Table 1: Dataset $p_{t,1}$ compares with state-of-the-art tuners on 300 budget/30 runs. $\mathtt{X}_p$ and $\mathtt{X}_r$ denotes tuning with and without target performance requirement, respectively. ✗ denotes failed to complete in a reasonable time. The format follows TableII.

$d\%$	**System**	$p_{t,1}$										
		CoTune	$\mathtt{HEBO}_p$	$\mathtt{HEBO}_r$	$\mathtt{Flash}_p$	$\mathtt{Flash}_r$	$\mathtt{SMAC}_p$	$\mathtt{SMAC}_r$	$\mathtt{TurBO}_p$	$\mathtt{TurBO}_r$	$\mathtt{Bounce}_p$	$\mathtt{Bounce}_r$
	7z	.28±.34 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.02 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	Kanzi	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	✗	✗	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)
	ExaStencils	.69±.46 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	Apache	.00±.01 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
0.10%	SQLite	.00±.01 (1)	.00±.00 (2)	.00±.00 (2)	✗	✗	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	DConvert	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)
	DeepArch	.66±.44 (1)	.11±.21 (2)	.00±.00 (4)	.00±.00 (4)	.00±.00 (4)	.13±.24 (2)	.00±.00 (4)	.00±.00 (4)	.00±.00 (4)	.02±.07 (3)	.00±.00 (4)
	Jump3r	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	✗	✗	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)
	HSMGP	.92±.23 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	7z	.54±.39 (1)	.02±.07 (3)	.02±.07 (3)	.02±.07 (3)	.02±.07 (3)	.02±.07 (3)	.02±.07 (3)	.09±.20 (2)	.02±.07 (3)	.02±.13 (3)	.02±.08 (3)
	Kanzi	.10±.28 (1)	.03±.13 (2)	.03±.13 (2)	✗	✗	.03±.13 (2)	.03±.13 (2)	.03±.13 (2)	.03±.13 (2)	.00±.00 (3)	.00±.00 (3)
	ExaStencils	1.00±.00 (1)	.11±.18 (3)	.30±.34 (2)	.03±.12 (4)	.03±.12 (4)	.11±.19 (3)	.03±.12 (4)	.00±.02 (5)	.04±.13 (4)	.01±.04 (5)	.00±.00 (6)
	Apache	.03±.12 (3)	.26±.27 (1)	.15±.30 (2)	.02±.08 (3)	.02±.08 (3)	.17±.26 (2)	.04±.14 (3)	.23±.26 (1)	.02±.08 (3)	.23±.26 (1)	.21±.26 (1)
1%	SQLite	.20±.28 (1)	.05±.15 (2)	.05±.15 (2)	✗	✗	.05±.15 (2)	.05±.15 (2)	.05±.15 (2)	.05±.15 (2)	.00±.00 (3)	.00±.00 (3)
	DConvert	.41±.14 (1)	.03±.09 (2)	.03±.09 (2)	.03±.09 (2)	.03±.09 (2)	.03±.09 (2)	.03±.09 (2)	.03±.09 (2)	.03±.09 (2)	.02±.07 (2)	.02±.07 (2)
	DeepArch	.91±.21 (1)	.67±.35 (2)	.28±.16 (4)	.00±.00 (7)	.00±.00 (7)	.40±.28 (3)	.00±.00 (7)	.00±.00 (7)	.00±.00 (7)	.08±.22 (5)	.00±.01 (6)
	Jump3r	.08±.20 (1)	.02±.11 (2)	.02±.11 (2)	✗	✗	.02±.11 (2)	.02±.11 (2)	.02±.11 (2)	.02±.11 (2)	.00±.00 (3)	.00±.00 (3)
	HSMGP	.96±.18 (1)	.08±.21 (2)	.06±.19 (2)	.06±.19 (2)	.06±.19 (2)	.06±.19 (2)	.06±.19 (2)	.06±.19 (2)	.06±.19 (2)	.03±.15 (3)	.00±.00 (4)
