NonSc_Sc

March 29, 2020

1 Study of the parallel program's effectiveness

[1]:
```
import pandas as pd
import csv
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
sns.set_style("darkgrid")
```

2 1. Non-Scalable

constant problem size

[2]:
```
df = pd.read_csv('./non_scalable.csv', header=0)
```

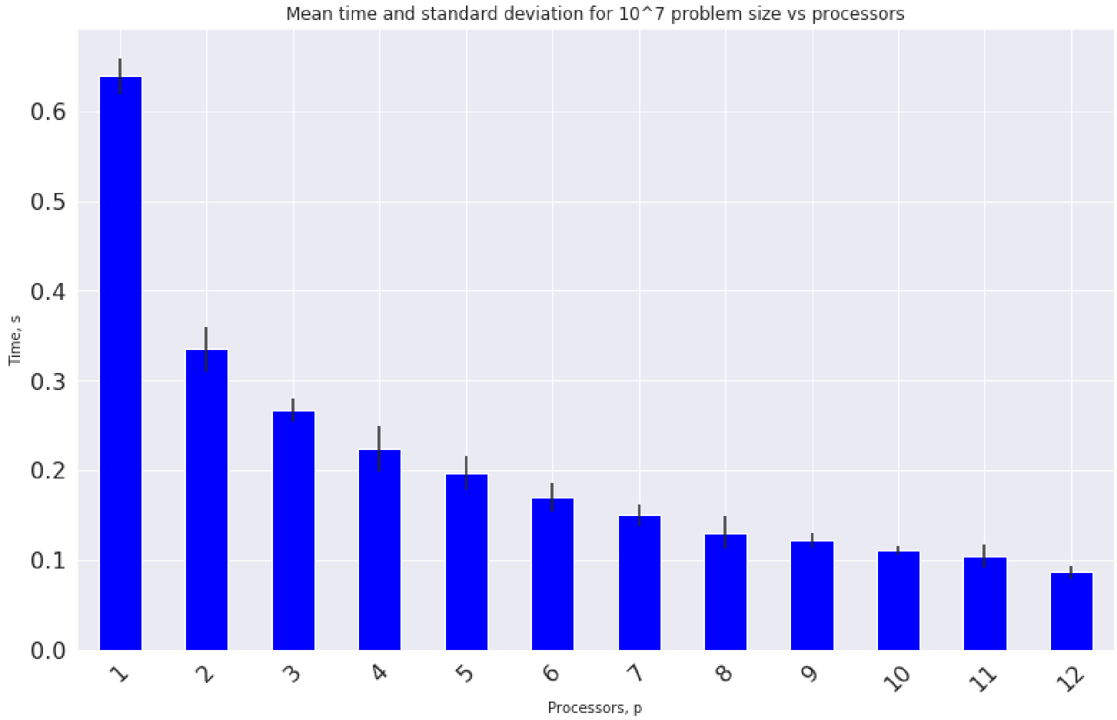
number of repetitions

[3]:
```
df.groupby(["m","p"], as_index= False).count()['n'].head(1)
```

[3]:
```
0    10
Name: n, dtype: int64
```

initial data check

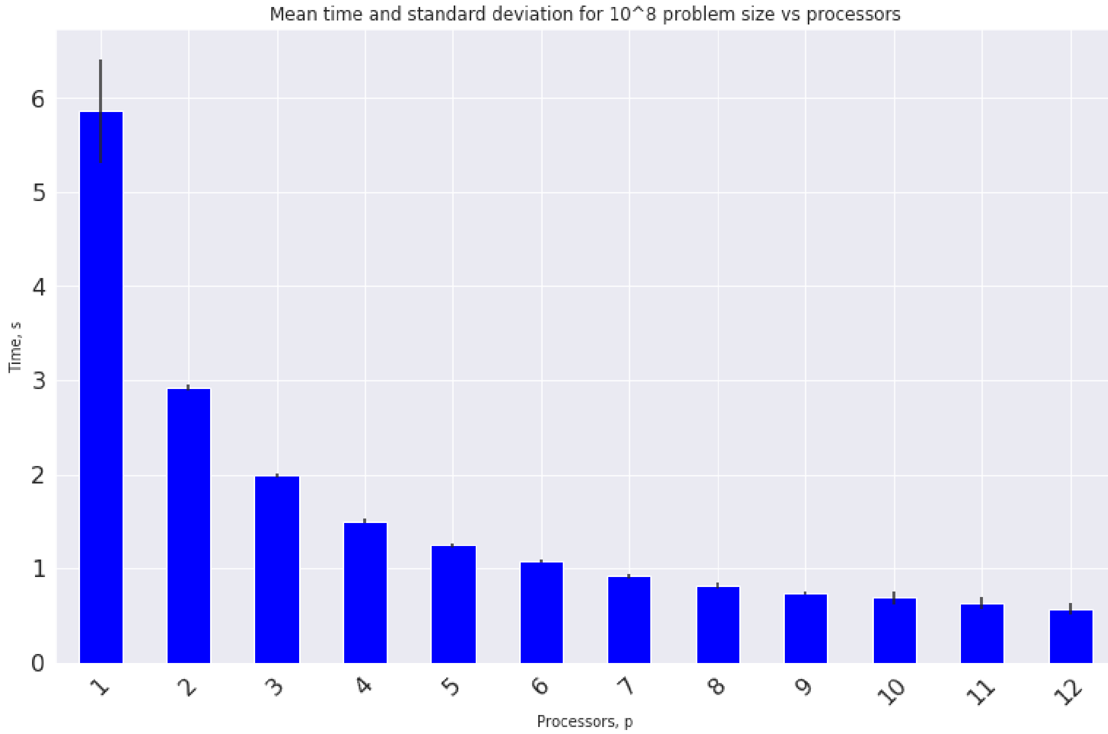
[4]:
```
std = df.groupby(["m","p"], as_index= False)['s'].std()
std = std.iloc[:12,2]
std.index+=1
s = df.groupby(["m","p"], as_index= False)['s'].mean()
s = s.iloc[:12,2]
s.index+=1
p = s.plot(legend=False,kind="bar",rot=45,color="blue",fontsize=16,yerr=std);
p.set_title("Mean time and standard deviation for 10^7 problem size vs␣
 ↪processors")
p.set(xlabel='Processors, p', ylabel='Time, s')
p.figure.set_size_inches(13, 8)
```



noticeably greater variance in calculation time for the smallest problem compared to the others

