STATISTICS OF Multi-threaded producer-consumer.
(The greek version is richer , this needs to be updated)

Bellow there are reported some of the statistics we got about the waiting time of a Workfunction in the queue . These measurements are achieved by using the matlab script that is located inside the data folder in the project.

- **Overall Mean Waiting time**

Queue size =10

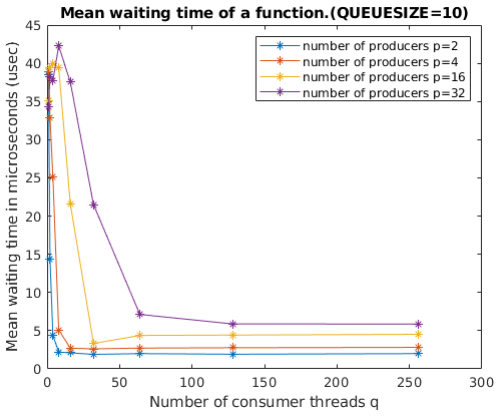
p \ q	q=1	q=2	q=4	q=8	q=16	q=32	q=64	q=128	Q=256
p=1	7.907	6.35	2.498	1.973	1.799	1.943	1.771	1.848	1.983
p=2	38.515	14.399	4.401	2.206	2.107	1.899	2	1.92	1.999
p=4	38.902	32.924	25.158	5.104	2.715	2.621	2.723	2.768	2.816
p=8	36.647	39.232	41.225	30.68	5.897	3.688	3.715	3.647	3.643
p=16	35.066	39.449	40.005	39.42	21.619	3.326	4.382	4.426	4.526
p=32	34.347	38.305	37.723	42.26	37.552	21.514	7.128	5.886	5.872
p=64	33.96	32.923	36.79	41.615	37.223	26.883	21.195	13.339	13.585

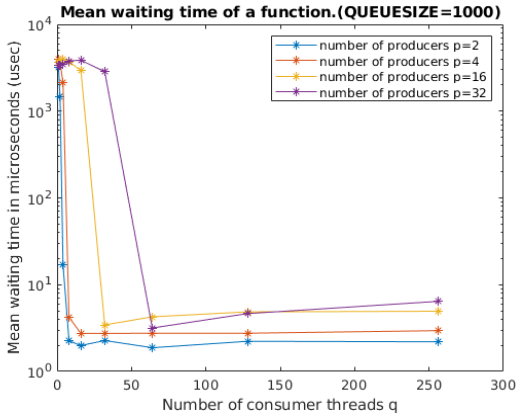
Overall mean waiting time for QUEUESIZE=10

Queue size =1000

p \ q	q=1	q=2	q=4	q=8	q=16	q=32	q=64	q=128	Q=256
p=1	107.228	682.416	4.572	2.115	1.959	1.93	1.903	1.988	2.034
p=2	3230.505	1464.026	16.89	2.253	1.989	2.272	1.877	2.226	2.198
p=4	3997.201	3654.78	2120.548	4.224	2.741	2.748	2.754	2.758	2.952
p=8	3909.871	4726.561	4603.474	3086.12	3.148	3.254	3.6	3.829	3.659
p=16	3604.914	3677.429	4003.022	3688.1	2958.501	3.439	4.262	4.861	4.941
p=32	3374.09	3394.415	3493.08	3803.286	3858.888	2856.644	3.17	4.641	6.421
p=64	3349.608	3373.243	3679.007	4137.892	3930.922	3526.686	1846.586	3.548	7.643

Overall mean waiting time for QUEUESIZE=1000





By seeing the tables and the graphs above we understand , that in general , for constant number of producers **p** , if the number of consumers **q** is increasing we get smaller values for the mean waiting time , until we get a really small value of mean waiting time , and the mean waiting time has a really small variation (practically is stable).Also we can see that for larger queues , we get bigger execution times in general.

