9
            if ((weight1 - weight2) > 200 and (weight2 - weight1) >= 800): # no
                print("brain2")
                R1.alphax = 0.9 # 0.9
                R1.betax = 0.1 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) >= 800): # no
                print("hand2")
                R1.alphax = 0.1 # 0.1
                R1.betax = 0.9 # 0.9
    # y part

    # change of January 26


    if (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight1 - weight2) > 50
        print("bla")
        R1.alphay = 0.3
        R1.betay = 0.7
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight2 - weight1) > 5
        print("gulp")
        R1.alphay = 0.7
        R1.betay = 0.3
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and (weight1 == weight2 or n
        print("stra-gulp")
        R1.alphay = 0.5 # change temporarily made on January 24: random generat
        R1.betay = 0.5 # same as above
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight2 - weight1) > 8
        print("thunderstorm!")
        R1.alphay = 0
        R1.betay = 1 # note of February 15: attention there: [1] rather than [0
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight2 - weight1) > 2
        print("avalanche!")
        R1.alphay = 0.1
        R1.betay = 0.9
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight2 - weight1) > 2
        print("earthquake!")
        R1.alphay = 0.9
        R1.betay = 0.1
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight1 - weight2) > 2
        print("avalanche bis!")
        R1.alphay = 0.1 # the same also in this case
        R1.betay = 0.9 # the same also in this case
    # same = outcome 0  # January 23
    elif (arr1[1] == arr2[1]) and (arr1[1] == '0') and ((weight1 - weight2) > 5
        print("bla 2")
        R1.alphay = 0.7  # the opposite??
        R1.betay = 0.3  # the opposite??
    elif (arr1[1] == arr2[1]) and (arr1[1] == '0') and ((weight2 - weight1) > 5
        print("gulp 2")
        R1.alphay = 0.3  # the opposite??
        R1.betay = 0.7  # the opposite??
    elif (arr1[1] == arr2[1]) and (arr1[1] == '0') and (weight1 == weight2 or n
        print("stra-gulp 2")
        R1.alphay = 0.5 # change temporarily made on January 24: random generat
        R1.betay = 0.5 # change temporarily made on January 24: random generato
    # different outcomes
    elif arr1[1] != arr2[1]:  # January 23
        print("blue")
        if (arr1[1] != arr2[1]) and (weight1 == weight2 or np.absolute(weight1
            print("google 1")
            R1.alphay = 0.5 # change temporarily made on January 24: random gen
            R1.betay = 0.5 # change temporarily made on January 24: random gene
        if (arr1[1] == '1' and arr2[1] == '0') and (weight1 == weight2 or np.ab
            # include the case of a very small difference!
            print("uffdah")
            R1.alphay = 0.5
            R1.betay = 0.5
        if (arr1[1] == '1' and arr2[1] == '0'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("abc")
                R1.alphay = 0.3
                R1.betay = 0.7
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("bca")
                R1.alphay = 0.7
                R1.betay = 0.3
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("news")
                R1.alphay = 0.2 #
                R1.betay = 0.8 #
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("idea")
                R1.alphay = 0.8 #
                R1.betay = 0.2 #
        if (arr1[1] == '0') and (arr2[1] == '1'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("bac")
                R1.alphay = 0.7
                R1.betay = 0.3
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("cba")
                R1.alphay = 0.3
                R1.betay = 0.7
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("brain")
                R1.alphay = 0.7 # 0.9
                R1.betay = 0.3 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("hand")
                R1.alphay = 0.3 # 0.1
                R1.betay = 0.7 # 0.9
            if ((weight1 - weight2) > 200 and (weight1 - weight2) >= 800): # no
                print("brain2")
                R1.alphay = 0.9 # 0.9
                R1.betay = 0.1 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) >= 800): # no
                print("hand2")
                R1.alphay = 0.1 # 0.1
                R1.betay = 0.9 # 0.9


 # z part

    # change of February 15

    if (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight1 - weight2) > 50
        print("bla")
        R1.alphay = 0.3
        R1.betay = 0.7
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight2 - weight1) > 5
        print("gulp")
        R1.alphay = 0.7
        R1.betay = 0.3
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and (weight1 == weight2 or n
        print("stra-gulp")
        R1.alphay = 0.5 # change temporarily made on January 24: random generat
        R1.betay = 0.5 # same as above
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight2 - weight1) > 8
        print("thunderstorm!")
        R1.alphay = 0
        R1.betay = 1 # note of February 15: attention there: [1] rather than [0
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight2 - weight1) > 2
        print("avalanche!")
        R1.alphay = 0.1
        R1.betay = 0.9
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight2 - weight1) > 2
        print("earthquake!")
```

```
            R1.alphay = 0.9
            R1.betay = 0.1
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight1 - weight2) > 2
        print("avalanche bis!")
        R1.alphay = 0.1 # the same also in this case
        R1.betay = 0.9 # the same also in this case
    # same = outcome 0  # January 23
    elif (arr1[0] == arr2[0]) and (arr1[0] == '0') and ((weight1 - weight2) > 5
        print("bla 2")
        R1.alphay = 0.7  # the opposite??
        R1.betay = 0.3  # the opposite??
    elif (arr1[0] == arr2[0]) and (arr1[0] == '0') and ((weight2 - weight1) > 5
        print("gulp 2")
        R1.alphay = 0.3  # the opposite??
        R1.betay = 0.7  # the opposite??
    elif (arr1[0] == arr2[0]) and (arr1[0] == '0') and (weight1 == weight2 or n
        print("stra-gulp 2")
        R1.alphay = 0.5 # change temporarily made on January 24: random generat
        R1.betay = 0.5 # change temporarily made on January 24: random generato
    # different outcomes
    elif arr1[0] != arr2[0]:  # January 23
        print("blue")
        if (arr1[0] != arr2[0]) and (weight1 == weight2 or np.absolute(weight1
            print("google 1")
            R1.alphay = 0.5 # change temporarily made on January 24: random gen
            R1.betay = 0.5 # change temporarily made on January 24: random gene
        if (arr1[0] == '1' and arr2[0] == '0') and (weight1 == weight2 or np.ab
            # include the case of a very small difference!
            print("uffdah")
            R1.alphay = 0.5
            R1.betay = 0.5
        if (arr1[0] == '1' and arr2[0] == '0'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("abc")
                R1.alphay = 0.3
                R1.betay = 0.7
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("bca")
                R1.alphay = 0.7
                R1.betay = 0.3
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("news")
                R1.alphay = 0.2 #
                R1.betay = 0.8 #
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("idea")
                R1.alphay = 0.8 #
                R1.betay = 0.2 #
        if (arr1[0] == '0') and (arr2[0] == '1'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("bac")
                R1.alphay = 0.7
                R1.betay = 0.3
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("cba")
                R1.alphay = 0.3
                R1.betay = 0.7
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("brain")
                R1.alphay = 0.7 # 0.9
                R1.betay = 0.3 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("hand")
                R1.alphay = 0.3 # 0.1
                R1.betay = 0.7 # 0.9
            if ((weight1 - weight2) > 200 and (weight1 - weight2) >= 800): # no
                print("brain2")
                R1.alphay = 0.9 # 0.9
                R1.betay = 0.1 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) >= 800): # no
                print("hand2")
                R1.alphay = 0.1 # 0.1
                R1.betay = 0.9 # 0.9
```

Position for R_2

In [60]:

```
if (R2.delta > R1.delta) and (R2.delta > R3.delta):
    # if R2 didn't entered the gate, keep its position
    R2.alphax = R2.alphax
    R2.betax = R2.betax
    R2.alphay = R2.alphay
    R2.betay = R2.betay
    R2.alphaz = R2.alphaz
    R2.betaz = R2.betaz
else:
# change of January 28: I'm substituting [0] with [1] and vice versa, because t
# February 15: in the case with xyz, we have [2] first
    if (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight1 - weight2) > 50
        print("bla")
        R2.alphax = 0.3
        R2.betax = 0.7
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight2 - weight1) > 5
        print("gulp")
        R2.alphax = 0.7
        R2.betax = 0.3
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and (weight1 == weight2 or n
        print("stra-gulp")
        R2.alphax = 0.5 # change temporarily made on January 24: random generat
        R2.betax = 0.5 # same as above
    elif (arr1[2] == arr2[0]) and (arr1[2] == '1') and ((weight2 - weight1) > 8
        print("thunderstorm!")
        R2.alphax = 0
        R2.betax = 1
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight2 - weight1) > 2
        print("avalanche!")
        R2.alphax = 0.1
        R2.betax = 0.9
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight2 - weight1) > 2
        print("earthquake!")
        R2.alphax = 0.9
        R2.betax = 0.1
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight1 - weight2) > 2
        print("avalanche bis!")
        R2.alphax = 0.1 # the same also in this case
        R2.betax = 0.9 # the same also in this case
    # same = outcome 0  # January 23
    elif (arr1[2] == arr2[2]) and (arr1[2] == '0') and ((weight1 - weight2) > 5
        print("bla 2")
        R2.alphax = 0.7  # the opposite??
        R2.betax = 0.3  # the opposite??
    elif (arr1[2] == arr2[2]) and (arr1[2] == '0') and ((weight2 - weight1) > 5
        print("gulp 2")
        R2.alphax = 0.3  # the opposite??
        R2.betax = 0.7  # the opposite??
    elif (arr1[2] == arr2[2]) and (arr1[2] == '0') and (weight1 == weight2 or n
        print("stra-gulp 2")
        R2.alphax = 0.5 # change temporarily made on January 24: random generat
        R2.betax = 0.5 # change temporarily made on January 24: random generato
    # different outcomes
    elif arr1[2] != arr2[2]:  # January 23
        print("blue")
        if (arr1[2] != arr2[2]) and (weight1 == weight2 or np.absolute(weight1
            print("google 1")
            R2.alphax = 0.5 # change temporarily made on January 24: random gen
            R2.betax = 0.5 # change temporarily made on January 24: random gene
        if (arr1[2] == '1' and arr2[1] == '0') and (weight1 == weight2 or np.ab
            # include the case of a very small difference!
            print("uffdah")
            R2.alphax = 0.5
            R2.betax = 0.5
        if (arr1[2] == '1' and arr2[1] == '0'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("abc")
                R2.alphax = 0.3
                R2.betax = 0.7
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("bca")
                R2.alphax = 0.7
                R2.betax = 0.3
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("news")
                R2.alphax = 0.2 #
                R2.betax = 0.8 #
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("idea")
                R2.alphax = 0.8 #
                R2.betax = 0.2 #
            if ((weight1 - weight2) > 200 and (weight2 - weight1) >= 800): # no
                print("news")
                R2.alphax = 0.1 #
                R2.betax = 0.9 #
            if ((weight2 - weight1) > 200 and (weight2 - weight1) >= 800): # no
                print("idea")
                R2.alphax = 0.9 #
                R2.betax = 0.1 #
        if (arr1[2] == '0') and (arr2[2] == '1'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("bac")
                R2.alphax = 0.7
                R2.betax = 0.3
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("cba")
                R2.alphax = 0.3
                R2.betax = 0.7
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("brain")
                R2.alphax = 0.7 # 0.9
                R2.betax = 0.3 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("hand")
                R2.alphax = 0.3 # 0.1
                R2.betax = 0.7 # 0.9
            if ((weight1 - weight2) > 200 and (weight2 - weight1) >= 800): # no
                print("brain2")
                R2.alphax = 0.9 # 0.9
                R2.betax = 0.1 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) >= 800): # no
                print("hand2")
                R2.alphax = 0.1 # 0.1
                R2.betax = 0.9 # 0.9
    # y part