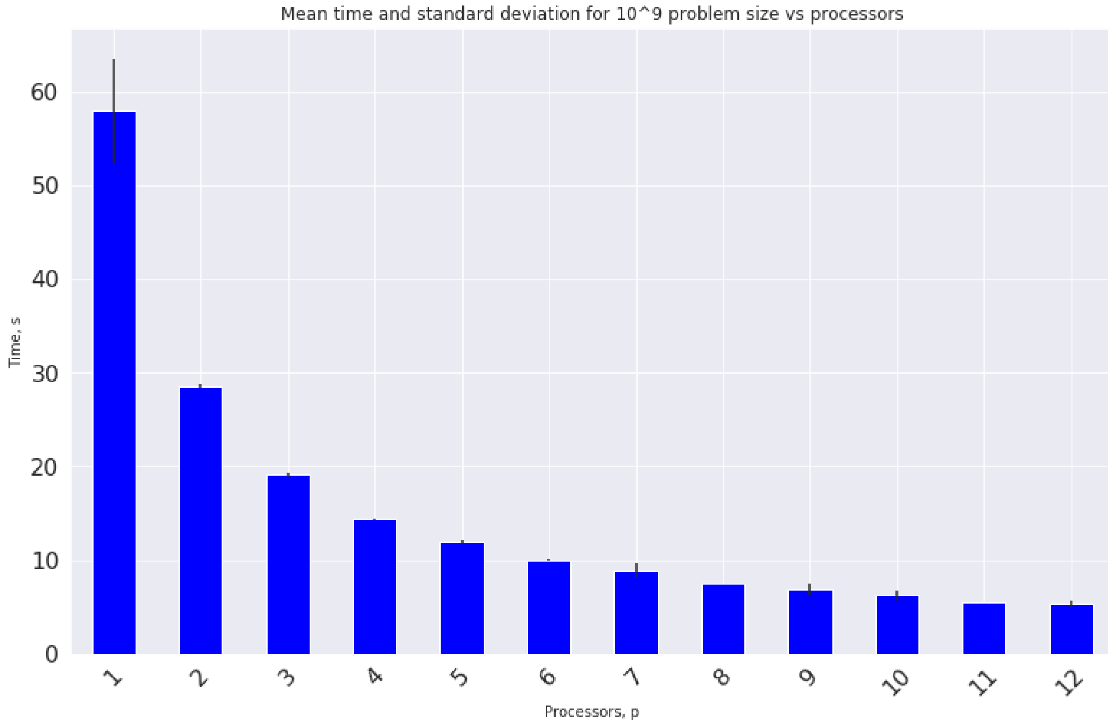
[5]:

```
std = df.groupby(["m","p"], as_index= False)['s'].std()
std = std.iloc[12:24,2]
std.reset_index(drop=True, inplace=True)
std.index+=1
s = df.groupby(["m","p"], as_index= False)['s'].mean()
s = s.iloc[12:24,2]
s.reset_index(drop=True, inplace=True)
s.index+=1
p = s.plot(legend=False,kind="bar",rot=45,color="blue",fontsize=16,yerr=std);
p.set_title("Mean time and standard deviation for 10^8 problem size vs␣
 ↪processors")
p.set(xlabel='Processors, p', ylabel='Time, s')
p.figure.set_size_inches(13, 8)
```



[6]:

```
std = df.groupby(["m","p"], as_index= False)['s'].std()
std = std.iloc[24:36,2]
std.reset_index(drop=True, inplace=True)
std.index+=1
s = df.groupby(["m","p"], as_index= False)['s'].mean()
s = s.iloc[24:36,2]
s.reset_index(drop=True, inplace=True)
s.index+=1
p = s.plot(legend=False,kind="bar",rot=45,color="blue",fontsize=16,yerr=std);
p.set_title("Mean time and standard deviation for 10^9 problem size vs␣
↪processors")
p.set(xlabel='Processors, p', ylabel='Time, s')
p.figure.set_size_inches(13, 8)
```



2.1 Calculations

[7]:
```
s = df.groupby(["m","p"], as_index= False).mean()
s['s_1p'] = 0
s.iloc[:12, 5]= s['s'][0]
s.iloc[12:24, 5]= s['s'][12]
s.iloc[24:36, 5]= s['s'][24]
s['n_1p'] = 0
s.iloc[:12, 6]= s['n'][0]
s.iloc[12:24, 6]= s['n'][12]
s.iloc[24:36, 6]= s['n'][24]
s['speedup'] = s['s_1p']/s['s']
s['speedup_sk'] = s['speedup']*(s['n']/s['n_1p'])
s['effectiveness'] = s['speedup']/s['p']
s['effectiveness_sk'] = s['speedup_sk']/s['p']
s['sequential_part'] = (1/s['speedup_sk'] - 1/s['p'])/(1-1/s['p'])
s.head(3)
```

[7]:

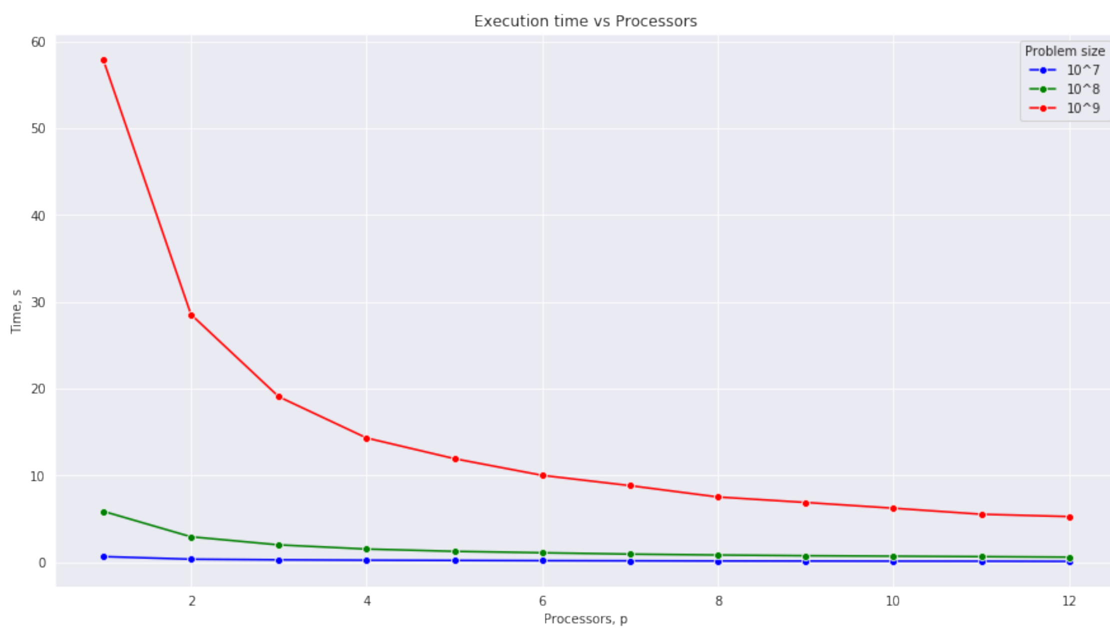
	m	p	n	s	pi	s_1p	n_1p	speedup	\
0	10000000	1	10000000	0.639018	3.141678	0.639018	10000000	1.000000	
1	10000000	2	10000000	0.334852	3.141488	0.639018	10000000	1.908357	
2	10000000	3	9999999	0.267095	3.140878	0.639018	10000000	2.392476	

