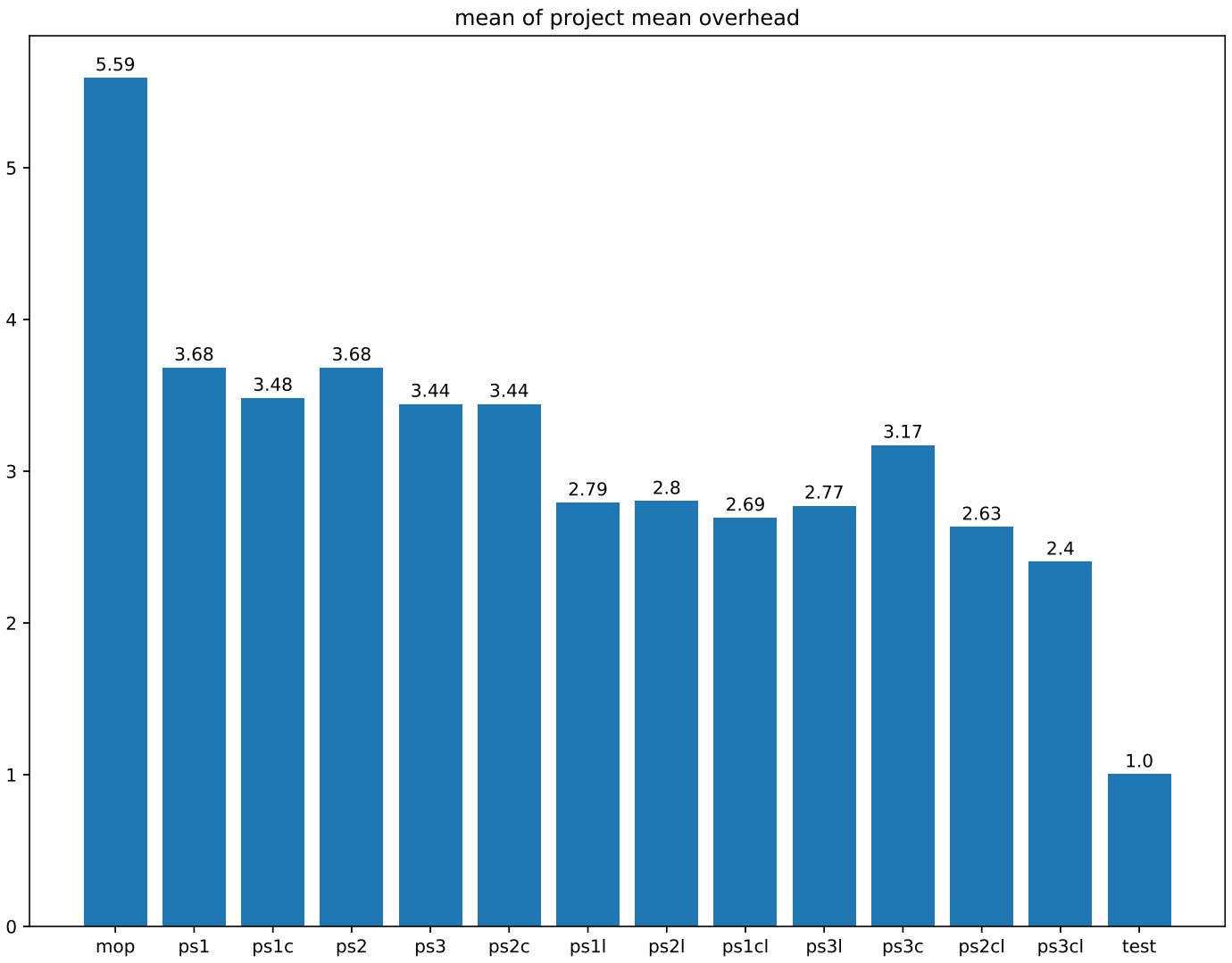
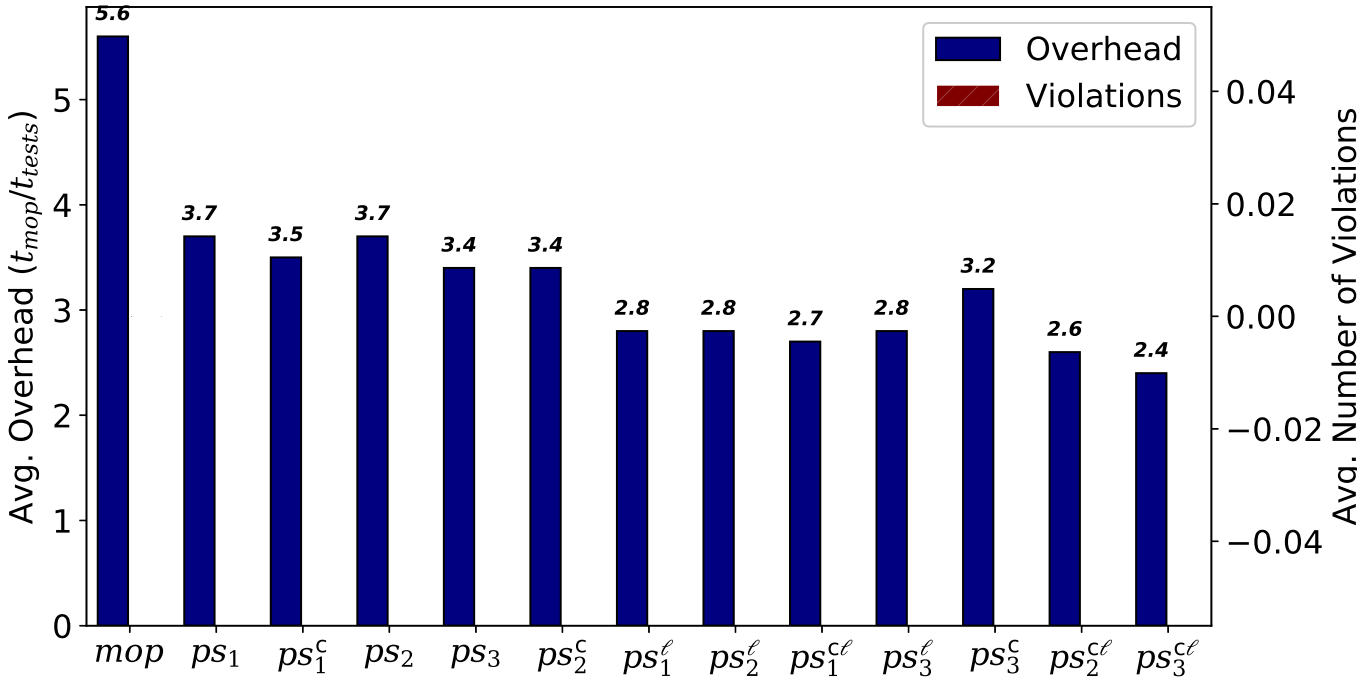
I. Appendix


mean of project mean overhead
5.59
3.68
3.48
3.68
3.44
3.44
2.79
2.8
2.69
2.77
3.17
2.63
2.4
1.0
0
1
2
3
4
5
mop
ps1
ps1c
ps2
ps3
ps2c
ps1l
ps2l
ps1cl
ps3l
ps3c
ps2cl
ps3cl
test


Overhead
Violations
Avg. Overhead (t_{mop}/t_{tests})
Avg. Number of Violations
0
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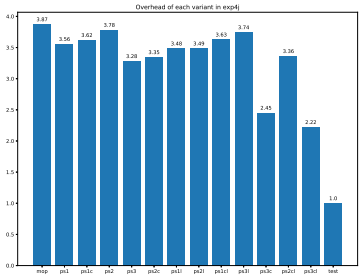
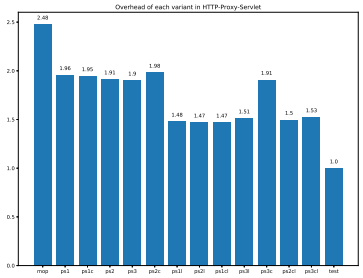
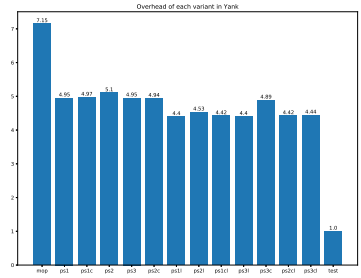
2
3
4
5
0.04
0.02
0.00
−0.02
−0.04
5.6
3.7
3.5
3.7
3.4
3.4
2.8
2.8
2.7
2.8
3.2
2.6
2.4
mop
ps_1
ps_1^{c}
ps_2
ps_3
ps_2^{c}
ps_1^{ℓ}
ps_2^{ℓ}
$ps_1^{\mathsf{c}\ell}$
ps_3^{ℓ}
ps_3^{c}
$ps_2^{\mathsf{c}\ell}$
$ps_3^{\mathsf{c}\ell}$



