Competition on Real-Parameter Single Objective Computationally expensive Optimization

CEC 2015, Sendai Japan, May 2015

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Test suite and ranking

- Test Suite
  - 15 functions
  - 2 dimensions: 10d, 30d
  - 4 types
    - Unimodal functions: TF1, TF2
    - Simple Multimodal functions: TF3-TF9
    - Hybrid functions: TF10, TF11, and TF12
    - Composition functions: TF13, TF14, and TF15

Test suite and ranking

- Ranking
  - F* removed from the function objectives
  - mean values and median values
  - all 15 problems for 10 and 30 dimensions
  - favor those algorithm can solve complicate problems

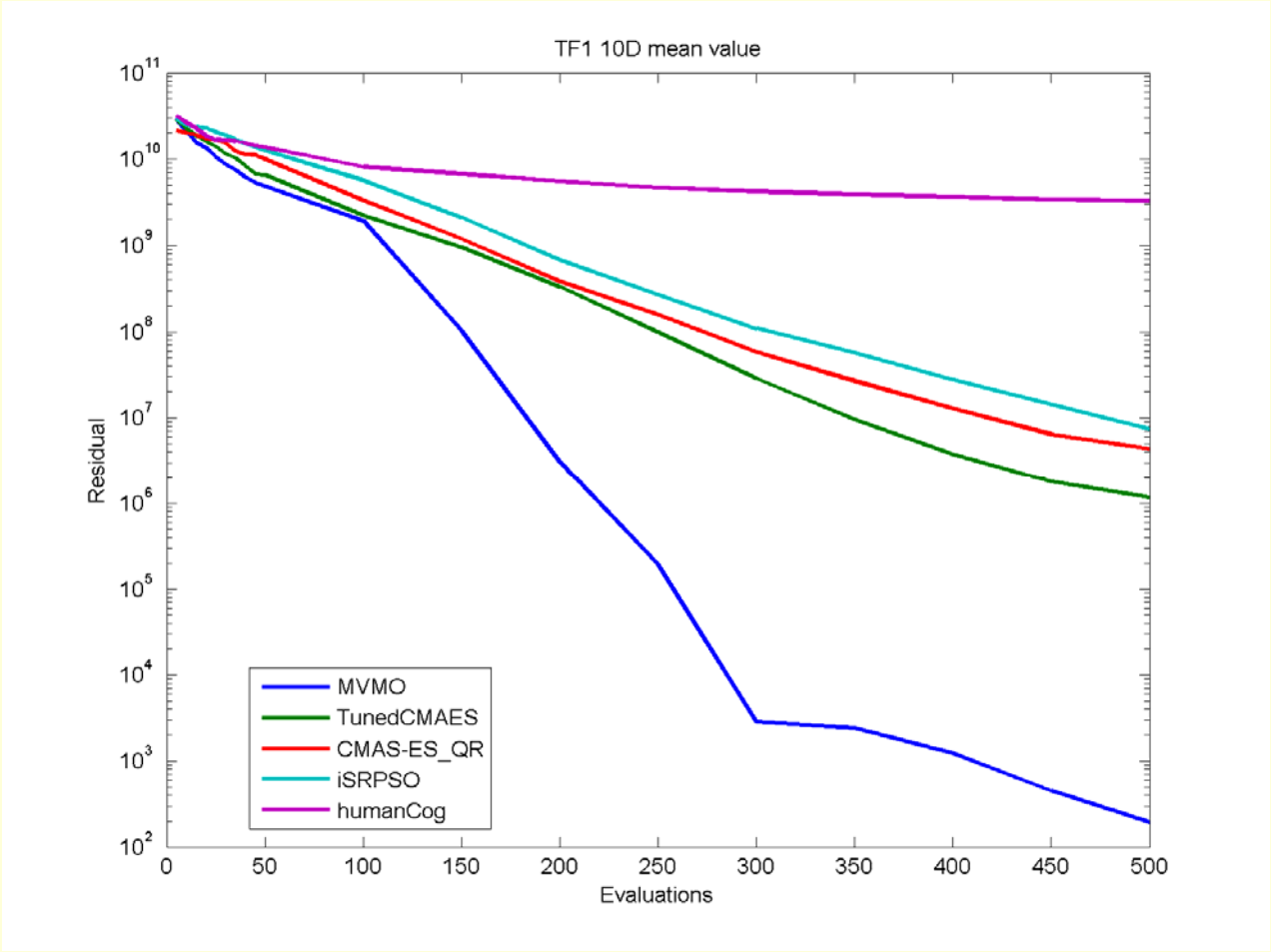
$$\text{Total score} = \sum_{i=1}^{15} mean(f_a)\Big|_{D=10} + \sum_{i=1}^{15} mean(f_a)\Big|_{D=30} + \sum_{i=1}^{15} median(f_a)\Big|_{D=10} + \sum_{i=1}^{15} median(f_a)\Big|_{D=30}$$