    # change of January 26


    if (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight1 - weight2) > 50
        print("bla")
        R2.alphay = 0.3
        R2.betay = 0.7
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight2 - weight1) > 5
        print("gulp")
        R2.alphay = 0.7
        R2.betay = 0.3
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and (weight1 == weight2 or n
        print("stra-gulp")
        R2.alphay = 0.5 # change temporarily made on January 24: random generat
        R2.betay = 0.5 # same as above
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight2 - weight1) > 8
        print("thunderstorm!")
        R2.alphay = 0
        R2.betay = 1 # note of February 15: attention there: [1] rather than [0
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight2 - weight1) > 2
        print("avalanche!")
        R2.alphay = 0.1
        R2.betay = 0.9
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight2 - weight1) > 2
        print("earthquake!")
        R2.alphay = 0.9
        R2.betay = 0.1
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight1 - weight2) > 2
        print("avalanche bis!")
        R2.alphay = 0.1 # the same also in this case
        R2.betay = 0.9 # the same also in this case
    # same = outcome 0  # January 23
    elif (arr1[1] == arr2[1]) and (arr1[1] == '0') and ((weight1 - weight2) > 5
        print("bla 2")
        R2.alphay = 0.7  # the opposite??
        R2.betay = 0.3  # the opposite??
    elif (arr1[1] == arr2[1]) and (arr1[1] == '0') and ((weight2 - weight1) > 5
        print("gulp 2")
        R2.alphay = 0.3  # the opposite??
        R2.betay = 0.7  # the opposite??
    elif (arr1[1] == arr2[1]) and (arr1[1] == '0') and (weight1 == weight2 or n
        print("stra-gulp 2")
        R2.alphay = 0.5 # change temporarily made on January 24: random generat
        R2.betay = 0.5 # change temporarily made on January 24: random generato
    # different outcomes
    elif arr1[1] != arr2[1]:  # January 23
        print("blue")
        if (arr1[1] != arr2[1]) and (weight1 == weight2 or np.absolute(weight1
            print("google 1")
            R2.alphay = 0.5 # change temporarily made on January 24: random gen
            R2.betay = 0.5 # change temporarily made on January 24: random gene
        if (arr1[1] == '1' and arr2[1] == '0') and (weight1 == weight2 or np.ab
            # include the case of a very small difference!
            print("uffdah")
            R2.alphay = 0.5
            R2.betay = 0.5
        if (arr1[1] == '1' and arr2[1] == '0'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("abc")
                R2.alphay = 0.3
                R2.betay = 0.7
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("bca")
                R2.alphay = 0.7
                R2.betay = 0.3
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("news")
                R2.alphay = 0.2 #
                R2.betay = 0.8 #
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("idea")
                R2.alphay = 0.8 #
                R2.betay = 0.2 #
        if (arr1[1] == '0') and (arr2[1] == '1'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("bac")
                R2.alphay = 0.7
                R2.betay = 0.3
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("cba")
                R2.alphay = 0.3
                R2.betay = 0.7
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("brain")
                R2.alphay = 0.7 # 0.9
                R2.betay = 0.3 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("hand")
                R2.alphay = 0.3 # 0.1
                R2.betay = 0.7 # 0.9
            if ((weight1 - weight2) > 200 and (weight1 - weight2) >= 800): # no
                print("brain2")
                R2.alphay = 0.9 # 0.9
                R2.betay = 0.1 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) >= 800): # no
                print("hand2")
                R2.alphay = 0.1 # 0.1
                R2.betay = 0.9 # 0.9


 # z part

    # change of February 15

    if (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight1 - weight2) > 50
        print("bla")
        R2.alphay = 0.3
        R2.betay = 0.7
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight2 - weight1) > 5
        print("gulp")
        R2.alphay = 0.7
        R2.betay = 0.3
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and (weight1 == weight2 or n
        print("stra-gulp")
        R2.alphay = 0.5 # change temporarily made on January 24: random generat
        R2.betay = 0.5 # same as above
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight2 - weight1) > 8
        print("thunderstorm!")
        R2.alphay = 0
        R2.betay = 1 # note of February 15: attention there: [1] rather than [0
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight2 - weight1) > 2
        print("avalanche!")
        R2.alphay = 0.1
        R2.betay = 0.9
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight2 - weight1) > 2
        print("earthquake!")
        R2.alphay = 0.9
        R2.betay = 0.1
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight1 - weight2) > 2
        print("avalanche bis!")
        R2.alphay = 0.1 # the same also in this case
        R2.betay = 0.9 # the same also in this case
    # same = outcome 0  # January 23
    elif (arr1[0] == arr2[0]) and (arr1[0] == '0') and ((weight1 - weight2) > 5
        print("bla 2")
        R2.alphay = 0.7  # the opposite??
        R2.betay = 0.3  # the opposite??
    elif (arr1[0] == arr2[0]) and (arr1[0] == '0') and ((weight2 - weight1) > 5
        print("gulp 2")
        R2.alphay = 0.3  # the opposite??
        R2.betay = 0.7  # the opposite??
    elif (arr1[0] == arr2[0]) and (arr1[0] == '0') and (weight1 == weight2 or n
        print("stra-gulp 2")
        R2.alphay = 0.5 # change temporarily made on January 24: random generat
        R2.betay = 0.5 # change temporarily made on January 24: random generato
    # different outcomes
    elif arr1[0] != arr2[0]:  # January 23
        print("blue")
        if (arr1[0] != arr2[0]) and (weight1 == weight2 or np.absolute(weight1
            print("google 1")
            R2.alphay = 0.5 # change temporarily made on January 24: random gen
            R2.betay = 0.5 # change temporarily made on January 24: random gene
        if (arr1[0] == '1' and arr2[0] == '0') and (weight1 == weight2 or np.ab
            # include the case of a very small difference!
            print("uffdah")
            R2.alphay = 0.5
            R2.betay = 0.5
        if (arr1[0] == '1' and arr2[0] == '0'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("abc")
                R2.alphay = 0.3
                R2.betay = 0.7
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("bca")
                R2.alphay = 0.7
                R2.betay = 0.3
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("news")
                R2.alphay = 0.2 #
                R2.betay = 0.8 #
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("idea")
                R2.alphay = 0.8 #
                R2.betay = 0.2 #
        if (arr1[0] == '0') and (arr2[0] == '1'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("bac")
                R2.alphay = 0.7
                R2.betay = 0.3
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("cba")
                R2.alphay = 0.3
                R2.betay = 0.7
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("brain")
                R2.alphay = 0.7 # 0.9
                R2.betay = 0.3 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("hand")
                R2.alphay = 0.3 # 0.1
                R2.betay = 0.7 # 0.9
            if ((weight1 - weight2) > 200 and (weight1 - weight2) >= 800): # no
                print("brain2")
                R2.alphay = 0.9 # 0.9
                R2.betay = 0.1 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) >= 800): # no
                print("hand2")
                R2.alphay = 0.1 # 0.1
                R2.betay = 0.9 # 0.9
```

```
stra-gulp 2
blue
google 1
stra-gulp 2
```

Position for R_3

In [61]:

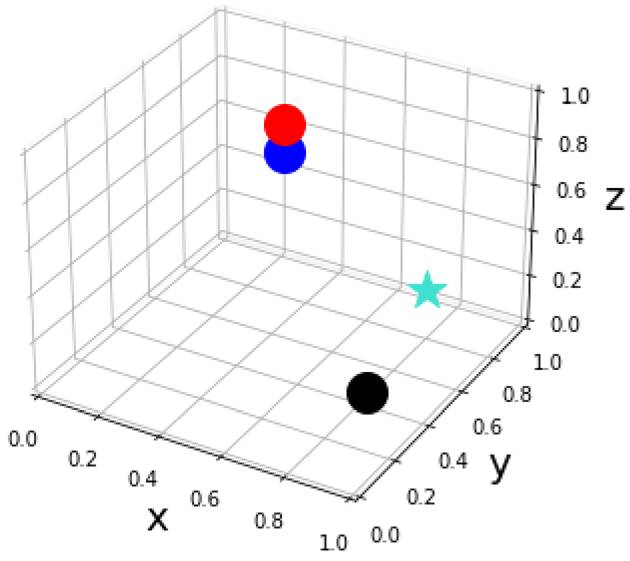
```
if (R3.delta > R1.delta) and (R3.delta > R2.delta):
    # if R3 didn't entered the gate, keep its position
    print("achtung!")
    R3.alphax = R3.alphax
    R3.betax = R3.betax
    R3.alphay = R3.alphay
    R3.betay = R3.betay
    R3.alphaz = R3.alphaz
    R3.betaz = R3.betaz
else:
# change of January 28: I'm substituting [0] with [1] and vice versa, because t
# February 15: in the case with xyz, we have [2] first
    if (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight1 - weight2) > 50
        print("bla")
        R3.alphax = 0.3
        R3.betax = 0.7
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight2 - weight1) > 5
        print("gulp")
        R3.alphax = 0.7
        R3.betax = 0.3
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and (weight1 == weight2 or n
        print("stra-gulp")
        R3.alphax = 0.5 # change temporarily made on January 24: random generat
        R3.betax = 0.5 # same as above
    elif (arr1[2] == arr2[0]) and (arr1[2] == '1') and ((weight2 - weight1) > 8
        print("thunderstorm!")
        R3.alphax = 0
        R3.betax = 1
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight2 - weight1) > 2
        print("avalanche!")
        R3.alphax = 0.1
        R3.betax = 0.9
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight2 - weight1) > 2
        print("earthquake!")
        R3.alphax = 0.9
        R3.betax = 0.1
    elif (arr1[2] == arr2[2]) and (arr1[2] == '1') and ((weight1 - weight2) > 2
        print("avalanche bis!")
        R3.alphax = 0.1 # the same also in this case
        R3.betax = 0.9 # the same also in this case
    # same = outcome 0  # January 23
    elif (arr1[2] == arr2[2]) and (arr1[2] == '0') and ((weight1 - weight2) > 5
        print("bla 2")
        R3.alphax = 0.7  # the opposite??
        R3.betax = 0.3  # the opposite??
    elif (arr1[2] == arr2[2]) and (arr1[2] == '0') and ((weight2 - weight1) > 5
        print("gulp 2")
        R3.alphax = 0.3  # the opposite??
        R3.betax = 0.7  # the opposite??
    elif (arr1[2] == arr2[2]) and (arr1[2] == '0') and (weight1 == weight2 or n
        print("stra-gulp 2")
        R3.alphax = 0.5 # change temporarily made on January 24: random generat
        R3.betax = 0.5 # change temporarily made on January 24: random generato
    # different outcomes
    elif arr1[2] != arr2[2]:  # January 23
        print("blue")
        if (arr1[2] != arr2[2]) and (weight1 == weight2 or np.absolute(weight1
            print("google 1")
            R3.alphax = 0.5 # change temporarily made on January 24: random gen
            R3.betax = 0.5 # change temporarily made on January 24: random gene
        if (arr1[2] == '1' and arr2[1] == '0') and (weight1 == weight2 or np.ab
            # include the case of a very small difference!
            print("uffdah")
            R3.alphax = 0.5
            R3.betax = 0.5
        if (arr1[2] == '1' and arr2[1] == '0'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("abc")
                R3.alphax = 0.3
                R3.betax = 0.7
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("bca")
                R3.alphax = 0.7
                R3.betax = 0.3
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("news")
                R3.alphax = 0.2 #
                R3.betax = 0.8 #
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("idea")
                R3.alphax = 0.8 #
                R3.betax = 0.2 #
            if ((weight1 - weight2) > 200 and (weight2 - weight1) >= 800): # no
                print("news")
                R3.alphax = 0.1 #
                R3.betax = 0.9 #
            if ((weight2 - weight1) > 200 and (weight2 - weight1) >= 800): # no
                print("idea")
                R3.alphax = 0.9 #
                R3.betax = 0.1 #
        if (arr1[2] == '0') and (arr2[2] == '1'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("bac")
                R3.alphax = 0.7
                R3.betax = 0.3
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("cba")
                R3.alphax = 0.3
                R3.betax = 0.7
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("brain")
                R3.alphax = 0.7 # 0.9
                R3.betax = 0.3 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("hand")
                R3.alphax = 0.3 # 0.1
                R3.betax = 0.7 # 0.9
            if ((weight1 - weight2) > 200 and (weight2 - weight1) >= 800): # no
                print("brain2")
                R3.alphax = 0.9 # 0.9
                R3.betax = 0.1 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) >= 800): # no
                print("hand2")
                R3.alphax = 0.1 # 0.1
                R3.betax = 0.9 # 0.9
    # y part