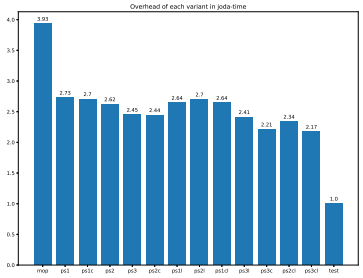
(a) rpstime for exp4j



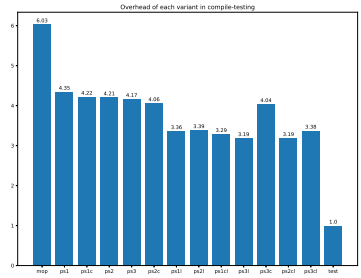
(b) rpstime for HTTP-Proxy-Servlet



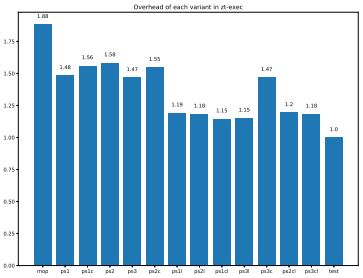
(c) rpstime for Yank



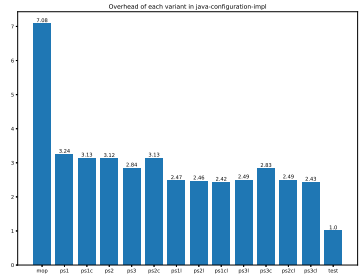
(d) rpstime for joda-time



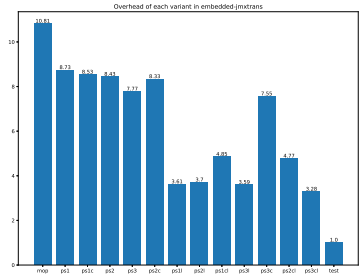
(e) rpstime for compile-testing



(f) rpstime for zt-exec

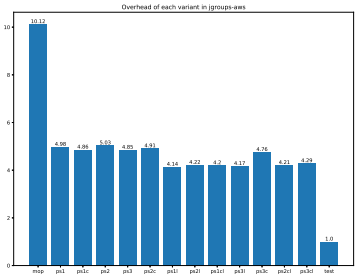


(g) rpstime for java-configuration-impl

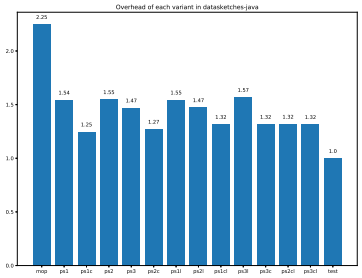


(h) rpstime for embedded-jmxtrans

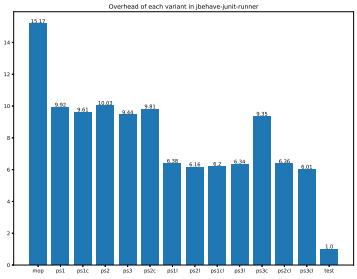
Fig. 1: Plots for rps Part 1



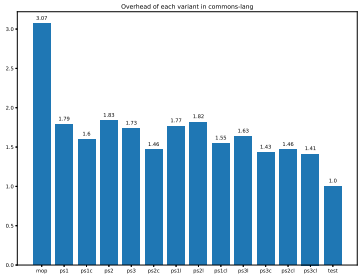
(a) rpstime for jgroups-aws



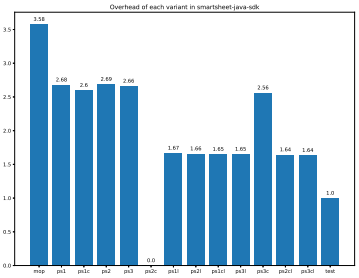
(b) rpstime for datasketches-java



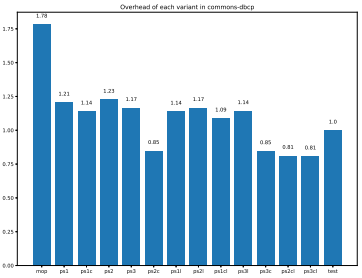
(c) rpstime for jbehave-junit-runner



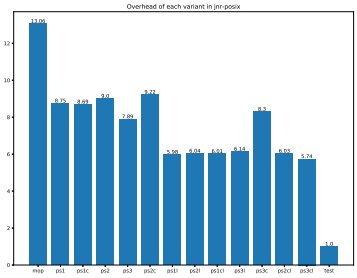
(d) rpstime for commons-lang



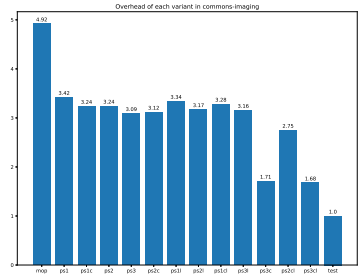
(e) rpstime for smartsheet-java-sdk



(f) rpstime for commons-dbcp

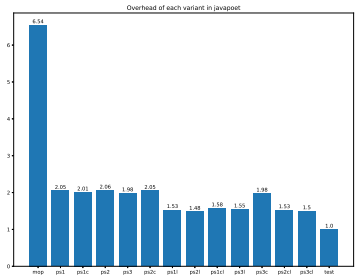


(g) rpstime for jnr-posix

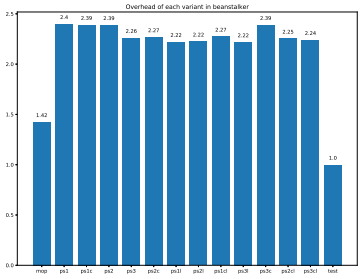


(h) rpstime for commons-imaging

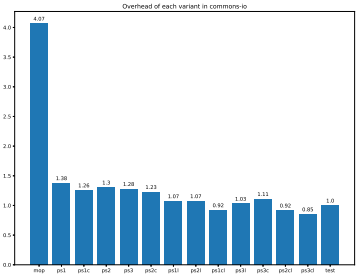
Fig. 2: Plots for rps Part 2



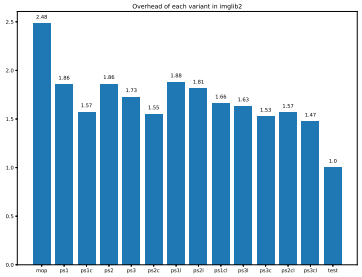
(a) rpstime for javapoet



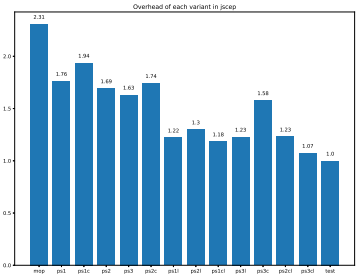
(b) rpstime for beanstalker



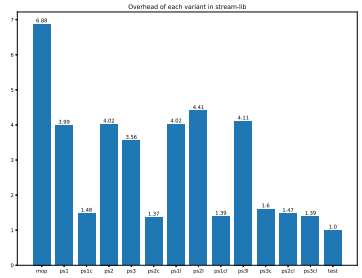
(c) rpstime for commons-io



(d) rpstime for imglib2



(e) rpstime for jscep



(f) rpstime for stream-lib

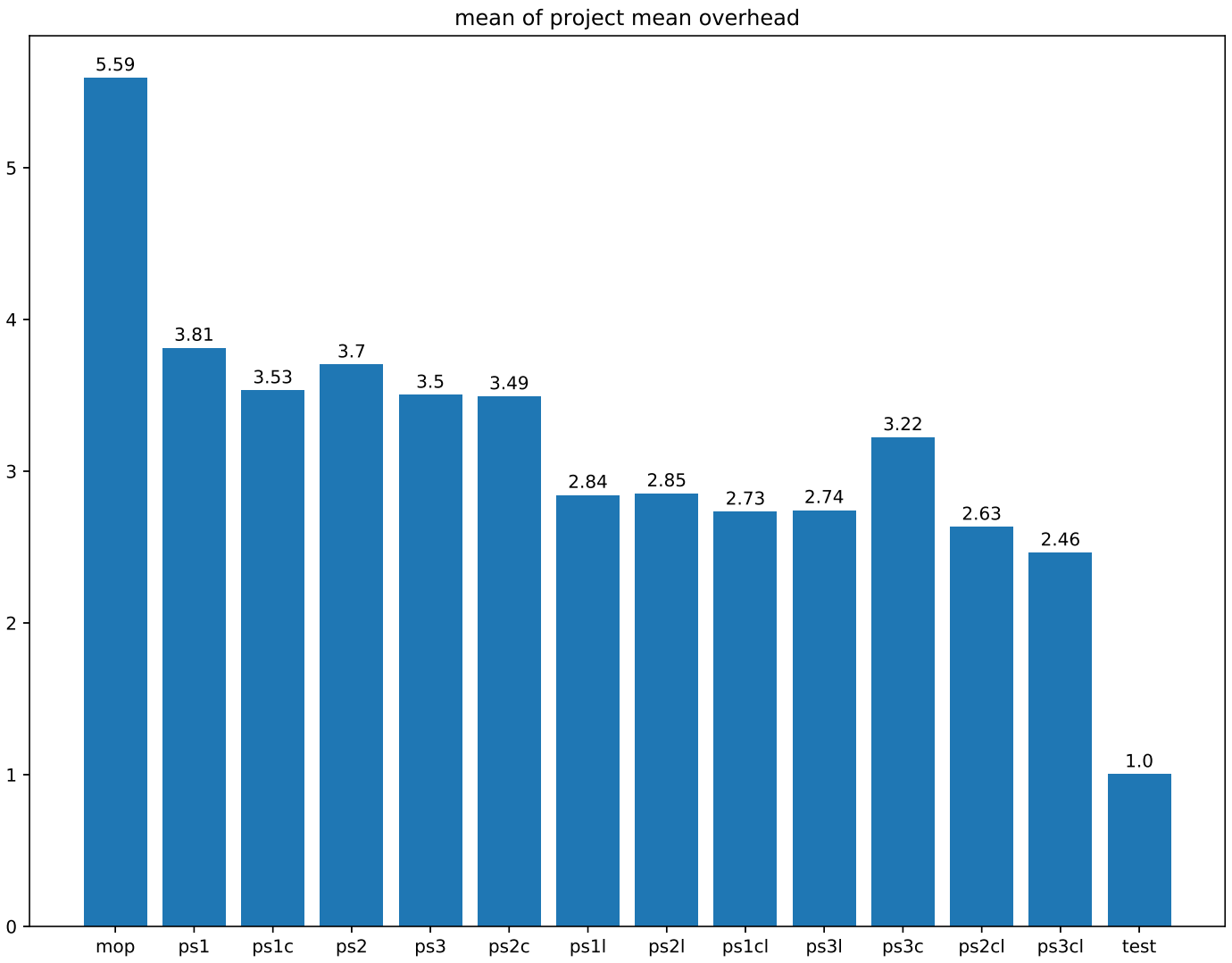
Fig. 3: Plots for rps Part END

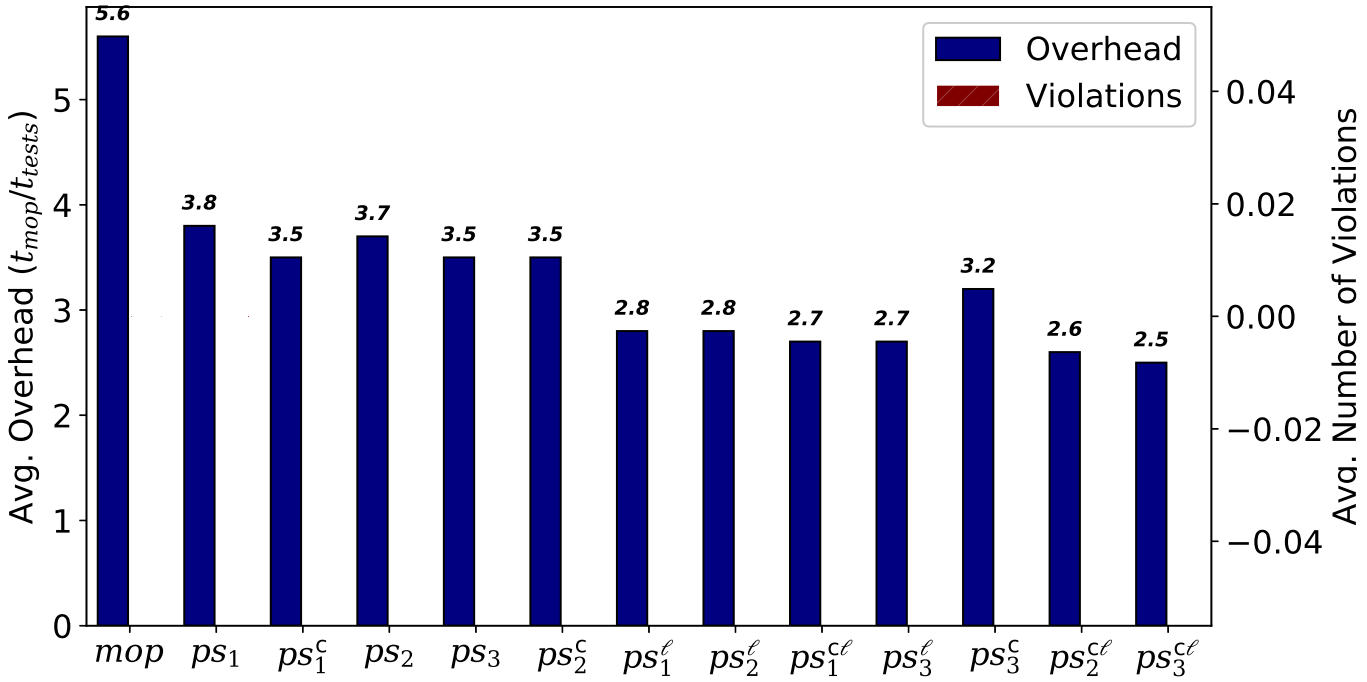
TABLE I: Outcomes of RPS (rps) sum time

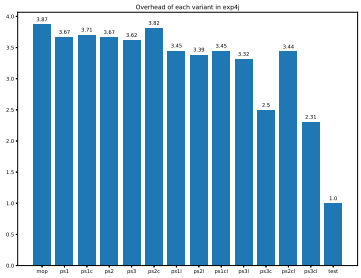
sha	mop	ps1	ps1c	ps2	ps3	ps2c	ps1l	ps2l	ps1cl	ps3l	ps3c	ps2cl	ps3cl	test
exp4j	1757.1	1613.7	1642.5	1716.2	1489.0	1517.7	1581.0	1581.2	1646.1	1699.1	1112.8	1525.5	1008.3	453.7
HTTP-Proxy-Servlet	1617.1	1278.0	1270.7	1249.3	1241.7	1294.2	966.0	960.3	960.1	987.6	1245.9	978.0	995.4	652.7
Yank	356.0	246.5	247.5	254.0	246.5	245.9	218.9	225.7	220.1	219.1	243.3	220.2	221.2	49.8
joda-time	2081.0	1442.9	1431.4	1386.9	1296.3	1293.4	1398.5	1428.3	1398.8	1276.3	1169.6	1236.6	1149.3	529.2
compile-testing	1844.4	1329.1	1290.7	1286.1	1274.0	1241.8	1028.3	1035.7	1005.8	974.8	1234.6	975.1	1031.9	305.7
zt-exec	386.0	304.1	320.0	324.6	300.9	317.4	244.5	242.7	234.9	236.1	301.2	244.9	242.6	204.9
java-configuration-impl	629.2	288.4	278.7	277.5	252.6	278.7	219.7	218.9	215.5	221.6	251.5	221.6	215.7	88.9
embedded-jmxtrans	2174.5	1756.3	1715.5	1696.2	1563.1	1675.0	726.9	744.1	974.5	722.1	1519.3	958.9	660.5	201.1
jgroups-aws	464.5	228.4	223.1	231.1	222.7	225.5	190.0	193.6	192.8	191.4	218.3	193.2	196.8	45.9
datasketches-java	3785.2	2599.6	2099.4	2606.6	2476.2	2142.2	2600.8	2480.4	2217.5	2641.1	2218.9	2221.2	2216.1	1683.3
jbehave-junit-runner	3524.8	2304.2	2232.6	2328.9	2193.1	2277.8	1482.9	1431.2	1439.9	1472.2	2171.2	1477.9	1396.6	232.3
commons-lang	1254.7	731.3	653.0	750.5	709.7	598.7	722.2	743.6	632.5	668.8	585.3	598.9	577.5	409.1
smartsheet-java-sdk	964.9	722.9	701.3	725.5	718.2	0.0	450.0	447.4	445.3	445.8	691.1	443.6	441.0	269.7
commons-dbcp	1796.3	1215.2	1148.9	1236.4	1175.2	855.0	1148.1	1174.7	1097.0	1151.8	853.4	818.7	814.3	1007.1
jnr-posix	7636.2	5116.7	5083.9	5265.1	4615.3	5393.9	3494.2	3530.0	3516.4	3591.7	4852.7	3527.6	3355.8	584.8
commons-imaging	1723.5	1198.4	1134.3	1135.8	1082.7	1092.5	1169.6	1110.9	1150.1	1105.6	599.4	963.0	586.8	350.3
javapoet	1133.4	355.3	347.9	356.7	343.8	355.2	265.4	257.0	273.1	268.0	342.6	264.4	259.6	173.2
beanstalker	1896.3	3193.8	3183.0	3180.6	3010.8	3019.7	2957.3	2962.2	3027.4	2952.6	3182.3	3000.7	2983.2	1331.6
commons-io	7885.4	2670.6	2435.9	2529.8	2480.9	2380.8	2080.8	2082.6	1785.9	1996.4	2151.5	1777.5	1652.2	1939.2
imglib2	613.9	458.9	388.7	460.5	427.2	383.3	464.7	448.7	410.9	403.6	377.2	387.1	364.6	247.3
jscep	2142.5	1636.1	1797.9	1570.6	1514.4	1617.2	1133.7	1205.3	1099.0	1140.9	1464.9	1142.1	997.1	927.9
stream-lib	11892.6	6896.5	2557.8	6953.9	6149.0	2364.3	6956.7	7620.1	2404.9	7102.1	2772.2	2542.7	2404.5	1729.5
sum	57559.5	37586.7	32184.6	37522.6	34783.3	30570.2	31500.2	32124.6	26348.9	31468.6	29559.2	25719.4	23771.0	13417.2
mean	2616.3	1708.5	1462.9	1705.6	1581.1	1389.6	1431.8	1460.2	1197.7	1430.4	1343.6	1169.1	1080.5	609.9

TABLE II: Outcomes of RPS (rps) mean time

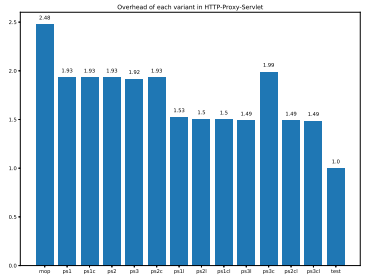
sha	mop	ps1	ps1c	ps2	ps3	ps2c	ps1l	ps2l	ps1cl	ps3l	ps3c	ps2cl	ps3cl	test
exp4j	35.9	32.9	33.5	35.0	30.4	31.0	32.3	32.3	33.6	34.7	22.7	31.1	20.6	9.3
HTTP-Proxy-Servlet	33.0	26.1	25.9	25.5	25.3	26.4	19.7	19.6	19.6	20.2	25.4	20.0	20.3	13.3
Yank	22.2	15.4	15.5	15.9	15.4	15.4	13.7	14.1	13.8	13.7	15.2	13.8	13.8	3.1
joda-time	42.5	29.4	29.2	28.3	26.5	26.4	28.5	29.1	28.5	26.0	23.9	25.2	23.5	10.8
compile-testing	37.6	27.1	26.3	26.2	26.0	25.3	21.0	21.1	20.5	19.9	25.2	19.9	21.1	6.2
zt-exec	27.6	21.7	22.9	23.2	21.5	22.7	17.5	17.3	16.8	16.9	21.5	17.5	17.3	14.6
java-configuration-impl	27.4	12.5	12.1	12.1	11.0	12.1	9.6	9.5	9.4	9.6	10.9	9.6	9.4	3.9
embedded-jmxtrans	44.4	35.8	35.0	34.6	31.9	34.2	14.8	15.2	19.9	14.7	31.0	19.6	13.5	4.1
jgroups-aws	29.0	14.3	13.9	14.4	13.9	14.1	11.9	12.1	12.1	12.0	13.6	12.1	12.3	2.9
datasketches-java	80.5	55.3	44.7	55.5	52.7	45.6	55.3	52.8	47.2	56.2	47.2	47.3	47.2	35.8
jbehave-junit-runner	71.9	47.0	45.6	47.5	44.8	46.5	30.3	29.2	29.4	30.0	44.3	30.2	28.5	4.7
commons-lang	66.0	38.5	34.4	39.5	37.4	31.5	38.0	39.1	33.3	35.2	30.8	31.5	30.4	21.5
smartsheet-java-sdk	48.2	36.1	35.1	36.3	35.9		22.5	22.4	22.3	22.3	34.6	22.2	22.1	13.5
commons-dbcp	94.5	64.0	60.5	65.1	61.9	45.0	60.4	61.8	57.7	60.6	44.9	43.1	42.9	53.0
jnr-posix	155.8	104.4	103.8	107.5	94.2	110.1	71.3	72.0	71.8	73.3	99.0	72.0	68.5	11.9
commons-imaging	90.7	63.1	59.7	59.8	57.0	57.5	61.6	58.5	60.5	58.2	31.5	50.7	30.9	18.4
javapoet	59.7	18.7	18.3	18.8	18.1	18.7	14.0	13.5	14.4	14.1	18.0	13.9	13.7	9.1
beanstalker	38.7	65.2	65.0	64.9	61.4	61.6	60.4	60.5	61.8	60.3	64.9	61.2	60.9	27.2
commons-io	415.0	140.6	128.2	133.1	130.6	125.3	109.5	109.6	94.0	105.1	113.2	93.6	87.0	102.1
imglib2	32.3	24.2	20.5	24.2	22.5	20.2	24.5	23.6	21.6	21.2	19.9	20.4	19.2	13.0
jscep	43.7	33.4	36.7	32.1	30.9	33.0	23.1	24.6	22.4	23.3	29.9	23.3	20.3	18.9
stream-lib	625.9	363.0	134.6	366.0	323.6	124.4	366.1	401.1	126.6	373.8	145.9	133.8	126.6	91.0
sum	2122.7	1268.7	1001.2	1265.4	1172.7	927.0	1105.9	1139.1	837.1	1101.2	913.8	811.9	749.6	488.5
mean	96.5	57.7	45.5	57.5	53.3	44.1	50.3	51.8	38.0	50.1	41.5	36.9	34.1	22.2


mean of project mean overhead
5.59
3.81
3.53
3.7
3.5
3.49
2.84
2.85
2.73
2.74
3.22
2.63
2.46
1.0
0
1
2
3
4
5
mop
ps1
ps1c
ps2
ps3
ps2c
ps1l
ps2l
ps1cl
ps3l
ps3c
ps2cl
ps3cl
test

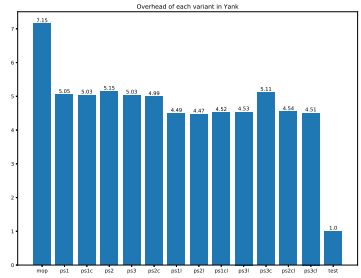

Overhead
Violations
Avg. Overhead (t_{mop}/t_{tests})
Avg. Number of Violations
0
1
2
3
4
5
0.04
0.02
0.00
−0.02
−0.04
5.6
3.8
3.5
3.7
3.5
3.5
2.8
2.8
2.7
2.7
3.2
2.6
2.5
mop
ps_1
ps_1^{c}
ps_2
ps_3
ps_2^{c}
ps_1^{ℓ}
ps_2^{ℓ}
$ps_1^{\mathsf{c}\ell}$
ps_3^{ℓ}
ps_3^{c}
$ps_2^{\mathsf{c}\ell}$
$ps_3^{\mathsf{c}\ell}$



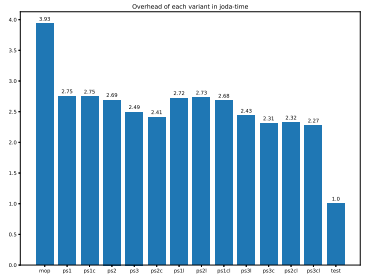
(a) rps-vmstime for exp4j



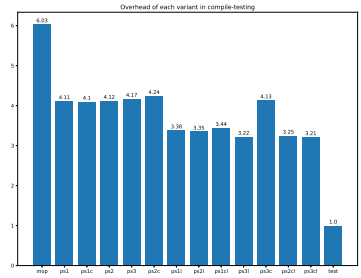
(b) rps-vmstime for HTTP-Proxy-Servlet



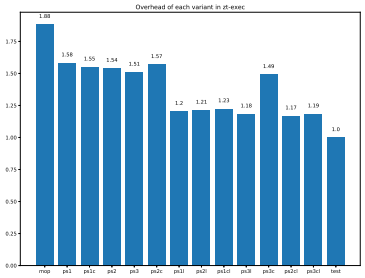
(c) rps-vmstime for Yank



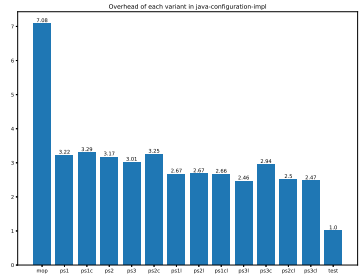
(d) rps-vmstime for joda-time



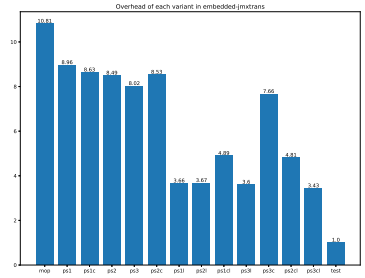
(e) rps-vmstime for compile-testing



(f) rps-vmstime for zt-exec

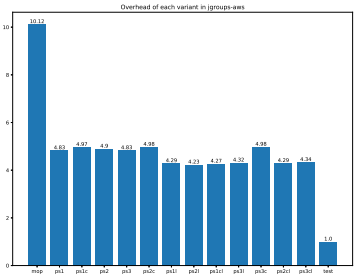


(g) rps-vmstime for java-configuration-impl

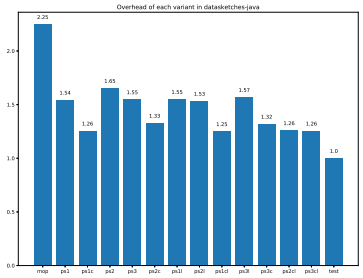


(h) rps-vmstime for embedded-jmxtrans

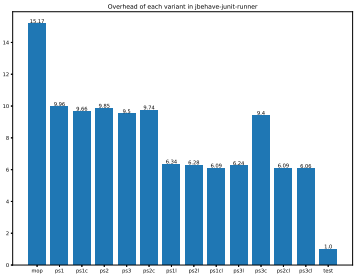
Fig. 4: Plots for rps-vms Part 1



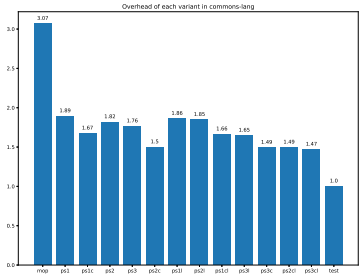
(a) rps-vmstime for jgroups-aws



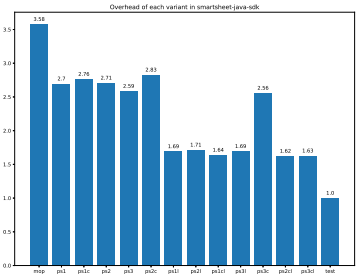
(b) rps-vmstime for datasketches-java



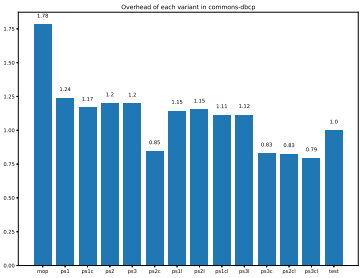
(c) rps-vmstime for jbehave-junit-runner



