Collaboration Project

1. Models tested

We tried and trained a Multi-DDPG algo (specifically 2 collaboring DDPG agents) with different sets of parameters:

- learning batch sizes for values [50, 100, 150, 200, 250, 300, 350, 400]
- number of steps between learning steps for values [1, 4, 8, 12, 16, 20]
- Ornstein-Uhlenbeck process (theta, sigma) for values [(0.15, 0.2), (0, 0)]
- Actor & Critic learning rates for values [(1e-4, 1e-3), (1e-3, 1e-3)]

Notation

An agent will be composed of 2 identical DDPG models and will be identified by the following string: "[batch*size]*[nb_learning*steps]*[actor*lr]*[critic*lr]*[noise*theta]*[noise*sigma]*[actor_hidden*layers]*[critic_hidden_layer]"

For instance "150_8_0.001_0.001_0.15*0.1*(128, 128)_(128, 128)" designates 2 collaborative DDPG agents trained with:

- an actor neural network composed of 2 hidden layers fully connected of 128 nodes each
- a critic neural network composed of 2 hidden layers fully connected of 128 nodes each
- using a learning batch size of 150 steps at a time
- every 8 steps
- with an actor learning rate of 1e-3
- and a critic learning rate of 1e-3
- with noise parameters of (theta = 0.15, sigma = 0.1)

In [1]:
```
%load_ext autoreload
%autoreload 2
```

In [2]:
```
import results_analysis
```

2. Training results

Below we gather the results of all the training runs tried with different sets of parameters

In [3]:
```
# Get results from all training runs contained in the Results directory
df_results_step, df_results, df_details = results_analysis.get_training_results()

# Get best training runs
# best_results_step finds the highest step-values among all training runs
# best_results finds the highest end-of-episode values among all training runs
best_results_step, best_results = results_analysis.get_best_runs(df_results_step, df_results, nb_runs=5)

display(best_results_step.iloc[:5])
display(best_results.iloc[:5])
```

		score
training	**model_tag**	
training_8	**200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)**	2.7
training_6	**400_1_0.001_0.001_0.0_0.0_(128; 128)_(128; 128)**	2.7
training_5	**350_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)**	2.7
	400_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	2.7
training_3	**200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)**	2.7

		score
training	**model_tag**	
training_8	**200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)**	1.4172
training_5	**350_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)**	1.1695
	400_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	0.9070
training_6	**400_1_0.001_0.001_0.0_0.0_(128; 128)_(128; 128)**	0.8414
training_3	**200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)**	0.6077

3. Parameter analysis

In order to find the best model, I used the first training runs I had done and tried to keep the variation of each parameter that got the "best" results over all the runs (looking at max and mean values)

After running some more training passes with the most promising combinations of parameter values, I got the below summary table.

In [4]:
```
# parameters_summary contains some statistics for each parameter values tried
parameters_summary = results_analysis.get_stats_per_parameter(df_details)
display(parameters_summary)
```

		max	mean	count
tag_type	**tag_value**			
batch_size	**250**	0.04	0.01	9
	300	0.05	0.01	9
	350	0.04	0.01	9
	400	0.10	0.02	9
	50	0.02	0.00	24
	100	0.02	0.00	24
	150	0.05	0.00	24
	200	0.06	0.01	25
learn_step	**1**	0.10	0.02	29
	4	0.02	0.00	28
	8	0.05	0.00	28
	12	0.02	0.00	16
	16	0.01	0.00	16
	20	0.01	0.00	16
actor_lr	**0.001**	0.06	0.01	24
	0.0001	0.10	0.01	109
critic_lr	**0.001**	0.10	0.01	133
noise_theta	**0.15**	0.01	0.00	12
	0.0	0.10	0.01	121
noise_sigma	**0.1**	0.01	0.00	12
	0.0	0.10	0.01	121
actor_nn	**(128; 128)**	0.10	0.01	61
	(32; 16)	0.02	0.00	24
	(32; 32)	0.05	0.00	24
	(64; 64)	0.03	0.00	24
critic_nn	**(128; 128)**	0.10	0.01	61
	(32; 16)	0.02	0.00	24
	(32; 32)	0.05	0.00	24
	(64; 64)	0.03	0.00	24

4. Best model

I selected as "best model" the one that reached an average score of 0.5 the fastest; in 1574 steps during training_3. I then re-trained it by itself in training_8 and tried to maximize its score.

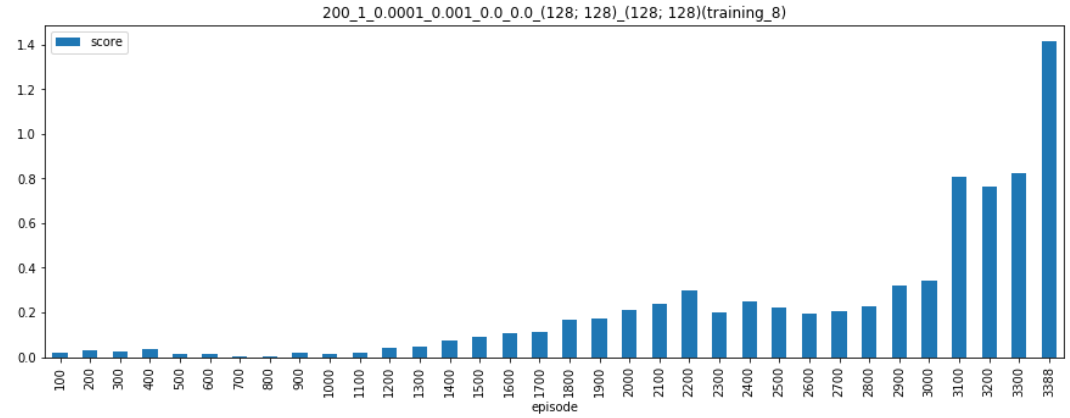
In [5]:
```
selected_model = best_results.index[0][1]

display(df_results[(df_results['model_tag']==selected_model)
                   & (df_results['training']=='training_3')])

display(df_results[(df_results['model_tag']==selected_model)
                   & (df_results['training']=='training_8')])
```