    # change of January 26


    if (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight1 - weight2) > 50
        print("bla")
        R3.alphay = 0.3
        R3.betay = 0.7
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight2 - weight1) > 5
        print("gulp")
        R3.alphay = 0.7
        R3.betay = 0.3
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and (weight1 == weight2 or n
        print("stra-gulp")
        R3.alphay = 0.5 # change temporarily made on January 24: random generat
        R3.betay = 0.5 # same as above
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight2 - weight1) > 8
        print("thunderstorm!")
        R3.alphay = 0
        R3.betay = 1 # note of February 15: attention there: [1] rather than [0
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight2 - weight1) > 2
        print("avalanche!")
        R3.alphay = 0.1
        R3.betay = 0.9
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight2 - weight1) > 2
        print("earthquake!")
        R3.alphay = 0.9
        R3.betay = 0.1
    elif (arr1[1] == arr2[1]) and (arr1[1] == '1') and ((weight1 - weight2) > 2
        print("avalanche bis!")
        R3.alphay = 0.1 # the same also in this case
        R3.betay = 0.9 # the same also in this case
    # same = outcome 0  # January 23
    elif (arr1[1] == arr2[1]) and (arr1[1] == '0') and ((weight1 - weight2) > 5
        print("bla 2")
        R3.alphay = 0.7  # the opposite??
        R3.betay = 0.3  # the opposite??
    elif (arr1[1] == arr2[1]) and (arr1[1] == '0') and ((weight2 - weight1) > 5
        print("gulp 2")
        R3.alphay = 0.3  # the opposite??
        R3.betay = 0.7  # the opposite??
    elif (arr1[1] == arr2[1]) and (arr1[1] == '0') and (weight1 == weight2 or n
        print("stra-gulp 2")
        R3.alphay = 0.5 # change temporarily made on January 24: random generat
        R3.betay = 0.5 # change temporarily made on January 24: random generato
    # different outcomes
    elif arr1[1] != arr2[1]:  # January 23
        print("blue")
        if (arr1[1] != arr2[1]) and (weight1 == weight2 or np.absolute(weight1
            print("google 1")
            R3.alphay = 0.5 # change temporarily made on January 24: random gen
            R3.betay = 0.5 # change temporarily made on January 24: random gene
        if (arr1[1] == '1' and arr2[1] == '0') and (weight1 == weight2 or np.ab
            # include the case of a very small difference!
            print("uffdah")
            R3.alphay = 0.5
            R3.betay = 0.5
        if (arr1[1] == '1' and arr2[1] == '0'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("abc")
                R3.alphay = 0.3
                R3.betay = 0.7
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("bca")
                R3.alphay = 0.7
                R3.betay = 0.3
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("news")
                R3.alphay = 0.2 #
                R3.betay = 0.8 #
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("idea")
                R3.alphay = 0.8 #
                R3.betay = 0.2 #
        if (arr1[1] == '0') and (arr2[1] == '1'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("bac")
                R3.alphay = 0.7
                R3.betay = 0.3
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("cba")
                R3.alphay = 0.3
                R3.betay = 0.7
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("brain")
                R3.alphay = 0.7 # 0.9
                R3.betay = 0.3 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("hand")
                R3.alphay = 0.3 # 0.1
                R3.betay = 0.7 # 0.9
            if ((weight1 - weight2) > 200 and (weight1 - weight2) >= 800): # no
                print("brain2")
                R3.alphay = 0.9 # 0.9
                R3.betay = 0.1 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) >= 800): # no
                print("hand2")
                R3.alphay = 0.1 # 0.1
                R3.betay = 0.9 # 0.9


 # z part

    # change of February 15

    if (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight1 - weight2) > 50
        print("bla")
        R3.alphay = 0.3
        R3.betay = 0.7
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight2 - weight1) > 5
        print("gulp")
        R3.alphay = 0.7
        R3.betay = 0.3
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and (weight1 == weight2 or n
        print("stra-gulp")
        R3.alphay = 0.5 # change temporarily made on January 24: random generat
        R3.betay = 0.5 # same as above
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight2 - weight1) > 8
        print("thunderstorm!")
        R3.alphay = 0
        R3.betay = 1 # note of February 15: attention there: [1] rather than [0
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight2 - weight1) > 2
        print("avalanche!")
        R3.alphay = 0.1
        R3.betay = 0.9
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight2 - weight1) > 2
```

```python
        print("earthquake!")
        R3.alphay = 0.9
        R3.betay = 0.1
    elif (arr1[0] == arr2[0]) and (arr1[0] == '1') and ((weight1 - weight2) > 2
        print("avalanche bis!")
        R3.alphay = 0.1 # the same also in this case
        R3.betay = 0.9 # the same also in this case
    # same = outcome 0  # January 23
    elif (arr1[0] == arr2[0]) and (arr1[0] == '0') and ((weight1 - weight2) > 5
        print("bla 2")
        R3.alphay = 0.7  # the opposite??
        R3.betay = 0.3  # the opposite??
    elif (arr1[0] == arr2[0]) and (arr1[0] == '0') and ((weight2 - weight1) > 5
        print("gulp 2")
        R3.alphay = 0.3  # the opposite??
        R3.betay = 0.7  # the opposite??
    elif (arr1[0] == arr2[0]) and (arr1[0] == '0') and (weight1 == weight2 or n
        print("stra-gulp 2")
        R3.alphay = 0.5 # change temporarily made on January 24: random generat
        R3.betay = 0.5 # change temporarily made on January 24: random generato
    # different outcomes
    elif arr1[0] != arr2[0]:  # January 23
        print("blue")
        if (arr1[0] != arr2[0]) and (weight1 == weight2 or np.absolute(weight1
            print("google 1")
            R3.alphay = 0.5 # change temporarily made on January 24: random gen
            R3.betay = 0.5 # change temporarily made on January 24: random gene
        if (arr1[0] == '1' and arr2[0] == '0') and (weight1 == weight2 or np.ab
            # include the case of a very small difference!
            print("uffdah")
            R3.alphay = 0.5
            R3.betay = 0.5
        if (arr1[0] == '1' and arr2[0] == '0'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("abc")
                R3.alphay = 0.3
                R3.betay = 0.7
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("bca")
                R3.alphay = 0.7
                R3.betay = 0.3
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("news")
                R3.alphay = 0.2 #
                R3.betay = 0.8 #
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("idea")
                R3.alphay = 0.8 #
                R3.betay = 0.2 #
        if (arr1[0] == '0') and (arr2[0] == '1'):
            if (weight1 - weight2 >= 50 and weight1 - weight2 <= 200):
                print("bac")
                R3.alphay = 0.7
                R3.betay = 0.3
            if (weight2 - weight1 >= 50 and weight1 - weight2 <= 200):
                print("cba")
                R3.alphay = 0.3
                R3.betay = 0.7
            if ((weight1 - weight2) > 200 and (weight1 - weight2) < 800): # no
                print("brain")
                R3.alphay = 0.7 # 0.9
                R3.betay = 0.3 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) < 800): # no
                print("hand")
                R3.alphay = 0.3 # 0.1
                R3.betay = 0.7 # 0.9
            if ((weight1 - weight2) > 200 and (weight1 - weight2) >= 800): # no
                print("brain2")
                R3.alphay = 0.9 # 0.9
                R3.betay = 0.1 # 0.1
            if ((weight2 - weight1) > 200 and (weight2 - weight1) >= 800): # no
                print("hand2")
                R3.alphay = 0.1 # 0.1
                R3.betay = 0.9 # 0.9
```

```
stra-gulp 2
blue
google 1
stra-gulp 2
```

In [62]:

```
fig = plt.figure()

ax = Axes3D(fig, auto_add_to_figure=False)
fig.add_axes(ax)

ax.set_xlim3d(0, 1)
ax.set_ylim3d(0, 1)
ax.set_zlim3d(0, 1)

ax.xaxis.pane.fill = False
ax.yaxis.pane.fill = False
ax.zaxis.pane.fill = False

ax.set_xlabel('x', fontsize=20)
ax.set_ylabel('y', fontsize=20)
ax.set_zlabel('z', fontsize=20) # r'\alpha'

ax.scatter3D(R1.betax, R1.betay, R1.betaz, s = 400, marker = 'o', color = 'black
ax.scatter3D(R2.betax, R2.betay, R2.betaz, s = 400, marker = 'o', color = 'red')
ax.scatter3D(R3.betax, R3.betay, R3.betaz, s = 400, marker = 'o', color = 'blue'
# ax.scatter3D(R4_[0], R4_[1], R4_[2], s = 400, marker = 'o', color = 'green')
ax.scatter3D(T.x, T.y, T.z, s = 400, marker = '*', color = 'turquoise')

plt.show()

# find how to automatically create trajectories: maybe LinePlot between R1, R2,
```



In [63]:

```
# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB2.mp3")
            print("cB2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#2.mp3")
            print("cC#2")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#2.mp3")
            print("cA#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD2.mp3")
            print("cD2")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#2.mp3")
            print("cD#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA2.mp3")
            print("cA2")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE2.mp3")
            print("cE2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#2.mp3")
            print("cG#2")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF2.mp3")
            print("cF2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG2.mp3")
            print("cG2")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#2.mp3")
        print("cF#2")

mixed_time6_ = audio1.overlay(audio2)          # combine , superimpose audio fi
mixed_time6  = mixed_time6_.overlay(audio3)          # further combine , superi

mixed_time6.export("notes_/mixed_time6.mp3", format='mp3') # export mixed  audi
play(mixed_time6)                                      # play mixed audio file
# change this line at each time point, so in the end we can get a little piece

```

```
tF#2
fA
cA
Could not import the PyAudio C module '_portaudio'.