	speedup_sk	effectiveness	effectiveness_sk	sequential_part
0	1.000000	1.000000	1.000000	NaN
1	1.908357	0.954179	0.954179	0.048022
2	2.392476	0.797492	0.797492	0.126966

3 Plots

points connected with lines were used for the charts the points show accurate results, and the connecting lines allow easier observation of trends

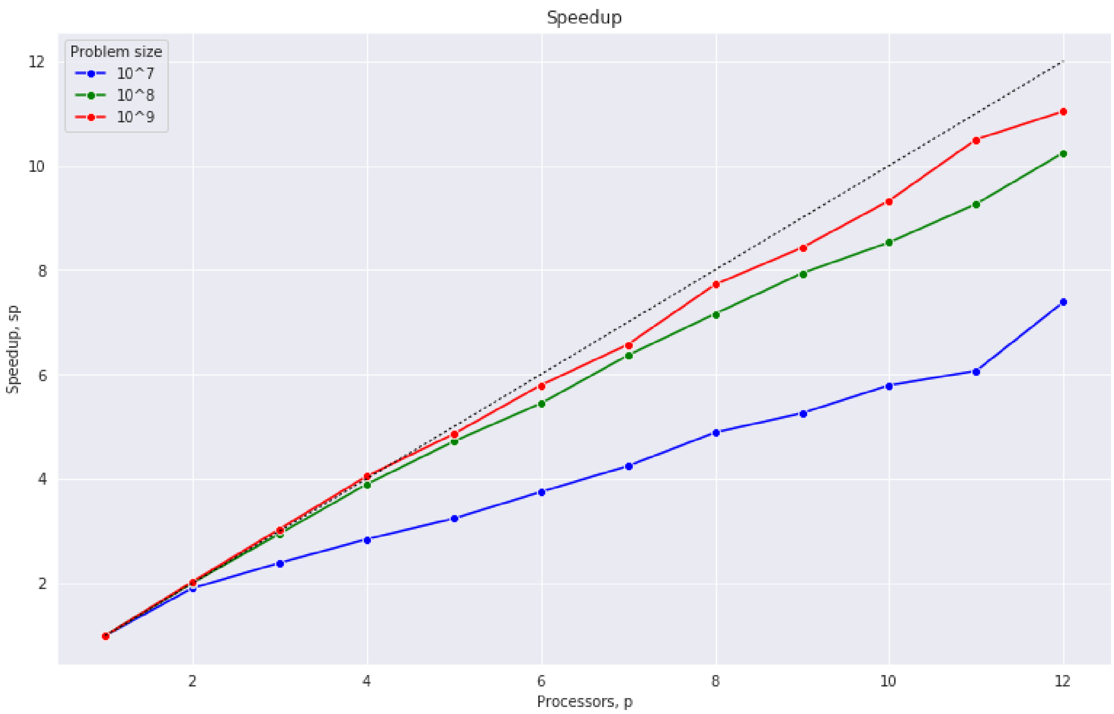
[8]:
```
g = sns.lineplot(x="p", y="s", style="m", hue="m", palette=["blue", "green",␣
 ↪"red"], marker="o", dashes=False, data=s)
g.set_title("Execution time vs Processors")
g.set(xlabel='Processors, p', ylabel='Time, s')
plt.legend(title='Problem size', labels=['10^7', '10^8', '10^9'])
g.figure.set_size_inches(15, 8)
```



because the size of the task is constant and the number of processors increases, the calculation time decreases

[9]:
```
g = sns.lineplot(x="p", y="speedup", hue="m", palette=["blue", "green", "red"],␣
 ↪marker="o", dashes=False, data=s)
g.plot([1, 12], [1, 12], 'k-', lw=1,dashes=[2, 2])
g.set_title("Speedup")
```

```
g.set(xlabel='Processors, p', ylabel='Speedup, sp')
plt.legend(title='Problem size', labels=['10^7', '10^8', '10^9'])
g.figure.set_size_inches(13, 8)
```

