```
import numpy as np
import gym
import matplotlib.pyplot as plt
```

```
env = gym.make("CartPole-v1")
state = env.reset()
state
# position, velocity, angle, angular velocity
```

```
     array([ 0.00243197, -0.04045838,  0.03059702,  0.03196711])
```

```
import keras
from keras.models import Sequential
from keras.layers import Dense
from collections import deque
import random
import tensorflow as tf
```

```
model = Sequential()
model.add(Dense(units = 50, input_dim=4, activation='relu'))
model.add(Dense(units = 50, activation = "relu"))
model.add(Dense(units = 2, activation = "linear"))
```

```
opt = tf.keras.optimizers.Adam(learning_rate=0.001)
#opt = tf.keras.optimizers.SGD(learning_rate=0.001)

model.compile(loss='MSE',optimizer=opt)
model.summary()
```

```
     Model: "sequential"
     _________________________________________________________________
      Layer (type)                Output Shape              Param #
     =================================================================
      dense (Dense)               (None, 50)                250
```

```
 dense_1 (Dense)             (None, 50)                2550      
                                                                 
 dense_2 (Dense)             (None, 2)                 102       
                                                                 
=================================================================
```

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```
_________________________________________________________________
```

Parametry:

```
train_episodes = 100
epsilon = 0.16
gamma = 0.99
max_steps = 50
```

Definiujemy **pamięć** jako kolejkę:

```
memory = deque(maxlen=100)
```

Ustalamy rozmiar **batch**:

```
batch_size = 10
```

```
def train():
  state_batch, Qs_target_batch = [], []

  minibatch = random.sample(memory, batch_size)

  for state, action, reward, next_state, done in minibatch:
    if done:
      y = reward
    else:
      y = reward + gamma*np.max(model.predict(next_state)[0])

    Q_target = model.predict(state)
```

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```
    state_batch.append(state)
    Qs_target_batch.append(Q_target)

  state_batch = np.array(state_batch).reshape(batch_size,4)
  Qs_target_batch = np.array(Qs_target_batch).reshape(batch_size,2)

  h = model.fit(state_batch,Qs_target_batch,epochs=1,verbose=0)

  loss = h.history['loss'][0]

  return loss


Loss = []
Rewards = []

for e in range(1, train_episodes+1):
  total_reward = 0
  t = 0

  state = env.reset()
  state = np.reshape(state, [1, 4])

  done = False
  while t < max_steps and done == False:

    Qs = model.predict(state)[0]

    if np.random.rand()<epsilon:
      action = env.action_space.sample()
```

```
   action = env.action_space.sample()
  else:
   action = np.argmax(Qs)

  next_state, reward, done, _ = env.step(action)
  next_state = np.reshape(next_state, [1, 4])
```

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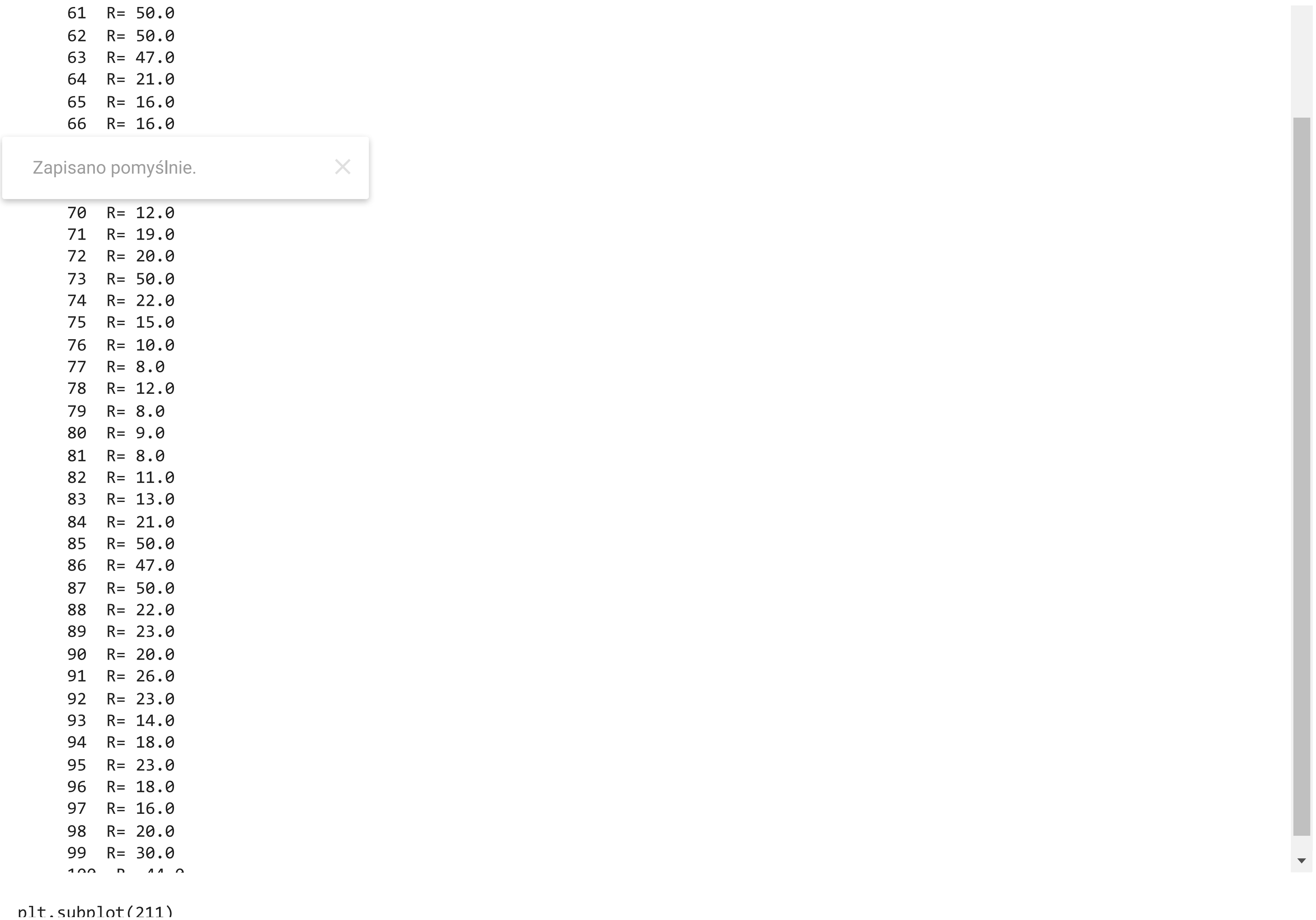
```
  memory.append((state,action,reward,next_state,done))

  if batch_size < len(memory):
   loss = train()
   Loss.append(loss)

  state = next_state
  t+=1

print(e," R=",total_reward)
Rewards.append(total_reward)
```

```
42  R= 16.0
43  R= 14.0
44  R= 9.0
45  R= 12.0
46  R= 10.0
47  R= 9.0
48  R= 9.0
49  R= 18.0
50  R= 16.0
51  R= 50.0
52  R= 50.0
53  R= 50.0
54  R= 50.0
55  R= 31.0
56  R= 30.0
57  R= 50.0
58  R= 50.0
59  R= 50.0
60  R= 50.0
```



```
61  R= 50.0
62  R= 50.0
63  R= 47.0
64  R= 21.0
65  R= 16.0
66  R= 16.0
```

