```
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

=================================================================
Total params: 2,902
Trainable params: 2,902
Non-trainable params: 0
_________________________________________________________________
```

Parametry:

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

Definiujemy **pamięć** jako kolejkę:

```
memory = deque(maxlen=150)
```

Ustalamy rozmiar **batch**:

```
batch_size = 15


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)
      Q_target[0][action] = y

      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()
      else:
        action = np.argmax(Qs)

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

      total_reward += reward
```

```
      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)
```

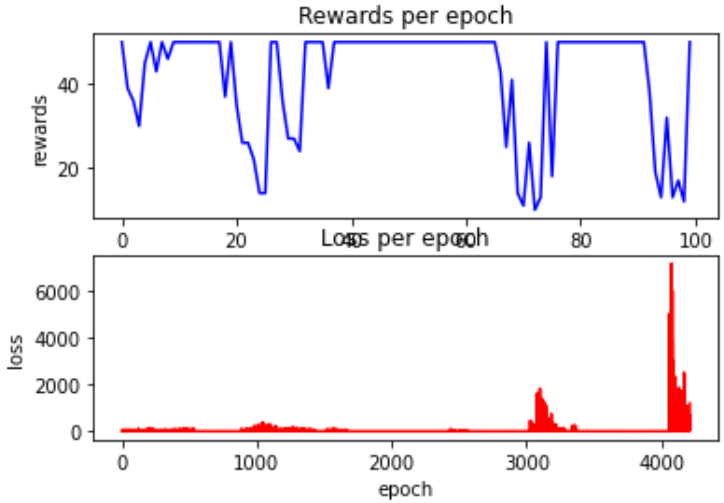
```
43  R= 50.0
44  R= 50.0
45  R= 50.0
46  R= 50.0
47  R= 50.0
48  R= 50.0
49  R= 50.0
50  R= 50.0
51  R= 50.0
52  R= 50.0
53  R= 50.0
54  R= 50.0
55  R= 50.0
56  R= 50.0
57  R= 50.0
58  R= 50.0
59  R= 50.0
60  R= 50.0
61  R= 50.0
62  R= 50.0
63  R= 50.0
64  R= 50.0
65  R= 50.0
66  R= 50.0
67  R= 43.0
68  R= 25.0
69  R= 41.0
70  R= 14.0
71  R= 11.0
72  R= 26.0
73  R= 10.0
74  R= 13.0
```

```
75  R= 50.0
76  R= 18.0
77  R= 50.0
78  R= 50.0
79  R= 50.0
80  R= 50.0
81  R= 50.0
82  R= 50.0
83  R= 50.0
84  R= 50.0
85  R= 50.0
86  R= 50.0
87  R= 50.0
88  R= 50.0
89  R= 50.0
90  R= 50.0
91  R= 50.0
92  R= 50.0
93  R= 38.0
94  R= 19.0
95  R= 13.0
96  R= 32.0
97  R= 13.0
98  R= 17.0
99  R= 12.0
100  R= 50.0
```

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

plt.subplot(212)
plt.xlabel('epoch')
plt.ylabel('loss')
plt.title('Loss per epoch')
plt.plot(range(len(Loss)),Loss,"r")

plt.show()
```


Rewards per epoch
rewards
40
20
0
20
40
60
80
100
Loss per epoch
loss
6000
4000
2000
0
0
1000
2000
3000
4000
epoch