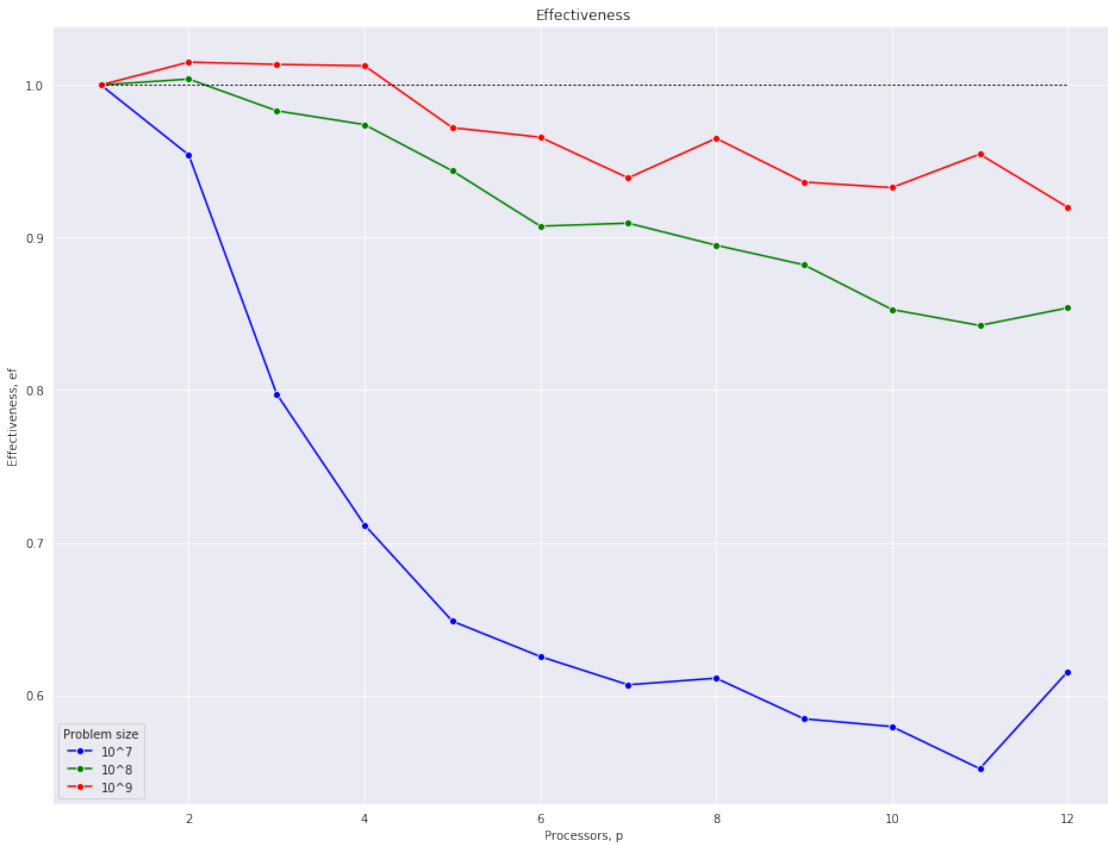


perfect speedup for the largest problem size up to four processors due to the large amount of computation compared to communication

noticeably less speedup for the smallest size of the problem, the impact of a large amount of communication in relation to calculations

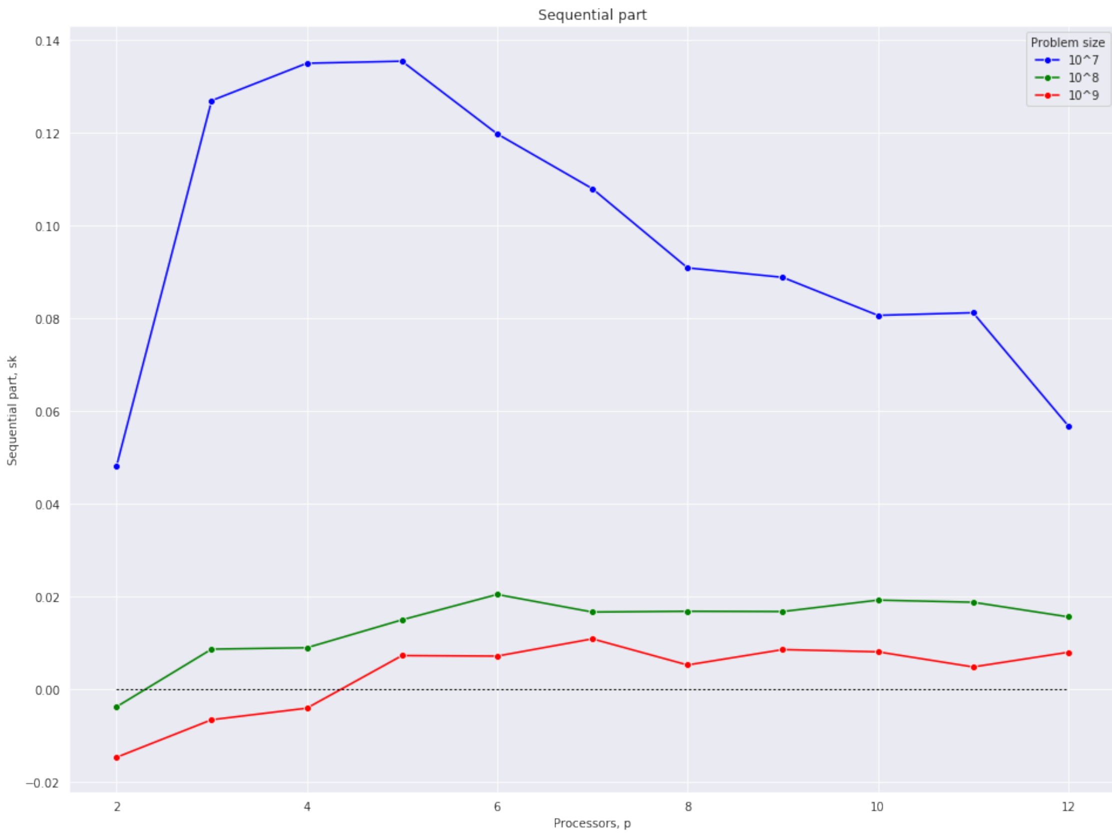
in the version with unscaled problem size, both scaled and unscaled acceleration are the same

[10]:
```
g = sns.lineplot(x="p", y="effectiveness", hue="m", palette=["blue", "green",␣
↪"red"], marker="o", dashes=False, data=s)
g.set_title("Effectiveness")
g.set(xlabel='Processors, p', ylabel='Effectiveness, ef')
plt.legend(title='Problem size', labels=['10^7', '10^8', '10^9'])
g.plot([1, 12], [1, 1], 'k-', lw=1,dashes=[2, 2])
g.figure.set_size_inches(16, 12)
```



much worse effectiveness for the smallest problem size coused by large communication

[11]:
```
g = sns.lineplot(x="p", y="sequential_part", hue="m", palette=["blue", "green",␣
↪"red"], marker="o", dashes=False, data=s)
g.set_title("Sequential part")
g.set(xlabel='Processors, p', ylabel='Sequential part, sk')
plt.legend(title='Problem size', labels=['10^7', '10^8', '10^9'])
g.plot([2, 12], [0, 0], 'k-', lw=1,dashes=[2, 2])
g.figure.set_size_inches(16, 12)
```



the smaller the problem, the greater part of it is communication, which translates into a larger sequential part