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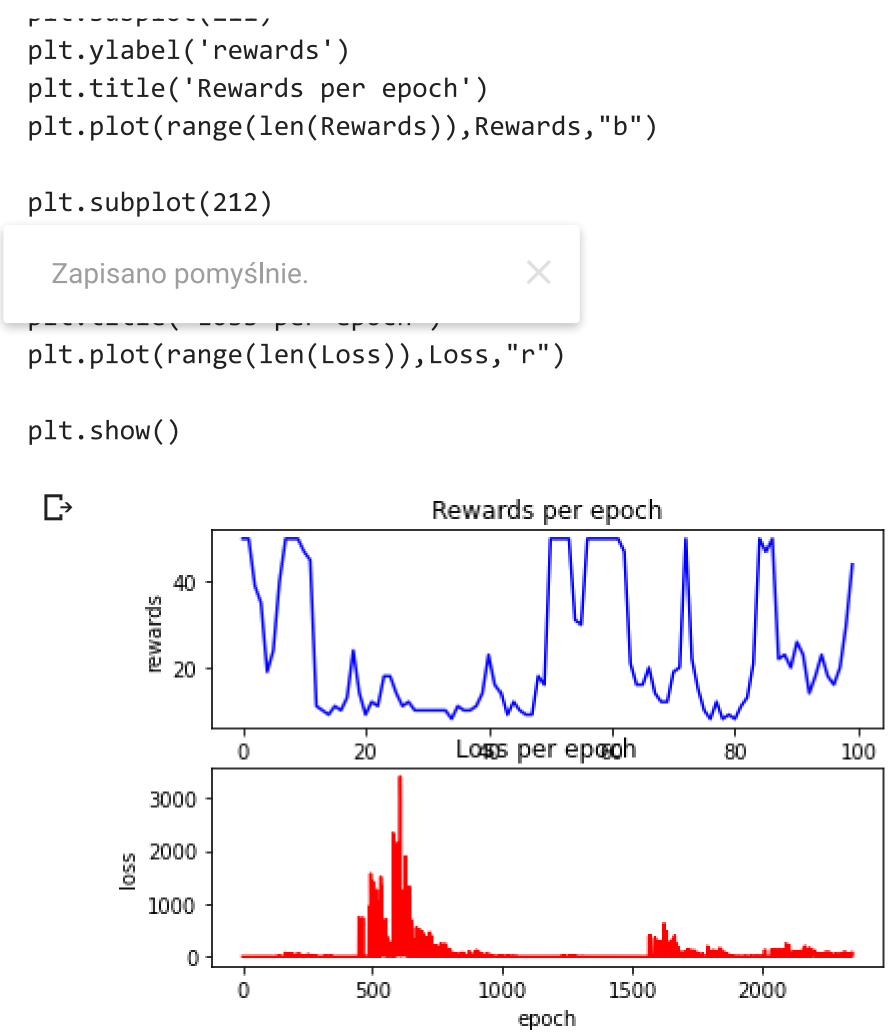
```
70  R= 12.0
71  R= 19.0
72  R= 20.0
73  R= 50.0
74  R= 22.0
75  R= 15.0
76  R= 10.0
77  R= 8.0
78  R= 12.0
79  R= 8.0
80  R= 9.0
81  R= 8.0
82  R= 11.0
83  R= 13.0
84  R= 21.0
85  R= 50.0
86  R= 47.0
87  R= 50.0
88  R= 22.0
89  R= 23.0
90  R= 20.0
91  R= 26.0
92  R= 23.0
93  R= 14.0
94  R= 18.0
95  R= 23.0
96  R= 18.0
97  R= 16.0
98  R= 20.0
99  R= 30.0
100  R= 44.0
```

```
plt.subplot(211)
```



```
plt.subplot(211)
plt.ylabel('rewards')
plt.title('Rewards per epoch')
plt.plot(range(len(Rewards)),Rewards,"b")

plt.subplot(212)
```

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```
plt.title('Loss per epoch')
plt.plot(range(len(Loss)),Loss,"r")

plt.show()
```

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