Input #0, wav, from '/var/folders/tc/5k6bdv0s421bnc52mnnj7p_w0000gn/T/tmpcmlep9_e.
wav':
  Duration: 00:00:07.34, bitrate: 1411 kb/s
  Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 44100 Hz, 2 channels, s1
6, 1411 kb/s
   7.24 M-A:  0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
   7.27 M-A:   0.000 fd=    0 aq=     0KB vq=     0KB sq=     0B f=0/0
```

And only NOW, change their rewards according to the new positions! If a robot didn't change the position, the reward will remain the same.

In [64]:

```
# the former ones

R1.delta, R2.delta, R3.delta
```

Out[64]:

```
(0.34, 0.19, 0.03)
```

In [65]:

```
# the new ones

R1.delta = reward(T, R1.betax, R1.betay, R1.betaz)
print(R1.delta)

R2.delta = reward(T, R2.betax, R2.betay, R2.betaz)
print(R2.delta)

R3.delta = reward(T, R3.betax, R3.betay, R3.betaz)
print(R3.delta)
```

```
0.34
0.1
0.2
```

In [ ]:

```

```

In [66]:

```
# January 28: SOS with a higher threshold
```

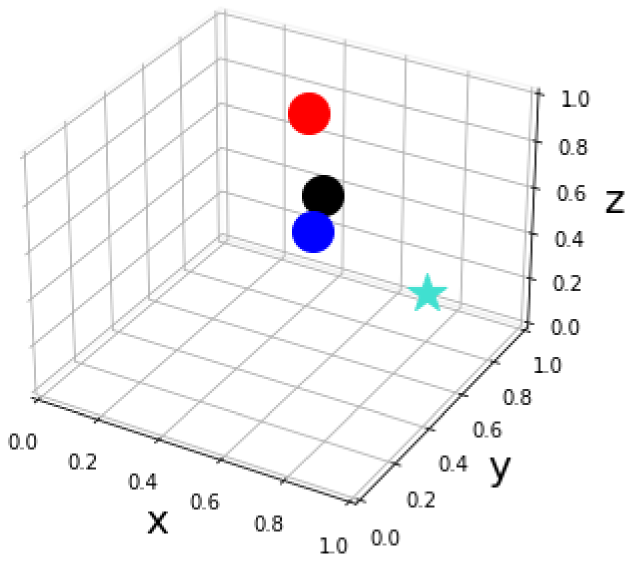
In [67]:

```python
# Another round of SOS with a higher threshold. Added on January 28

# threshold for initial reward
# random fluctuations

if (R1.delta <= 0.6) and (R2.delta <= 0.6) and (R3.delta <= 0.6):
    print("SOS")
    # R1
    R1.alphax = round(np.random.uniform(0,0.9), 3)
    R1.betax = round(1 - R1.alphax, 3)
    print("the new x-positions for R1 are: ", R1.alphax, R1.betax)
    R1.alphay = round(np.random.uniform(0,0.9), 3)
    R1.betay = round(1 - R1.alphay, 3)
    print("the new y-positions for R1 are: ", R1.alphay, R1.betay)
    R1.alphaz = round(np.random.uniform(0,0.9), 3)
    R1.betaz = round(1 - R1.alphaz, 3)
    print("the new y-positions for R1 are: ", R1.alphaz, R1.betaz)
    # R2
    R2.alphax = round(np.random.uniform(0,0.9), 3)
    R2.betax = round(1 - R2.alphax, 3)
    print("the new x-positions for R2 are: ", R2.alphax, R1.betax)
    R2.alphay = round(np.random.uniform(0,0.9), 3)
    R2.betay = round(1 - R2.alphay, 3)
    print("the new y-positions for R2 are: ", R2.alphay, R1.betay)
    R2.alphaz = round(np.random.uniform(0,0.9), 3)
    R2.betaz = round(1 - R2.alphaz, 3)
    print("the new y-positions for R2 are: ", R2.alphay, R1.betay)
    # R3
    R3.alphax = round(np.random.uniform(0,0.9), 3)
    R3.betax = round(1 - R3.alphax, 3)
    print("the new x-positions for R3 are: ", R3.alphax, R1.betax)
    R3.alphay = round(np.random.uniform(0,0.9), 3)
    R3.betay = round(1 - R3.alphay, 3)
    print("the new y-positions for R3 are: ", R3.alphay, R1.betay)
    R3.alphaz = round(np.random.uniform(0,0.9), 3)
    R3.betaz = round(1 - R3.alphaz, 3)
    print("the new y-positions for R3 are: ", R3.alphaz, R1.betaz)

R1.delta = reward(T, R1.betax, R1.betay, R1.betaz)
R1.gamma = 1 - R1.delta
R2.delta = reward(T, R2.betax, R2.betay, R1.betaz)
R2.gamma = 1 - R2.delta
R3.delta = reward(T, R3.betax, R3.betay, R1.betaz)
R3.gamma = 1 - R3.delta
print(R1.delta, R2.delta, R3.delta, R1.betaz)
```

```
SOS
the new x-positions for R1 are:  0.467 0.533
the new y-positions for R1 are:  0.345 0.655
the new y-positions for R1 are:  0.378 0.622
the new x-positions for R2 are:  0.646 0.533
the new y-positions for R2 are:  0.114 0.655
the new y-positions for R2 are:  0.114 0.655
the new x-positions for R3 are:  0.196 0.533
the new y-positions for R3 are:  0.879 0.655
the new y-positions for R3 are:  0.08 0.622
0.48 0.38 0.2 0.622
```

In [68]:

```
fig = plt.figure()

ax = Axes3D(fig, auto_add_to_figure=False)
fig.add_axes(ax)

ax.set_xlim3d(0, 1)
ax.set_ylim3d(0, 1)
ax.set_zlim3d(0, 1)

ax.xaxis.pane.fill = False
ax.yaxis.pane.fill = False
ax.zaxis.pane.fill = False

ax.set_xlabel('x', fontsize=20)
ax.set_ylabel('y', fontsize=20)
ax.set_zlabel('z', fontsize=20) # r'\alpha'

ax.scatter3D(R1.betax, R1.betay, R1.betaz, s = 400, marker = 'o', color = 'black
ax.scatter3D(R2.betax, R2.betay, R2.betaz, s = 400, marker = 'o', color = 'red')
ax.scatter3D(R3.betax, R3.betay, R3.betaz, s = 400, marker = 'o', color = 'blue'
# ax.scatter3D(R4_[0], R4_[1], R4_[2], s = 400, marker = 'o', color = 'green')
ax.scatter3D(T.x, T.y, T.z, s = 400, marker = '*', color = 'turquoise')

plt.show()

# find how to automatically create trajectories: maybe LinePlot between R1, R2,
```



In [69]:

```
# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB2.mp3")
            print("cB2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#2.mp3")
            print("cC#2")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#2.mp3")
            print("cA#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD2.mp3")
            print("cD2")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#2.mp3")
            print("cD#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA2.mp3")
            print("cA2")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE2.mp3")
            print("cE2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#2.mp3")
            print("cG#2")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF2.mp3")
            print("cF2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG2.mp3")
            print("cG2")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#2.mp3")
        print("cF#2")

mixed_time7_ = audio1.overlay(audio2)          # combine , superimpose audio fi
mixed_time7  = mixed_time7_.overlay(audio3)          # further combine , superi

mixed_time7.export("notes_/mixed_time7.mp3", format='mp3') # export mixed  audi
play(mixed_time7)                              # play mixed audio file
# change this line at each time point, so in the end we can get a little piece

```

```
tG#
fA
cF
Could not import the PyAudio C module '_portaudio'.

Input #0, wav, from '/var/folders/tc/5k6bdv0s421bnc52mnnj7p_w0000gn/T/tmp793msb5n.
wav':
  Duration: 00:00:07.31, bitrate: 1411 kb/s
  Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 44100 Hz, 2 channels, s1
6, 1411 kb/s
   7.21 M-A:  0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
   7.25 M-A: -0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
```

In [70]:

```
# January 22, 2022
```

In [ ]:

```

```

NEW LINES of code: IF the initial reward is very high (greater than 0.8) for at least one of the three robots ("or"), THEN the other robots have to just reach it (with a pretty small fluctuation), without entering the circuit.

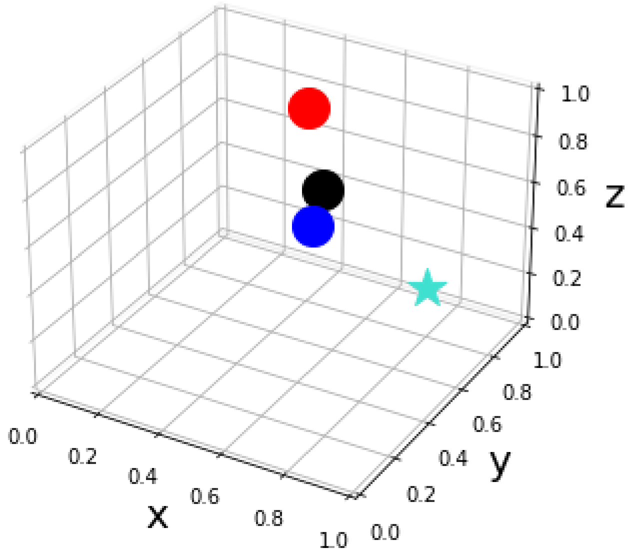
In [71]:

```python
if((R1.delta >= 0.8) or (R2.delta >= 0.8) or (R3.delta >= 0.8)):
    print('yuk')
    if (R1.delta > R2.delta and R1.delta > R3.delta):
        print('quokka')
        R2.betax = round(R1.betax + np.random.uniform(0,0.1), 3) # Here and late
        R2.alphax = round(1 - R2.betax, 3)
        R2.betay = round(R1.betay + np.random.uniform(0,0.1), 3)
        R2.alphay = round(1 - R2.betay, 3)
        R2.betaz = round(R1.betaz + np.random.uniform(0,0.1), 3)
        R2.alphaz = round(1 - R2.betaz, 3)
        R3.betax = round(R1.betax + np.random.uniform(0,0.1), 3)
        R3.alphax = round(1 - R2.betax, 3)
        R3.betay = round(R1.betay + np.random.uniform(0,0.1), 3)
        R3.alphay = round(1 - R2.betay, 3)
        R3.betaz = round(R1.betay + np.random.uniform(0,0.1), 3)
        R3.alphaz = round(1 - R2.betaz, 3)
    if (R2.delta > R1.delta and R2.delta > R3.delta):
        print('quagga')
        R1.betax = round(R2.betax + np.random.uniform(0,0.1), 3)
        R1.alphax = round(1 - R1.betax, 3)
        R1.betay = round(R2.betay + np.random.uniform(0,0.1), 3)
        R1.alphay = round(1 - R1.betay, 3)
        R1.betaz = round(R2.betaz + np.random.uniform(0,0.1), 3)
        R1.alphaz = round(1 - R1.betaz, 3)
        R3.betax = round(R2.betax + np.random.uniform(0,0.1), 3)
        R3.alphax = round(1 - R3.betax, 3)
        R3.betay = round(R2.betay + np.random.uniform(0,0.1), 3)
        R3.alphay = round(1 - R3.betay, 3)
        R3.betaz = round(R2.betaz + np.random.uniform(0,0.1), 3)
        R3.alphaz = round(1 - R3.betaz, 3)
    if (R3.delta > R1.delta and R3.delta > R2.delta):
        print('quark')
        R1.betax = round(R3.betax + np.random.uniform(0,0.1), 3)
        R1.alphax = round(1 - R1.betax, 3)
        R1.betay = round(R3.betay + np.random.uniform(0,0.1), 3)
        R1.alphay = round(1 - R1.betay, 3)
        R1.betaz = round(R3.betaz + np.random.uniform(0,0.1), 3)
        R1.alphaz = round(1 - R1.betaz, 3)
        R2.betax = round(R3.betax + np.random.uniform(0,0.1), 3)
        R2.alphax = round(1 - R2.betax, 3)
        R2.betay = round(R3.betay + np.random.uniform(0,0.1), 3)
        R2.alphay = round(1 - R2.betay, 3)
        R2.betaz = round(R3.betaz + np.random.uniform(0,0.1), 3)
        R2.alphaz = round(1 - R2.betaz, 3)