$$f_a = 0.5 \times \left(f_{MaxFEs} + f_{0.5MaxFEs} \right)$$

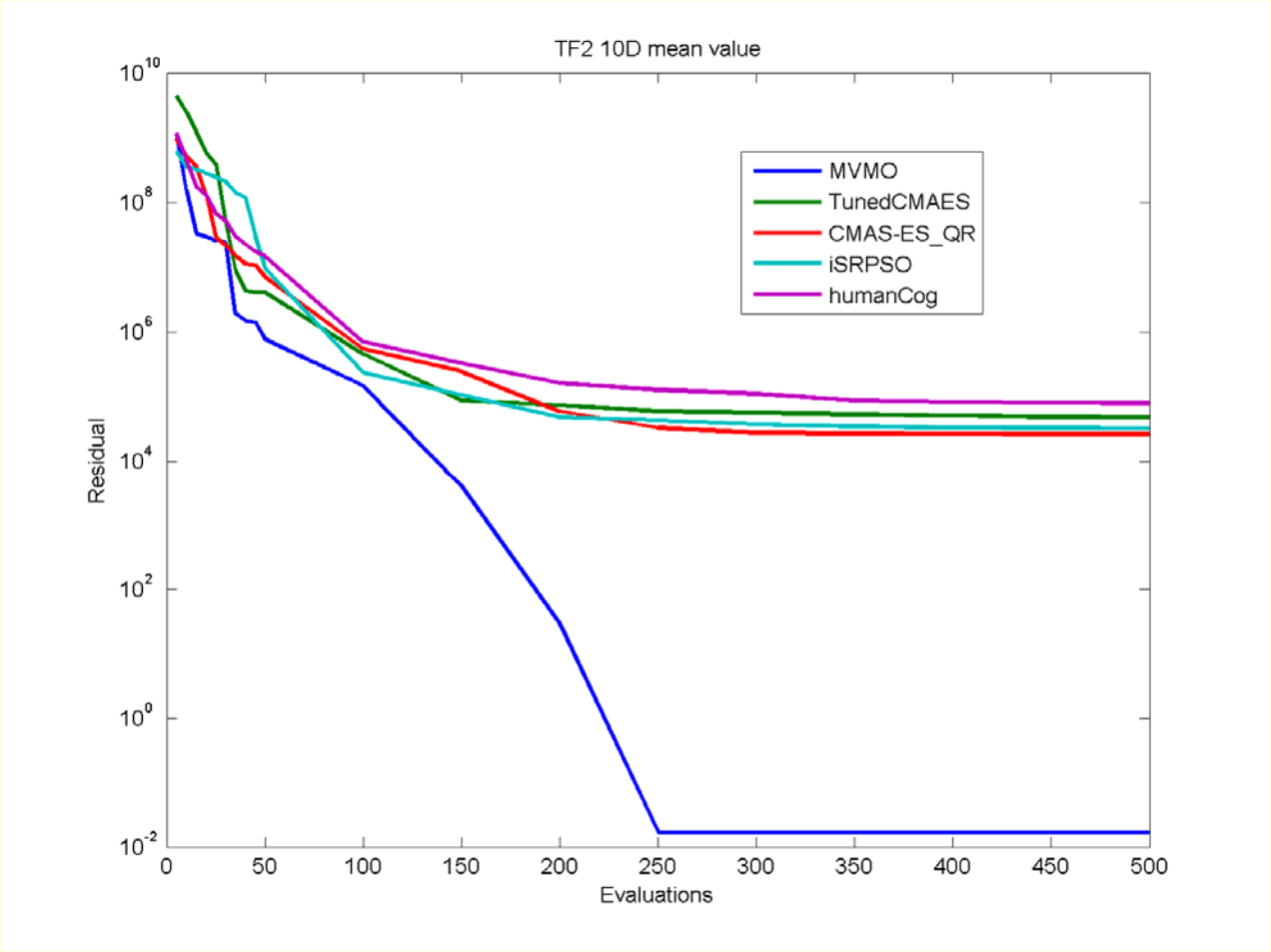
Ranking results

Paper ID	Algorithm	Score
E-15035	MVMO	3,062,550.15
E-15487	TunedCMAES	203,324,192.51
E-15664	CMAS-ES_QR	475,807,278.19
E-15667	iSRPSO	9,213,589,132.86
E-15682	humanCog	106,093,535,263.79