3.1 2. Scalable

[12]:
```
df = pd.read_csv('./scalable.csv', header=0)
```

number of repetitions

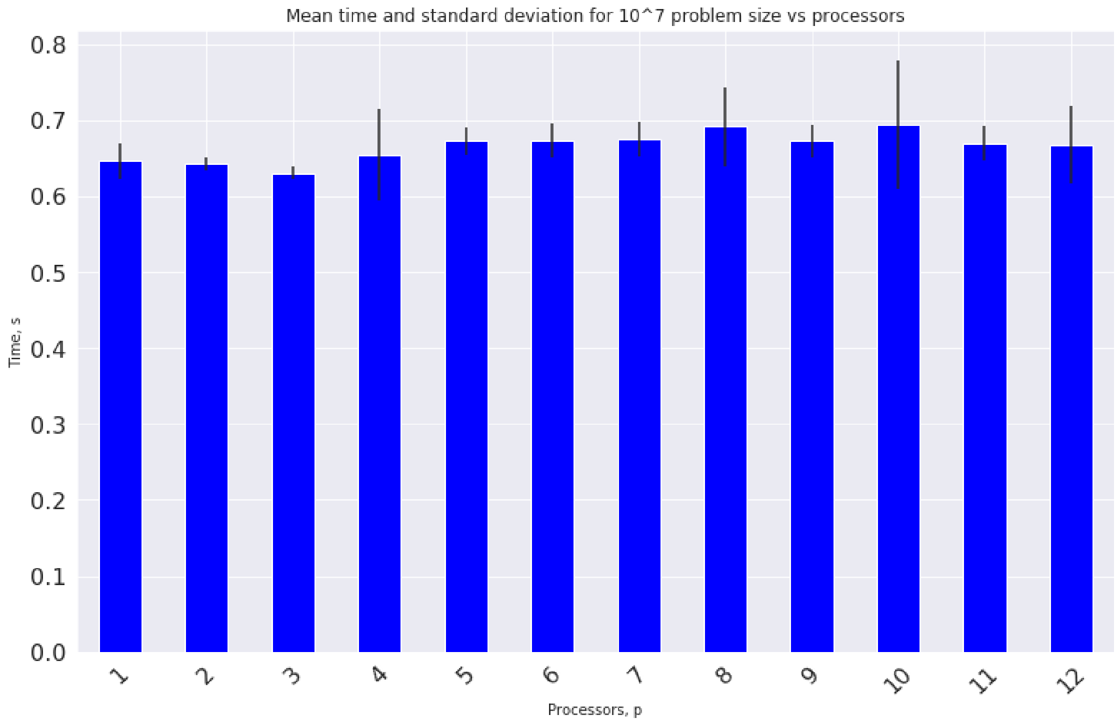
[13]:
```
df.groupby(["m","p"], as_index= False).count()['n'].head(1)
```

[13]:
```
0    10
Name: n, dtype: int64
```

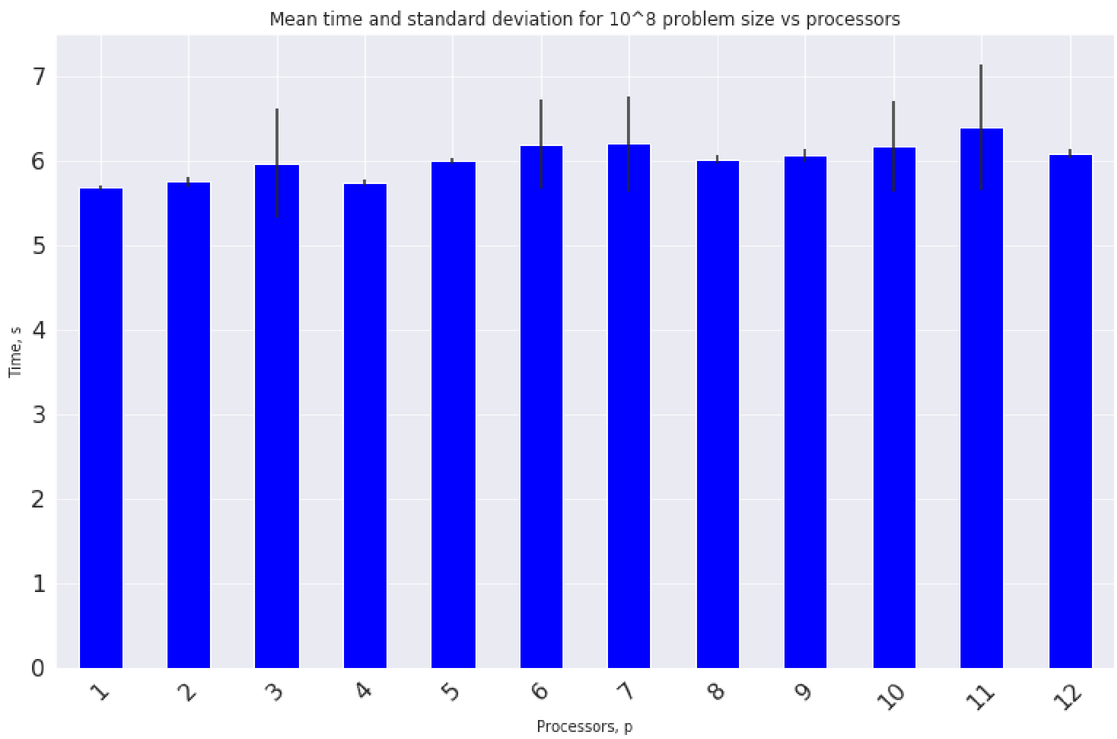
initial data check

[14]:
```
std = df.groupby(["m","p"], as_index= False)['s'].std()
std = std.iloc[:12,2]
std.index +=1
s = df.groupby(["m","p"], as_index= False)['s'].mean()
s = s.iloc[:12,2]
```

