

Comparison Results of \tilde{T} -test on the Eight Models' Performance

The results of \tilde{T} -test on contribution performance of the eight models are shown below, i.e., tables on the left. Note that $p\text{-value} < 0.05$ means the two models are different significantly on a specific dimension. The \tilde{T} -graphs are on the right, where an edge from node A to node B if A tends to have higher values for a given metric than B (i.e., for the comparison A–B, \tilde{T} -test reports $p < 0.05$). \tilde{T} -graph omits direct edges between A and B if there is a path from A to B passing through at least one other node. Consider the example \tilde{T} -graph from Figure 1, summarizing the results of the \tilde{T} -test applied to four groups of values A, B, C and D: D tends to have higher values than both B and C, but lower than A; A tends to have higher values than all other groups (D directly, B and C transitively).

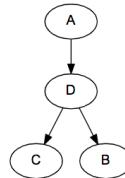


Fig. 1: Example \tilde{T} -graph

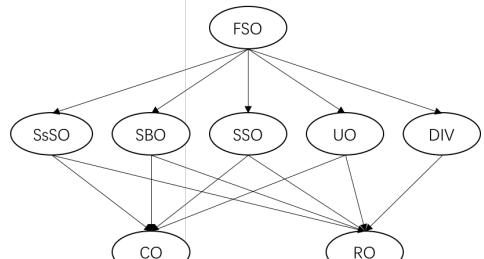
1. Contribution intensity

a) Contribution intensity at OpenStack level (CI^0)

i. Commit aspect:

#----Analysis----					
	Estimator	Lower	Upper	Statistic	p.Value
DIV - CO	0.230	-0.019	0.452	2.997	8.484739e-02
FSO - CO	0.454	0.292	0.590	8.405	1.018844e-06
RO - CO	-0.034	-0.206	0.141	-0.621	9.977390e-01
SBO - CO	0.232	0.062	0.389	4.412	3.387745e-03
SSO - CO	0.235	0.051	0.403	4.132	6.582521e-03
SsSo - CO	0.313	0.140	0.468	5.743	1.769058e-04
UO - CO	0.301	0.134	0.450	5.747	1.479984e-04
FSO - DIV	0.224	0.029	0.402	3.717	1.752240e-02
RO - DIV	-0.263	-0.448	-0.058	-4.133	6.555102e-03
SBO - DIV	0.003	-0.194	0.199	0.042	1.000000e+00
SSO - DIV	0.005	-0.204	0.214	0.075	1.000000e+00
SsSo - DIV	0.083	-0.122	0.282	1.319	8.654471e-01
UO - DIV	0.071	-0.127	0.263	1.155	9.261673e-01
RO - FSO	-0.487	-0.560	-0.407	-17.163	0.000000e+00
SBO - FSO	-0.221	-0.295	-0.144	-9.184	5.472254e-09
SSO - FSO	-0.219	-0.318	-0.115	-6.739	1.223501e-05
SsSo - FSO	-0.140	-0.226	-0.053	-5.180	4.450793e-04
UO - FSO	-0.153	-0.226	-0.078	-6.605	8.340795e-06
SBO - RO	0.266	0.181	0.347	9.883	1.805653e-09
SSO - RO	0.268	0.153	0.376	7.411	3.456538e-06
SsSo - RO	0.347	0.250	0.437	10.981	2.139404e-10
UO - RO	0.334	0.249	0.414	12.075	5.051515e-13
SSO - SBO	0.002	-0.108	0.112	0.069	1.000000e+00
SsSo - SBO	0.081	-0.014	0.174	2.782	1.305287e-01
UO - SBO	0.068	-0.013	0.149	2.716	1.474544e-01
SSo - SSO	0.079	-0.041	0.196	2.129	3.940542e-01
UO - SSO	0.066	-0.043	0.173	1.955	4.967745e-01
UO - SsSo	-0.013	-0.105	0.080	-0.448	9.997243e-01

