

## Lab 5 Report

### 1. Step 1: Create a Portfolio Database

date	nvda_adj_close	nvda_cum_return	nvda_value	goog_adj_close	goog_cum_return	goog_value	fb_adj_close	fb_cum_return
2017-10-03	179.37	2.66365	NULL	957.79	1.2329	NULL	169.96	1.32018
2017-10-02	179	2.65815	NULL	953.27	1.22708	NULL	169.47	1.31637
2017-09-29	178.77	2.65474	NULL	959.11	1.2346	NULL	170.87	1.32725
2017-09-28	175.68	2.60885	NULL	949.5	1.22223	NULL	168.73	1.31063
2017-09-27	175.73	2.60959	NULL	944.49	1.21578	NULL	167.68	1.30247
2017-09-26	171.96	2.55361	NULL	924.86	1.19051	NULL	164.21	1.27552
2017-09-25	171	2.53935	NULL	920.97	1.1855	NULL	162.87	1.26511
2017-09-22	179	2.65815	NULL	928.53	1.19523	NULL	170.54	1.32469
2017-09-21	180.76	2.68429	NULL	932.45	1.20028	NULL	171.11	1.32911
2017-09-20	185.84	2.75973	NULL	931.58	1.19916	NULL	172.17	1.33735
2017-09-19	187.35	2.78215	NULL	921.81	1.18658	NULL	172.52	1.34007
2017-09-18	187.55	2.78512	NULL	915	1.17782	NULL	170.01	1.32057
2017-09-15	180.11	2.67464	NULL	920.29	1.18463	NULL	171.64	1.33323
2017-09-14	169.4	2.51559	NULL	925.11	1.19083	NULL	170.96	1.32795
2017-09-13	170.37	2.53	NULL	935.09	1.20368	NULL	173.05	1.34418
2017-09-12	169.61	2.51871	NULL	932.07	1.19979	NULL	172.96	1.34348
2017-09-11	169	2.50965	NULL	929.08	1.19594	NULL	173.51	1.34776
2017-09-08	163.69	2.4308	NULL	926.5	1.19262	NULL	170.95	1.32787
2017-09-07	166.58	2.47372	NULL	935.95	1.20479	NULL	173.21	1.34542
2017-09-06	165.81	2.46228	NULL	927.81	1.19431	NULL	172.09	1.33673
2017-09-05	165.91	2.46377	NULL	928.45	1.19513	NULL	170.72	1.32608
2017-09-01	170.46	2.53133	NULL	937.34	1.20658	NULL	172.02	1.33618
2017-08-31	169.44	2.51619	NULL	939.33	1.20914	NULL	171.97	1.33579
2017-08-30	165.68	2.46035	NULL	929.57	1.19657	NULL	169.92	1.31987
2017-08-29	164.7	2.4458	NULL	921.29	1.18592	NULL	168.05	1.30534
2017-08-28	164.97	2.44981	NULL	913.81	1.17629	NULL	167.24	1.29905
2017-08-25	163.81	2.43258	NULL	915.89	1.17896	NULL	166.32	1.29191

fb_value	celg_adj_dose	celg_cum_return	celg_value	spy_adj_dose	spy_cum_return	spy_value	pf_cum_return	pf_value
NULL	146.08	1.40421	NULL	252.86	1.17184	NULL	NULL	NULL
NULL	146.04	1.40383	NULL	252.32	1.16934	NULL	NULL	NULL
NULL	145.82	1.40171	NULL	251.23	1.16429	NULL	NULL	NULL
NULL	142.76	1.3723	NULL	250.35	1.16021	NULL	NULL	NULL
NULL	142.97	1.37432	NULL	250.05	1.15882	NULL	NULL	NULL
NULL	143.63	1.38066	NULL	249.08	1.15432	NULL	NULL	NULL
NULL	144.94	1.39325	NULL	248.93	1.15363	NULL	NULL	NULL
NULL	143.89	1.38316	NULL	249.44	1.15599	NULL	NULL	NULL
NULL	143.78	1.3821	NULL	249.39	1.15576	NULL	NULL	NULL
NULL	144.24	1.38652	NULL	250.06	1.15887	NULL	NULL	NULL
NULL	143.47	1.37912	NULL	249.97	1.15845	NULL	NULL	NULL
NULL	142.84	1.37307	NULL	249.72	1.15729	NULL	NULL	NULL
NULL	142.04	1.36538	NULL	249.19	1.15483	NULL	NULL	NULL
NULL	140.61	1.35163	NULL	250.09	1.159	NULL	NULL	NULL
NULL	141.26	1.35788	NULL	250.17	1.15938	NULL	NULL	NULL
NULL	142.07	1.36566	NULL	250.05	1.15882	NULL	NULL	NULL
NULL	140.92	1.35461	NULL	249.21	1.15493	NULL	NULL	NULL
NULL	140.5	1.35057	NULL	246.58	1.14274	NULL	NULL	NULL
NULL	141.76	1.36268	NULL	246.87	1.14408	NULL	NULL	NULL
NULL	140.16	1.3473	NULL	246.9	1.14422	NULL	NULL	NULL
NULL	139.35	1.33952	NULL	246.06	1.14033	NULL	NULL	NULL
NULL	139.38	1.33981	NULL	247.84	1.14858	NULL	NULL	NULL
NULL	138.93	1.33548	NULL	247.49	1.14696	NULL	NULL	NULL
NULL	134.34	1.29136	NULL	246.01	1.1401	NULL	NULL	NULL
NULL	132.44	1.27309	NULL	244.85	1.13472	NULL	NULL	NULL
NULL	131.65	1.2655	NULL	244.57	1.13342	NULL	NULL	NULL
NULL	129.68	1.24656	NULL	244.56	1.13338	NULL	NULL	NULL

## 2. Step 2: Write a Portfolio Simulation Function

- First Output: [0.17543293857311348, 1.2729382239999993, 22.876149282470582, 0.5879000000000001]

date	nvda_adj_close	nvda_cum_return	nvda_value	goog_adj_close	goog_cum_return	goog_value	fb_adj_close	fb_cum_return
2017-06-13	151.4	2.24829	0.449658	953.4	1.22725	0.368174	150.68	1.17042
2017-06-12	149.97	2.22706	0.445411	942.9	1.21373	0.36412	148.44	1.15302
2017-06-09	149.6	2.22156	0.444312	949.83	1.22265	0.366796	149.6	1.16203
2017-06-08	159.94	2.37511	0.475022	983.41	1.26588	0.379763	154.71	1.20172
2017-06-07	149.12	2.21443	0.442887	981.08	1.26288	0.378864	153.12	1.18937
2017-06-06	147.34	2.188	0.4376	976.57	1.25707	0.377122	152.81	1.18697
2017-06-05	148.01	2.19795	0.43959	983.68	1.26623	0.379868	153.63	1.19334
2017-06-02	143.64	2.13306	0.426611	975.6	1.25582	0.376747	153.61	1.19318
2017-06-01	144.36	2.14375	0.42875	966.95	1.24469	0.373407	151.53	1.17702
2017-05-31	144.35	2.1436	0.42872	964.86	1.242	0.3726	151.46	1.17648
2017-05-30	144.87	2.15132	0.430264	975.88	1.25619	0.376856	152.38	1.18363
2017-05-26	141.84	2.10633	0.421265	971.47	1.25051	0.375153	152.13	1.18168
2017-05-25	138.26	2.05316	0.410633	969.54	1.24802	0.374407	151.96	1.18036
2017-05-24	138.57	2.05777	0.411553	954.96	1.22926	0.368777	150.04	1.16545
2017-05-23	137.03	2.0349	0.40698	948.82	1.22135	0.366406	148.07	1.15015
2017-05-22	138.9	2.06267	0.412533	941.86	1.21239	0.363718	148.24	1.15147
2017-05-19	136	2.0196	0.40392	934.01	1.20229	0.360687	148.06	1.15007
2017-05-18	133.07	1.97609	0.395218	930.24	1.19744	0.359231	147.66	1.14696
2017-05-17	127.72	1.89664	0.379329	919.62	1.18377	0.35513	144.85	1.12514
2017-05-16	136.81	2.03163	0.406326	943	1.21386	0.364158	149.78	1.16343
2017-05-15	134.31	1.99451	0.398901	937.08	1.20624	0.361872	150.19	1.16661
2017-05-12	127.89	1.89917	0.379834	932.22	1.19998	0.359995	150.33	1.1677
2017-05-11	126.5	1.87853	0.375705	930.6	1.1979	0.35937	150.04	1.16545
2017-05-10	121.29	1.80116	0.360232	928.78	1.19556	0.358667	150.29	1.16739
2017-05-09	102.94	1.52866	0.305732	932.17	1.19992	0.359976	150.48	1.16887
2017-05-08	102.77	1.52614	0.305227	934.3	1.20266	0.360799	151.06	1.17337
fb_value	celg_adj_close	celg_cum_return	celg_value	spy_adj_close	spy_cum_return	spy_value	pf_cum_return	pf_value
0.234084	119.62	1.14986	0.344958	244.55	1.13333	1.13333	1.39688	1.39688
0.230604	119.35	1.14727	0.34418	243.36	1.12782	1.12782	1.38432	1.38432
0.232406	118.19	1.13611	0.340834	243.41	1.12805	1.12805	1.38435	1.38435
0.240345	117.06	1.12525	0.337576	243.78	1.12976	1.12976	1.43271	1.43271
0.237875	117.57	1.13015	0.339046	243.66	1.12921	1.12921	1.39867	1.39867
0.237393	116.88	1.12352	0.337057	243.21	1.12712	1.12712	1.38917	1.38917
0.238667	118.1	1.13525	0.340575	243.99	1.13074	1.13074	1.3987	1.3987
0.238636	118.73	1.14131	0.342392	244.17	1.13157	1.13157	1.38439	1.38439
0.235405	116.41	1.119	0.335701	243.36	1.12782	1.12782	1.37326	1.37326
0.235296	114.41	1.09978	0.329934	241.44	1.11892	1.11892	1.36655	1.36655
0.236725	115.13	1.1067	0.33201	241.5	1.1192	1.1192	1.37585	1.37585
0.236337	116.78	1.12256	0.336768	241.71	1.12017	1.12017	1.36952	1.36952
0.236073	116.74	1.12218	0.336653	241.76	1.1204	1.1204	1.35777	1.35777
0.23309	117.75	1.13189	0.339566	240.61	1.11507	1.11507	1.35299	1.35299
0.23003	117.31	1.12766	0.338297	240.05	1.11248	1.11248	1.34171	1.34171
0.230294	115.71	1.11228	0.333683	239.52	1.11002	1.11002	1.34023	1.34023
0.230014	116.93	1.124	0.337201	238.31	1.10441	1.10441	1.33182	1.33182
0.229393	117.4	1.12852	0.338556	236.77	1.09728	1.09728	1.3224	1.3224
0.225027	117.1	1.12564	0.337691	235.82	1.09287	1.09287	1.29718	1.29718
0.232686	119.36	1.14736	0.344208	240.08	1.11261	1.11261	1.34738	1.34738
0.233323	119.04	1.14429	0.343286	240.3	1.11363	1.11363	1.33738	1.33738
0.23354	119.32	1.14698	0.344093	238.98	1.10752	1.10752	1.31746	1.31746
0.23309	119.52	1.1489	0.34467	239.38	1.10937	1.10937	1.31283	1.31283
0.233478	119.68	1.15044	0.345131	239.87	1.11164	1.11164	1.29751	1.29751
0.233773	120.1	1.15447	0.346342	239.44	1.10965	1.10965	1.24582	1.24582
0.234675	118.36	1.13775	0.341325	239.66	1.11067	1.11067	1.24203	1.24203

- b. Attempt with weights [0.4, 0.2, 0.3, 0.1] (Improved Sharpe Ratio): [0.21172756592678624, 1.3357620799999992, 23.82446144692153, 0.7051099999999999]

3. Step 3: Write a Portfolio Optimization Function

- a. Output: [[0.0, 0.8, 0.2, 0.0], [0.1749573215489264, 1.3070978280000007, 26.852085184038852, 0.6560999999999999]]

date	nvda_adj_close	nvda_cum_return	nvda_value	goog_adj_close	goog_cum_return	goog_value	fb_adj_close	fb_cum_return
2017-10-03	179.37	2.66365	0.532729	957.79	1.2329	0	169.96	1.32018
2017-10-02	179	2.65815	0.531631	953.27	1.22708	0	169.47	1.31637
2017-09-29	178.77	2.65474	0.530948	959.11	1.2346	0	170.87	1.32725
2017-09-28	175.68	2.60885	0.52177	949.5	1.22223	0	168.73	1.31063
2017-09-27	175.73	2.60959	0.521919	944.49	1.21578	0	167.68	1.30247
2017-09-26	171.96	2.55361	0.510722	924.86	1.19051	0	164.21	1.27552
2017-09-25	171	2.53935	0.507871	920.97	1.1855	0	162.87	1.26511
2017-09-22	179	2.65815	0.531631	928.53	1.19523	0	170.54	1.32469
2017-09-21	180.76	2.68429	0.536858	932.45	1.20028	0	171.11	1.32911
2017-09-20	185.84	2.75973	0.551945	931.58	1.19916	0	172.17	1.33735
2017-09-19	187.35	2.78215	0.55643	921.81	1.18658	0	172.52	1.34007
2017-09-18	187.55	2.78512	0.557024	915	1.17782	0	170.01	1.32057
2017-09-15	180.11	2.67464	0.534927	920.29	1.18463	0	171.64	1.33323
2017-09-14	169.4	2.51559	0.503119	925.11	1.19083	0	170.96	1.32795
2017-09-13	170.37	2.53	0.505999	935.09	1.20368	0	173.05	1.34418
2017-09-12	169.61	2.51871	0.503742	932.07	1.19979	0	172.96	1.34348
2017-09-11	169	2.50965	0.501931	929.08	1.19594	0	173.51	1.34776
2017-09-08	163.69	2.4308	0.48616	926.5	1.19262	0	170.95	1.32787
2017-09-07	166.58	2.47372	0.494743	935.95	1.20479	0	173.21	1.34542
2017-09-06	165.81	2.46228	0.492456	927.81	1.19431	0	172.09	1.33673
2017-09-05	165.91	2.46377	0.492753	928.45	1.19513	0	170.72	1.32608
2017-09-01	170.46	2.53133	0.506267	937.34	1.20658	0	172.02	1.33618
2017-08-31	169.44	2.51619	0.503237	939.33	1.20914	0	171.97	1.33579
2017-08-30	165.68	2.46035	0.49207	929.57	1.19657	0	169.92	1.31987
2017-08-29	164.7	2.4458	0.489159	921.29	1.18592	0	168.05	1.30534
2017-08-28	164.97	2.44981	0.489961	913.81	1.17629	0	167.24	1.29905



fb_value	celg_adj_close	celg_cum_return	celg_value	spy_adj_close	spy_cum_return	spy_value	pf_cum_return	pf_value
0	146.08	1.40421	1.12337	252.86	1.17184	1.17184	1.6561	1.6561
0	146.04	1.40383	1.12306	252.32	1.16934	1.16934	1.65469	1.65469
0	145.82	1.40171	1.12137	251.23	1.16429	1.16429	1.65232	1.65232
0	142.76	1.3723	1.09784	250.35	1.16021	1.16021	1.61961	1.61961
0	142.97	1.37432	1.09945	250.05	1.15882	1.15882	1.62137	1.62137
0	143.63	1.38066	1.10453	249.08	1.15432	1.15432	1.61525	1.61525
0	144.94	1.39325	1.1146	248.93	1.15363	1.15363	1.62247	1.62247
0	143.89	1.38316	1.10653	249.44	1.15599	1.15599	1.63816	1.63816
0	143.78	1.3821	1.10568	249.39	1.15576	1.15576	1.64254	1.64254
0	144.24	1.38652	1.10922	250.06	1.15887	1.15887	1.66116	1.66116
0	143.47	1.37912	1.1033	249.97	1.15845	1.15845	1.65973	1.65973
0	142.84	1.37307	1.09845	249.72	1.15729	1.15729	1.65548	1.65548
0	142.04	1.36538	1.0923	249.19	1.15483	1.15483	1.62723	1.62723
0	140.61	1.35163	1.0813	250.09	1.159	1.159	1.58442	1.58442
0	141.26	1.35788	1.0863	250.17	1.15938	1.15938	1.5923	1.5923
0	142.07	1.36566	1.09253	250.05	1.15882	1.15882	1.59627	1.59627
0	140.92	1.35461	1.08369	249.21	1.15493	1.15493	1.58562	1.58562
0	140.5	1.35057	1.08046	246.58	1.14274	1.14274	1.56662	1.56662
0	141.76	1.36268	1.09015	246.87	1.14408	1.14408	1.58489	1.58489
0	140.16	1.3473	1.07784	246.9	1.14422	1.14422	1.5703	1.5703
0	139.35	1.33952	1.07161	246.06	1.14033	1.14033	1.56437	1.56437
0	139.38	1.33981	1.07184	247.84	1.14858	1.14858	1.57811	1.57811
0	138.93	1.33548	1.06838	247.49	1.14696	1.14696	1.57162	1.57162
0	134.34	1.29136	1.03309	246.01	1.1401	1.1401	1.52516	1.52516
0	132.44	1.27309	1.01848	244.85	1.13472	1.13472	1.50763	1.50763
0	131.65	1.2655	1.0124	244.57	1.13342	1.13342	1.50236	1.50236