- **Mean Waiting time of ¾ of executions**

Queue size =10

p \ q	q=1	q=2	q=4	q=8	q=16	q=32	q=64	q=128	Q=256
p=1	7.644	6.693	2.504	1.995	1.816	1.95	1.748	1.902	2.009
p=2	41.32	14.352	4.584	2.268	2.159	1.936	2.066	1.95	2.052
p=4	40.116	34.501	25.681	4.663	2.76	2.585	2.773	2.846	2.964
p=8	36.847	40.025	42.107	32.263	5.9	3.899	3.863	3.739	3.748
p=16	35.396	39.851	40.063	40.768	22.438	3.383	4.51	4.448	4.537
p=32	34.083	38.646	39.104	42.338	37.141	26.508	7.062	6.848	5.722
p=64	34.04	33.626	37.689	42.127	37.654	27.429	20.998	12.156	14.014

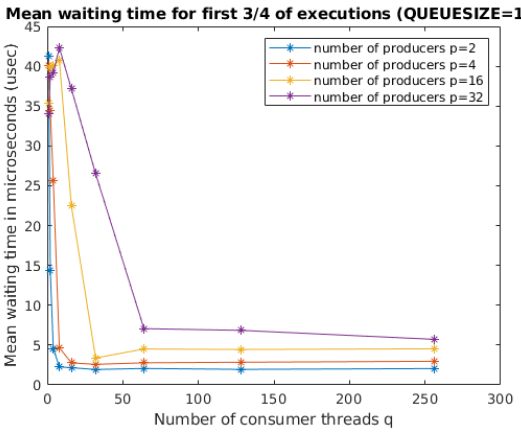
Mean Waiting time for the 3/4 of the executions(QUEUESIZE=10)

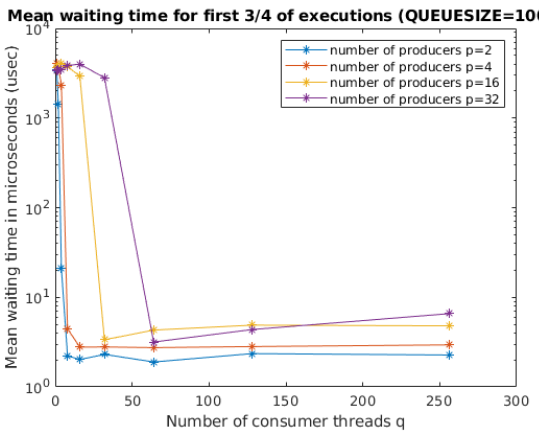
Queue size =1000

p \ q	q=1	q=2	q=4	q=8	q=16	q=32	q=64	q=128	Q=256
p=1	129.265	620.704	4.499	2.134	2.023	1.959	1.956	2.034	2.129
p=2	3481.751	1413.774	20.845	2.221	2.02	2.306	1.897	2.352	2.269
p=4	4089.464	3762.176	2344.189	4.435	2.78	2.792	2.744	2.82	2.945
p=8	3880.412	4388.218	4702.959	3386.596	3.105	3.334	3.772	3.912	3.708
p=16	3604.905	3736.126	4101.541	3754.885	2922.81	3.359	4.307	4.889	4.803
p=32	3358.302	3429.288	3495.123	3859.064	3995.572	2813.277	3.167	4.365	6.564
p=64	3363.048	3343.893	3630.564	4149.279	3919.26	3557.495	1776.763	3.517	7.683

Mean Waiting time for the 3/4 of the executions(QUEUESIZE=1000)

As we can see for the values of the mean waiting time in the ¾ of the total executions ((¾) * P*LOOP) is about the same as the overall mean wait time. That mean that the total number of executions are big enough to give as statistical conclusions. Also the graphs for the two statistics are the about the same as we can see bellow.