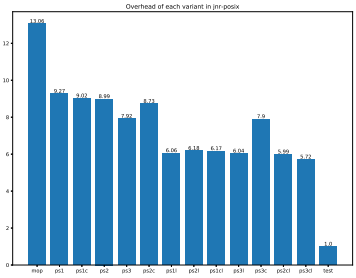
(d) rps-vmstime for commons-lang



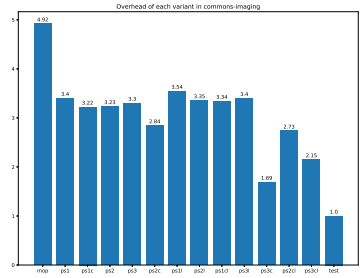
(e) rps-vmstime for smartsheet-java-sdk



(f) rps-vmstime for commons-dbcp

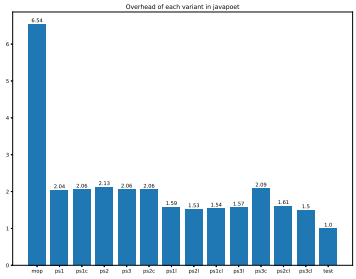


(g) rps-vmstime for jnr-posix

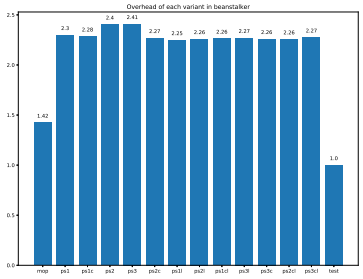


(h) rps-vmstime for commons-imaging

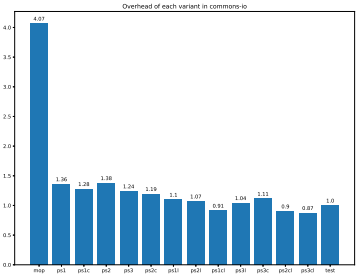
Fig. 5: Plots for rps-vms Part 2



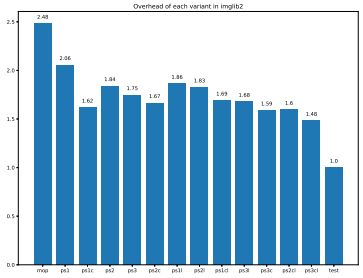
(a) rps-vmstime for javapoet



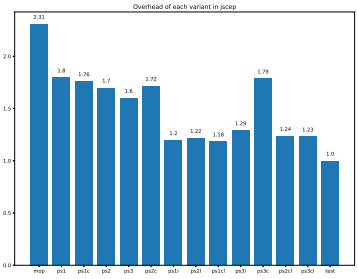
(b) rps-vmstime for beanstalker



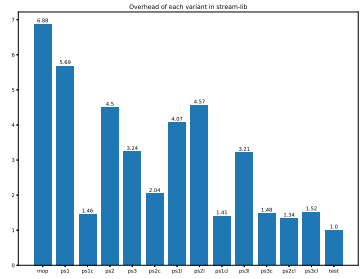
(c) rps-vmstime for commons-io



(d) rps-vmstime for imglib2



(e) rps-vmstime for jscep



(f) rps-vmstime for stream-lib

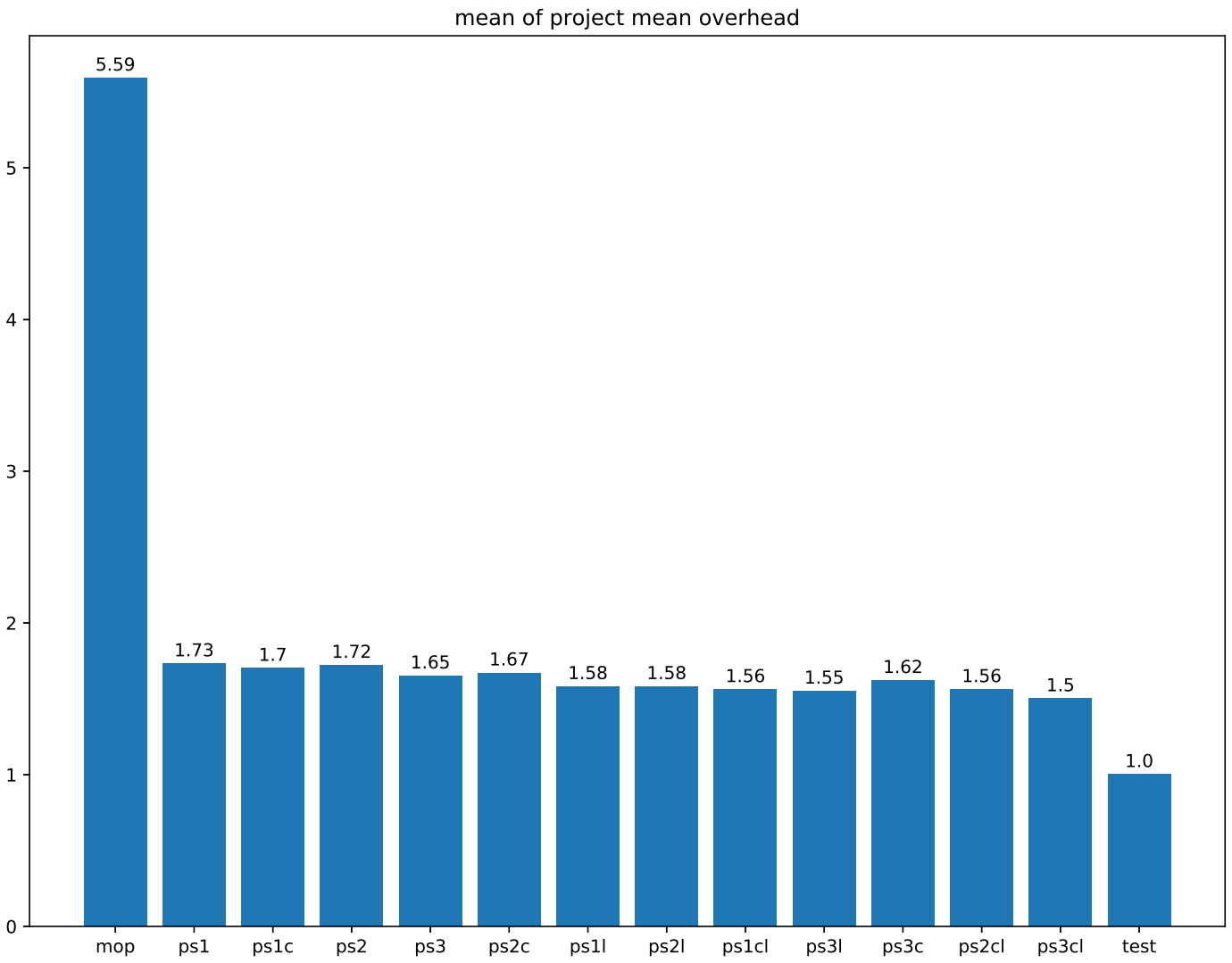
Fig. 6: Plots for rps-vms Part END

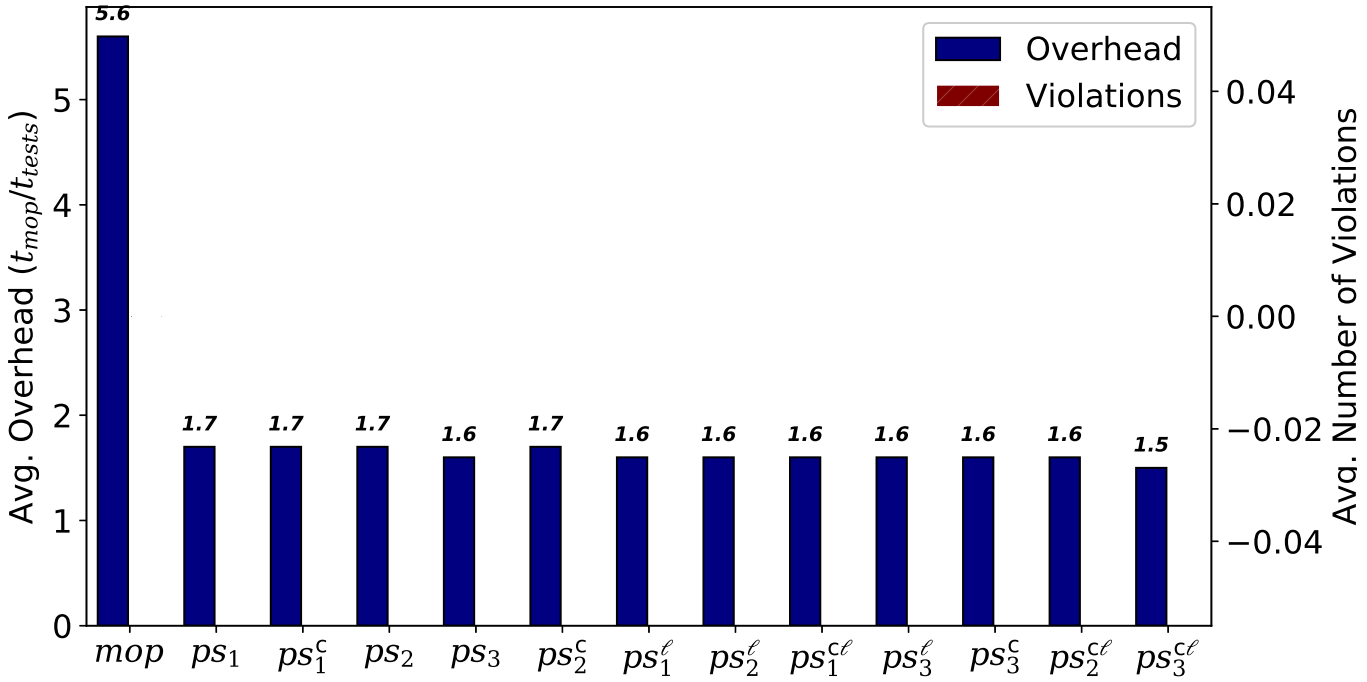
TABLE III: Outcomes of RPS (rps-vms) sum time