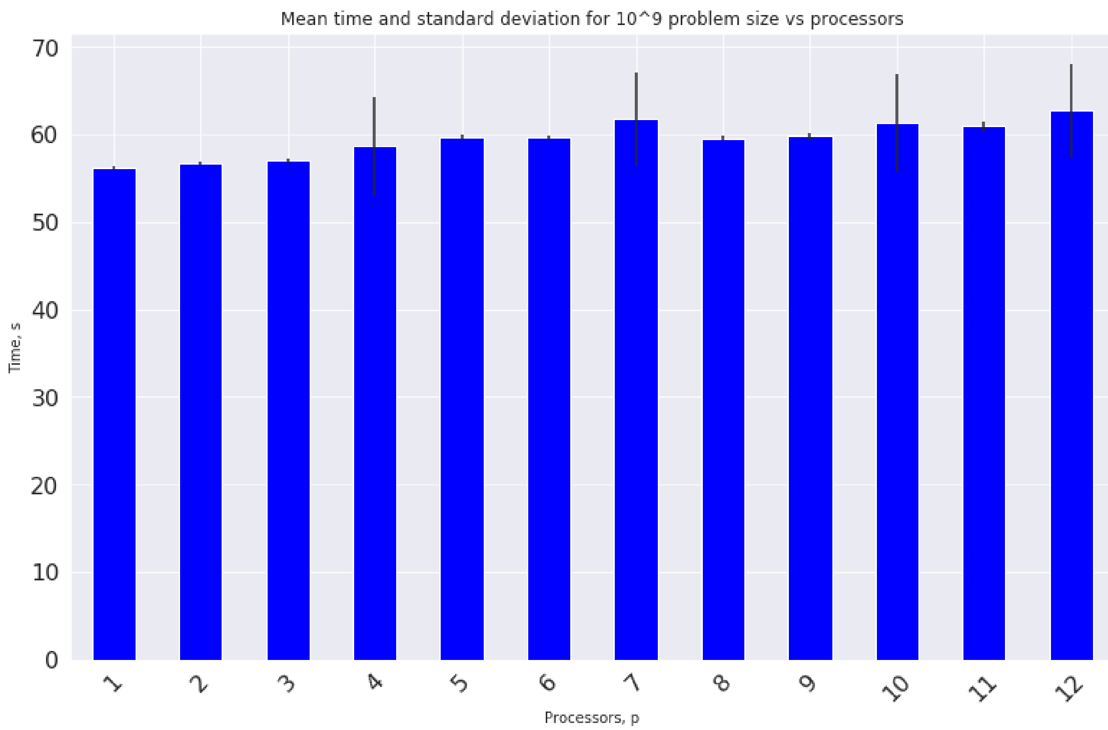
```
s.index+=1
p = s.plot(legend=False,kind="bar",rot=45,color="blue",fontsize=16,yerr=std);
p.set_title("Mean time and standard deviation for 10^7 problem size vs␣
↪processors")
p.set(xlabel='Processors, p', ylabel='Time, s')
p.figure.set_size_inches(13, 8)
```



[15]:
```
std = df.groupby(["m","p"], as_index= False)['s'].std()
std = std.iloc[12:24,2]
std.reset_index(drop=True, inplace=True)
std.index+=1
s = df.groupby(["m","p"], as_index= False)['s'].mean()
s = s.iloc[12:24,2]
s.reset_index(drop=True, inplace=True)
s.index+=1
p = s.plot(legend=False,kind="bar",rot=45,color="blue",fontsize=16,yerr=std);
p.set_title("Mean time and standard deviation for 10^8 problem size vs␣
↪processors")
p.set(xlabel='Processors, p', ylabel='Time, s')
p.figure.set_size_inches(13, 8)
```



[16]:
```
std = df.groupby(["m","p"], as_index= False)['s'].std()
std = std.iloc[24:36,2]
std.reset_index(drop=True, inplace=True)
std.index+=1
s = df.groupby(["m","p"], as_index= False)['s'].mean()
s = s.iloc[24:36,2]
s.reset_index(drop=True, inplace=True)
s.index+=1
p = s.plot(legend=False,kind="bar",rot=45,color="blue",fontsize=16,yerr=std);
p.set_title("Mean time and standard deviation for 10^9 problem size vs␣
↪processors")
p.set(xlabel='Processors, p', ylabel='Time, s')
p.figure.set_size_inches(13, 8)
```



3.2 Calculations

[17]:

```
s = df.groupby(["m","p"], as_index= False).mean()
s['s_1p'] = 0
s.iloc[:12, 5]= s['s'][0]
s.iloc[12:24, 5]= s['s'][12]
s.iloc[24:36, 5]= s['s'][24]
s['n_1p'] = 0
s.iloc[:12, 6]= s['n'][0]
s.iloc[12:24, 6]= s['n'][12]
s.iloc[24:36, 6]= s['n'][24]
s['speedup'] = s['s_1p']/s['s']
s['speedup_sk'] = s['speedup']*(s['n']/s['n_1p'])
s['effectiveness'] = s['speedup']/s['p']
s['effectiveness_sk'] = s['speedup_sk']/s['p']
s['sequential_part'] = (1/s['speedup_sk'] - 1/s['p'])/(1-1/s['p'])
s.head(3)
```

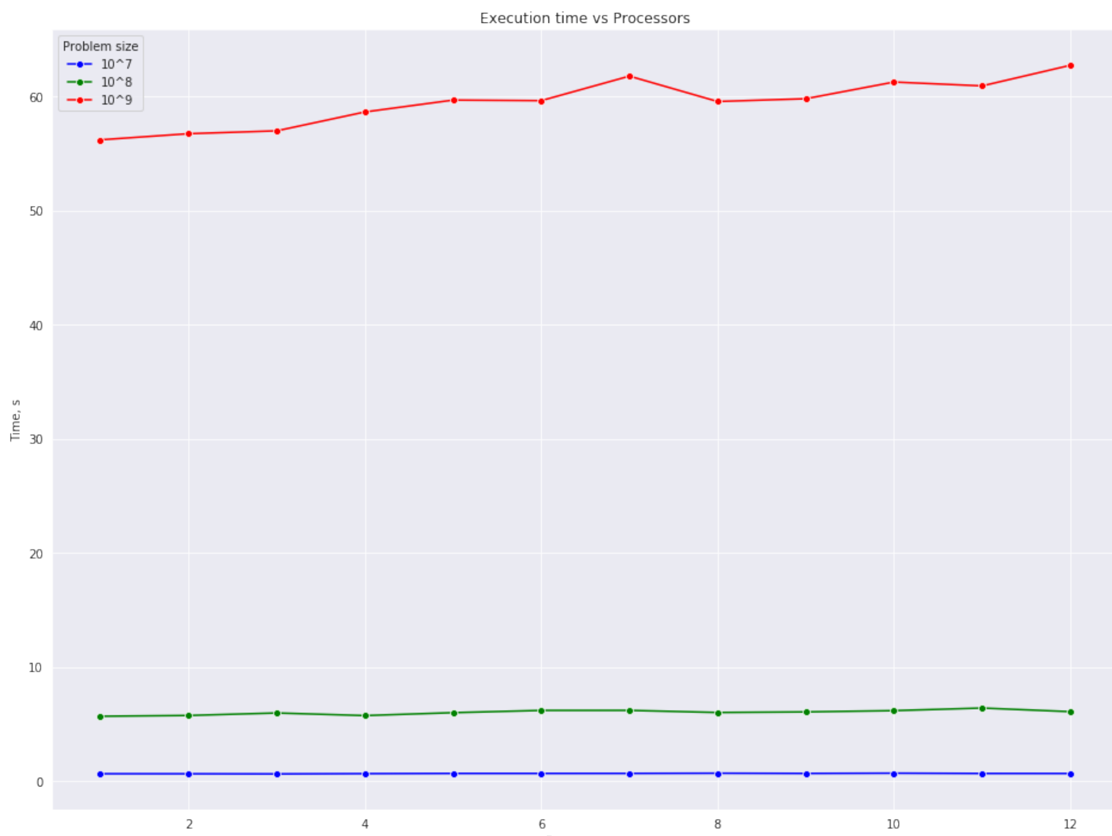
[17]:

```
          m  p         n         s        pi      s_1p      n_1p   speedup  \
0  10000000  1  10000000  0.646524  3.141561  0.646524  10000000  1.000000
1  10000000  2  20000000  0.642632  3.141683  0.646524  10000000  1.006056
2  10000000  3  30000000  0.631140  3.141372  0.646524  10000000  1.024373
```