	7z	.72±.20 (1)	.21±.25 (3)	.21±.25 (3)	.21±.25 (3)	.20±.25 (3)	.34±.26 (2)	.20±.25 (3)	.24±.30 (3)	.21±.25 (3)	.02±.13 (5)	.05±.11 (4)
	Kanzi	.24±.32 (1)	.20±.27 (1)	.20±.27 (1)	✗	✗	.19±.28 (1)	.20±.27 (1)	.20±.27 (1)	.20±.27 (1)	.06±.12 (2)	.06±.12 (2)
	ExaStencils	.95±.14 (1)	.22±.20 (2)	.21±.25 (2)	.06±.15 (4)	.06±.15 (4)	.20±.21 (2)	.06±.15 (4)	.11±.14 (3)	.12±.19 (3)	.01±.07 (5)	.00±.01 (6)
	Apache	.13±.06 (5)	.37±.26 (1)	.22±.27 (3)	.04±.10 (6)	.04±.10 (6)	.16±.17 (4)	.06±.14 (6)	.32±.20 (2)	.05±.10 (6)	.34±.21 (1)	.29±.19 (2)
5%	SQLite	.21±.22 (1)	.08±.11 (2)	.07±.11 (2)	✗	✗	.08±.11 (2)	.08±.11 (2)	.08±.11 (2)	.08±.11 (2)	.00±.00 (3)	.00±.00 (3)
	DConvert	.75±.21 (1)	.22±.29 (2)	.21±.30 (2)	.21±.30 (2)	.21±.30 (2)	.21±.30 (2)	.21±.30 (2)	.22±.29 (2)	.21±.30 (2)	.08±.20 (3)	.08±.20 (3)
	DeepArch	.99±.01 (1)	.99±.01 (2)	.97±.01 (3)	.16±.36 (6)	.16±.36 (6)	.80±.35 (4)	.16±.36 (6)	.17±.36 (6)	.16±.36 (6)	.33±.45 (5)	.05±.20 (7)
	Jump3r	.15±.31 (1)	.06±.21 (2)	.06±.21 (2)	✗	✗	.06±.21 (2)	.06±.21 (2)	.06±.21 (2)	.06±.21 (2)	.03±.13 (2)	.03±.13 (2)
	HSMGP	1.00±.00 (1)	.28±.35 (2)	.23±.32 (3)	.21±.32 (3)	.21±.32 (3)	.29±.34 (2)	.21±.32 (3)	.21±.32 (3)	.21±.32 (3)	.17±.30 (4)	.13±.26 (4)
	7z	.91±.16 (1)	.28±.34 (4)	.35±.34 (3)	.35±.34 (3)	.33±.35 (3)	.39±.34 (2)	.33±.35 (3)	.39±.41 (2)	.34±.35 (3)	.25±.38 (5)	.12±.19 (6)
	Kanzi	.72±.29 (1)	.67±.33 (1)	.68±.33 (1)	✗	✗	.68±.33 (1)	.68±.33 (1)	.69±.33 (1)	.68±.33 (1)	.38±.39 (2)	.37±.39 (2)
	ExaStencils	.98±.05 (1)	.68±.17 (3)	.81±.17 (2)	.25±.24 (6)	.23±.24 (6)	.29±.24 (5)	.23±.24 (6)	.35±.25 (4)	.28±.27 (5)	.07±.15 (7)	.03±.08 (8)
	Apache	.67±.08 (3)	.71±.15 (2)	.59±.13 (4)	.34±.26 (6)	.32±.25 (6)	.45±.25 (5)	.34±.26 (6)	.75±.09 (1)	.34±.25 (6)	.75±.09 (1)	.75±.08 (1)
20%	SQLite	.74±.26 (1)	.45±.27 (2)	.45±.27 (2)	✗	✗	.44±.28 (2)	.45±.27 (2)	.46±.26 (2)	.45±.27 (2)	.08±.14 (3)	.08±.14 (3)
	DConvert	.91±.03 (1)	.35±.24 (2)	.31±.19 (3)	.32±.20 (3)	.29±.20 (3)	.31±.21 (3)	.29±.20 (3)	.31±.21 (3)	.30±.20 (3)	.22±.23 (4)	.22±.23 (4)
	DeepArch	1.00±.00 (1)	1.00±.00 (2)	1.00±.00 (2)	.56±.30 (4)	.57±.29 (4)	.73±.16 (3)	.55±.30 (4)	.58±.29 (4)	.56±.30 (4)	.54±.22 (4)	.35±.31 (5)
	Jump3r	.27±.40 (1)	.08±.22 (2)	.08±.22 (2)	✗	✗	.08±.22 (2)	.08±.23 (2)	.08±.22 (2)	.08±.23 (2)	.03±.16 (3)	.03±.16 (3)
	HSMGP	1.00±.00 (1)	.81±.25 (2)	.73±.35 (3)	.62±.40 (4)	.61±.41 (4)	.70±.34 (3)	.62±.40 (4)	.59±.41 (4)	.67±.37 (3)	.58±.39 (4)	.54±.39 (4)
	7z	1.00±.00 (1)	.93±.11 (2)	.92±.12 (2)	.93±.12 (2)	.92±.12 (2)	.92±.12 (2)	.92±.12 (2)	.84±.23 (4)	.93±.12 (2)	.83±.11 (4)	.87±.12 (3)
	Kanzi	.64±.14 (1)	.57±.17 (2)	.56±.17 (2)	✗	✗	.56±.17 (2)	.53±.18 (3)	.56±.17 (2)	.56±.17 (2)	.41±.21 (4)	.41±.21 (4)
	ExaStencils	.99±.04 (1)	.70±.25 (3)	.82±.13 (2)	.29±.26 (5)	.29±.26 (5)	.29±.26 (5)	.28±.26 (5)	.43±.29 (4)	.38±.29 (4)	.08±.05 (6)	.08±.09 (6)
	Apache	.70±.03 (3)	.72±.13 (2)	.66±.07 (4)	.56±.12 (6)	.54±.14 (6)	.60±.14 (5)	.56±.16 (6)	.78±.12 (1)	.55±.14 (6)	.80±.13 (1)	.78±.12 (1)
50%	SQLite	.74±.16 (1)	.51±.17 (2)	.50±.17 (2)	✗	✗	.51±.17 (2)	.51±.17 (2)	.50±.17 (2)	.51±.17 (2)	.24±.13 (3)	.25±.13 (3)
	DConvert	.89±.04 (1)	.66±.23 (2)	.57±.21 (3)	.56±.21 (3)	.56±.22 (3)	.56±.21 (3)	.56±.22 (3)	.57±.20 (3)	.56±.22 (3)	.42±.21 (4)	.43±.22 (4)
	DeepArch	1.00±.00 (1)	1.00±.00 (2)	1.00±.00 (3)	.86±.09 (4)	.85±.11 (4)	.86±.09 (4)	.85±.11 (4)	.86±.11 (4)	.85±.11 (4)	.85±.06 (4)	.79±.16 (5)
	Jump3r	.45±.33 (1)	.23±.20 (2)	.23±.20 (2)	✗	✗	.23±.20 (2)	.23±.20 (2)	.23±.20 (2)	.23±.20 (2)	.12±.15 (3)	.12±.15 (3)
	HSMGP	1.00±.00 (1)	.86±.16 (2)	.84±.16 (2)	.77±.21 (3)	.75±.22 (4)	.84±.15 (2)	.76±.22 (4)	.79±.20 (3)	.78±.21 (3)	.74±.20 (4)	.73±.20 (4)
	7z	.77±.31 (1)	.36±.26 (2)	.35±.26 (2)	.36±.26 (2)	.35±.26 (2)	.36±.26 (2)	.35±.26 (2)	.33±.30 (2)	.36±.26 (2)	.15±.07 (4)	.20±.12 (3)
	Kanzi	.46±.19 (1)	.41±.22 (2)	.41±.23 (2)	✗	✗	.40±.22 (2)	.40±.23 (2)	.41±.22 (2)	.40±.23 (2)	.23±.21 (3)	.23±.21 (3)
	ExaStencils	1.00±.02 (1)	.86±.08 (2)	.86±.08 (2)	.63±.17 (5)	.62±.16 (5)	.60±.20 (5)	.61±.19 (5)	.69±.18 (3)	.65±.21 (4)	.35±.18 (6)	.32±.14 (6)
	Apache	.99±.00 (3)	.99±.00 (4)	1.00±.01 (1)	.98±.01 (5)	.98±.01 (5)	.98±.01 (5)	.98±.01 (5)	.98±.01 (5)	.98±.01 (5)	.99±.00 (2)	.99±.00 (2)
90%	SQLite	.63±.18 (1)	.50±.17 (2)	.51±.17 (2)	✗	✗	.51±.17 (2)	.51±.17 (2)	.52±.17 (2)	.52±.17 (2)	.30±.08 (3)	.30±.08 (3)
	DConvert	.88±.04 (1)	.58±.27 (2)	.52±.22 (3)	.52±.22 (3)	.52±.22 (3)	.52±.22 (3)	.52±.22 (3)	.52±.22 (3)	.52±.22 (3)	.38±.20 (4)	.38±.20 (4)
	DeepArch	1.00±.00 (1)	1.00±.00 (2)	1.00±.00 (2)	.85±.11 (3)	.85±.11 (3)	.85±.11 (3)	.85±.11 (3)	.86±.11 (3)	.85±.11 (3)	.83±.07 (4)	.79±.15 (5)
	Jump3r	.32±.17 (1)	.24±.15 (2)	.26±.19 (2)	✗	✗	.27±.19 (2)	.27±.19 (2)	.26±.19 (2)	.26±.19 (2)	.17±.14 (3)	.17±.14 (3)
	HSMGP	1.00±.00 (1)	.84±.23 (2)	.81±.24 (2)	.68±.34 (4)	.68±.35 (4)	.68±.34 (4)	.68±.34 (4)	.66±.34 (4)	.77±.26 (3)	.62±.33 (5)	.60±.34 (5)
Average p_t score/rank		.62/1.15	.39/1.96	.38/2.11	.32/3.17	.31/3.17	.33/2.39	.29/2.72	.32/2.57	.29/2.87	.24/3.22	.22/3.41

Table 2: Dataset $p_{t,2}$ compares with state-of-the-art tuners on 300 budget/30 runs. $\texttt{X}_p$ and $\texttt{X}_r$ denotes tuning with and without target performance requirement, respectively. ✗ denotes failed to complete in a reasonable time. The format follows TableII.

d%	System	$p_{t,2}$										
		CoTune	HEBO$_p$	HEBO$_r$	Flash$_p$	Flash$_r$	SMAC$_p$	SMAC$_r$	TurBO$_p$	TurBO$_r$	Bounce$_p$	Bounce$_r$
0.10%	7z	.35±.39 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.01 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	Kanzi	.01±.05 (1)	.00±.00 (2)	.00±.00 (2)	✗	✗	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	ExaStencils	.69±.46 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	Apache	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)
	SQLite	.03±.18 (1)	.00±.00 (2)	.00±.00 (2)	✗	✗	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	DConvert	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)
	DeepArch	.73±.40 (1)	.10±.23 (2)	.00±.00 (3)	.00±.00 (3)	.00±.00 (3)	.12±.23 (2)	.00±.00 (3)	.00±.00 (3)	.00±.00 (3)	.00±.00 (3)	.00±.00 (3)
	Jump3r	.00±.00 (1)	.00±.00 (2)	.00±.00 (2)	✗	✗	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	HSMGP	.75±.40 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.01±.03 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
1%	7z	.16±.18 (1)	.00±.01 (3)	.00±.01 (3)	.00±.01 (3)	.00±.01 (3)	.00±.01 (3)	.00±.01 (3)	.02±.06 (2)	.00±.00 (3)	.01±.05 (2)	.00±.02 (3)
	Kanzi	.05±.18 (1)	.04±.16 (1)	.04±.16 (1)	✗	✗	.04±.16 (1)	.04±.16 (1)	.04±.16 (1)	.04±.16 (1)	.00±.00 (2)	.00±.00 (2)
	ExaStencils	.80±.26 (1)	.07±.13 (3)	.29±.32 (2)	.02±.09 (4)	.02±.09 (4)	.09±.15 (3)	.02±.08 (4)	.02±.05 (4)	.02±.09 (4)	.01±.03 (5)	.00±.00 (6)
	Apache	.01±.06 (5)	.28±.35 (2)	.47±.41 (1)	.02±.10 (5)	.02±.10 (5)	.16±.25 (3)	.05±.18 (4)	.28±.33 (2)	.02±.10 (5)	.28±.33 (2)	.22±.31 (2)
	SQLite	.19±.30 (1)	.03±.10 (3)	.05±.16 (2)	✗	✗	.03±.13 (3)	.05±.16 (2)	.07±.19 (2)	.05±.16 (2)	.00±.00 (4)	.00±.00 (4)
	DConvert	.25±.14 (1)	.02±.05 (2)	.02±.05 (2)	.02±.05 (2)	.02±.05 (2)	.02±.05 (2)	.02±.05 (2)	.02±.05 (2)	.02±.05 (2)	.01±.04 (2)	.01±.04 (2)
	DeepArch	.93±.13 (1)	.51±.28 (3)	.30±.03 (4)	.00±.00 (7)	.00±.00 (7)	.60±.37 (2)	.00±.00 (7)	.00±.00 (7)	.00±.00 (7)	.09±.24 (5)	.00±.02 (6)
	Jump3r	.08±.21 (1)	.02±.13 (2)	.02±.13 (2)	✗	✗	.02±.13 (2)	.02±.13 (2)	.02±.13 (2)	.02±.13 (2)	.00±.00 (3)	.00±.00 (3)
	HSMGP	1.00±.01 (1)	.07±.21 (2)	.07±.21 (2)	.07±.21 (2)	.07±.21 (2)	.07±.21 (2)	.07±.21 (2)	.07±.21 (2)	.07±.21 (2)	.03±.17 (2)	.00±.00 (3)
5%	7z	.62±.41 (1)	.19±.32 (4)	.19±.32 (4)	.19±.32 (4)	.19±.32 (4)	.35±.38 (2)	.18±.32 (4)	.26±.38 (3)	.19±.32 (4)	.03±.16 (5)	.02±.04 (5)
	Kanzi	.14±.25 (2)	.22±.31 (1)	.25±.32 (1)	✗	✗	.23±.32 (1)	.23±.32 (1)	.25±.32 (1)	.23±.32 (1)	.10±.19 (2)	.10±.19 (2)
	ExaStencils	.95±.07 (1)	.29±.23 (3)	.38±.39 (2)	.08±.19 (6)	.08±.19 (6)	.26±.27 (3)	.07±.18 (6)	.18±.19 (4)	.13±.21 (5)	.02±.08 (7)	.00±.02 (8)
	Apache	.34±.16 (3)	.53±.23 (1)	.30±.29 (3)	.08±.17 (4)	.08±.17 (4)	.30±.25 (3)	.11±.20 (4)	.50±.19 (2)	.09±.18 (4)	.50±.20 (2)	.48±.19 (2)
	SQLite	.42±.39 (1)	.18±.29 (2)	.19±.30 (2)	✗	✗	.21±.30 (2)	.21±.30 (2)	.21±.30 (2)	.21±.30 (2)	.00±.00 (3)	.00±.00 (3)
	DConvert	.77±.16 (1)	.23±.32 (2)	.21±.30 (2)	.22±.30 (2)	.22±.30 (2)	.22±.30 (2)	.22±.30 (2)	.23±.30 (2)	.20±.29 (2)	.09±.21 (3)	.09±.21 (3)
	DeepArch	.99±.01 (1)	.82±.06 (2)	.80±.08 (3)	.12±.26 (6)	.12±.26 (6)	.65±.27 (4)	.12±.26 (6)	.12±.26 (6)	.12±.27 (6)	.23±.34 (5)	.04±.15 (7)
	Jump3r	.18±.34 (1)	.06±.22 (2)	.06±.22 (2)	✗	✗	.06±.22 (2)	.06±.22 (2)	.06±.22 (2)	.06±.22 (2)	.03±.15 (2)	.03±.15 (2)
	HSMGP	1.00±.00 (1)	.30±.34 (2)	.24±.34 (3)	.22±.34 (3)	.19±.31 (4)	.31±.35 (2)	.19±.31 (4)	.22±.34 (3)	.22±.34 (3)	.19±.32 (4)	.14±.29 (4)
20%	7z	.70±.15 (1)	.27±.25 (4)	.34±.24 (3)	.35±.24 (3)	.34±.24 (3)	.45±.18 (2)	.34±.24 (3)	.32±.27 (3)	.36±.23 (3)	.20±.24 (5)	.19±.18 (5)
	Kanzi	.64±.23 (1)	.52±.26 (2)	.51±.26 (2)	✗	✗	.52±.27 (2)	.52±.26 (2)	.52±.26 (2)	.52±.26 (2)	.28±.29 (3)	.28±.29 (3)
	ExaStencils	.99±.04 (1)	.58±.15 (3)	.65±.19 (2)	.23±.21 (6)	.22±.21 (6)	.26±.20 (5)	.21±.21 (6)	.32±.23 (4)	.26±.22 (5)	.06±.13 (7)	.02±.07 (8)
	Apache	.14±.02 (3)	.23±.22 (2)	.12±.07 (4)	.08±.08 (5)	.07±.08 (5)	.08±.09 (5)	.09±.13 (5)	.29±.21 (1)	.08±.09 (5)	.27±.20 (1)	.25±.19 (1)
	SQLite	.64±.19 (1)	.52±.20 (2)	.52±.20 (2)	✗	✗	.51±.22 (2)	.50±.22 (2)	.50±.22 (2)	.52±.21 (2)	.12±.20 (3)	.12±.20 (3)
	DConvert	.95±.02 (1)	.61±.29 (2)	.41±.24 (3)	.42±.24 (3)	.39±.25 (3)	.41±.24 (3)	.39±.25 (3)	.43±.23 (3)	.39±.25 (3)	.27±.27 (4)	.19±.25 (5)
	DeepArch	1.00±.00 (1)	1.00±.00 (3)	1.00±.00 (2)	.63±.29 (5)	.63±.29 (5)	.78±.14 (4)	.61±.30 (5)	.65±.29 (5)	.64±.30 (5)	.66±.27 (5)	.39±.33 (6)
	Jump3r	.15±.32 (1)	.08±.24 (2)	.08±.24 (2)	✗	✗	.08±.24 (2)	.08±.24 (2)	.08±.24 (2)	.08±.24 (2)	.04±.17 (3)	.04±.17 (3)
	HSMGP	.98±.13 (1)	.83±.30 (2)	.74±.38 (3)	.65±.42 (4)	.62±.43 (4)	.74±.36 (3)	.63±.42 (4)	.62±.43 (4)	.71±.37 (3)	.61±.40 (4)	.58±.41 (4)
50%	7z	.64±.28 (1)	.29±.19 (3)	.30±.20 (3)	.31±.20 (3)	.30±.20 (3)	.30±.20 (3)	.30±.20 (3)	.30±.23 (3)	.33±.22 (2)	.15±.04 (5)	.18±.07 (4)
	Kanzi	.64±.22 (1)	.59±.19 (2)	.60±.19 (2)	✗	✗	.59±.19 (2)	.60±.18 (2)	.59±.19 (2)	.59±.19 (2)	.41±.21 (3)	.41±.21 (3)
	ExaStencils	.88±.15 (1)	.12±.07 (2)	.11±.08 (2)	.06±.04 (4)	.06±.04 (4)	.06±.04 (4)	.06±.04 (4)	.07±.02 (3)	.07±.04 (3)	.02±.02 (5)	.02±.02 (6)
	Apache	.34±.17 (3)	.39±.30 (2)	.42±.21 (2)	.20±.16 (4)	.19±.16 (4)	.20±.16 (4)	.22±.21 (4)	.56±.30 (1)	.20±.16 (4)	.60±.30 (1)	.56±.30 (1)
	SQLite	.68±.19 (1)	.53±.11 (2)	.53±.11 (2)	✗	✗	.53±.11 (2)	.53±.11 (2)	.54±.11 (2)	.53±.11 (2)	.36±.14 (3)	.37±.14 (3)
	DConvert	.94±.02 (1)	.49±.28 (2)	.38±.26 (3)	.42±.24 (3)	.38±.26 (3)	.42±.24 (3)	.38±.26 (3)	.45±.23 (2)	.40±.25 (3)	.29±.22 (4)	.24±.22 (5)
	DeepArch	1.00±.00 (1)	1.00±.00 (3)	1.00±.00 (2)	.92±.07 (4)	.91±.10 (4)	.92±.07 (4)	.91±.10 (4)	.91±.10 (4)	.91±.10 (4)	.91±.02 (4)	.86±.16 (5)
	Jump3r	.42±.25 (1)	.32±.19 (2)	.33±.18 (2)	✗	✗	.33±.18 (2)	.33±.18 (2)	.33±.18 (2)	.32±.19 (2)	.21±.17 (3)	.21±.17 (3)
	HSMGP	1.00±.00 (1)	.92±.14 (2)	.87±.20 (3)	.79±.24 (4)	.79±.24 (4)	.89±.15 (3)	.80±.23 (4)	.83±.22 (4)	.79±.24 (4)	.76±.23 (5)	.76±.23 (5)
90%	7z	.81±.26 (1)	.42±.28 (2)	.42±.28 (2)	.42±.28 (2)	.42±.28 (2)	.42±.28 (2)	.42±.28 (2)	.39±.32 (2)	.43±.28 (2)	.21±.09 (4)	.25±.13 (3)
	Kanzi	.30±.22 (1)	.33±.24 (1)	.33±.24 (1)	✗	✗	.33±.23 (1)	.32±.23 (1)	.32±.24 (1)	.32±.24 (1)	.15±.15 (2)	.15±.15 (2)
	ExaStencils	.91±.14 (1)	.28±.19 (3)	.32±.15 (2)	.13±.10 (4)	.13±.10 (4)	.12±.10 (4)	.12±.10 (4)	.13±.07 (4)	.14±.10 (4)	.07±.02 (5)	.07±.02 (5)
	Apache	.80±.00 (4)	.81±.04 (3)	.87±.10 (1)	.80±.02 (4)	.80±.02 (4)	.80±.02 (4)	.80±.04 (3)	.80±.02 (4)	.80±.02 (4)	.85±.08 (2)	.84±.08 (2)
	SQLite	.68±.17 (1)	.53±.11 (2)	.53±.11 (2)	✗	✗	.53±.11 (2)	.53±.11 (2)	.54±.11 (2)	.53±.11 (2)	.41±.06 (3)	.41±.06 (3)
	DConvert	.94±.03 (1)	.51±.31 (2)	.51±.32 (2)	.51±.32 (2)	.51±.32 (2)	.51±.32 (2)	.51±.32 (2)	.51±.32 (2)	.51±.32 (2)	.33±.28 (3)	.33±.28 (3)
	DeepArch	1.00±.00 (1)	1.00±.00 (2)	1.00±.00 (2)	.91±.10 (3)	.91±.09 (3)	.91±.10 (3)	.91±.09 (3)	.92±.07 (3)	.91±.10 (3)	.89±.13 (4)	.86±.16 (4)
	Jump3r	.27±.38 (1)	.10±.23 (2)	.11±.23 (2)	✗	✗	.11±.23 (2)	.11±.23 (2)	.11±.23 (2)	.11±.23 (2)	.06±.17 (3)	.06±.17 (3)
	HSMGP	1.00±.00 (1)	.82±.31 (2)	.82±.29 (2)	.70±.38 (4)	.67±.39 (4)	.70±.38 (4)	.68±.38 (4)	.76±.34 (3)	.76±.34 (3)	.61±.39 (5)	.61±.38 (5)
Average p_t score/rank		.57/1.19	.34/2.00	.33/2.09	.27/3.11	.26/3.11	.30/2.35	.25/2.65	.28/2.54	.26/2.83	.21/3.26	.19/3.46

Table 3: Dataset $p_{t,3}$ compares with state-of-the-art tuners on 300 budget/30 runs. $\texttt{X}_p$ and $\texttt{X}_r$ denotes tuning with and without target performance requirement, respectively. ✗ denotes failed to complete in a reasonable time. The format follows TableII.

d%	**System**	$p_{t,3}$										
		CoTune	HEBO$_p$	HEBO$_r$	Flash$_p$	Flash$_r$	SMAC$_p$	SMAC$_r$	TurBO$_p$	TurBO$_r$	Bounce$_p$	Bounce$_r$
	7z	.21±.33 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.01 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	Kanzi	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	✗	✗	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)
	ExaStencils	.62±.49 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	Apache	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)	.00±.00 (1)
0.10%	SQLite	.01±.03 (1)	.00±.00 (2)	.00±.00 (2)	✗	✗	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	DConvert	.03±.18 (1)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	DeepArch	.72±.42 (1)	.09±.26 (2)	.00±.00 (4)	.00±.00 (4)	.00±.00 (4)	.06±.15 (2)	.00±.00 (4)	.00±.00 (4)	.00±.00 (4)	.00±.02 (3)	.00±.00 (4)
	Jump3r	.00±.00 (1)	.00±.00 (2)	.00±.00 (2)	✗	✗	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)	.00±.00 (2)
	HSMGP	.76±.42 (1)	.00±.00 (2)	.00±.00 (3)	.00±.00 (3)	.00±.00 (3)	.00±.00 (2)	.00±.00 (3)	.00±.00 (3)	.00±.00 (3)	.00±.00 (3)	.00±.00 (3)
	7z	.34±.31 (1)	.00±.02 (4)	.00±.02 (4)	.00±.02 (4)	.00±.02 (4)	.00±.02 (4)	.00±.02 (4)	.05±.12 (2)	.00±.01 (4)	.01±.07 (3)	.01±.04 (4)
	Kanzi	.06±.21 (1)	.03±.12 (2)	.03±.12 (2)	✗	✗	.03±.12 (2)	.03±.12 (2)	.03±.12 (2)	.03±.12 (2)	.00±.00 (3)	.00±.00 (3)