sha	mop	ps1	ps1c	ps2	ps3	ps2c	ps1l	ps2l	ps1cl	ps3l	ps3c	ps2cl	ps3cl	test
exp4j	1757.1	1665.5	1681.9	1664.1	1642.9	1731.1	1565.9	1536.7	1564.0	1505.3	1134.2	1558.7	1046.8	453.7
HTTP-Proxy-Servlet	1617.1	1262.5	1261.2	1261.9	1252.2	1261.5	995.7	982.0	980.1	973.1	1299.8	973.0	970.7	652.7
Yank	356.0	251.4	250.7	256.3	250.6	248.4	223.6	222.6	224.9	225.8	254.6	226.1	224.4	49.8
joda-time	2081.0	1455.9	1453.0	1424.0	1319.8	1275.8	1440.2	1444.5	1417.5	1287.9	1222.3	1229.0	1203.5	529.2
compile-testing	1844.4	1257.1	1253.5	1259.7	1274.6	1296.8	1034.0	1024.6	1052.5	985.2	1263.4	993.0	981.9	305.7
zt-exec	386.0	324.5	317.9	315.9	309.6	321.8	246.9	248.8	251.1	242.8	305.8	239.7	242.9	204.9
java-configuration-impl	629.2	286.1	292.8	281.6	267.6	288.6	237.0	237.6	236.4	218.8	261.7	222.6	219.3	88.9
embedded-jmxtrans	2174.5	1801.4	1735.3	1707.1	1612.5	1714.9	735.1	738.4	983.4	723.4	1540.7	966.4	690.7	201.1
jgroups-aws	464.5	221.7	228.0	224.8	221.8	228.4	196.8	194.3	196.0	198.1	228.5	197.1	199.0	45.9
datasketches-java	3785.2	2598.5	2113.4	2782.8	2604.8	2236.3	2608.8	2581.0	2104.1	2640.6	2221.6	2119.7	2113.3	1683.3
jbehave-junit-runner	3524.8	2313.5	2245.0	2288.7	2207.8	2263.1	1473.0	1459.9	1414.6	1449.6	2183.6	1415.4	1408.4	232.3
commons-lang	1254.7	774.2	684.5	743.3	721.7	612.8	760.8	755.2	680.0	673.3	610.2	611.5	600.5	409.1
smartsheet-java-sdk	964.9	727.0	745.4	730.3	697.4	762.6	456.1	462.5	441.9	456.7	689.8	437.8	439.0	269.7
commons-dbcp	1796.3	1248.5	1176.8	1209.6	1208.1	853.4	1153.9	1163.1	1121.5	1123.7	836.7	831.8	800.5	1007.1
jnr-posix	7636.2	5422.7	5277.5	5255.3	4632.3	5103.2	3544.5	3616.7	3607.9	3531.3	4620.4	3503.3	3343.3	584.8
commons-imaging	1723.5	1191.2	1128.9	1132.3	1156.4	995.6	1241.7	1174.4	1170.3	1190.3	591.6	957.8	752.5	350.3
javapoet	1133.4	353.7	356.2	368.2	356.6	356.0	274.9	264.3	267.3	272.3	361.7	279.3	259.7	173.2
beanstalker	1896.3	3061.2	3042.5	3201.3	3207.2	3021.0	2993.6	3007.4	3013.5	3023.2	3008.1	3004.1	3029.2	1331.6
commons-io	7885.4	2635.9	2477.7	2671.9	2403.8	2315.1	2130.2	2073.7	1770.7	2019.8	2159.8	1748.4	1695.4	1939.2
imglib2	613.9	508.6	400.5	455.1	432.2	412.0	460.7	451.8	418.4	415.1	393.2	394.7	366.8	247.3
jscep	2142.5	1666.9	1633.5	1576.7	1484.7	1592.1	1109.2	1129.7	1098.5	1197.2	1657.4	1146.9	1142.4	927.9
stream-lib	11892.6	9833.0	2516.9	7781.2	5598.2	3528.6	7041.8	7895.4	2430.7	5554.5	2560.0	2315.1	2622.3	1729.5
sum	57559.5	40861.1	32273.4	38592.2	34862.9	32419.3	31924.1	32664.6	26445.2	29908.1	29405.2	25371.4	24352.4	13417.2
mean	2616.3	1857.3	1467.0	1754.2	1584.7	1473.6	1451.1	1484.8	1202.1	1359.5	1336.6	1153.2	1106.9	609.9

TABLE IV: Outcomes of RPS (rps-vms) mean time

sha	mop	ps1	ps1c	ps2	ps3	ps2c	ps1l	ps2l	ps1cl	ps3l	ps3c	ps2cl	ps3cl	test
exp4j	35.9	34.0	34.3	34.0	33.5	35.3	32.0	31.4	31.9	30.7	23.1	31.8	21.4	9.3
HTTP-Proxy-Servlet	33.0	25.8	25.7	25.8	25.6	25.7	20.3	20.0	20.0	19.9	26.5	19.9	19.8	13.3
Yank	22.2	15.7	15.7	16.0	15.7	15.5	14.0	13.9	14.1	14.1	15.9	14.1	14.0	3.1
joda-time	42.5	29.7	29.7	29.1	26.9	26.0	29.4	29.5	28.9	26.3	24.9	25.1	24.6	10.8
compile-testing	37.6	25.7	25.6	25.7	26.0	26.5	21.1	20.9	21.5	20.1	25.8	20.3	20.0	6.2
zt-exec	27.6	23.2	22.7	22.6	22.1	23.0	17.6	17.8	17.9	17.3	21.8	17.1	17.3	14.6
java-configuration-impl	27.4	12.4	12.7	12.2	11.6	12.5	10.3	10.3	10.3	9.5	11.4	9.7	9.5	3.9
embedded-jmxtrans	44.4	36.8	35.4	34.8	32.9	35.0	15.0	15.1	20.1	14.8	31.4	19.7	14.1	4.1
jgroups-aws	29.0	13.9	14.3	14.0	13.9	14.3	12.3	12.1	12.3	12.4	14.3	12.3	12.4	2.9
datasketches-java	80.5	55.3	45.0	59.2	55.4	47.6	55.5	54.9	44.8	56.2	47.3	45.1	45.0	35.8
jbehave-junit-runner	71.9	47.2	45.8	46.7	45.1	46.2	30.1	29.8	28.9	29.6	44.6	28.9	28.7	4.7
commons-lang	66.0	40.7	36.0	39.1	38.0	32.3	40.0	39.7	35.8	35.4	32.1	32.2	31.6	21.5
smartsheet-java-sdk	48.2	36.3	37.3	36.5	34.9	38.1	22.8	23.1	22.1	22.8	34.5	21.9	21.9	13.5
commons-dbcp	94.5	65.7	61.9	63.7	63.6	44.9	60.7	61.2	59.0	59.1	44.0	43.8	42.1	53.0
jnr-posix	155.8	110.7	107.7	107.3	94.5	104.1	72.3	73.8	73.6	72.1	94.3	71.5	68.2	11.9
commons-imaging	90.7	62.7	59.4	59.6	60.9	52.4	65.4	61.8	61.6	62.6	31.1	50.4	39.6	18.4
javapoet	59.7	18.6	18.7	19.4	18.8	18.7	14.5	13.9	14.1	14.3	19.0	14.7	13.7	9.1
beanstalker	38.7	62.5	62.1	65.3	65.5	61.7	61.1	61.4	61.5	61.7	61.4	61.3	61.8	27.2
commons-io	415.0	138.7	130.4	140.6	126.5	121.8	112.1	109.1	93.2	106.3	113.7	92.0	89.2	102.1
imglib2	32.3	26.8	21.1	24.0	22.7	21.7	24.2	23.8	22.0	21.8	20.7	20.8	19.3	13.0
jscep	43.7	34.0	33.3	32.2	30.3	32.5	22.6	23.1	22.4	24.4	33.8	23.4	23.3	18.9
stream-lib	625.9	517.5	132.5	409.5	294.6	185.7	370.6	415.5	127.9	292.3	134.7	121.8	138.0	91.0
sum	2122.7	1433.9	1007.3	1317.3	1159.0	1021.7	1124.0	1162.2	843.8	1023.9	906.5	797.8	775.8	488.5
mean	96.5	65.2	45.8	59.9	52.7	46.4	51.1	52.8	38.4	46.5	41.2	36.3	35.3	22.2


mean of project mean overhead
5.59
1.73
1.7
1.72
1.65
1.67
1.58
1.58
1.56
1.55
1.62
1.56
1.5
1.0
0
1
2
3
4
5
mop
ps1
ps1c
ps2
ps3
ps2c
ps1l
ps2l
ps1cl
ps3l
ps3c
ps2cl
ps3cl
test


Overhead
Violations
Avg. Overhead (t_{mop}/t_{tests})
Avg. Number of Violations
0
1
2
3
4
5
0.04
0.02
0.00
−0.02
−0.04
5.6
1.7
1.7
1.7
1.6
1.7
1.6
1.6
1.6
1.6
1.6
1.6
1.5
mop
ps_1
ps_1^{c}
ps_2
ps_3
ps_2^{c}
ps_1^{ℓ}
ps_2^{ℓ}
$ps_1^{\mathsf{c}\ell}$
ps_3^{ℓ}
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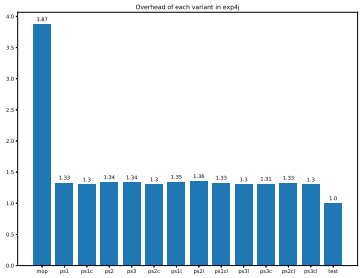
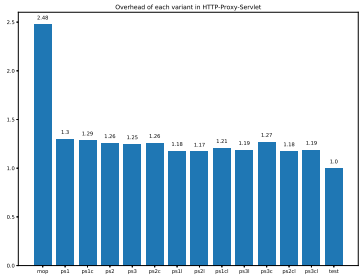
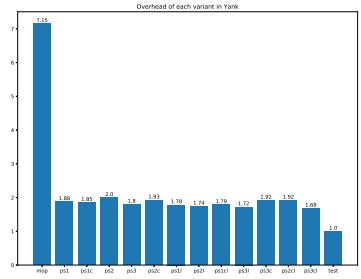


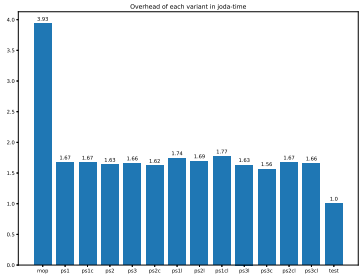
(a) rps-rpptime for exp4j



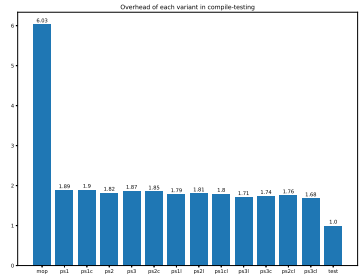
(b) rps-rpptime for HTTP-Proxy-Servlet



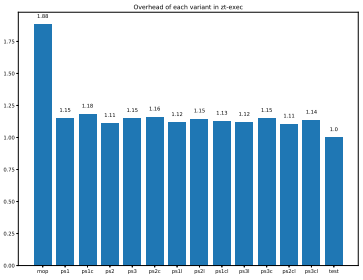
(c) rps-rpptime for Yank



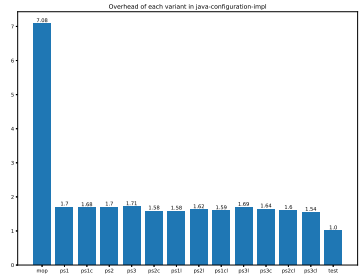
(d) rps-rpptime for joda-time



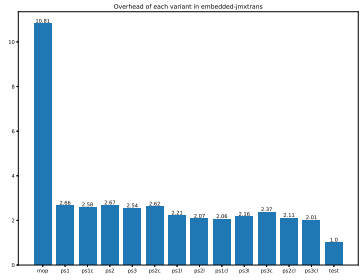
(e) rps-rpptime for compile-testing



(f) rps-rpptime for zt-exec

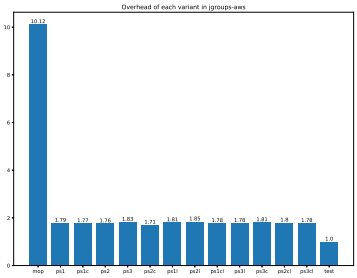


(g) rps-rpptime for java-configuration-impl

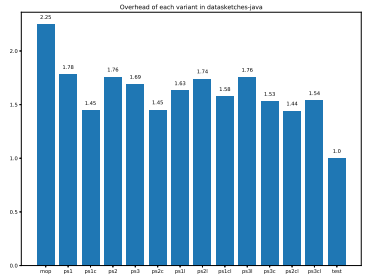


(h) rps-rpptime for embedded-jmxtrans

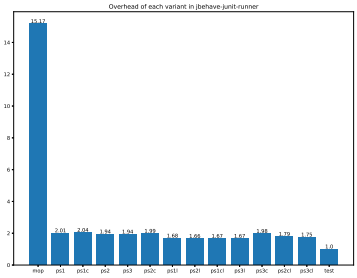
Fig. 7: Plots for rps-rpp Part 1



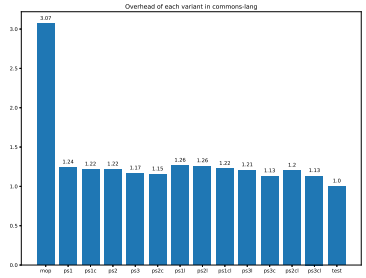
(a) rps-rpptime for jgroups-aws



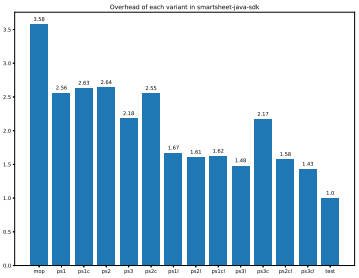
(b) rps-rpptime for datasketches-java



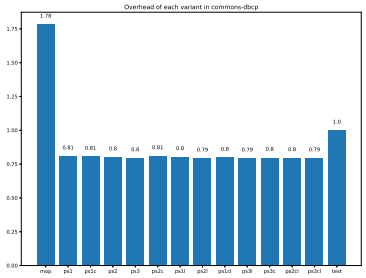
(c) rps-rpptime for jbehave-junit-runner



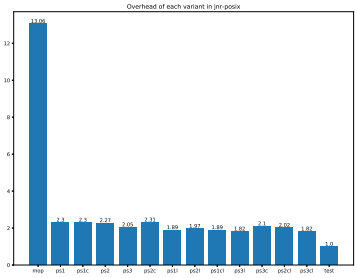
(d) rps-rpptime for commons-lang



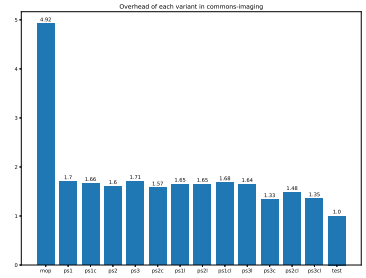
(e) rps-rpptime for smartsheet-java-sdk



(f) rps-rpptime for commons-dbcp

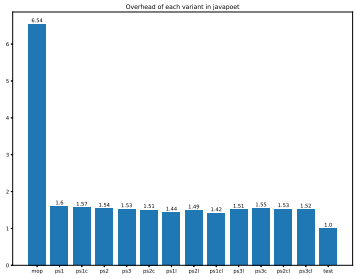


(g) rps-rpptime for jnr-posix

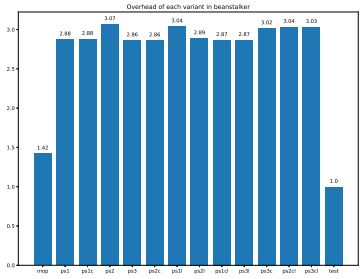


(h) rps-rpptime for commons-imaging

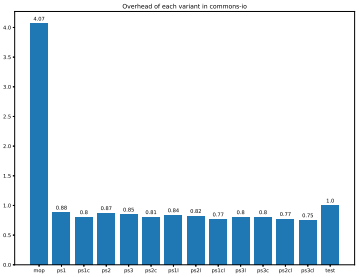
Fig. 8: Plots for rps-rpp Part 2



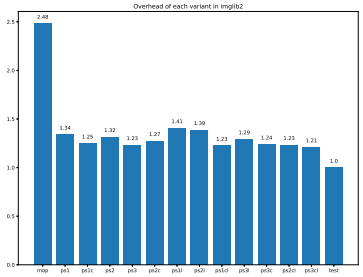
(a) rps-rpptime for javapoet



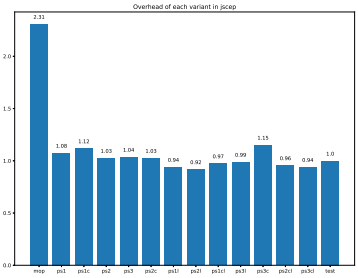
(b) rps-rpptime for beanstalker



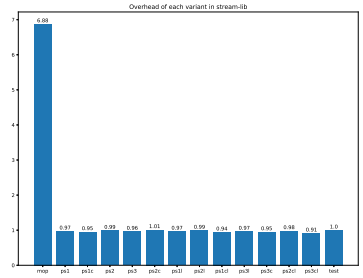
(c) rps-rpptime for commons-io



(d) rps-rpptime for imglib2



(e) rps-rpptime for jscep



(f) rps-rpptime for stream-lib

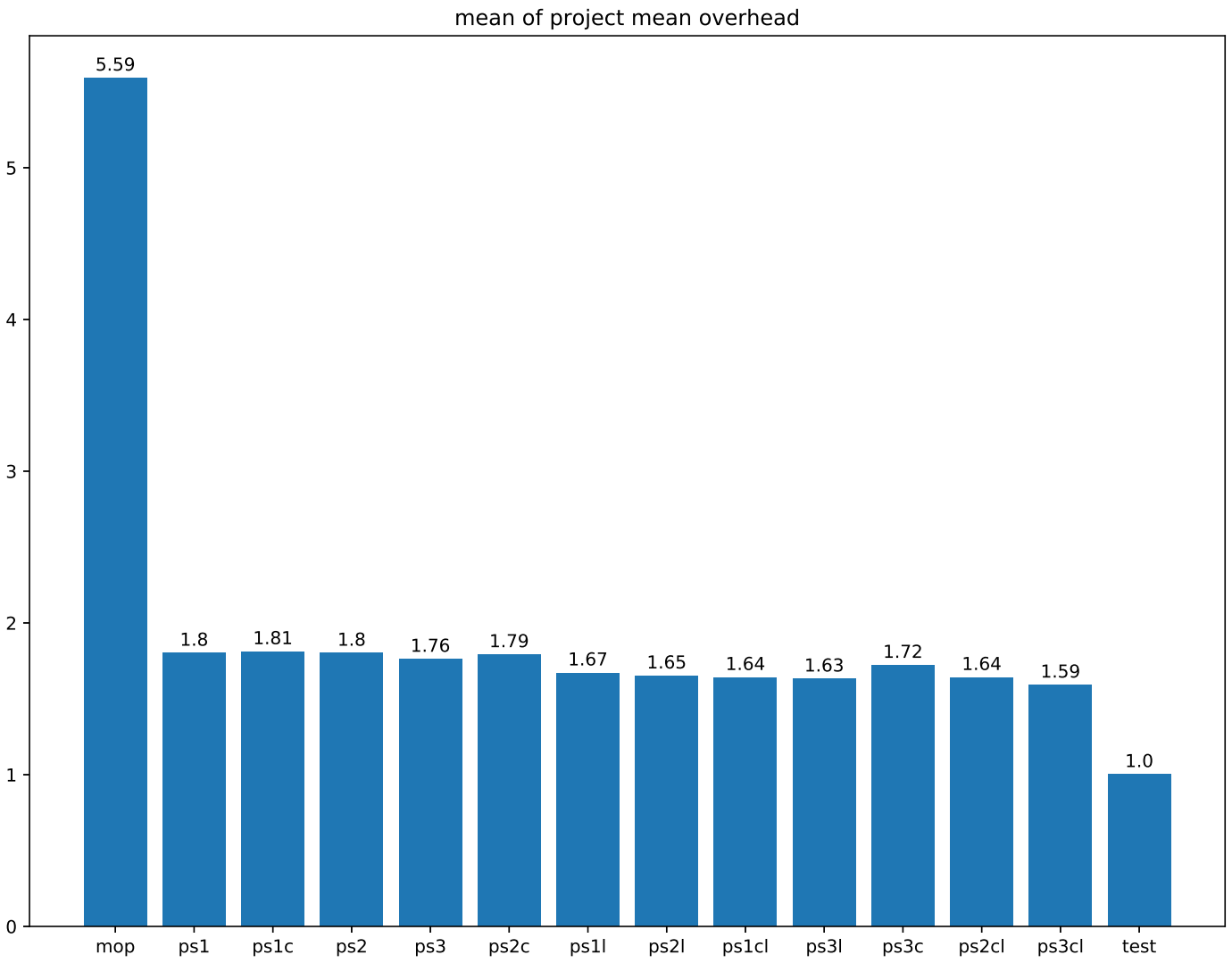
Fig. 9: Plots for rps-rpp Part END

TABLE V: Outcomes of RPS (rps-rpp) sum time

sha	mop	ps1	ps1c	ps2	ps3	ps2c	ps1l	ps2l	ps1cl	ps3l	ps3c	ps2cl	ps3cl	test
exp4j	1757.1	604.5	590.2	607.2	605.8	591.6	610.3	614.9	603.5	591.0	595.3	603.1	590.2	453.7
HTTP-Proxy-Servlet	1617.1	849.8	840.0	822.1	814.8	823.4	769.6	764.6	789.3	776.2	830.3	767.5	777.2	652.7
Yank	356.0	93.4	92.1	99.4	89.6	95.9	88.7	86.7	88.9	85.7	95.4	95.6	83.7	49.8
joda-time	2081.0	884.8	883.0	865.0	877.1	855.4	921.5	895.3	936.7	862.7	827.8	884.2	876.1	529.2
compile-testing	1844.4	576.7	579.6	557.3	571.7	566.8	546.2	552.2	548.8	523.7	532.3	537.4	514.4	305.7
zt-exec	386.0	235.7	242.5	227.5	235.5	237.9	229.0	234.8	231.2	229.4	235.6	226.6	232.8	204.9
java-configuration-impl	629.2	151.1	149.2	151.0	151.7	140.7	140.3	143.9	141.3	150.0	145.9	142.1	137.2	88.9
embedded-jmxtrans	2174.5	534.2	519.6	537.0	510.4	526.2	444.1	416.2	413.4	433.7	476.3	423.6	403.6	201.1
jgroups-aws	464.5	82.1	81.3	81.0	83.9	78.4	83.1	84.7	81.6	81.8	83.2	82.6	81.7	45.9
datasketches-java	3785.2	3000.2	2435.7	2961.8	2846.5	2446.8	2746.4	2932.4	2654.8	2956.6	2578.1	2428.3	2590.9	1683.3
jbehave-junit-runner	3524.8	467.0	474.3	451.2	449.6	461.3	390.8	386.2	387.1	387.5	458.9	416.0	406.4	232.3
commons-lang	1254.7	507.9	497.2	497.5	476.8	471.8	517.1	514.6	500.5	493.4	462.2	491.3	463.2	409.1
smartsheet-java-sdk	964.9	690.8	710.0	712.5	588.2	688.6	450.7	433.5	437.8	399.9	585.3	424.9	386.0	269.7
commons-dbcp	1796.3	814.6	811.8	807.5	801.0	816.1	809.6	799.3	804.6	799.3	803.6	801.5	800.4	1007.1
jnr-posix	7636.2	1347.7	1345.7	1328.1	1196.2	1351.3	1107.2	1152.1	1106.6	1065.0	1227.4	1182.4	1065.0	584.8
commons-imaging	1723.5	595.9	583.1	561.2	598.0	551.2	577.7	576.6	588.5	576.1	467.6	518.3	473.8	350.3
javapoet	1133.4	277.5	271.4	266.5	264.5	261.0	248.7	258.7	245.7	261.7	268.4	264.9	262.9	173.2
beanstalker	1896.3	3829.3	3838.3	4088.0	3813.7	3813.0	4050.9	3848.9	3818.3	3820.7	4018.1	4042.5	4039.7	1331.6
commons-io	7885.4	1709.9	1560.3	1692.8	1644.5	1561.1	1622.9	1599.2	1487.1	1558.9	1560.0	1501.0	1457.3	1939.2
imglib2	613.9	331.6	309.0	325.4	305.0	315.3	348.0	343.3	303.4	319.7	306.6	305.3	299.4	247.3
jscep	2142.5	997.9	1037.5	952.2	962.2	952.3	873.2	852.2	904.3	917.8	1069.5	887.4	872.3	927.9
stream-lib	11892.6	1680.2	1648.7	1715.0	1667.6	1747.6	1672.3	1718.3	1632.4	1669.9	1642.9	1696.5	1580.4	1729.5
sum	57559.5	20262.9	19500.6	20307.1	19554.0	19353.9	19248.2	19208.6	18705.7	18960.7	19270.8	18723.1	18394.7	13417.2
mean	2616.3	921.0	886.4	923.1	888.8	879.7	874.9	873.1	850.3	861.8	875.9	851.0	836.1	609.9

TABLE VI: Outcomes of RPS (rps-rpp) mean time

sha	mop	ps1	ps1c	ps2	ps3	ps2c	ps1l	ps2l	ps1cl	ps3l	ps3c	ps2cl	ps3cl	test
exp4j	35.9	12.3	12.0	12.4	12.4	12.1	12.5	12.5	12.3	12.1	12.1	12.3	12.0	9.3
HTTP-Proxy-Servlet	33.0	17.3	17.1	16.8	16.6	16.8	15.7	15.6	16.1	15.8	16.9	15.7	15.9	13.3
Yank	22.2	5.8	5.8	6.2	5.6	6.0	5.5	5.4	5.6	5.4	6.0	6.0	5.2	3.1
joda-time	42.5	18.1	18.0	17.7	17.9	17.5	18.8	18.3	19.1	17.6	16.9	18.0	17.9	10.8
compile-testing	37.6	11.8	11.8	11.4	11.7	11.6	11.1	11.3	11.2	10.7	10.9	11.0	10.5	6.2
zt-exec	27.6	16.8	17.3	16.2	16.8	17.0	16.4	16.8	16.5	16.4	16.8	16.2	16.6	14.6
java-configuration-impl	27.4	6.6	6.5	6.6	6.6	6.1	6.1	6.3	6.1	6.5	6.3	6.2	6.0	3.9
embedded-jmxtrans	44.4	10.9	10.6	11.0	10.4	10.7	9.1	8.5	8.4	8.9	9.7	8.6	8.2	4.1
jgroups-aws	29.0	5.1	5.1	5.1	5.2	4.9	5.2	5.3	5.1	5.1	5.2	5.2	5.1	2.9
datasketches-java	80.5	63.8	51.8	63.0	60.6	52.1	58.4	62.4	56.5	62.9	54.9	51.7	55.1	35.8
jbehave-junit-runner	71.9	9.5	9.7	9.2	9.2	9.4	8.0	7.9	7.9	7.9	9.4	8.5	8.3	4.7
commons-lang	66.0	26.7	26.2	26.2	25.1	24.8	27.2	27.1	26.3	26.0	24.3	25.9	24.4	21.5
smartsheet-java-sdk	48.2	34.5	35.5	35.6	29.4	34.4	22.5	21.7	21.9	20.0	29.3	21.2	19.3	13.5
commons-dbcp	94.5	42.9	42.7	42.5	42.2	43.0	42.6	42.1	42.3	42.1	42.3	42.2	42.1	53.0
jnr-posix	155.8	27.5	27.5	27.1	24.4	27.6	22.6	23.5	22.6	21.7	25.0	24.1	21.7	11.9
commons-imaging	90.7	31.4	30.7	29.5	31.5	29.0	30.4	30.3	31.0	30.3	24.6	27.3	24.9	18.4
javapoet	59.7	14.6	14.3	14.0	13.9	13.7	13.1	13.6	12.9	13.8	14.1	13.9	13.8	9.1
beanstalker	38.7	78.1	78.3	83.4	77.8	77.8	82.7	78.5	77.9	78.0	82.0	82.5	82.4	27.2
commons-io	415.0	90.0	82.1	89.1	86.6	82.2	85.4	84.2	78.3	82.0	82.1	79.0	76.7	102.1
imglib2	32.3	17.5	16.3	17.1	16.1	16.6	18.3	18.1	16.0	16.8	16.1	16.1	15.8	13.0
jscep	43.7	20.4	21.2	19.4	19.6	19.4	17.8	17.4	18.5	18.7	21.8	18.1	17.8	18.9
stream-lib	625.9	88.4	86.8	90.3	87.8	92.0	88.0	90.4	85.9	87.9	86.5	89.3	83.2	91.0
sum	2122.7	650.2	627.3	649.8	627.3	624.7	617.5	617.1	598.5	606.6	613.3	598.9	583.1	488.5
mean	96.5	29.6	28.5	29.5	28.5	28.4	28.1	28.1	27.2	27.6	27.9	27.2	26.5	22.2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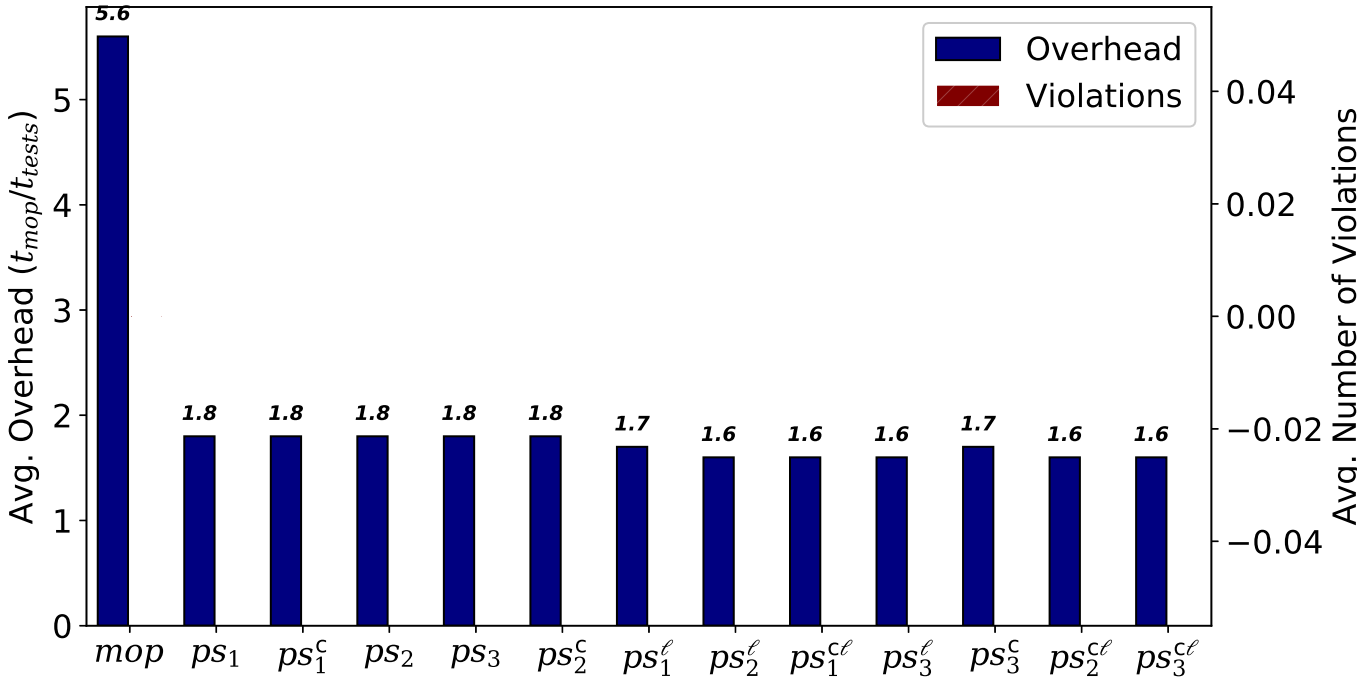
5.59
1.8
1.81
1.8
1.76
1.79
1.67
1.65
1.64
1.63
1.72
1.64
1.59
1.0
0
1
2
3
4
5
mop
ps1
ps1c
ps2
ps3
ps2c
ps1l
ps2l
ps1cl
ps3l
ps3c
ps2cl
ps3cl
test


Overhead
Violations
Avg. Overhead (t_{mop}/t_{tests})
Avg. Number of Violations
0
1
2
3
4
5
0.04
0.02
0.00
−0.02
−0.04
5.6
1.8
1.8
1.8
1.8
1.8
1.7
1.6
1.6
1.6
1.7
1.6
1.6
mop
ps_1
ps_1^{c}
ps_2
ps_3
ps_2^{c}
ps_1^{ℓ}
ps_2^{ℓ}
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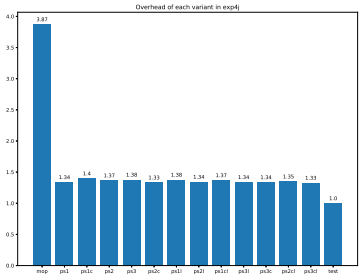
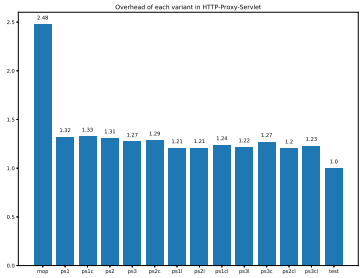
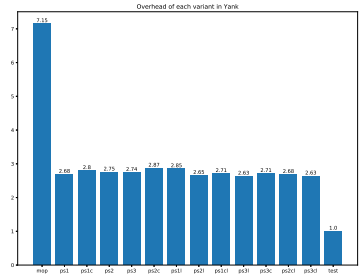


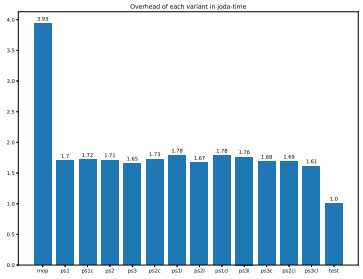
(a) rps-rpp-vmstime for exp4j



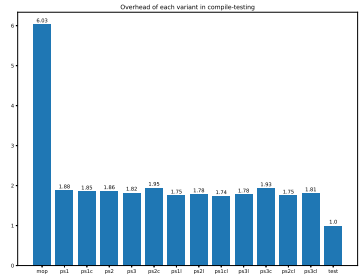
(b) rps-rpp-vmstime for HTTP-Proxy-Servlet