	speedup_sk	effectiveness	effectiveness_sk	sequential_part
0	1.000000	1.000000	1.000000	NaN
1	2.012111	0.503028	1.006056	-0.006019
2	3.073120	0.341458	1.024373	-0.011897

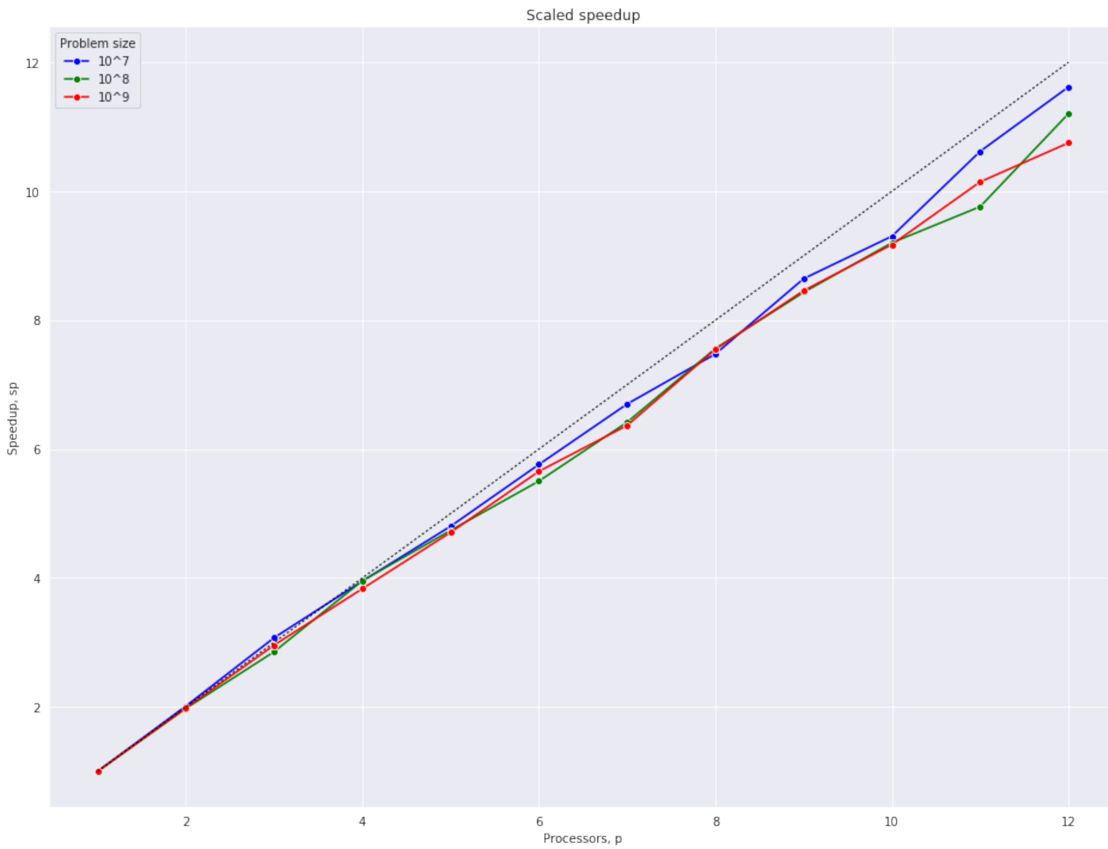
4 Plots

[18]:
```
g = sns.lineplot(x="p", y="s", style="m", hue="m", palette=["blue", "green",␣
↪"red"], marker="o", dashes=False, data=s)
g.set_title("Execution time vs Processors")
g.set(xlabel='Processors, p', ylabel='Time, s')
plt.legend(title='Problem size', labels=['10^7', '10^8', '10^9'])
g.figure.set_size_inches(16, 12)
```