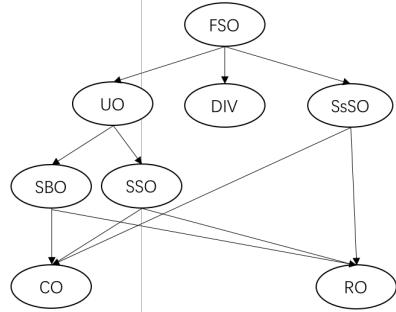
#----Overall----		
Quantile	p.Value	
1	3.2461	0



ii. Developer aspect:

----Analysis----					
	Estimator	Lower	Upper	Statistic	p.Value
DIV - CO	0.175	-0.042	0.376	2.636	1.742653e-01
FSO - CO	0.460	0.299	0.596	8.575	1.197460e-07
RO - CO	0.007	-0.168	0.182	0.137	9.999999e-01
SBO - CO	0.208	0.042	0.363	4.059	8.057988e-03
SSO - CO	0.188	0.003	0.361	3.305	4.507325e-02
SsSO - CO	0.304	0.130	0.460	5.583	2.347029e-04
UO - CO	0.324	0.159	0.472	6.233	4.363421e-05
FSO - DIV	0.286	0.134	0.425	6.006	8.945291e-05
RO - DIV	-0.167	-0.334	0.010	-3.083	7.234086e-02
SBO - DIV	0.033	-0.126	0.191	0.679	9.961712e-01
SSO - DIV	0.013	-0.165	0.191	0.241	9.999960e-01
SsSO - DIV	0.129	-0.037	0.289	2.531	2.100093e-01
UO - DIV	0.150	-0.008	0.300	3.100	6.973620e-02
RO - FSO	-0.453	-0.545	-0.351	-13.041	1.186273e-12
SBO - FSO	-0.252	-0.330	-0.172	-9.931	3.238057e-09
SSO - FSO	-0.272	-0.378	-0.160	-7.720	2.706059e-07
SsSO - FSO	-0.156	-0.242	-0.068	-5.723	1.597807e-04
UO - FSO	-0.136	-0.207	-0.063	-6.080	6.462504e-05
SBO - RO	0.201	0.089	0.308	5.789	1.424257e-04
SSO - RO	0.181	0.042	0.312	4.242	5.112074e-03
SsSO - RO	0.297	0.177	0.408	7.828	3.550347e-06
UO - RO	0.317	0.210	0.417	9.256	3.088685e-08
SSO - SBO	-0.020	-0.140	0.100	-0.544	9.990551e-01
SsSO - SBO	0.096	-0.004	0.194	3.118	6.730765e-02
UO - SBO	0.116	0.030	0.200	4.395	3.506872e-03
SsSO - SSO	0.116	-0.013	0.241	2.939	9.750354e-02
UO - SSO	0.136	0.019	0.250	3.784	1.517241e-02
UO - SsSO	0.020	-0.074	0.114	0.697	9.955247e-01

----Overall----	
Quantile	p.Value
1	3.258218 1.186273e-12

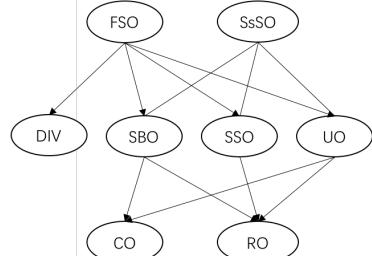


b) Contribution intensity at project type level (CI^T)

i. Commit aspect:

----Analysis----					
	Estimator	Lower	Upper	Statistic	p.Value
DIV - CO	0.176	-0.086	0.416	2.198	3.582714e-01
FSO - CO	0.398	0.212	0.556	6.675	7.807685e-06
RO - CO	-0.016	-0.206	0.176	-0.266	9.999918e-01
SBO - CO	0.232	0.042	0.405	3.965	1.029249e-02
SSO - CO	0.192	-0.011	0.380	3.086	7.183871e-02
SsSO - CO	0.370	0.175	0.537	5.981	5.870169e-05
UO - CO	0.246	0.058	0.417	4.230	5.353807e-03
FSO - DIV	0.221	0.022	0.404	3.606	2.316311e-02
RO - DIV	-0.192	-0.387	0.019	-2.971	9.103499e-02
SBO - DIV	0.055	-0.145	0.252	0.894	9.805461e-01
SSO - DIV	0.016	-0.197	0.227	0.237	9.999963e-01
SsSO - DIV	0.194	-0.015	0.386	3.021	8.243191e-02
UO - DIV	0.070	-0.132	0.265	1.123	9.356639e-01
RO - FSO	-0.413	-0.495	-0.324	-13.887	1.432188e-14
SBO - FSO	-0.166	-0.241	-0.089	-7.004	1.082903e-05
SSO - FSO	-0.206	-0.307	-0.099	-6.236	4.069317e-05
SsSO - FSO	-0.028	-0.116	0.061	-1.015	9.613867e-01
UO - FSO	-0.152	-0.227	-0.075	-6.386	2.502474e-05
SBO - RO	0.247	0.156	0.335	8.618	6.105484e-08
SSO - RO	0.208	0.086	0.323	5.527	2.360648e-04
SsSO - RO	0.386	0.282	0.481	11.336	2.007892e-10
UO - RO	0.262	0.169	0.350	8.954	1.705630e-08
SSO - SBO	-0.040	-0.149	0.071	-1.171	9.215552e-01
SsSO - SBO	0.138	0.044	0.230	4.789	1.406912e-03
UO - SBO	0.014	-0.066	0.094	0.579	9.985561e-01
SsSO - SSO	0.178	0.057	0.293	4.788	1.366929e-03
UO - SSO	0.054	-0.056	0.163	1.590	7.248233e-01
UO - SsSO	-0.124	-0.216	-0.030	-4.278	5.015371e-03

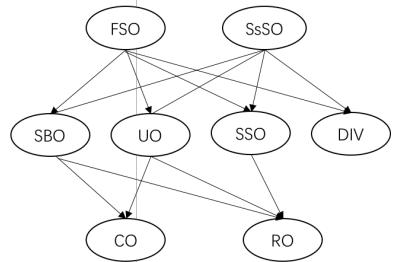
----Overall----	
Quantile	p.Value
1	3.258898 1.432188e-14



ii. Developer aspect:

#----Analysis-----#					
	Estimator	Lower	Upper	Statistic	p.Value
DIV - CO	0.095	-0.143	0.323	1.300	8.747855e-01
FSO - CO	0.380	0.200	0.535	6.632	2.349621e-05
RO - CO	-0.012	-0.201	0.177	-0.207	9.999986e-01
SBO - CO	0.228	0.045	0.396	4.049	8.559524e-03
SSO - CO	0.138	-0.061	0.327	2.269	3.239210e-01
SsSo - CO	0.359	0.170	0.522	6.014	7.118314e-05
UO - CO	0.239	0.057	0.406	4.271	5.095680e-03
FSO - DIV	0.285	0.111	0.442	5.279	4.400093e-04
RO - DIV	-0.107	-0.292	0.085	-1.822	5.831934e-01
SBO - DIV	0.133	-0.045	0.302	2.435	2.479344e-01
SSO - DIV	0.043	-0.152	0.236	0.717	9.945959e-01
SsSo - DIV	0.264	0.081	0.429	4.661	2.012080e-03
UO - DIV	0.144	-0.033	0.313	2.657	1.682862e-01
RO - FSO	-0.392	-0.486	-0.290	-11.649	2.541956e-11
SBO - FSO	-0.152	-0.229	-0.074	-6.333	3.567505e-05
SSO - FSO	-0.242	-0.350	-0.127	-6.755	1.291049e-05
SsSo - FSO	-0.021	-0.108	0.065	-0.808	9.891331e-01
UO - FSO	-0.141	-0.216	-0.064	-5.976	1.123784e-04
SBO - RO	0.240	0.132	0.342	7.169	1.273772e-05
SSO - RO	0.150	0.014	0.282	3.591	2.436364e-02
SsSo - RO	0.371	0.256	0.475	9.958	5.895308e-09
UO - RO	0.251	0.145	0.352	7.556	8.985192e-07
SSO - SBO	-0.089	-0.206	0.030	-2.442	2.451180e-01
SsSo - SBO	0.131	0.037	0.222	4.549	2.643060e-03
UO - SBO	0.012	-0.071	0.094	0.459	9.996837e-01
SSO - SSO	0.220	0.093	0.340	5.604	1.948341e-04
UO - SSO	0.101	-0.018	0.217	2.776	1.346586e-01
UO - SsSo	-0.119	-0.210	-0.027	-4.205	6.076442e-03

#----Overall-----#	
Quantile	p.Value
1	3.265349 2.541956e-11

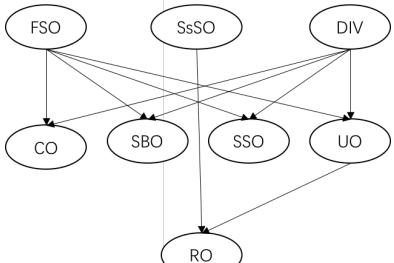


c) Contribution intensity at project level (CI^P)

i. Commit aspect:

#----Analysis-----#					
	Estimator	Lower	Upper	Statistic	p.Value
DIV - CO	0.322	0.071	0.535	4.135	6.492753e-03
FSO - CO	0.214	0.042	0.374	4.039	8.441647e-03
RO - CO	-0.043	-0.233	0.149	-0.729	9.942459e-01
SBO - CO	0.061	-0.116	0.234	1.116	9.394933e-01
SSO - CO	0.068	-0.122	0.253	1.159	9.273361e-01
SsSo - CO	0.189	-0.001	0.367	3.239	5.238110e-02
UO - CO	0.111	-0.064	0.280	2.068	4.344805e-01
FSO - DIV	-0.107	-0.290	0.083	-1.843	5.725789e-01
RO - DIV	-0.365	-0.547	-0.150	-5.391	2.697444e-04
SBO - DIV	-0.261	-0.439	-0.063	-4.262	4.927687e-03
SSO - DIV	-0.254	-0.442	-0.044	-3.929	1.089003e-02
SsSo - DIV	-0.132	-0.326	0.072	-2.108	4.113269e-01
UO - DIV	-0.211	-0.391	-0.015	-3.496	2.952374e-02
RO - FSO	-0.258	-0.363	-0.146	-7.360	1.141600e-06
SBO - FSO	-0.154	-0.234	-0.071	-6.027	9.187818e-05
SSO - FSO	-0.147	-0.247	-0.043	-4.581	2.167096e-03
SsSo - FSO	-0.025	-0.131	0.082	-0.759	9.926918e-01
UO - FSO	-0.103	-0.180	-0.025	-4.309	4.377596e-03
SBO - RO	0.104	-0.012	0.218	2.917	1.018717e-01
SSO - RO	0.111	-0.022	0.241	2.717	1.503514e-01
SsSo - RO	0.233	0.096	0.361	5.492	2.507704e-04
UO - RO	0.155	0.040	0.265	4.388	3.392860e-03
SSO - SBO	0.007	-0.102	0.116	0.213	9.999984e-01
SsSo - SBO	0.129	0.015	0.239	3.692	1.893936e-02
UO - SBO	0.050	-0.035	0.135	1.918	5.253077e-01
SsSo - SSO	0.122	-0.009	0.248	3.035	8.025284e-02
UO - SSO	0.043	-0.063	0.149	1.323	8.675035e-01
UO - SsSo	-0.078	-0.187	0.032	-2.303	3.081169e-01

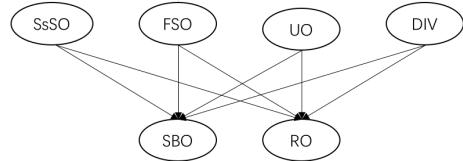
#----Overall-----#	
Quantile	p.Value
1	3.257435 1.1416e-06



ii. Developer aspect:

-----Analysis-----#					
	Estimator	Lower	Upper	Statistic	p.Value
DIV - CO	0.191	-0.064	0.422	2.447	2.428820e-01
FSO - CO	0.081	-0.076	0.234	1.680	6.744361e-01
RO - CO	-0.106	-0.278	0.073	-1.924	5.218606e-01
SBO - CO	-0.067	-0.225	0.094	-1.360	8.510880e-01
SSO - CO	0.024	-0.159	0.205	0.424	9.998194e-01
SsSo - CO	0.061	-0.114	0.233	1.130	9.356796e-01
UO - CO	0.027	-0.133	0.184	0.540	9.991132e-01
FSO - DIV	-0.110	-0.312	0.102	-1.685	6.718491e-01
RO - DIV	-0.296	-0.500	-0.062	-4.085	7.233164e-03
SBO - DIV	-0.258	-0.454	-0.038	-3.807	1.448514e-02
SSO - DIV	-0.167	-0.382	0.066	-2.337	2.918958e-01
SsSo - DIV	-0.130	-0.342	0.095	-1.879	5.487759e-01
UO - DIV	-0.164	-0.366	0.052	-2.475	2.321219e-01
RO - FSO	-0.187	-0.293	-0.076	-5.444	2.416397e-04
SBO - FSO	-0.148	-0.229	-0.065	-5.801	8.635421e-05
SSO - FSO	-0.057	-0.175	0.063	-1.550	7.520488e-01
SsSo - FSO	-0.020	-0.127	0.087	-0.611	9.980632e-01
UO - FSO	-0.055	-0.132	0.023	-2.283	3.174350e-01
SBO - RO	0.039	-0.078	0.154	1.074	9.498759e-01
SSO - RO	0.130	-0.017	0.271	2.884	1.090832e-01
SsSo - RO	0.167	0.030	0.297	3.961	1.007581e-02
UO - RO	0.132	0.018	0.244	3.751	1.657998e-02
SSO - SBO	0.091	-0.035	0.214	2.361	2.808816e-01
SsSo - SBO	0.128	0.014	0.239	3.645	2.132071e-02
UO - SBO	0.094	0.006	0.180	3.476	3.095568e-02
SsSo - SSO	0.037	-0.106	0.178	0.842	9.866159e-01
UO - SSO	0.003	-0.120	0.125	0.067	1.000000e+00
UO - SsSo	-0.034	-0.145	0.077	-1.007	9.640757e-01

-----Overall-----#	
Quantile	p.Value
1	3.255274 8.635421e-05

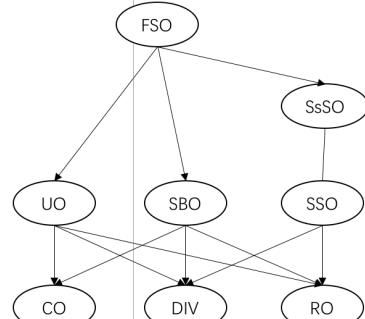


2. Contribution extent

a) Contribution extent at project type level (CE^T)