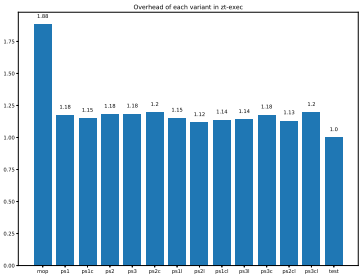
(c) rps-rpp-vmstime for Yank



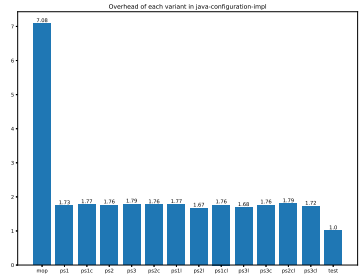
(d) rps-rpp-vmstime for joda-time



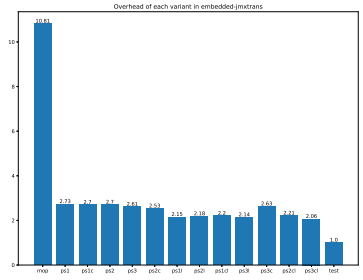
(e) rps-rpp-vmstime for compile-testing



(f) rps-rpp-vmstime for zt-exec

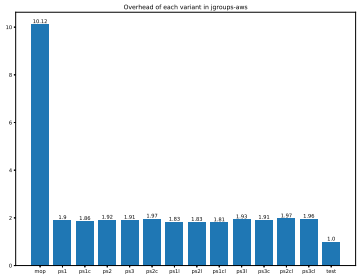


(g) rps-rpp-vmstime for java-configuration-impl

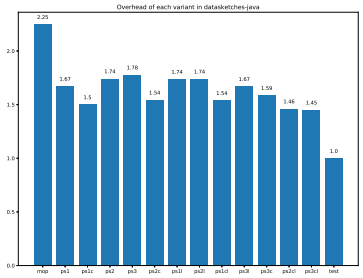


(h) rps-rpp-vmstime for embedded-jmxtrans

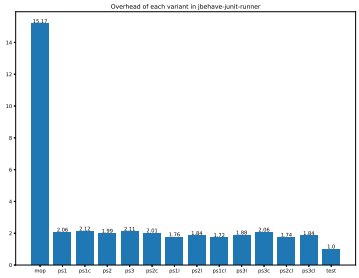
Fig. 10: Plots for rps-rpp-vms Part 1



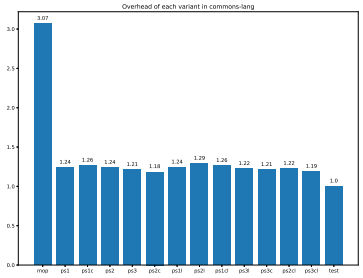
(a) rps-rpp-vmstime for jgroups-aws



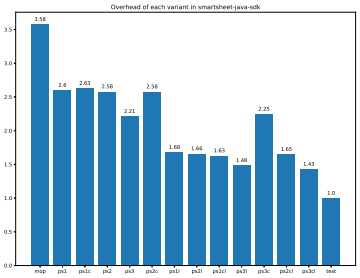
(b) rps-rpp-vmstime for datasketches-java



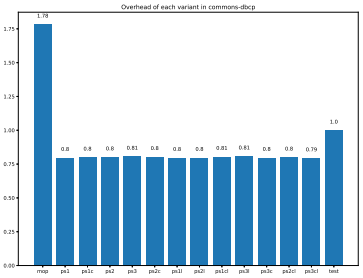
(c) rps-rpp-vmstime for jbehave-junit-runner



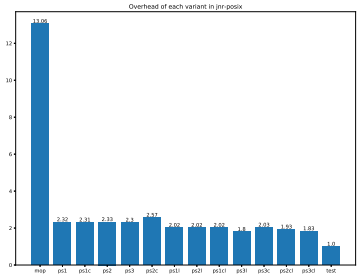
(d) rps-rpp-vmstime for commons-lang



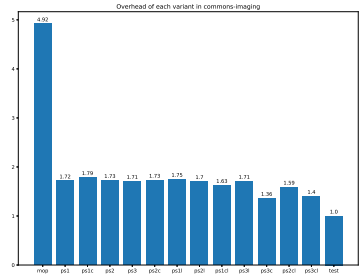
(e) rps-rpp-vmstime for smartsheet-java-sdk



(f) rps-rpp-vmstime for commons-dbcp

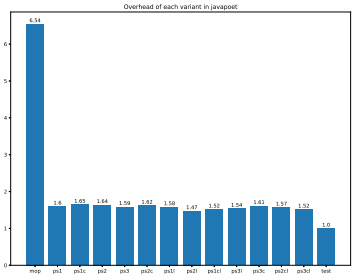


(g) rps-rpp-vmstime for jnr-posix

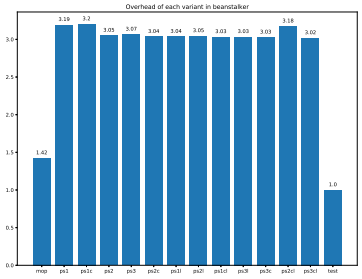


(h) rps-rpp-vmstime for commons-imaging

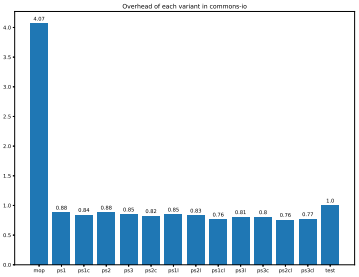
Fig. 11: Plots for rps-rpp-vms Part 2



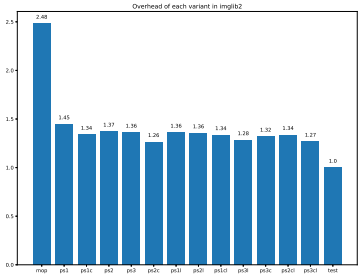
(a) rps-rpp-vmstime for javapoet



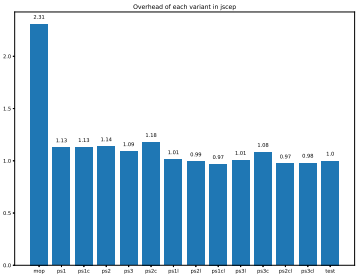
(b) rps-rpp-vmstime for beanstalker



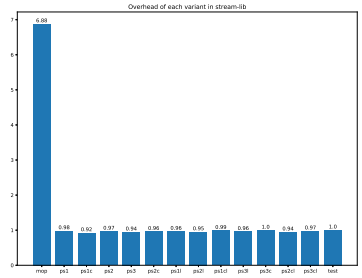
(c) rps-rpp-vmstime for commons-io



(d) rps-rpp-vmstime for imglib2



(e) rps-rpp-vmstime for jscep



(f) rps-rpp-vmstime for stream-lib

Fig. 12: Plots for rps-rpp-vms Part END

TABLE VII: Sum of RPS+RPP+VMS times (in seconds) across all versions of several projects in this paper. "l": 3rd-party libraries not instrumented. "c": non-impacted classes not instrumented. §**??** explains ps_1, ps_2, and ps_3.

sha	mop	ps1	ps1c	ps2	ps3	ps2c	ps1l	ps2l	ps1cl	ps3l	ps3c	ps2cl	ps3cl	test
P1	1757	607	634	620	625	605	625	610	621	607	606	612	603	453
P2	1617	862	865	854	831	839	787	788	808	793	829	786	803	652
P3	356	133	139	137	136	142	141	132	134	131	134	133	131	49
P4	2081	899	907	904	875	913	944	881	943	931	890	891	851	529
P5	1844	575	566	569	557	595	535	545	531	543	591	535	552	305
P6	386	240	235	242	242	245	236	228	233	233	241	231	245	204
P7	629	154	157	156	158	156	157	148	156	149	156	159	153	88
P8	2174	548	542	543	524	509	432	438	443	429	527	444	415	201
P9	464	87	85	88	87	90	84	83	83	88	87	90	89	45
P10	3785	2815	2526	2933	2993	2600	2925	2930	2592	2812	2671	2461	2443	1683
P11	3524	477	493	462	490	466	408	427	399	435	478	404	426	232
P12	1254	506	517	505	495	483	507	527	515	499	494	500	485	409
P13	964	701	709	695	596	695	452	447	439	400	606	444	385	269
P14	1796	803	806	807	812	810	803	804	811	814	804	806	800	1007
P15	7636	1356	1350	1361	1345	1500	1182	1180	1183	1051	1189	1127	1072	584
P16	1723	601	625	604	598	606	612	596	569	598	476	557	491	350
P17	1133	276	285	283	275	280	273	255	262	266	279	272	262	173
P18	1896	4253	4265	4064	4083	4042	4044	4056	4039	4040	4032	4228	4020	1331
P19	7885	1707	1633	1709	1647	1594	1645	1612	1482	1561	1559	1470	1494	1939
P20	613	357	331	339	336	312	336	335	330	317	326	330	313	247
P21	2142	1046	1048	1055	1012	1093	940	921	898	934	1005	902	909	927
P22	11892	1693	1594	1671	1632	1658	1665	1641	1707	1654	1721	1633	1684	1729
sum	57559	20707	20321	20610	20359	20244	19743	19593	19186	19297	19710	19026	18635	13417
mean	2616	941	923	936	925	920	897	890	872	877	895	864	847	609

TABLE VIII: Outcomes of RPS (rps-rpp-vms) mean time

sha	mop	ps1	ps1c	ps2	ps3	ps2c	ps1l	ps2l	ps1cl	ps3l	ps3c	ps2cl	ps3cl	test
exp4j	35.9	12.4	13.0	12.7	12.8	12.3	12.8	12.4	12.7	12.4	12.4	12.5	12.3	9.3
HTTP-Proxy-Servlet	33.0	17.6	17.7	17.4	17.0	17.1	16.1	16.1	16.5	16.2	16.9	16.0	16.4	13.3
Yank	22.2	8.4	8.7	8.6	8.5	8.9	8.9	8.3	8.4	8.2	8.4	8.3	8.2	3.1
joda-time	42.5	18.4	18.5	18.5	17.9	18.6	19.3	18.0	19.2	19.0	18.2	18.2	17.4	10.8
compile-testing	37.6	11.7	11.6	11.6	11.4	12.1	10.9	11.1	10.8	11.1	12.1	10.9	11.3	6.2
zt-exec	27.6	17.2	16.8	17.3	17.3	17.5	16.9	16.3	16.7	16.7	17.2	16.6	17.5	14.6
java-configuration-impl	27.4	6.7	6.8	6.8	6.9	6.8	6.8	6.4	6.8	6.5	6.8	6.9	6.7	3.9
embedded-jmxtrans	44.4	11.2	11.1	11.1	10.7	10.4	8.8	9.0	9.0	8.8	10.8	9.1	8.5	4.1
jgroups-aws	29.0	5.5	5.3	5.5	5.5	5.6	5.3	5.2	5.2	5.5	5.5	5.7	5.6	2.9
datasketches-java	80.5	59.9	53.8	62.4	63.7	55.3	62.2	62.3	55.2	59.8	56.8	52.4	52.0	35.8
jbehave-junit-runner	71.9	9.8	10.1	9.4	10.0	9.5	8.3	8.7	8.1	8.9	9.8	8.2	8.7	4.7
commons-lang	66.0	26.7	27.2	26.6	26.1	25.5	26.7	27.7	27.1	26.3	26.0	26.4	25.5	21.5
smartsheet-java-sdk	48.2	35.1	35.4	34.8	29.8	34.8	22.6	22.4	22.0	20.0	30.3	22.2	19.3	13.5
commons-dbcp	94.5	42.3	42.4	42.5	42.8	42.6	42.3	42.3	42.7	42.9	42.3	42.4	42.1	53.0
jnr-posix	155.8	27.7	27.6	27.8	27.5	30.6	24.1	24.1	24.1	21.5	24.3	23.0	21.9	11.9
commons-imaging	90.7	31.7	32.9	31.8	31.5	31.9	32.2	31.4	30.0	31.5	25.1	29.3	25.9	18.4
javapoet	59.7	14.6	15.0	14.9	14.5	14.8	14.4	13.4	13.8	14.0	14.7	14.3	13.8	9.1
beanstalker	38.7	86.8	87.1	82.9	83.3	82.5	82.5	82.8	82.4	82.5	82.3	86.3	82.0	27.2
commons-io	415.0	89.9	86.0	90.0	86.7	83.9	86.6	84.9	78.0	82.2	82.1	77.4	78.6	102.1
imglib2	32.3	18.8	17.4	17.9	17.7	16.5	17.7	17.6	17.4	16.7	17.2	17.4	16.5	13.0
jscep	43.7	21.4	21.4	21.5	20.7	22.3	19.2	18.8	18.3	19.1	20.5	18.4	18.6	18.9
stream-lib	625.9	89.1	83.9	88.0	85.9	87.3	87.6	86.4	89.9	87.1	90.6	86.0	88.6	91.0
sum	2122.7	662.6	649.7	660.0	648.1	647.1	632.4	625.9	614.5	616.8	630.2	608.1	597.4	488.5
mean	96.5	30.1	29.5	30.0	29.5	29.4	28.7	28.4	27.9	28.0	28.6	27.6	27.2	22.2