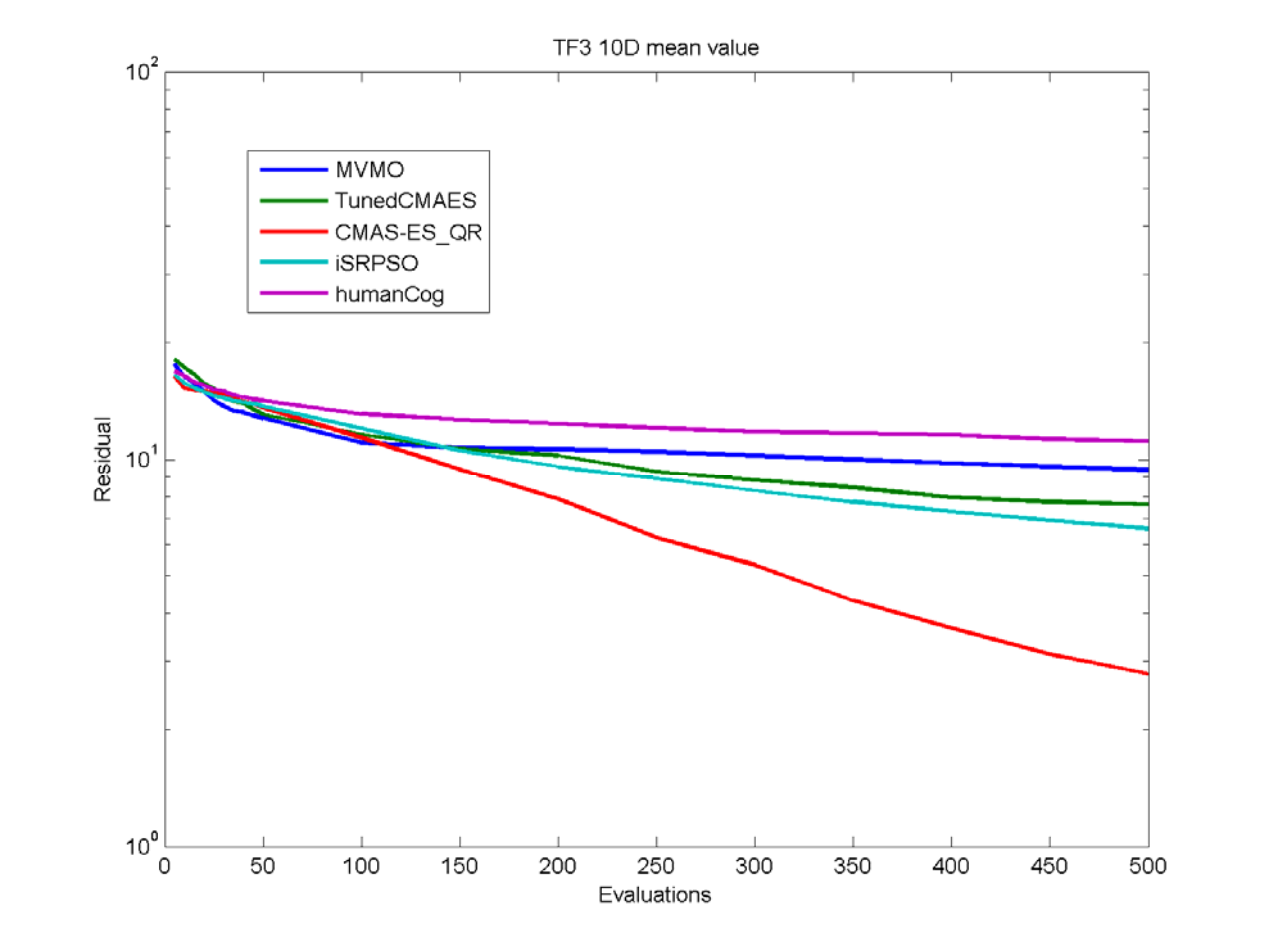
Unimodal functions



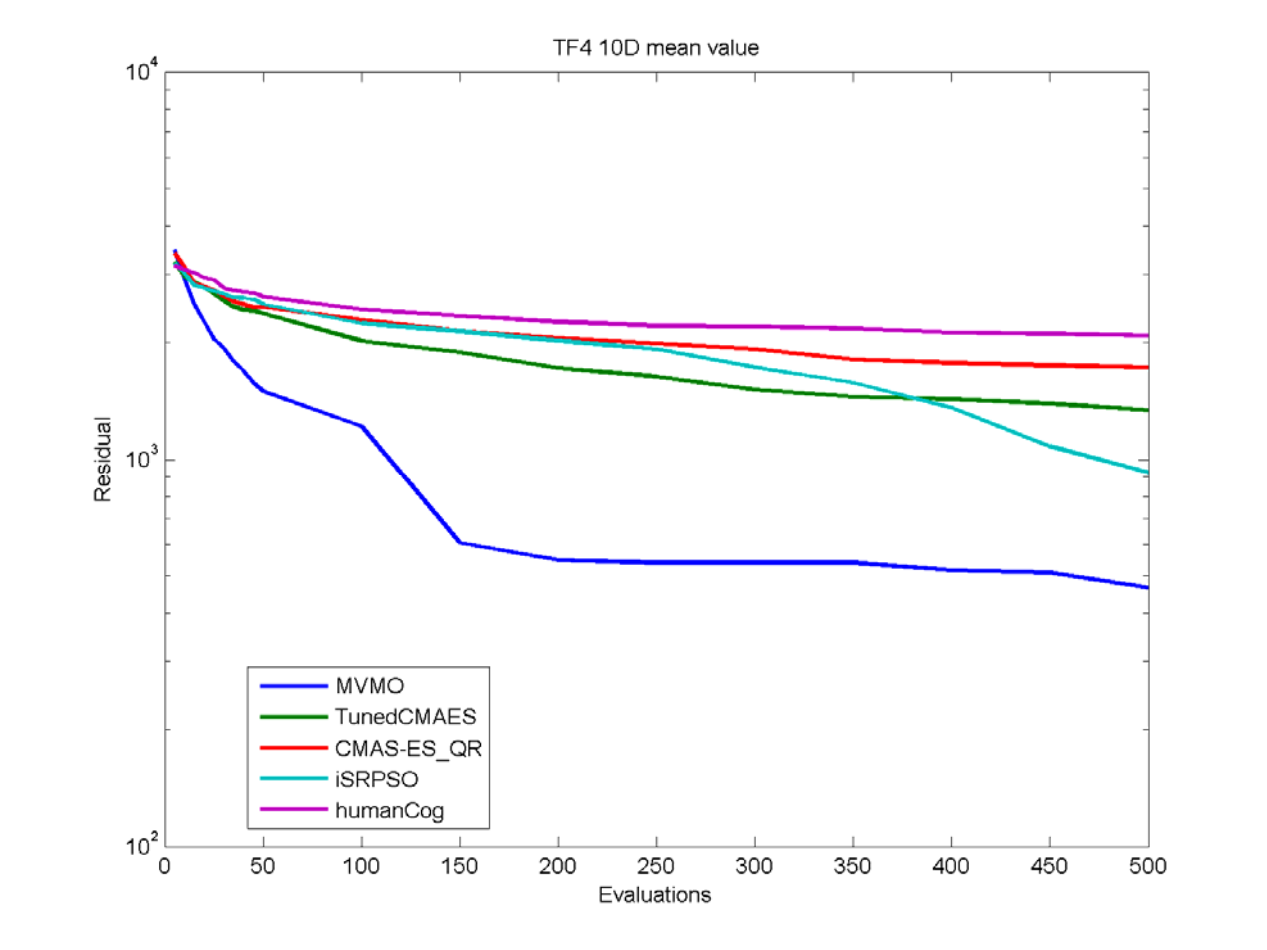
Unimodal functions



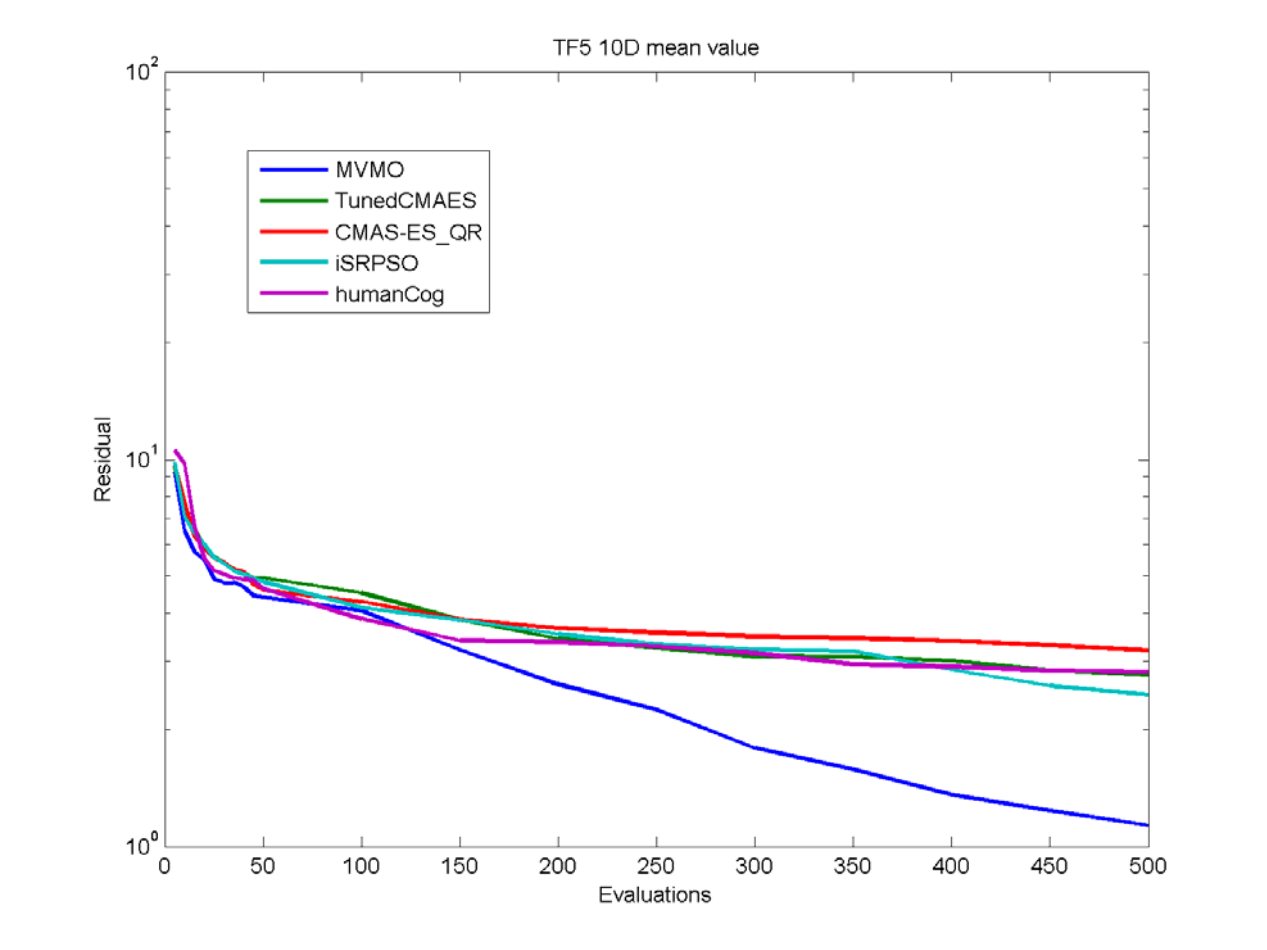
Simple Multimodal functions



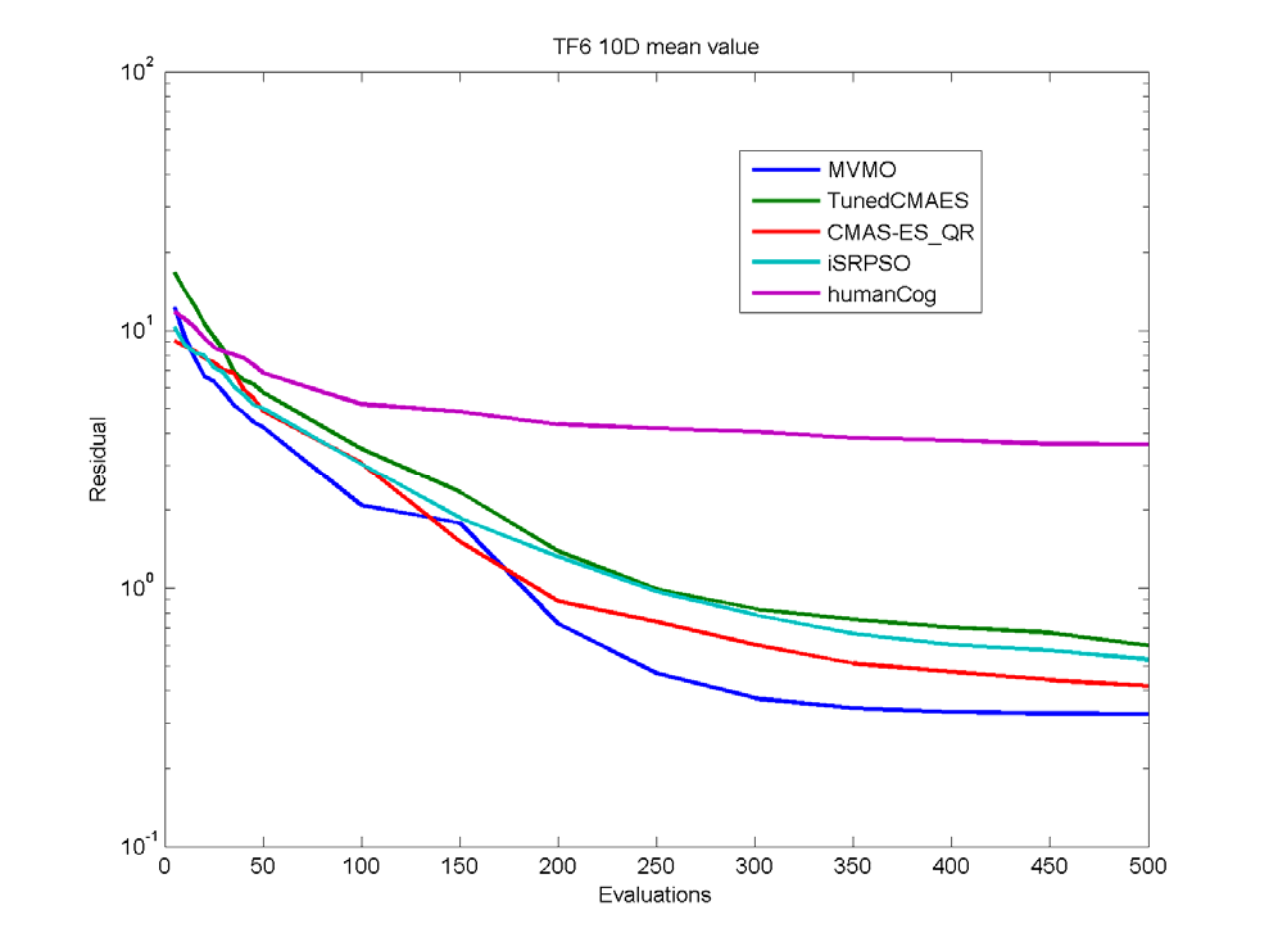
Simple Multimodal functions



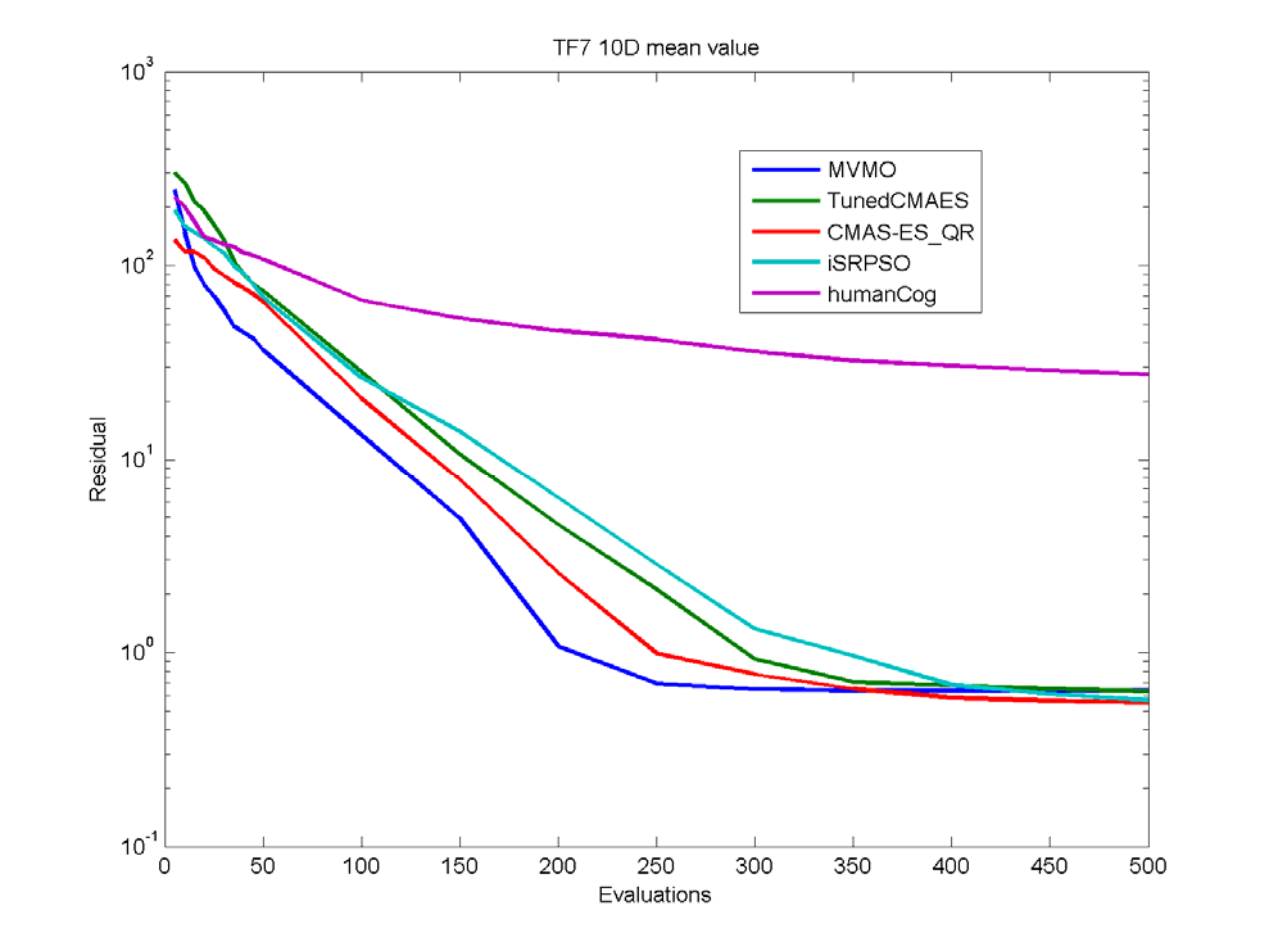
Simple Multimodal functions