	model_id	model_tag	episode	score	training
360	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	100	0.0371	training_3
361	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	200	0.0160	training_3
362	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	300	0.0080	training_3
363	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	400	0.0440	training_3
364	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	500	0.0219	training_3
365	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	600	0.0282	training_3
366	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	700	0.0389	training_3
367	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	800	0.0544	training_3
368	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	900	0.0697	training_3
369	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1000	0.0620	training_3
370	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1100	0.0718	training_3
371	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1200	0.0810	training_3
372	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1300	0.1153	training_3
373	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1400	0.0878	training_3
374	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1500	0.1908	training_3
375	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1574	0.6077	training_3

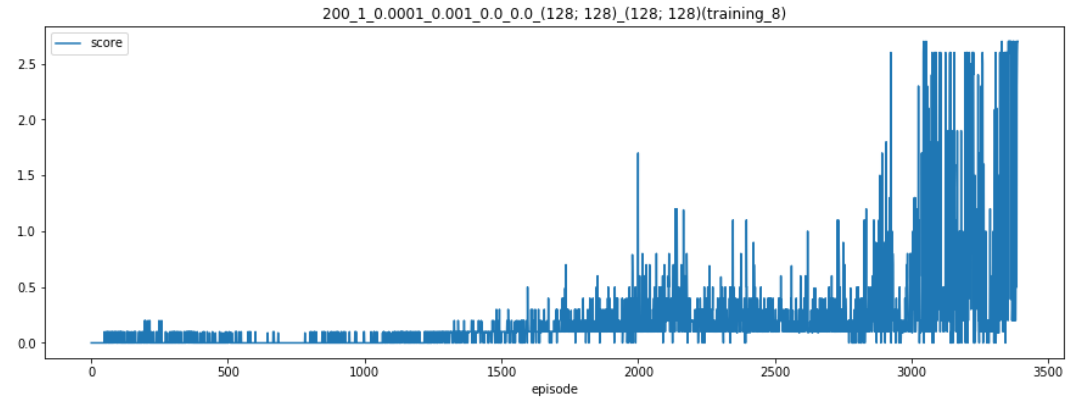
	model_id	model_tag	episode	score	training
0	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	100	0.0199	training_8
1	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	200	0.0300	training_8
2	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	300	0.0228	training_8
3	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	400	0.0338	training_8
4	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	500	0.0141	training_8
5	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	600	0.0162	training_8
6	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	700	0.0048	training_8
7	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	800	0.0009	training_8
8	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	900	0.0168	training_8
9	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1000	0.0148	training_8
10	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1100	0.0169	training_8
11	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1200	0.0430	training_8
12	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1300	0.0479	training_8
13	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1400	0.0765	training_8
14	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1500	0.0912	training_8
15	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1600	0.1097	training_8
16	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1700	0.1127	training_8
17	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1800	0.1646	training_8
18	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	1900	0.1727	training_8
19	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	2000	0.2118	training_8
20	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	2100	0.2368	training_8
21	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	2200	0.2983	training_8
22	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	2300	0.1999	training_8
23	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	2400	0.2510	training_8
24	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	2500	0.2233	training_8
25	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	2600	0.1969	training_8
26	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	2700	0.2051	training_8
27	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	2800	0.2297	training_8
28	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	2900	0.3205	training_8
29	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	3000	0.3439	training_8
30	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	3100	0.8053	training_8
31	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	3200	0.7657	training_8
32	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	3300	0.8257	training_8
33	18	200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)	3388	1.4172	training_8

4.1 Training plots

In [6]:
```
# Plot 100-steps average scores
training_run, selected_model = best_results.index[0]
results_analysis.plot_model(df_results_step, df_results, training_run, selecte
d_model, by_step=False, kind='bar')
```



In [7]:
```
# Plot all steps
results_analysis.plot_model(df_results_step, df_results, training_run, selecte
d_model, by_step=True, kind='line')
```



4.2 Test

Below a test run using the selected "best model"

In [8]:
```
import os
import results_analysis

#You need to be at the root directory of the collaboration directory to run th
e model in the next cell
os.chdir('..')
print(os.getcwd())

try:
    selected_model = best_results.index[0][1]
except:
    selected_model = '200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)'

print('selected_model', selected_model)
```

```
/home/jrfalou/Programming/VSC/UdacityRL/Collaboration
selected_model 200_1_0.0001_0.001_0.0_0.0_(128; 128)_(128; 128)
```

In [9]:
```
#If you get the "handle is closed" error, you need to restart your kernel and
execute from the Conclusion first cell;
#I don't know how to fix that
%run -i collaboration.py test --test_params=best_params.json --test_model="aut
o" --test_results_path=""
```

```
INFO:unityagents:
'Academy' started successfully!
Unity Academy name: Academy
        Number of Brains: 1
        Number of External Brains : 1
        Lesson number : 0
        Reset Parameters :

Unity brain name: TennisBrain
        Number of Visual Observations (per agent): 0
        Vector Observation space type: continuous
        Vector Observation space size (per agent): 8
        Number of stacked Vector Observation: 3
        Vector Action space type: continuous
        Vector Action space size (per agent): 2
        Vector Action descriptions: ,

Load model weights ./ModelWeights/200_1_0.0001_0.001_0.0_0.0_(128, 128)_(128,
128).pth
Score: 2.6
```

In [ ]: