An Example

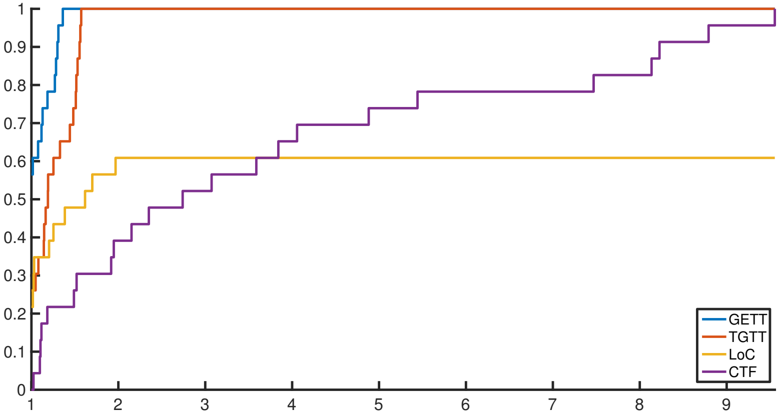

Figure: Final Performance Profile

Starting Matrix

```
ans = A(1:10,:);
```

12.1	8.39	0	1.62
13.18	8.38	0	1.62
9.47	7.96	0	1.74
28.25	29.02	30.41	15.86
28.89	37.53	0	33.66
28.58	37.44	22.02	34.13
29.35	37.66	23.29	31.84
27.81	37.85	37.85	36.97
12.17	9.16	0	3
13.96	9.24	0	2.86

Failure of a solver

```
A( A == 0 ) = NaN;
ans = A(1:10,:)
```

12.1	8.39	NaN	1.62
13.18	8.38	NaN	1.62
9.47	7.96	NaN	1.74
28.25	29.02	30.41	15.86
28.89	37.53	NaN	33.66
28.58	37.44	22.02	34.13
29.35	37.66	23.29	31.84
27.81	37.85	37.85	36.97
12.17	9.16	NaN	3
13.96	9.24	NaN	2.86

Smaller Metric indicates better performance

```
A = 1./A;
ans = A(1:10,:)
```

0.082645	0.11919	NaN	0.61728
0.075873	0.11933	NaN	0.61728
0.1056	0.12563	NaN	0.57471
0.035398	0.034459	0.032884	0.063052
0.034614	0.026645	NaN	0.029709
0.03499	0.026709	0.045413	0.0293
0.034072	0.026553	0.042937	0.031407
0.035958	0.02642	0.02642	0.027049
0.082169	0.10917	NaN	0.33333
0.071633	0.10823	NaN	0.34965

Normalize on a per-testcase basis

```
minA = min(A,[],2);
ans = minA(1:10)
```

0.082645
0.075873
0.1056
0.032884
0.026645
0.026709
0.026553
0.02642
0.082169
0.071633

Normalize on a per-testcase basis

```
A = A ./ repmat(minA, 1, size(A,2) );
ans = A(1:10,:)
```

1	1.4422	NaN	7.4691
1	1.5728	NaN	8.1358
1	1.1897	NaN	5.4425
1.0765	1.0479	1	1.9174
1.2991	1	NaN	1.115
1.31	1	1.7003	1.097
1.2831	1	1.617	1.1828
1.361	1	1	1.0238
1	1.3286	NaN	4.0567
1	1.5108	NaN	4.8811

What does this say about the solvers?

```
ans = max(A)
```

1.361 1.5728 1.9682 9.5538

Visualizations. . .

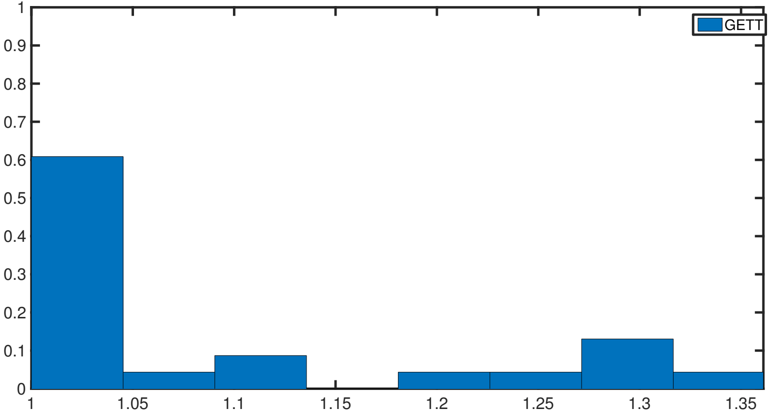

Figure: GETT data set. This data is relative to the other solvers!

Visualizations. . .

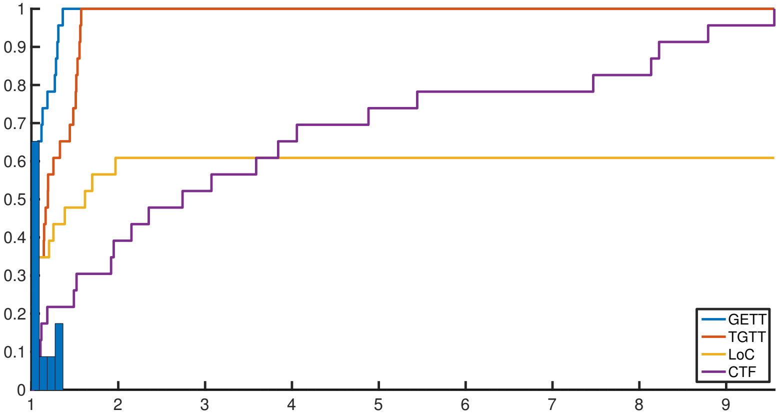

Figure: GETT data set

Visualizations. . .

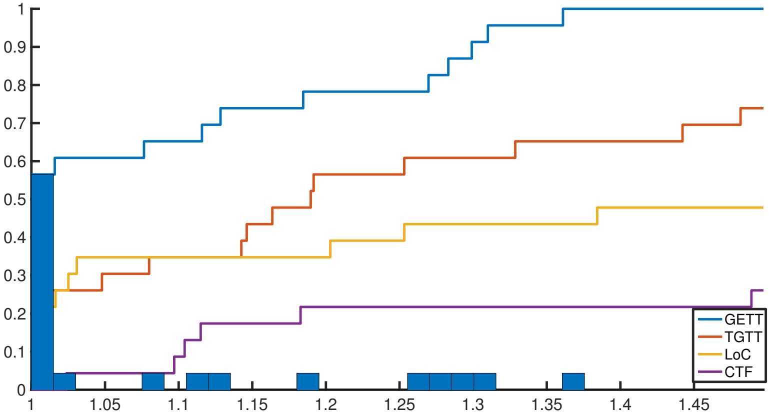

Figure: GETT data set

Visualizations. . .

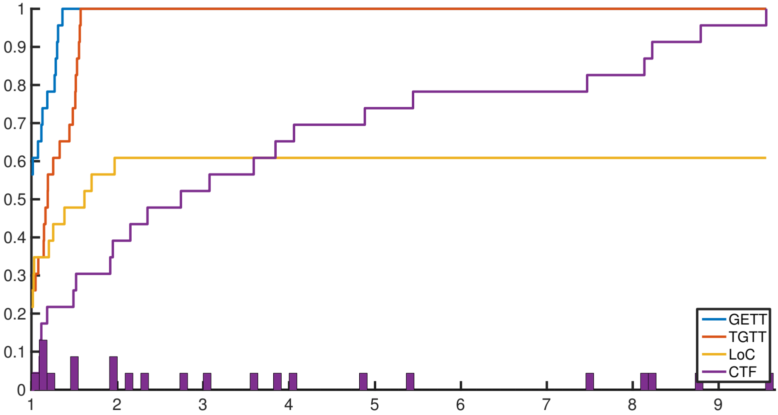

Figure: CTF data set

Performance Ratios

- Let $S = \{S_1, ..., S_n\}$ be Solvers (GETT, TGTT, ...)
- Let $P = \{P_1, ..., P_m\}$ be Reference Problems
- Let $t_s(p)$ be the Performance of $s \in S$ on $p \in P$ where a smaller measure $t_s(p)$ indicates better performance
  `NaN` indicates failure
- Define the *Performance Ratio* of $s \in S$ on $p \in P$ as

$$r_{s,p} = \frac{t_s(p)}{min_{\sigma \in s} t_\sigma(p)} \geq 1$$

```
A(1:5,:)
```

1	1.4422	NaN	7.4691
1	1.5728	NaN	8.1358
1	1.1897	NaN	5.4425
1.0765	1.0479	1	1.9174
1.2991	1	NaN	1.115

Performance Profiles

- Let $S = \{S_1, ..., S_n\}$ be Solvers (GETT, TGTT, ...)
- Let $P = \{P_1, ..., P_m\}$ be Reference Problems
- Let $t_s(p)$ be the Performance of $s \in S$ on $p \in P$ where a smaller measure $t_s(p)$ indicates better performance
  `NaN` indicates failure
- Define the *Performance Ratio* of $s \in S$ on $p \in P$ as

$$r_{s,p} = \frac{t_s(p)}{min_{\sigma \in s} t_\sigma(p)} \geq 1$$

- Define the *Performance Profile* for solver $s \in S$ as

$$\phi_s(\theta) = \frac{1}{|P|} \cdot \left| \left\{ \; p \mid p \in P, r_{s,p} \leq \theta \; \right\} \right|$$

Final Picture, Discussion

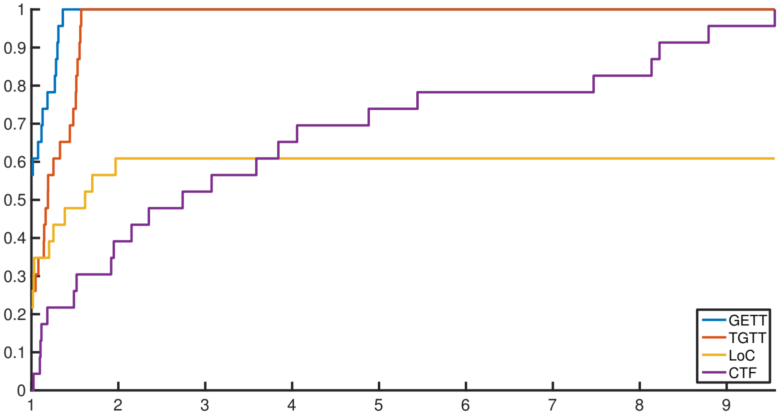

Figure: Final Performance Profile

$$\phi_s(\theta) = \frac{1}{|P|} \cdot \left| \left\{ \, p \mid p \in P, r_{s,p} \leq \theta \, \right\} \right|$$

Final Picture Zoomed

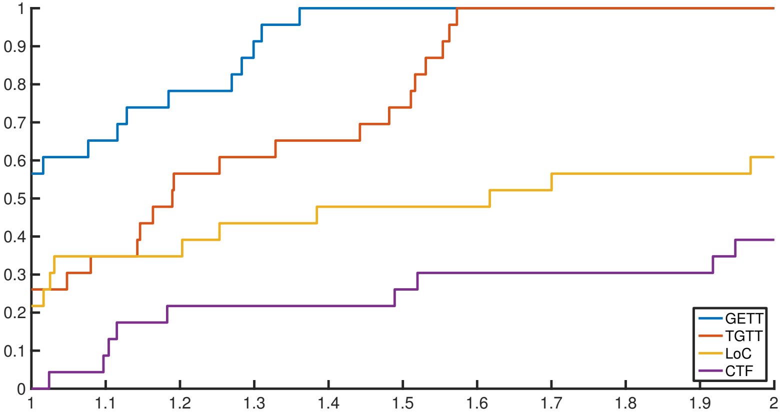

Figure: Final Performance Profile (zoomed)

Summary

- Performance Profiles compares solvers based on a test-set
- No distinction of test-cases (i.e., bandwith- or compute-bound)
- Particularly useful for large test-sets
- The performance ratio is relative to all solvers!

$$r_{s,p} = \frac{t_s(p)}{min_{\sigma \in s} t_\sigma(p)} \geq 1$$

- A really good method when there is no clear winner
- Protip: consider logarithm of performance metric
- "Using Performance Profiles in a publication requires a entire page on how to read your graphs" - EP
- Get the MATLAB code here [1]

[1] `http://www.maths.man.ac.uk/~higham/mg/m/perfprof.m`

References

Elizabeth D. Dolan and Jorge J. Moré.
Benchmarking optimization software with performance profiles.
Mathematical Programming, 91(2):201–213, 2002.

Desmond J. Higham and Nicholas J. Higham.
Matlab Guide.
Society for Industrial & Applied Mathematics (SIAM), 2005.