	ExaStencils	.92±.07 (1)	.06±.19 (4)	.21±.33 (2)	.03±.14 (4)	.03±.14 (4)	.14±.27 (3)	.03±.14 (4)	.01±.03 (5)	.05±.15 (4)	.00±.03 (6)	.00±.00 (7)
	Apache	.01±.07 (5)	.45±.44 (1)	.53±.46 (1)	.05±.13 (4)	.03±.11 (5)	.13±.28 (3)	.06±.21 (4)	.33±.39 (2)	.03±.11 (5)	.35±.39 (2)	.29±.38 (2)
1%	SQLite	.11±.23 (1)	.04±.14 (2)	.04±.14 (2)	✗	✗	.04±.14 (2)	.04±.14 (2)	.04±.14 (2)	.04±.14 (2)	.00±.00 (3)	.00±.00 (3)
	DConvert	.24±.12 (1)	.03±.07 (2)	.03±.07 (2)	.03±.07 (2)	.03±.07 (2)	.03±.07 (2)	.03±.07 (2)	.03±.07 (2)	.03±.07 (2)	.02±.06 (2)	.02±.06 (2)
	DeepArch	.84±.26 (1)	.53±.37 (2)	.08±.01 (4)	.00±.00 (6)	.00±.00 (6)	.44±.42 (3)	.00±.00 (6)	.00±.00 (6)	.00±.00 (6)	.06±.20 (4)	.00±.01 (5)
	Jump3r	.04±.13 (1)	.02±.11 (1)	.02±.11 (1)	✗	✗	.02±.11 (1)	.02±.11 (1)	.02±.11 (1)	.02±.11 (1)	.00±.00 (2)	.00±.00 (2)
	HSMGP	.93±.25 (1)	.06±.19 (2)	.06±.19 (2)	.06±.19 (2)	.06±.19 (2)	.06±.19 (2)	.06±.19 (2)	.06±.19 (2)	.06±.19 (2)	.03±.14 (2)	.00±.00 (3)
	7z	.59±.36 (1)	.15±.27 (3)	.17±.30 (3)	.18±.29 (3)	.17±.30 (3)	.31±.34 (2)	.17±.30 (3)	.25±.36 (2)	.18±.29 (3)	.03±.15 (4)	.02±.05 (4)
	Kanzi	.29±.32 (1)	.19±.27 (2)	.19±.27 (2)	✗	✗	.20±.28 (2)	.19±.28 (2)	.20±.28 (2)	.20±.28 (2)	.10±.18 (3)	.10±.18 (3)
	ExaStencils	.91±.12 (1)	.27±.25 (3)	.39±.43 (2)	.06±.17 (6)	.06±.17 (6)	.18±.27 (4)	.06±.17 (6)	.10±.13 (5)	.08±.18 (5)	.02±.07 (7)	.00±.01 (8)
	Apache	.22±.13 (3)	.53±.31 (1)	.25±.22 (3)	.06±.14 (5)	.06±.14 (5)	.19±.20 (4)	.08±.20 (5)	.44±.26 (2)	.06±.14 (5)	.41±.25 (2)	.41±.25 (2)
5%	SQLite	.23±.27 (1)	.13±.19 (2)	.11±.18 (2)	✗	✗	.13±.19 (2)	.13±.19 (2)	.13±.19 (2)	.13±.18 (2)	.00±.00 (3)	.00±.00 (3)
	DConvert	.48±.08 (1)	.12±.19 (2)	.10±.15 (2)	.10±.15 (2)	.10±.15 (2)	.10±.15 (2)	.10±.15 (2)	.10±.15 (2)	.09±.15 (2)	.04±.11 (3)	.04±.11 (3)
	DeepArch	.99±.01 (1)	.98±.01 (2)	.98±.01 (3)	.17±.36 (6)	.17±.36 (6)	.81±.36 (4)	.17±.36 (6)	.17±.36 (6)	.17±.37 (6)	.35±.45 (5)	.05±.19 (7)
	Jump3r	.08±.20 (1)	.06±.19 (1)	.06±.19 (1)	✗	✗	.06±.19 (1)	.05±.19 (1)	.06±.19 (1)	.06±.19 (1)	.02±.12 (2)	.02±.12 (2)
	HSMGP	.96±.18 (1)	.28±.33 (2)	.22±.30 (2)	.19±.30 (3)	.19±.30 (3)	.26±.30 (2)	.19±.30 (3)	.18±.30 (3)	.19±.30 (3)	.15±.27 (3)	.10±.21 (4)
	7z	.82±.21 (1)	.46±.35 (3)	.49±.34 (3)	.50±.33 (3)	.47±.34 (3)	.60±.27 (2)	.47±.34 (3)	.48±.37 (3)	.49±.34 (3)	.26±.32 (4)	.26±.27 (4)
	Kanzi	.37±.19 (1)	.37±.16 (1)	.36±.17 (1)	✗	✗	.35±.17 (1)	.36±.17 (1)	.36±.17 (1)	.36±.17 (1)	.20±.19 (2)	.20±.19 (2)
	ExaStencils	.96±.07 (1)	.58±.16 (3)	.63±.17 (2)	.27±.20 (6)	.26±.20 (6)	.34±.19 (5)	.23±.19 (6)	.39±.19 (4)	.31±.22 (5)	.09±.14 (7)	.03±.08 (8)
	Apache	.14±.07 (3)	.22±.19 (2)	.11±.08 (4)	.07±.09 (5)	.07±.09 (5)	.09±.10 (5)	.09±.14 (5)	.32±.20 (1)	.08±.09 (5)	.30±.19 (1)	.30±.18 (1)
20%	SQLite	.24±.16 (1)	.15±.08 (2)	.15±.08 (2)	✗	✗	.15±.08 (2)	.15±.08 (2)	.15±.08 (2)	.15±.08 (2)	.03±.06 (3)	.03±.06 (3)
	DConvert	.89±.05 (1)	.51±.38 (2)	.26±.27 (3)	.29±.25 (3)	.25±.26 (3)	.29±.25 (3)	.25±.26 (3)	.27±.26 (3)	.26±.27 (3)	.13±.18 (4)	.11±.19 (4)