-----Analysis-----#					
	Estimator	Lower	Upper	Statistic	p.Value
DIV - CO	-0.005	-0.179	0.170	-0.090	1.000000e+00
FSO - CO	0.498	0.362	0.614	10.593	9.275458e-11
RO - CO	0.073	-0.094	0.237	1.424	8.190826e-01
SBO - CO	0.241	0.094	0.377	5.286	3.154141e-04
SSO - CO	0.197	0.035	0.349	3.946	1.042418e-02
SsSo - CO	0.326	0.176	0.461	6.871	4.331660e-06
UO - CO	0.302	0.157	0.434	6.605	7.493667e-06
FSO - DIV	0.503	0.388	0.603	12.491	2.426948e-13
RO - DIV	0.078	-0.072	0.225	1.694	6.649727e-01
SBO - DIV	0.245	0.120	0.363	6.277	2.256946e-05
SSO - DIV	0.202	0.059	0.337	4.575	2.151792e-03
SsSo - DIV	0.331	0.202	0.449	8.026	1.517383e-07
UO - DIV	0.306	0.182	0.421	7.785	8.286843e-07
RO - FSO	-0.425	-0.524	-0.315	-11.564	9.115819e-12
SBO - FSO	-0.258	-0.329	-0.183	-10.964	2.407619e-11
SSO - FSO	-0.301	-0.392	-0.204	-9.738	6.850996e-10
SsSo - FSO	-0.172	-0.250	-0.091	-6.896	8.401176e-06
UO - FSO	-0.197	-0.267	-0.124	-8.670	2.093170e-08
SBO - RO	0.167	0.047	0.282	4.523	2.614361e-03
SSO - RO	0.124	-0.013	0.256	2.949	9.422296e-02
SsSo - RO	0.253	0.128	0.370	6.460	2.508521e-05
UO - RO	0.228	0.109	0.341	6.158	4.437741e-05
SSO - SBO	-0.043	-0.149	0.064	-1.311	8.715245e-01
SsSo - SBO	0.086	-0.006	0.176	3.045	7.781608e-02
UO - SBO	0.061	-0.024	0.145	2.340	2.899664e-01
SsSo - SSO	0.129	0.015	0.239	3.686	1.888900e-02
UO - SSO	0.104	-0.003	0.209	3.175	5.895475e-02
UO - SsSo	-0.025	-0.115	0.066	-0.881	9.823851e-01

-----Overall-----#	
Quantile	p.Value
1	3.254197 2.426948e-13



b) Contribution extent at project level (CE^P)

-----Analysis-----#					
	Estimator	Lower	Upper	Statistic	p.Value
DIV - CO	0.037	-0.209	0.279	0.486	9.994846e-01
FSO - CO	0.484	0.296	0.637	7.698	1.396227e-06
RO - CO	-0.002	-0.199	0.196	-0.027	1.000000e+00
SBO - CO	0.228	0.033	0.406	3.804	1.527455e-02
SSO - CO	0.238	0.029	0.427	3.699	1.942612e-02
SsSo - CO	0.249	0.048	0.431	4.026	9.227403e-03
UO - CO	0.284	0.090	0.457	4.721	1.849067e-03
FSO - DIV	0.447	0.265	0.598	7.503	2.316456e-06
RO - DIV	-0.039	-0.228	0.153	-0.658	9.965083e-01
SBO - DIV	0.191	0.003	0.366	3.313	4.505927e-02
SSO - DIV	0.200	-0.002	0.387	3.229	5.384840e-02
SsSo - DIV	0.212	0.018	0.391	3.563	2.626978e-02
UO - DIV	0.246	0.059	0.417	4.272	5.411223e-03
RO - FSO	-0.486	-0.565	-0.399	-15.893	0.000000e+00
SBO - FSO	-0.256	-0.327	-0.182	-11.000	1.467628e-09
SSO - FSO	-0.247	-0.345	-0.143	-7.629	8.846900e-07
SsSo - FSO	-0.235	-0.314	-0.153	-9.135	1.675017e-07
UO - FSO	-0.201	-0.269	-0.131	-9.237	1.217802e-08
SBO - RO	0.230	0.134	0.322	7.684	2.805860e-06
SSO - RO	0.239	0.116	0.356	6.237	3.848384e-05
SsSo - RO	0.251	0.149	0.348	7.867	7.792883e-07
UO - RO	0.285	0.192	0.374	9.634	5.081398e-09
SSO - SBO	0.010	-0.102	0.121	0.277	9.999881e-01
SsSo - SBO	0.021	-0.068	0.111	0.774	9.907648e-01
UO - SBO	0.055	-0.025	0.135	2.250	3.278549e-01
SsSo - SSO	0.012	-0.107	0.130	0.323	9.999662e-01
UO - SSO	0.046	-0.065	0.155	1.355	8.443695e-01
UO - SsSo	0.034	-0.054	0.121	1.265	8.832458e-01

-----Overall-----#	
Quantile	p.Value
1	3.261981 0