Furthermore bellow we can see the absolute difference between the mean waiting time at the ¾ of the executions and the absolute mean waiting time:

Queue size =10

p \ q	q=1	q=2	q=4	q=8	q=16	q=32	q=64	q=128	Q=256
p=1	0.262	0.343	0.005	0.022	0.017	0.007	0.023	0.054	0.026
p=2	2.805	0.047	0.183	0.061	0.053	0.037	0.066	0.03	0.053
p=4	1.214	1.578	0.523	0.441	0.045	0.037	0.05	0.078	0.148
p=8	0.2	0.793	0.882	1.583	0.003	0.212	0.147	0.092	0.105
p=16	0.33	0.402	0.059	1.347	0.819	0.056	0.127	0.022	0.011
p=32	0.264	0.341	1.381	0.078	0.411	4.994	0.065	0.962	0.151
p=64	0.08	0.703	0.9	0.512	0.431	0.546	0.197	1.183	0.429

Absolute Difference between mean waiting time at the ¾ of executions and the overall mean waiting(QUEUEASIZE=10)

Queue size =1000

p \ q	q=1	q=2	q=4	q=8	q=16	q=32	q=64	q=128	Q=256
p=1	22.037	61.711	0.074	0.02	0.063	0.03	0.053	0.046	0.095
p=2	251.246	50.252	3.954	0.032	0.031	0.035	0.02	0.126	0.071
p=4	92.263	107.396	223.641	0.212	0.04	0.044	0.009	0.062	0.007
p=8	29.459	338.343	99.485	300.476	0.043	0.079	0.172	0.083	0.049
p=16	0.009	58.697	98.519	66.785	35.691	0.08	0.046	0.028	0.138
p=32	15.788	34.874	2.043	55.778	136.684	43.367	0.003	0.276	0.142
p=64	13.44	29.351	48.443	11.387	11.662	30.809	69.822	0.031	0.041

Absolute Difference between mean waiting time at the ¾ of executions and the overall mean waiting(QUEUEASIZE=1000)

We see from the tables above that the absolute difference between mean waiting time at the ¾ of executions and the overall mean waiting time is a value so small , not comparable with the two statistics .

- **Standard Deviation of waiting times**

Queue size =10

p \ q	q=1	q=2	q=4	q=8	q=16	q=32	q=64	q=128	Q=256
p=1	8.64	6.565	7.963	4.266	1.952	2.918	1.354	1.407	3.181
p=2	21.177	15.392	5.987	13.042	12.241	1.426	10.028	4.71	9.91
p=4	69.074	39.517	43.018	31.541	14.811	12.655	20.905	20.73	24.211
p=8	59.862	69.675	84.851	58.086	18.558	41.877	38.41	35.512	36.118
p=16	66.097	106.547	102.671	109.36	57.675	25.144	51.558	50.392	53.813
p=32	61.972	123.786	114.908	141.734	128.617	33.898	21.26	49.964	68.938
p=64	61.037	88.535	125.789	156.498	124.545	37.774	26.458	25.569	35.214

Standard Deviation of waiting times (QUEUESIZE=10)

Queue size =1000

p \ q	q=1	q=2	q=4	q=8	q=16	q=32	q=64	q=128	Q=256
p=1	80.175	340.653	13.136	2.882	3.017	1.464	3.469	5.143	3.049
p=2	1770.506	539.343	37.896	11.214	3.739	19.19	6.901	24.965	11.297
p=4	782.155	871.73	1191.392	15.329	12.943	20.248	21.009	17.038	23.373
p=8	886.092	1975.131	1224.828	1374.703	13.084	30.606	36.114	40.376	34.042
p=16	619.073	702.983	1038.824	744.932	1479.741	29.803	46.214	59.416	56.967
p=32	413.523	683.517	644.403	1108.105	1115.186	1278.458	10.316	49.879	74.013
p=64	258.867	869.086	1184.714	1488.907	1374.579	968.736	1527.268	7.564	86.352

Standard Deviation of waiting times (QUEUESIZE=1000)

As we can see standard deviation gets significant values that are comparable with mean waiting time value and for some compinations of p and q , standard deviations also get bigger values . That means that the waiting times in our experiments vary in time . This is something we expected to see as soon as there are functions that are going to come out immediately (especially in the beginning of the programm, as we first spawn the consumer threads) and there are functions that are going to be in pending state inside the queue for a portion of time .