R1.delta = reward(T, R1.betax, R1.betay, R1.betaz)
print(R1.delta)

R2.delta = reward(T, R2.betax, R2.betay, R2.betaz)
print(R2.delta)

R3.delta = reward(T, R3.betax, R3.betay, R3.betaz)
print(R2.delta)
```

```
0.48
0.27
0.27
```

In [72]:

```
fig = plt.figure()

ax = Axes3D(fig, auto_add_to_figure=False)
fig.add_axes(ax)

ax.set_xlim3d(0, 1)
ax.set_ylim3d(0, 1)
ax.set_zlim3d(0, 1)

ax.xaxis.pane.fill = False
ax.yaxis.pane.fill = False
ax.zaxis.pane.fill = False

ax.set_xlabel('x', fontsize=20)
ax.set_ylabel('y', fontsize=20)
ax.set_zlabel('z', fontsize=20) # r'\alpha'

ax.scatter3D(R1.betax, R1.betay, R1.betaz, s = 400, marker = 'o', color = 'black
ax.scatter3D(R2.betax, R2.betay, R2.betaz, s = 400, marker = 'o', color = 'red')
ax.scatter3D(R3.betax, R3.betay, R3.betaz, s = 400, marker = 'o', color = 'blue'
# ax.scatter3D(R4_[0], R4_[1], R4_[2], s = 400, marker = 'o', color = 'green')
ax.scatter3D(T.x, T.y, T.z, s = 400, marker = '*', color = 'turquoise')

plt.show()

# find how to automatically create trajectories: maybe LinePlot between R1, R2,
```



Now, all robots reach the robot with the highest reward, with fluctuations:

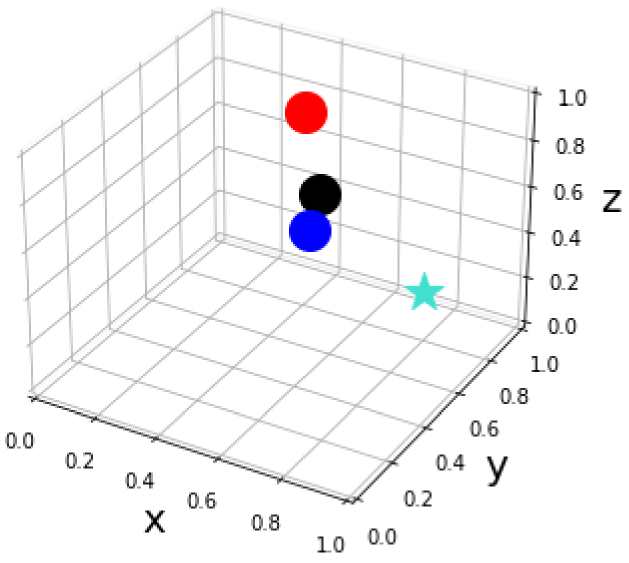
In [73]:

```
# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB2.mp3")
            print("cB2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#2.mp3")
            print("cC#2")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#2.mp3")
            print("cA#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD2.mp3")
            print("cD2")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#2.mp3")
            print("cD#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA2.mp3")
            print("cA2")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE2.mp3")
            print("cE2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#2.mp3")
            print("cG#2")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF2.mp3")
            print("cF2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG2.mp3")
            print("cG2")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#2.mp3")
        print("cF#2")

mixed_time8_ = audio1.overlay(audio2)        # combine , superimpose audio fi
mixed_time8  = mixed_time8_.overlay(audio3)        # further combine , superi

mixed_time8.export("notes_/mixed_time8.mp3", format='mp3') # export mixed  audi
play(mixed_time8)                           # play mixed audio file
# change this line at each time point, so in the end we can get a little piece

```

```
tG#
fA
cF
Could not import the PyAudio C module '_portaudio'.

Input #0, wav, from '/var/folders/tc/5k6bdv0s421bnc52mnnj7p_w0000gn/T/tmp3rm68zf7.
wav':
  Duration: 00:00:07.31, bitrate: 1411 kb/s
  Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 44100 Hz, 2 channels, s1
6, 1411 kb/s
   7.18 M-A: -0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
   7.25 M-A:   0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
```

In [74]:

```
fig = plt.figure()

ax = Axes3D(fig, auto_add_to_figure=False)
fig.add_axes(ax)

ax.set_xlim3d(0, 1)
ax.set_ylim3d(0, 1)
ax.set_zlim3d(0, 1)

ax.xaxis.pane.fill = False
ax.yaxis.pane.fill = False
ax.zaxis.pane.fill = False

ax.set_xlabel('x', fontsize=20)
ax.set_ylabel('y', fontsize=20)
ax.set_zlabel('z', fontsize=20) # r'\alpha'

ax.scatter3D(R1.betax, R1.betay, R1.betaz, s = 400, marker = 'o', color = 'black
ax.scatter3D(R2.betax, R2.betay, R2.betaz, s = 400, marker = 'o', color = 'red')
ax.scatter3D(R3.betax, R3.betay, R3.betaz, s = 400, marker = 'o', color = 'blue'
# ax.scatter3D(R4_[0], R4_[1], R4_[2], s = 400, marker = 'o', color = 'green')
ax.scatter3D(T.x, T.y, T.z, s = 400, marker = '*', color = 'turquoise')

plt.show()

# find how to automatically create trajectories: maybe LinePlot between R1, R2,
```



In [75]:

```
# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB2.mp3")
            print("cB2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#2.mp3")
            print("cC#2")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#2.mp3")
            print("cA#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD2.mp3")
            print("cD2")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#2.mp3")
            print("cD#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA2.mp3")
            print("cA2")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE2.mp3")
            print("cE2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#2.mp3")
            print("cG#2")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF2.mp3")
            print("cF2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG2.mp3")
            print("cG2")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#2.mp3")
        print("cF#2")

mixed_time9_ = audio1.overlay(audio2)          # combine , superimpose audio fi
mixed_time9  = mixed_time9_.overlay(audio3)          # further combine , superi

mixed_time9.export("notes_/mixed_time9.mp3", format='mp3') # export mixed  audi
play(mixed_time9)                             # play mixed audio file
# change this line at each time point, so in the end we can get a little piece

```

```
tG#
fA
cF
Could not import the PyAudio C module '_portaudio'.

Input #0, wav, from '/var/folders/tc/5k6bdv0s421bnc52mnnj7p_w0000gn/T/tmp6su7r1cb.
wav':
  Duration: 00:00:07.31, bitrate: 1411 kb/s
  Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 44100 Hz, 2 channels, s1
6, 1411 kb/s
   7.26 M-A:  0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
```

Let us now update $\gamma,\ \delta_i,\ i = 1, 2, 3$ according to the target (fixed) positions and the new positions.

New reward amplitude probabilities for R_1:

In [76]:

```
R1.delta = reward(T,R1.betax,R1.betay, R1.betaz)
R1.gamma = round((1 - R1.delta),3)
print(R1.delta)
```

```
0.48
```

New reward amplitude probabilities for R_2:

In [77]:

```
R2.delta = reward(T,R2.betax,R2.betay, R2.betaz)
R2.gamma = round((1 - R2.delta),3)
print(R2.delta)
```

```
0.27
```

New reward amplitude probabilities for R_3:

In [78]:

```
R3.delta = reward(T,R3.betax,R3.betay,R3.betaz)
R3.gamma = round((1 - R3.delta),3)
print(R3.delta)
```

```
0.01
```

In [79]:

```
# January 22, 2022
```

NEW LINES of code: IF the initial reward is very high (greater than 0.8) for at least one of the three robots ("or"), THEN the other robots have to just reach it (with a pretty small fluctuation), without entering the circuit.

In [80]:

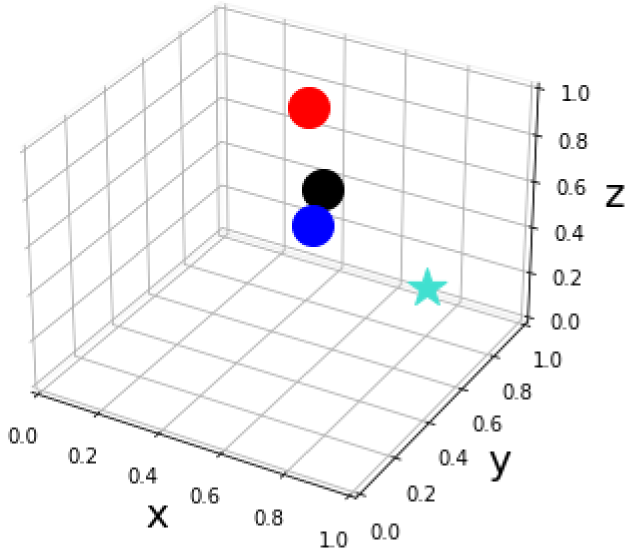
```
# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
```

```python
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB2.mp3")
            print("cB2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#2.mp3")
            print("cC#2")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#2.mp3")
            print("cA#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD2.mp3")
            print("cD2")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#2.mp3")
            print("cD#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA2.mp3")
            print("cA2")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE2.mp3")
            print("cE2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#2.mp3")
            print("cG#2")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF2.mp3")
            print("cF2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG2.mp3")
            print("cG2")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#2.mp3")
        print("cF#2")

mixed_time10_ = audio1.overlay(audio2)          # combine , superimpose audio f
mixed_time10  = mixed_time10_.overlay(audio3)          # further combine , supe

mixed_time10.export("notes_/mixed_time10.mp3", format='mp3') # export mixed  au
play(mixed_time10)                                     # play mixed audio file
# change this line at each time point, so in the end we can get a little piece

```

```
tG#
fA
cF
Could not import the PyAudio C module '_portaudio'.