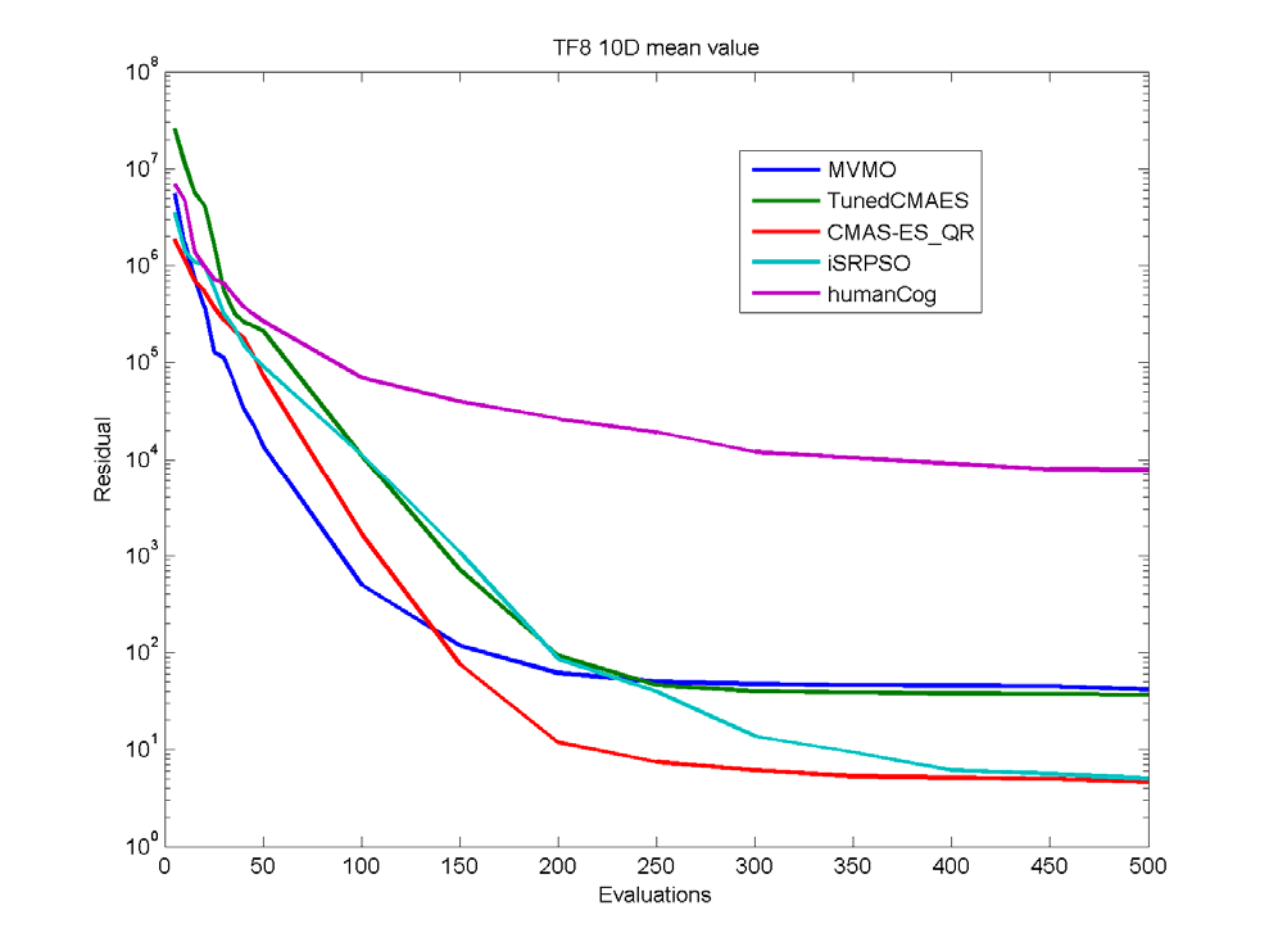
Simple Multimodal functions



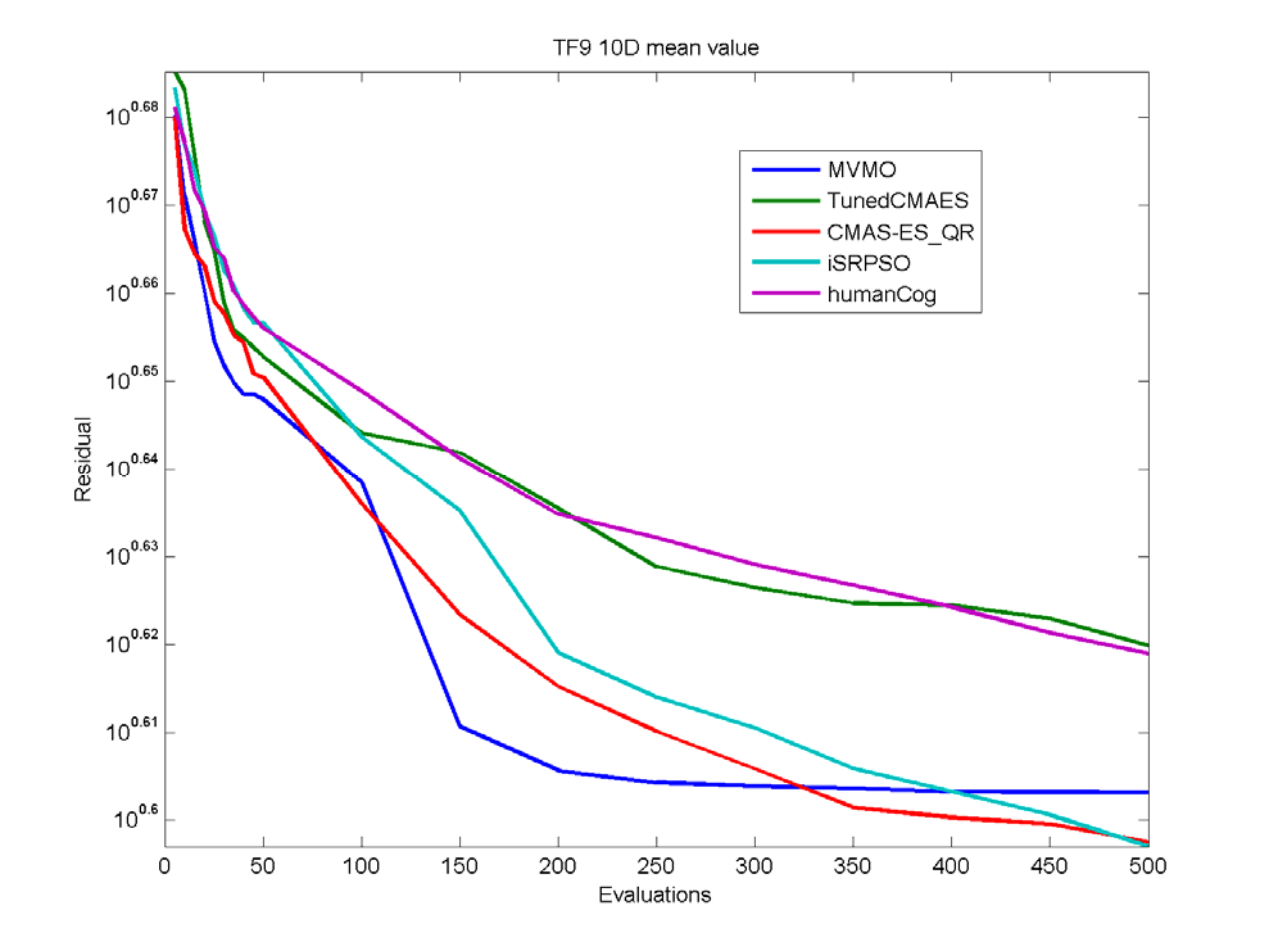