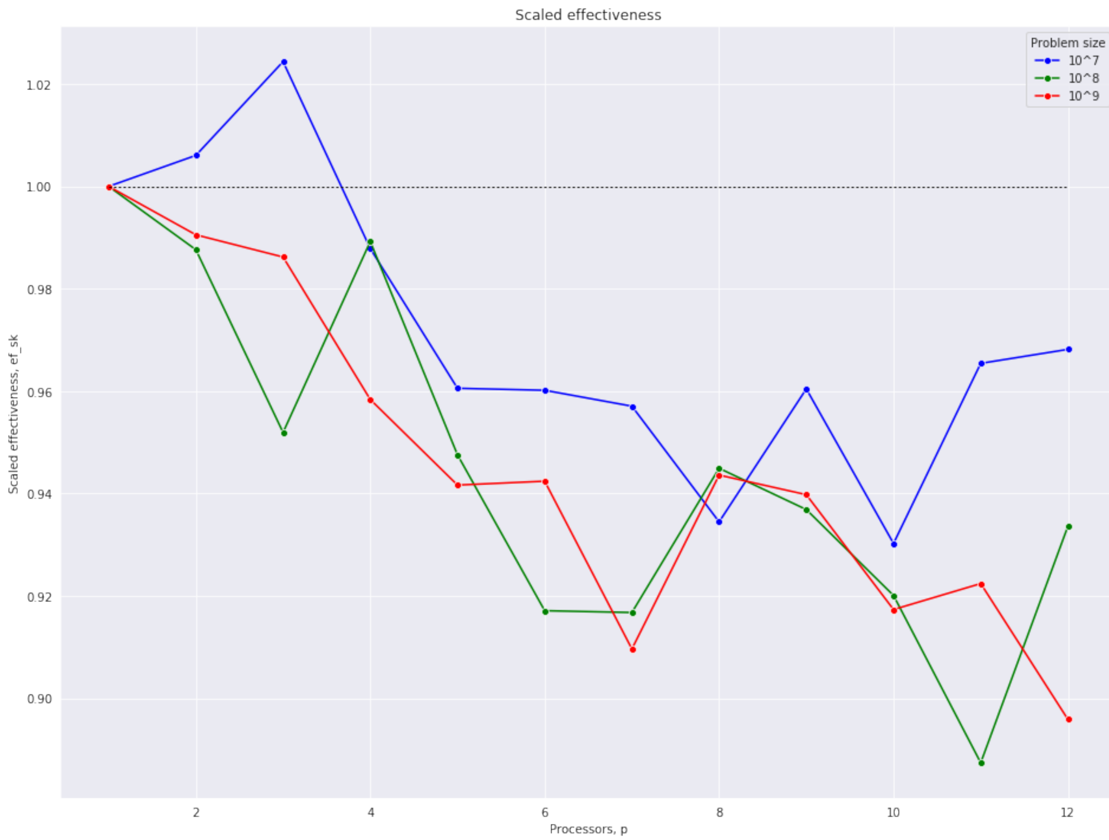
the size of the problem increases with the number of processors, the calculation time increases slightly

[19]:
```
g = sns.lineplot(x="p", y="speedup_sk", hue="m", palette=["blue", "green",␣
↪"red"], marker="o", dashes=False, data=s)
g.plot([1, 12], [1, 12], 'k-', lw=1,dashes=[2, 2])
g.set_title("Scaled speedup")
g.set(xlabel='Processors, p', ylabel='Speedup, sp')
plt.legend(title='Problem size', labels=['10^7', '10^8', '10^9'])
g.figure.set_size_inches(16, 12)
```



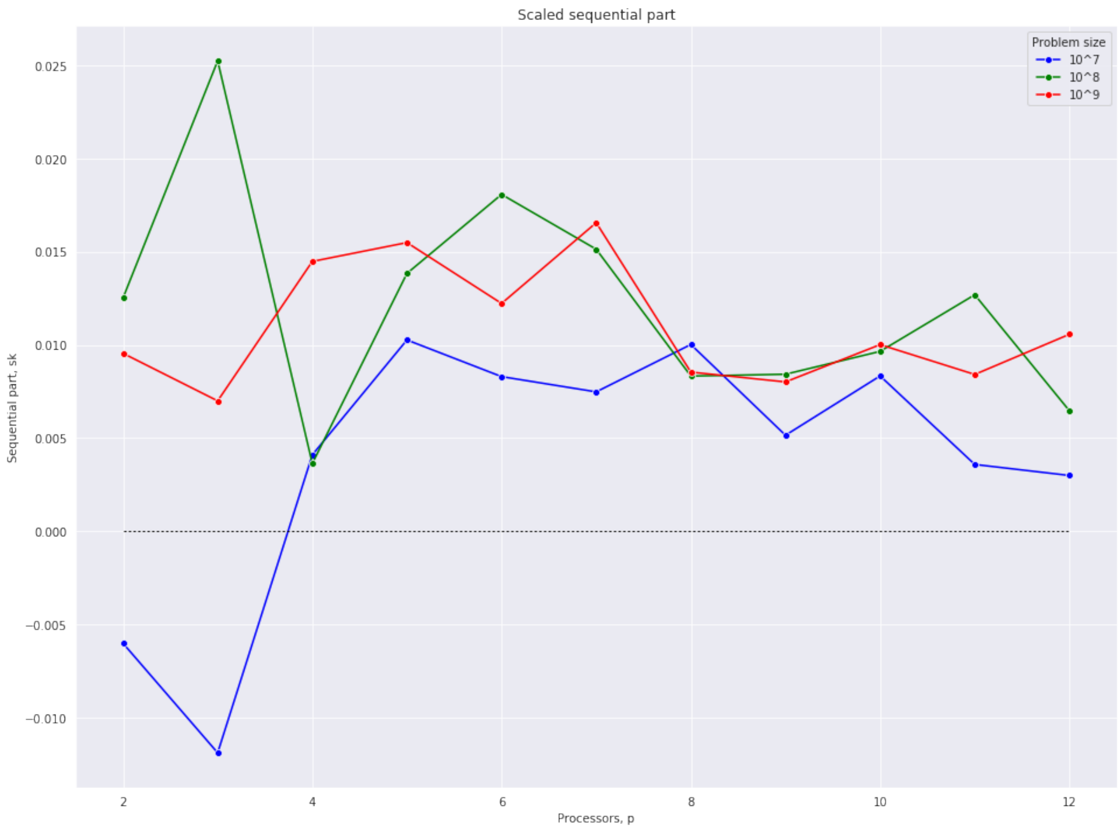
scaled speedup was used, it allows comparing the calculation with unscaled and scaled problem size

[20]:
```
g = sns.lineplot(x="p", y="effectiveness_sk", hue="m", palette=["blue",␣
↪"green", "red"], marker="o", dashes=False, data=s)
g.set_title("Scaled effectiveness")
g.set(xlabel='Processors, p', ylabel='Scaled effectiveness, ef_sk')
plt.legend(title='Problem size', labels=['10^7', '10^8', '10^9'])
g.plot([1, 12], [1, 1], 'k-', lw=1,dashes=[2, 2])
g.figure.set_size_inches(16, 12)
```



disturbances in the scaled effectiveness for the smallest problem caused by the fact that the time for equivalent sequential program was calculated

[21]:
```
g = sns.lineplot(x="p", y="sequential_part", hue="m", palette=["blue", "green",␣
↪"red"], marker="o", dashes=False, data=s)
g.set_title("Scaled sequential part")
g.set(xlabel='Processors, p', ylabel='Sequential part, sk')
plt.legend(title='Problem size', labels=['10^7', '10^8', '10^9'])
g.plot([2, 12], [0, 0], 'k-', lw=1,dashes=[2, 2])
g.figure.set_size_inches(16, 12)
```



again disturbances in the scaled sequential part for the smallest problem caused by the fact that the time for equivalent sequential program was calculated