Input #0, wav, from '/var/folders/tc/5k6bdv0s421bnc52mnnj7p_w0000gn/T/tmpu44d4icv.
wav':
  Duration: 00:00:07.31, bitrate: 1411 kb/s
  Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 44100 Hz, 2 channels, s1
6, 1411 kb/s
   7.24 M-A:  0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
```

In [81]:

```
fig = plt.figure()

ax = Axes3D(fig, auto_add_to_figure=False)
fig.add_axes(ax)

ax.set_xlim3d(0, 1)
ax.set_ylim3d(0, 1)
ax.set_zlim3d(0, 1)

ax.xaxis.pane.fill = False
ax.yaxis.pane.fill = False
ax.zaxis.pane.fill = False

ax.set_xlabel('x', fontsize=20)
ax.set_ylabel('y', fontsize=20)
ax.set_zlabel('z', fontsize=20) # r'\alpha'

ax.scatter3D(R1.betax, R1.betay, R1.betaz, s = 400, marker = 'o', color = 'black
ax.scatter3D(R2.betax, R2.betay, R2.betaz, s = 400, marker = 'o', color = 'red')
ax.scatter3D(R3.betax, R3.betay, R3.betaz, s = 400, marker = 'o', color = 'blue'
# ax.scatter3D(R4_[0], R4_[1], R4_[2], s = 400, marker = 'o', color = 'green')
ax.scatter3D(T.x, T.y, T.z, s = 400, marker = '*', color = 'turquoise')

plt.show()

# find how to automatically create trajectories: maybe LinePlot between R1, R2,
```



In [82]:

```
# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB2.mp3")
            print("cB2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#2.mp3")
            print("cC#2")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#2.mp3")
            print("cA#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD2.mp3")
            print("cD2")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#2.mp3")
            print("cD#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA2.mp3")
            print("cA2")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE2.mp3")
            print("cE2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#2.mp3")
            print("cG#2")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF2.mp3")
            print("cF2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG2.mp3")
            print("cG2")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#2.mp3")
        print("cF#2")

mixed_time11_ = audio1.overlay(audio2)          # combine , superimpose audio f
mixed_time11  = mixed_time11_.overlay(audio3)          # further combine , supe

mixed_time11.export("notes_/mixed_time11.mp3", format='mp3') # export mixed  au
play(mixed_time11)                             # play mixed audio file
# change this line at each time point, so in the end we can get a little piece

```

```
tG#
fA
cF
Could not import the PyAudio C module '_portaudio'.

Input #0, wav, from '/var/folders/tc/5k6bdv0s421bnc52mnnj7p_w0000gn/T/tmp7r7vuozh.
wav':
  Duration: 00:00:07.31, bitrate: 1411 kb/s
  Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 44100 Hz, 2 channels, s1
6, 1411 kb/s
   7.22 M-A: -0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
```

Let us now try to use entanglement, teleportation, or what is needed, to somehow `glue' together two or more robots which are pretty close to the target.

In [83]:

```
# to be improved: probabilistic representation of positions for more position-u
# Python probability plot???
```

When we measure the position of R_1 and we get 1, 1, also R_2 are R_3 in 1, 1. If we measure and we get 0, 0, also R_2, R_3 are in 0, 0. In the following code lines, I separated x, y for clarity, but the idea is the same. In this way, we create an entangled GHZ state $\frac{1}{\sqrt{2}}(|11111\rangle + |00000\rangle)$, where the qubits indicate x- and y-positions. Reward is not included in this discussion, because this section is activated only if all robots present almost the same reward (here, pairwise difference ≤ 0.1).

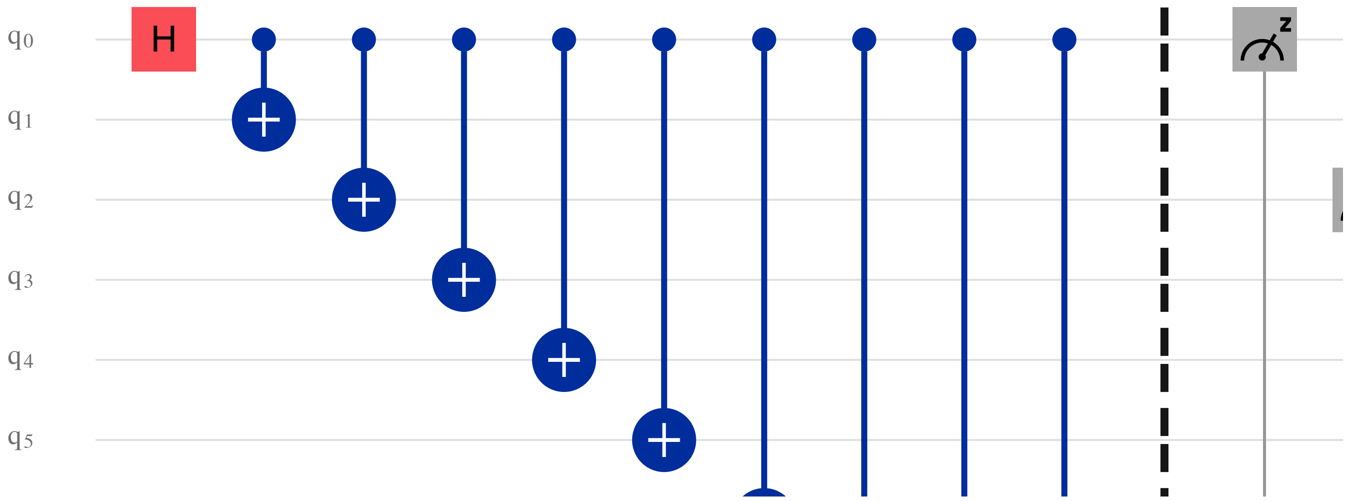
In [102]:

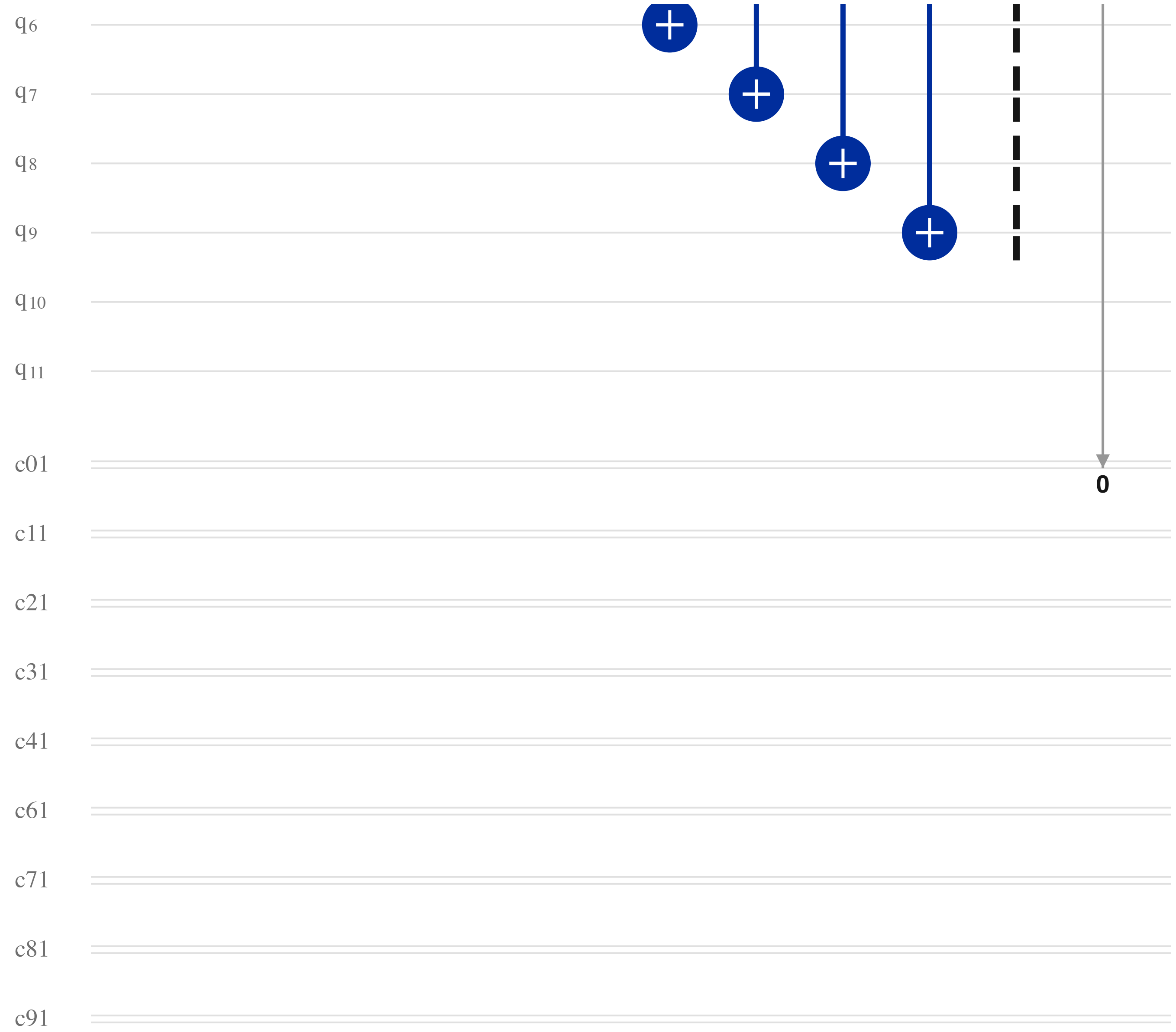
```
# a new circuit
q = QuantumRegister(12, 'q'); # qubits # it was 9; here, for 3D, we have 12
#c0 = ClassicalRegister(6, 'c0');
c0 = ClassicalRegister(1, 'c0');
c1 = ClassicalRegister(1, 'c1');
c2 = ClassicalRegister(1, 'c2');
c3 = ClassicalRegister(1, 'c3');
c4 = ClassicalRegister(1, 'c4');
c6 = ClassicalRegister(1, 'c6');
c7 = ClassicalRegister(1, 'c7');
c8 = ClassicalRegister(1, 'c8');
c9 = ClassicalRegister(1, 'c9');
qc_small = QuantumCircuit(q, c0, c1, c2, c3, c4, c6, c7, c8, c9);
```

In [103]:

```
if ((R3.delta - R2.delta) <= 0.3) and ((R3.delta - R1.delta) <= 0.3) and ((R2.de
    # 0.3 rather than 0.1
    print("cometa")# GHZ for all
    qc_small.h(q[0]) # Hadamard
    qc_small.cx(q[0], q[1]) # CNOT
    qc_small.cx(q[0], q[2]) # CNOT
    qc_small.cx(q[0], q[3]) # CNOT
    qc_small.cx(q[0], q[4]) # CNOT
    qc_small.cx(q[0], q[5]) # CNOT
    qc_small.cx(q[0], q[6]) # CNOT
    qc_small.cx(q[0], q[7]) # CNOT
    qc_small.cx(q[0], q[8]) # CNOT
    qc_small.cx(q[0], q[9]) # CNOT
    # barrier
    qc_small.barrier(q[0], q[1], q[2], q[3], q[4], q[5], q[6], q[7], q[8], q[9])
    # measures
    qc_small.measure(q[0],c0[0])
    qc_small.measure(q[2],c2[0])
    qc_small.measure(q[3],c3[0])
    qc_small.measure(q[6],c6[0])
    qc_small.measure(q[1],c1[0])
    qc_small.measure(q[4],c4[0])
    qc_small.measure(q[7],c7[0])
    qc_small.measure(q[8],c8[0])
    qc_small.measure(q[9],c9[0])
    # draw circuit
    draw_circuit(qc_small)
    # definition of quantum simulator
    simulator = Aer.get_backend('qasm_simulator') # statevector_simulator # aer_
    qc_small = transpile(qc_small, simulator)
    # Run and get counts
    result = simulator.run(qc_small, shots=1024).result()
    counts_GHZ_all = result.get_counts(qc_small)
    counts_GHZ = counts_GHZ_all.most_frequent() # does not work if multiple stat
    # decide something if multiple states have the same count --> e.g., ``choose
    print(counts_GHZ_all)
    print(counts_GHZ)
    #plot_histogram(counts_GHZ_all, title='outcomes')
    #plot_histogram(counts_GHZ, title='outcomes')
```