Simple Multimodal functions



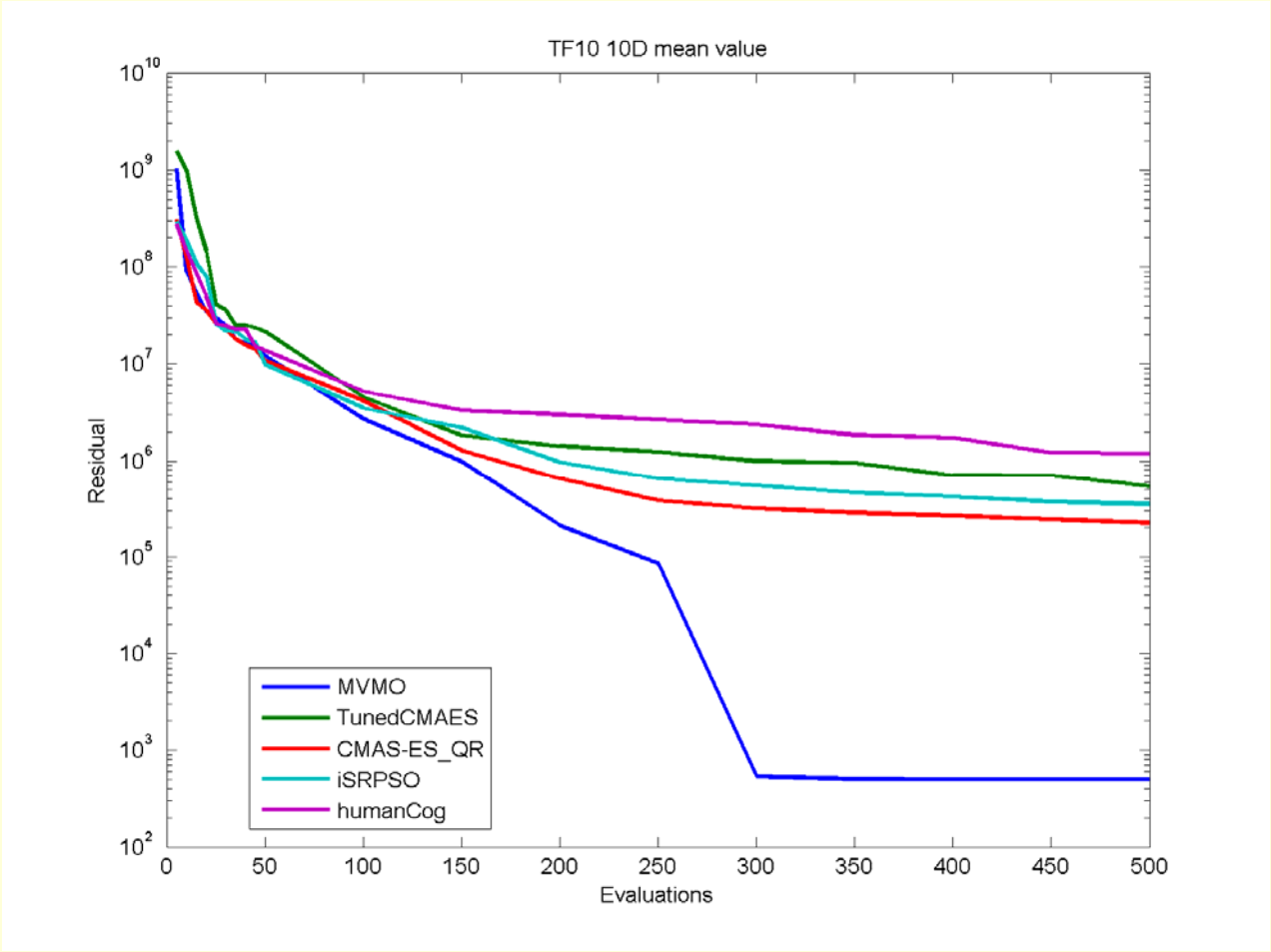
Simple Multimodal functions