	DeepArch	1.00±.00 (1)	.99±.01 (2)	.99±.00 (3)	.48±.27 (6)	.48±.27 (6)	.60±.23 (4)	.48±.27 (6)	.54±.29 (5)	.47±.28 (6)	.52±.27 (5)	.29±.25 (7)
	Jump3r	.10±.23 (1)	.07±.20 (1)	.07±.20 (1)	✗	✗	.08±.20 (1)	.08±.20 (1)	.08±.20 (1)	.05±.13 (2)	.03±.13 (2)	.03±.13 (2)
	HSMGP	.97±.14 (1)	.75±.25 (2)	.69±.25 (3)	.54±.36 (5)	.53±.37 (5)	.61±.32 (4)	.54±.36 (5)	.52±.37 (5)	.60±.32 (4)	.51±.32 (5)	.48±.33 (5)
	7z	.93±.18 (1)	.40±.37 (2)	.41±.38 (2)	.43±.37 (2)	.41±.38 (2)	.41±.38 (2)	.41±.38 (2)	.32±.39 (3)	.41±.38 (2)	.10±.19 (5)	.18±.25 (4)
	Kanzi	.50±.15 (1)	.41±.12 (2)	.40±.12 (2)	✗	✗	.40±.12 (2)	.40±.12 (2)	.40±.12 (2)	.41±.12 (2)	.29±.12 (3)	.30±.12 (3)
	ExaStencils	.99±.02 (1)	.79±.11 (3)	.82±.11 (2)	.52±.19 (5)	.53±.17 (5)	.52±.19 (5)	.51±.20 (5)	.60±.16 (4)	.57±.22 (4)	.27±.15 (6)	.23±.15 (7)
	Apache	.69±.07 (2)	.65±.15 (3)	.69±.17 (2)	.43±.16 (4)	.44±.16 (4)	.46±.18 (4)	.44±.17 (4)	.74±.09 (1)	.44±.16 (4)	.75±.09 (1)	.74±.09 (1)
50%	SQLite	.80±.21 (1)	.54±.22 (3)	.54±.22 (3)	✗	✗	.53±.22 (3)	.54±.22 (3)	.52±.21 (3)	.57±.22 (2)	.20±.15 (4)	.20±.15 (4)
	DConvert	.93±.03 (1)	.41±.32 (2)	.28±.24 (3)	.30±.24 (3)	.29±.24 (3)	.30±.24 (3)	.29±.24 (3)	.31±.23 (3)	.27±.23 (3)	.22±.17 (4)	.21±.17 (4)
	DeepArch	1.00±.00 (1)	.99±.00 (2)	.99±.00 (2)	.73±.15 (3)	.73±.15 (3)	.73±.15 (3)	.74±.13 (3)	.73±.14 (3)	.73±.15 (3)	.69±.10 (4)	.64±.14 (5)
	Jump3r	.35±.24 (1)	.27±.15 (2)	.27±.15 (2)	✗	✗	.27±.15 (2)	.27±.15 (2)	.27±.15 (2)	.27±.15 (2)	.22±.11 (3)	.22±.11 (3)
	HSMGP	.98±.11 (1)	.75±.20 (2)	.73±.21 (2)	.66±.25 (4)	.65±.26 (4)	.73±.18 (2)	.65±.25 (4)	.67±.24 (4)	.69±.22 (3)	.62±.23 (5)	.60±.23 (5)
	7z	.94±.15 (1)	.54±.27 (2)	.56±.26 (2)	.54±.27 (2)	.55±.27 (2)	.55±.27 (2)	.55±.27 (2)	.50±.28 (3)	.54±.27 (2)	.34±.14 (5)	.38±.16 (4)
	Kanzi	.30±.28 (1)	.15±.11 (2)	.14±.11 (2)	✗	✗	.15±.11 (2)	.14±.11 (2)	.14±.11 (2)	.14±.11 (2)	.07±.06 (3)	.07±.06 (3)
	ExaStencils	.98±.04 (1)	.61±.20 (2)	.56±.17 (3)	.30±.15 (5)	.30±.14 (5)	.30±.15 (5)	.29±.15 (5)	.35±.12 (4)	.33±.15 (4)	.18±.12 (6)	.15±.06 (7)
	Apache	.98±.00 (3)	.98±.01 (3)	.99±.01 (1)	.97±.01 (4)	.97±.01 (4)	.97±.01 (4)	.98±.01 (4)	.98±.01 (4)	.98±.01 (4)	.98±.00 (2)	.98±.00 (2)
90%	SQLite	.78±.22 (1)	.54±.21 (2)	.53±.21 (2)	✗	✗	.55±.21 (2)	.54±.21 (2)	.55±.21 (2)	.55±.21 (2)	.26±.11 (3)	.26±.11 (3)
	DConvert	.88±.13 (1)	.55±.28 (2)	.54±.28 (2)	.54±.28 (2)	.54±.28 (2)	.54±.28 (2)	.54±.28 (2)	.55±.28 (2)	.55±.28 (2)	.36±.26 (3)	.36±.26 (3)
	DeepArch	1.00±.00 (1)	.99±.00 (2)	.99±.00 (3)	.73±.15 (4)	.73±.15 (4)	.73±.15 (4)	.73±.15 (4)	.73±.15 (4)	.73±.15 (4)	.67±.11 (5)	.64±.14 (6)
	Jump3r	.09±.20 (1)	.08±.20 (1)	.08±.20 (1)	✗	✗	.08±.20 (1)	.08±.20 (1)	.08±.20 (1)	.08±.20 (1)	.04±.13 (2)	.04±.13 (2)
	HSMGP	.98±.13 (1)	.77±.17 (2)	.68±.29 (3)	.61±.31 (4)	.59±.32 (5)	.61±.31 (4)	.59±.31 (5)	.62±.30 (4)	.64±.29 (4)	.54±.30 (5)	.54±.30 (5)
Average p_t score/rank		.56/1.11	.34/1.94	.32/2.11	.27/3.22	.27/3.25	.28/2.39	.24/2.69	.27/2.65	.24/2.91	.29/2.72	.18/3.57