```
cometa
```





```
{'1 1 1 1 1 1 1 1 1': 470, '0 0 0 0 0 0 0 0 0': 554}
0 0 0 0 0 0 0 0 0
```

In [104]:

```python
print(counts_GHZ) # order: R3, R2, R1. Add some uncertainty?
# export as an array
str_ = counts_GHZ
arr_GHZ = str_.split(' ') # to split the string and avoid empty spaces as array
print(arr_GHZ)
# We do not need to update rewards; they should be done externally... excluded s
```

```
0 0 0 0 0 0 0 0 0
['0', '0', '0', '0', '0', '0', '0', '0', '0']
```

Define the 'new 0':

In [105]:

```python
if (R1.delta >= R2.delta) and (R1.delta >= R3.delta):
    print('gosh')
    new_zero_betax = R1.betax + np.random.uniform(0,0.1)
    new_zero_alphax = 1 - R1.betax
    new_zero_betay = R1.betay + np.random.uniform(0,0.1)
    new_zero_alphay = 1 - R2.betay + np.random.uniform(0,0.1)
    new_zero_betaz = R1.betaz + np.random.uniform(0,0.1)
    new_zero_alphaz = 1 - R2.betaz + np.random.uniform(0,0.1)

if (R2.delta >= R1.delta) and (R2.delta >= R3.delta):
    print('kinda')
    new_zero_betax = R2.betax + np.random.uniform(0,0.1)
    new_zero_alphax = 1 - R2.betax
    new_zero_betay = R2.betay + np.random.uniform(0,0.1)
    new_zero_alphay = 1 - R2.betay
    new_zero_betaz = R2.betaz + np.random.uniform(0,0.1)
    new_zero_alphaz = 1 - R2.betaz

if (R3.delta >= R2.delta) and (R3.delta >= R1.delta):
    print('uffdah')
    new_zero_betax = R3.betax + np.random.uniform(0,0.1)
    new_zero_alphax = 1 - R3.betax
    new_zero_betay = R3.betay + np.random.uniform(0,0.1)
    new_zero_alphay = 1 - R3.betay
    new_zero_betaz = R3.betaz + np.random.uniform(0,0.1)
    new_zero_alphaz = 1 - R3.betaz
```

```
gosh
```

Define the 'new 1':

In [106]:

```
# flip thanks to the 'minus' sign?
# I had tried with if(R1... < R2...) etc., but it is not ok,
# because we need to initialize all elements.

if (R1.delta >= R2.delta) and (R1.delta >= R3.delta):
    print('gosh')
    new_one_betax = R1.betax - np.random.uniform(0,0.1)
    new_one_alphax = 1 - R1.betax
    new_one_betay = R1.betay - np.random.uniform(0,0.1)
    new_one_alphay = 1 - R2.betay
    new_one_betaz = R1.betaz - np.random.uniform(0,0.1)
    new_one_alphaz = 1 - R2.betaz

if (R2.delta >= R1.delta) and (R2.delta >= R3.delta):
    print('kinda')
    new_one_betax = R2.betax - np.random.uniform(0,0.1)
    new_one_alphax = 1 - R2.betax
    new_one_betay = R2.betay - np.random.uniform(0,0.1)
    new_one_alphay = 1 - R2.betay
    new_one_betaz = R2.betaz - np.random.uniform(0,0.1)
    new_one_alphaz = 1 - R2.betaz

if (R3.delta >= R2.delta) and (R3.delta >= R1.delta):
    print('uffdah')
    new_one_betax = R3.betax - np.random.uniform(0,0.1)
    new_one_alphax = 1 - R3.betax
    new_one_betay = R3.betay - np.random.uniform(0,0.1)
    new_one_alphay = 1 - R3.betay
    new_one_betaz = R3.betaz - np.random.uniform(0,0.1)
    new_one_alphaz = 1 - R3.betaz
```

```
gosh
```

Choose the 'new 0' or the 'new 1' according to the outcome of GHZ circuit:

In [107]:

```
if (arr_GHZ[0] =='0'):
    R1.alphaz = new_zero_alphaz
    R1.betaz = new_zero_betaz
if (arr_GHZ[1] =='0'):
    R1.alphay = new_zero_alphay
    R1.betay = new_zero_betay
if (arr_GHZ[2] =='0'):
    R1.alphax = new_zero_alphax
    R1.betax = new_zero_betax
if (arr_GHZ[3] =='0'):
    R2.alphaz = new_zero_alphaz
    R2.betaz = new_zero_betaz
if (arr_GHZ[4] =='0'):
    R2.alphay = new_zero_alphay
    R2.betay = new_zero_betay
if (arr_GHZ[5] =='0'):
    R2.alphax = new_zero_alphax
    R2.betax = new_zero_betax
if (arr_GHZ[6] =='0'):
    R3.alphaz = new_zero_alphaz
    R3.betaz = new_zero_betaz
if (arr_GHZ[7] =='0'):
    R3.alphay = new_zero_alphay
    R3.betay = new_zero_betay
if (arr_GHZ[8] =='0'):
    R3.alphax = new_zero_alphax
    R3.betax = new_zero_betax


if (arr_GHZ[0] =='1'):
    R1.alphaz = new_one_alphaz
    R1.betaz = new_one_betaz
if (arr_GHZ[1] =='1'):
    R1.alphay = new_one_alphay
    R1.betay = new_one_betay
if (arr_GHZ[2] =='1'):
    R1.alphax = new_one_alphax
    R1.betax = new_one_betax
if (arr_GHZ[3] =='1'):
    R2.alphaz = new_one_alphaz
    R2.betaz = new_one_betaz
if (arr_GHZ[4] =='1'):
    R2.alphay = new_one_alphay
    R2.betay = new_one_betay
if (arr_GHZ[5] =='1'):
    R2.alphax = new_one_alphax
    R2.betax = new_one_betax
if (arr_GHZ[6] =='1'):
    R3.alphaz = new_one_alphaz
    R3.betaz = new_one_betaz
if (arr_GHZ[7] =='1'):
    R3.alphay = new_one_alphay
    R3.betay = new_one_betay
if (arr_GHZ[8] =='1'):
    R3.alphax = new_one_alphax
    R3.betax = new_one_betax
```

if (arr_GHZ[0] =='0'): # all the other bits are supposed to be equal in GHZ......... R3.alphax = new_zero_alphax

R3.betax = new_zero_betax R2.alphax = new_zero_alphax R2.betax = new_zero_betax R1.alphax = new_zero_alphax R1.betax = new_zero_betax if (arr_GHZ[0] =='1'): R3.alphax = new_zero_alphax R3.betax = new_zero_betax R2.alphax = new_zero_alphax R2.betax = new_zero_betax R1.alphax = new_zero_alphax R1.betax = new_zero_betax

New reward for R_1:

In [108]:

```
R1.delta = reward(T,R1.betax,R1.betay,R1.betaz)
R1.gamma = round((1 - R1.delta),2)
print(R1.delta)
```

```
0.46
```

New reward for R_2:

In [109]:

```
R2.delta = reward(T,R2.betax,R2.betay,R2.betaz)
R2.gamma = round((1 - R2.delta),2)
print(R2.delta)
```

```
0.46
```

New reward for R_3:

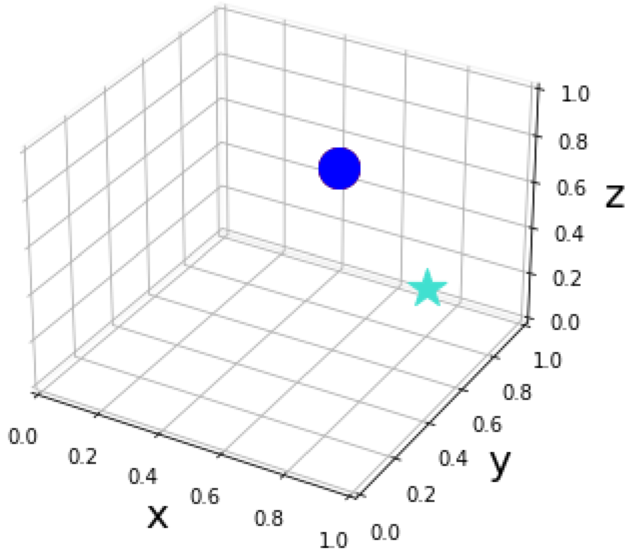
In [110]:

```
R3.delta = reward(T,R3.betax,R3.betay,R3.betaz)
R3.gamma = round((1 - R3.delta),2)
print(R3.delta)
```

```
0.46
```

In [111]:

```
fig = plt.figure()

ax = Axes3D(fig, auto_add_to_figure=False)
fig.add_axes(ax)

ax.set_xlim3d(0, 1)
ax.set_ylim3d(0, 1)
ax.set_zlim3d(0, 1)

ax.xaxis.pane.fill = False
ax.yaxis.pane.fill = False
ax.zaxis.pane.fill = False

ax.set_xlabel('x', fontsize=20)
ax.set_ylabel('y', fontsize=20)
ax.set_zlabel('z', fontsize=20) # r'\alpha'

ax.scatter3D(R1.betax, R1.betay, R1.betaz, s = 400, marker = 'o', color = 'black
ax.scatter3D(R2.betax, R2.betay, R2.betaz, s = 400, marker = 'o', color = 'red')
ax.scatter3D(R3.betax, R3.betay, R3.betaz, s = 400, marker = 'o', color = 'blue'
# ax.scatter3D(R4_[0], R4_[1], R4_[2], s = 400, marker = 'o', color = 'green')
ax.scatter3D(T.x, T.y, T.z, s = 400, marker = '*', color = 'turquoise')

plt.show()

# find how to automatically create trajectories: maybe LinePlot between R1, R2,
```



In [112]:

```
# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB2.mp3")
            print("cB2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#2.mp3")
            print("cC#2")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#2.mp3")
            print("cA#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD2.mp3")
            print("cD2")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#2.mp3")
            print("cD#2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA2.mp3")
            print("cA2")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE2.mp3")
            print("cE2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#2.mp3")
            print("cG#2")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF2.mp3")
            print("cF2")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG2.mp3")
            print("cG2")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#2.mp3")
        print("cF#2")

mixed_time12_ = audio1.overlay(audio2)          # combine , superimpose audio f
mixed_time12  = mixed_time12_.overlay(audio3)          # further combine , supe

mixed_time12.export("notes_/mixed_time12.mp3", format='mp3') # export mixed  au
play(mixed_time12)                             # play mixed audio file
# change this line at each time point, so in the end we can get a little piece

```

```
tG#
fG#
cG#
Could not import the PyAudio C module '_portaudio'.

Input #0, wav, from '/var/folders/tc/5k6bdv0s421bnc52mnnj7p_w0000gn/T/tmp553t1fuu.
wav':
  Duration: 00:00:07.31, bitrate: 1411 kb/s
  Stream #0:0: Audio: pcm_s16le ([1][0][0][0] / 0x0001), 44100 Hz, 2 channels, s1
6, 1411 kb/s
   7.18 M-A:  0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
   7.25 M-A:  0.000 fd=   0 aq=    0KB vq=    0KB sq=    0B f=0/0
```

In [113]:

```
R1.delta, R2.delta, R3.delta
```

Out[113]:

```
(0.46, 0.46, 0.46)
```

In [114]:

```
# January 22, 2022
```

NEW LINES of code: IF the initial reward is very high (greater than 0.8) for at least one of the three robots ("or"), THEN the other robots have to just reach it (with a pretty small fluctuation), without entering the circuit.

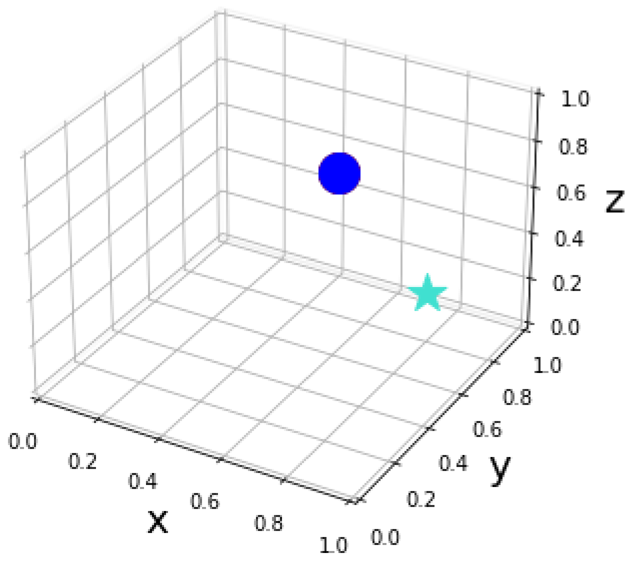
In [115]:

```
if((R1.delta >= 0.8) or (R2.delta >= 0.8) or (R3.delta >= 0.8)):
    print('yuk')
    if (R1.delta > R2.delta and R1.delta > R3.delta):
        print('quokka')
        R2.betax = round(R1.betax + np.random.uniform(0,0.1), 3) # Here and late
        R2.alphax = round(1 - R2.betax, 3)
        R2.betay = round(R1.betay + np.random.uniform(0,0.1), 3)
        R2.alphay = round(1 - R2.betay, 3)
        R2.betaz = round(R1.betaz + np.random.uniform(0,0.1), 3)
        R2.alphaz = round(1 - R2.betaz, 3)
        R3.betax = round(R1.betax + np.random.uniform(0,0.1), 3)
        R3.alphax = round(1 - R2.betax, 3)
        R3.betay = round(R1.betay + np.random.uniform(0,0.1), 3)
        R3.alphay = round(1 - R2.betay, 3)
        R3.betaz = round(R1.betay + np.random.uniform(0,0.1), 3)
        R3.alphaz = round(1 - R2.betaz, 3)
    if (R2.delta > R1.delta and R2.delta > R3.delta):
        print('quagga')
        R1.betax = round(R2.betax + np.random.uniform(0,0.1), 3)
        R1.alphax = round(1 - R1.betax, 3)
        R1.betay = round(R2.betay + np.random.uniform(0,0.1), 3)
        R1.alphay = round(1 - R1.betay, 3)
        R1.betaz = round(R2.betaz + np.random.uniform(0,0.1), 3)
        R1.alphaz = round(1 - R1.betaz, 3)
        R3.betax = round(R2.betax + np.random.uniform(0,0.1), 3)
        R3.alphax = round(1 - R3.betax, 3)
        R3.betay = round(R2.betay + np.random.uniform(0,0.1), 3)
        R3.alphay = round(1 - R3.betay, 3)
        R3.betaz = round(R2.betaz + np.random.uniform(0,0.1), 3)
        R3.alphaz = round(1 - R3.betaz, 3)
    if (R3.delta > R1.delta and R3.delta > R2.delta):
        print('quark')
        R1.betax = round(R3.betax + np.random.uniform(0,0.1), 3)
        R1.alphax = round(1 - R1.betax, 3)
        R1.betay = round(R3.betay + np.random.uniform(0,0.1), 3)
        R1.alphay = round(1 - R1.betay, 3)
        R1.betaz = round(R3.betaz + np.random.uniform(0,0.1), 3)
        R1.alphaz = round(1 - R1.betaz, 3)
        R2.betax = round(R3.betax + np.random.uniform(0,0.1), 3)
        R2.alphax = round(1 - R2.betax, 3)
        R2.betay = round(R3.betay + np.random.uniform(0,0.1), 3)
        R2.alphay = round(1 - R2.betay, 3)
        R2.betaz = round(R3.betaz + np.random.uniform(0,0.1), 3)
        R2.alphaz = round(1 - R2.betaz, 3)

R1.delta = reward(T, R1.betax, R1.betay, R1.betaz)
print(R1.delta)

R2.delta = reward(T, R2.betax, R2.betay, R2.betaz)
print(R2.delta)

R3.delta = reward(T, R3.betax, R3.betay, R3.betaz)
print(R2.delta)
```

```
0.46
0.46
0.46
```

In [116]:

```
fig = plt.figure()

ax = Axes3D(fig, auto_add_to_figure=False)
fig.add_axes(ax)

ax.set_xlim3d(0, 1)
ax.set_ylim3d(0, 1)
ax.set_zlim3d(0, 1)

ax.xaxis.pane.fill = False
ax.yaxis.pane.fill = False
ax.zaxis.pane.fill = False

ax.set_xlabel('x', fontsize=20)
ax.set_ylabel('y', fontsize=20)
ax.set_zlabel('z', fontsize=20) # r'\alpha'

ax.scatter3D(R1.betax, R1.betay, R1.betaz, s = 400, marker = 'o', color = 'black
ax.scatter3D(R2.betax, R2.betay, R2.betaz, s = 400, marker = 'o', color = 'red')
ax.scatter3D(R3.betax, R3.betay, R3.betaz, s = 400, marker = 'o', color = 'blue'
# ax.scatter3D(R4_[0], R4_[1], R4_[2], s = 400, marker = 'o', color = 'green')
ax.scatter3D(T.x, T.y, T.z, s = 400, marker = '*', color = 'turquoise')

plt.show()

# find how to automatically create trajectories: maybe LinePlot between R1, R2,
```



In [117]:

```
# audio 1, R_1

if(R1.betaz >= 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC.mp3")
            print("tC")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB.mp3")
            print("tB")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#.mp3")
            print("tC#")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#.mp3")
            print("tA#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD.mp3")
            print("tD")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#.mp3")
            print("tD#")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA.mp3")
            print("tA")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE.mp3")
            print("tE")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#.mp3")
            print("tG#")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF.mp3")
            print("tF")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG.mp3")
            print("tG")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#.mp3")
        print("tF#")
if(R1.betaz < 0.5):
    if (R1.betax == 0):
        if (R1.betay == 0.5):
            audio1 = AudioSegment.from_file("notes_/tC2.mp3")
            print("tC2")
    if (R1.betax > 0 and R1.betax <= 0.17):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tB2.mp3")
            print("tB2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tC#2.mp3")
            print("tC#2")
    if (R1.betax > 0.17 and R1.betax <= 0.3):
        if (R1.betay < 0.5): # if (R1.betay >= 0.17 and R1.betay < 0.3):
            audio1 = AudioSegment.from_file("notes_/tA#2.mp3")
            print("tA#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tD2.mp3")
            print("tD2")
    if (R1.betax > 0.3 and R1.betax <= 0.5):
        if (R1.betay < 0.5): # (R1.betay == 1):
            audio1 = AudioSegment.from_file("notes_/tD#2.mp3")
            print("tD#2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tA2.mp3")
            print("tA2")
    if (R1.betax > 0.5 and R1.betax <= 0.64):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tE2.mp3")
            print("tE2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG#2.mp3")
            print("tG#2")
    if (R1.betax > 0.64 and R1.betax <= 0.84):
        if (R1.betay < 0.5):
            audio1 = AudioSegment.from_file("notes_/tF2.mp3")
            print("tF2")
        if (R1.betay >= 0.5):
            audio1 = AudioSegment.from_file("notes_/tG2.mp3")
            print("tG2")
    if (R1.betax > 0.84 and R1.betax <= 1):
        #if (R1.betay == 0.5):
        audio1 = AudioSegment.from_file("notes_/tF#2.mp3")
        print("tF#2")



    # CHANGE from this point


# audio 2, R_2

if(R2.betaz < 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC2.mp3")
            print("fC2")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB2.mp3")
            print("fB2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#2.mp3")
            print("fC#2")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#2.mp3")
            print("fA#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD2.mp3")
            print("fD2")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#2.mp3")
            print("fD#2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA2.mp3")
            print("fA2")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE2.mp3")
            print("fE2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#2.mp3")
            print("fG#2")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF2.mp3")
            print("fF2")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG2.mp3")
            print("fG2")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#2.mp3")
        print("fF#2")
if(R2.betaz >= 0.5):
    if (R2.betax == 0):
        if (R2.betay == 0.5):
            audio2 = AudioSegment.from_file("notes_/fC.mp3")
            print("fC")
    if (R2.betax > 0 and R2.betax <= 0.17):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fB.mp3")
            print("fB")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fC#.mp3")
            print("fC#")
    if (R2.betax > 0.17 and R2.betax <= 0.3):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fA#.mp3")
            print("fA#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fD.mp3")
            print("fD")
    if (R2.betax > 0.3 and R2.betax <= 0.5):
        if (R2.betay < 0.5): # (R1.betay == 1):
            audio2 = AudioSegment.from_file("notes_/fD#.mp3")
            print("fD#")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fA.mp3")
            print("fA")
    if (R2.betax > 0.5 and R2.betax <= 0.64):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fE.mp3")
            print("fE")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG#.mp3")
            print("fG#")
    if (R2.betax > 0.64 and R2.betax <= 0.84):
        if (R2.betay < 0.5):
            audio2 = AudioSegment.from_file("notes_/fF.mp3")
            print("fF")
        if (R2.betay >= 0.5):
            audio2 = AudioSegment.from_file("notes_/fG.mp3")
            print("fG")
    if (R2.betax > 0.84 and R2.betax <= 1):
        #if (R2.betay == 0.5):
        audio2 = AudioSegment.from_file("notes_/fF#.mp3")
        print("fF#")





# audio 3, R_3

if (R3.betaz >= 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC.mp3")
            print("cC")
    if (R3.betax > 0 and R3.betax <= 0.17):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cB.mp3")
            print("cB")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cC#.mp3")
            print("cC#")
    if (R3.betax > 0.17 and R3.betax <= 0.3):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cA#.mp3")
            print("cA#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cD.mp3")
            print("cD")
    if (R3.betax > 0.3 and R3.betax <= 0.5):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cD#.mp3")
            print("cD#")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cA.mp3")
            print("cA")
    if (R3.betax > 0.5 and R3.betax <= 0.64):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cE.mp3")
            print("cE")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG#.mp3")
            print("cG#")
    if (R3.betax > 0.64 and R3.betax <= 0.84):
        if (R3.betay < 0.5):
            audio3 = AudioSegment.from_file("notes_/cF.mp3")
            print("cF")
        if (R3.betay >= 0.5):
            audio3 = AudioSegment.from_file("notes_/cG.mp3")
            print("cG")
    if (R3.betax > 0.84 and R3.betax <= 1):
        #if (R3.betay == 0.5):
        audio3 = AudioSegment.from_file("notes_/cF#.mp3")
        print("cF#")
if (R3.betaz < 0.5):
    if (R3.betax == 0):
        if (R3.betay == 0.5):
            audio3 = AudioSegment.from_file("notes_/cC2.mp3")
            print("cC2")
```