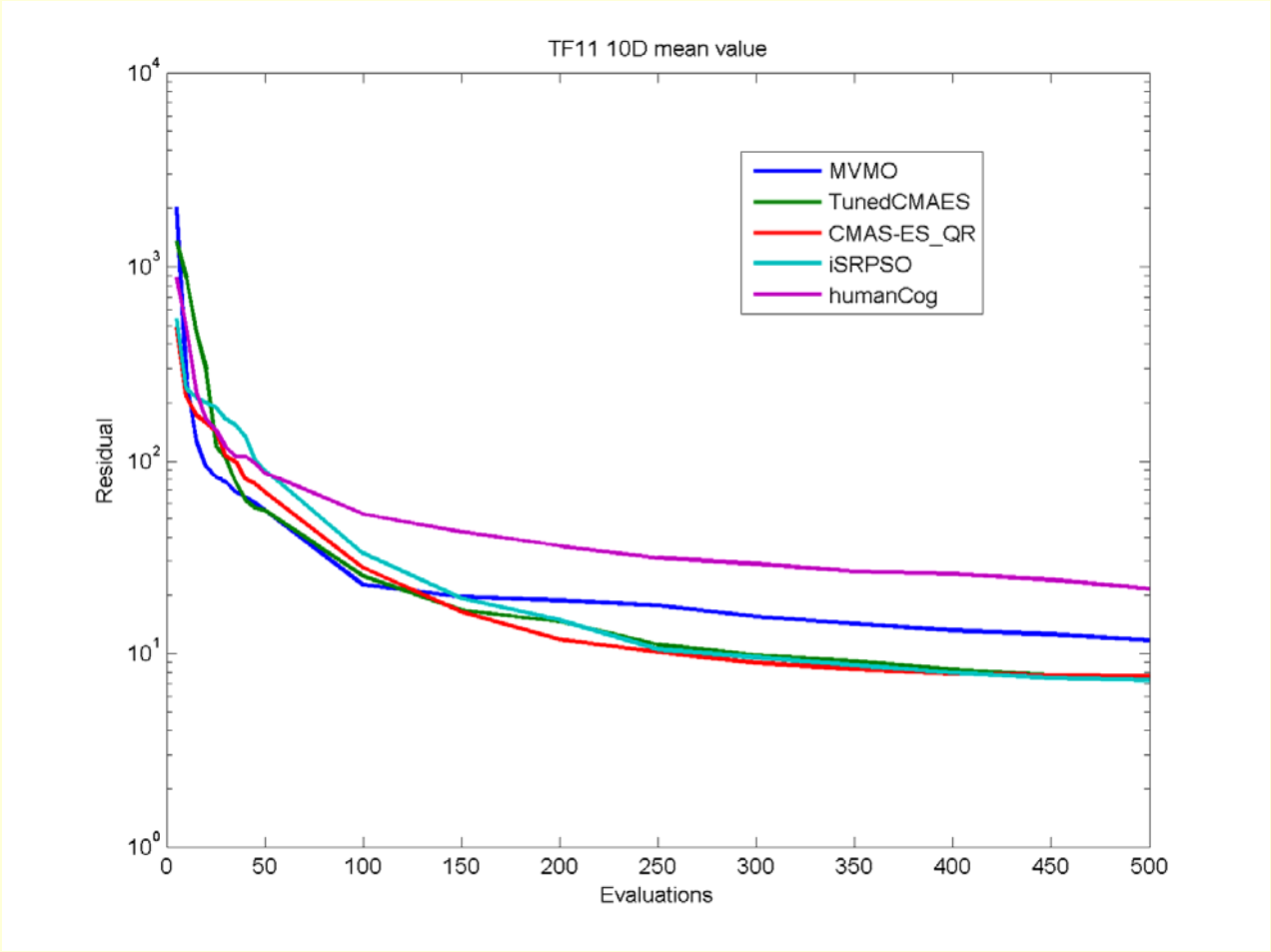
Simple Multimodal functions



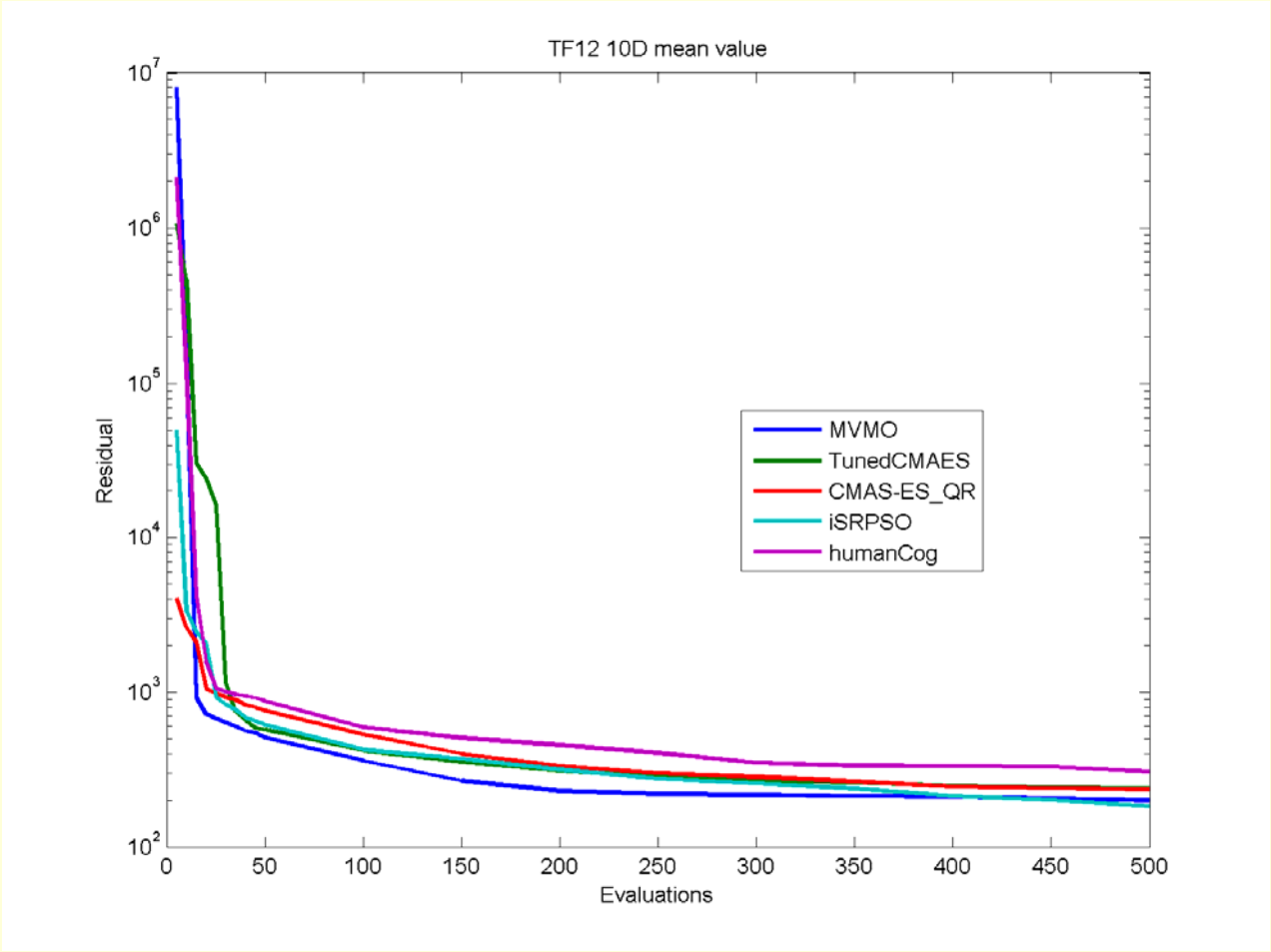
Hybrid functions



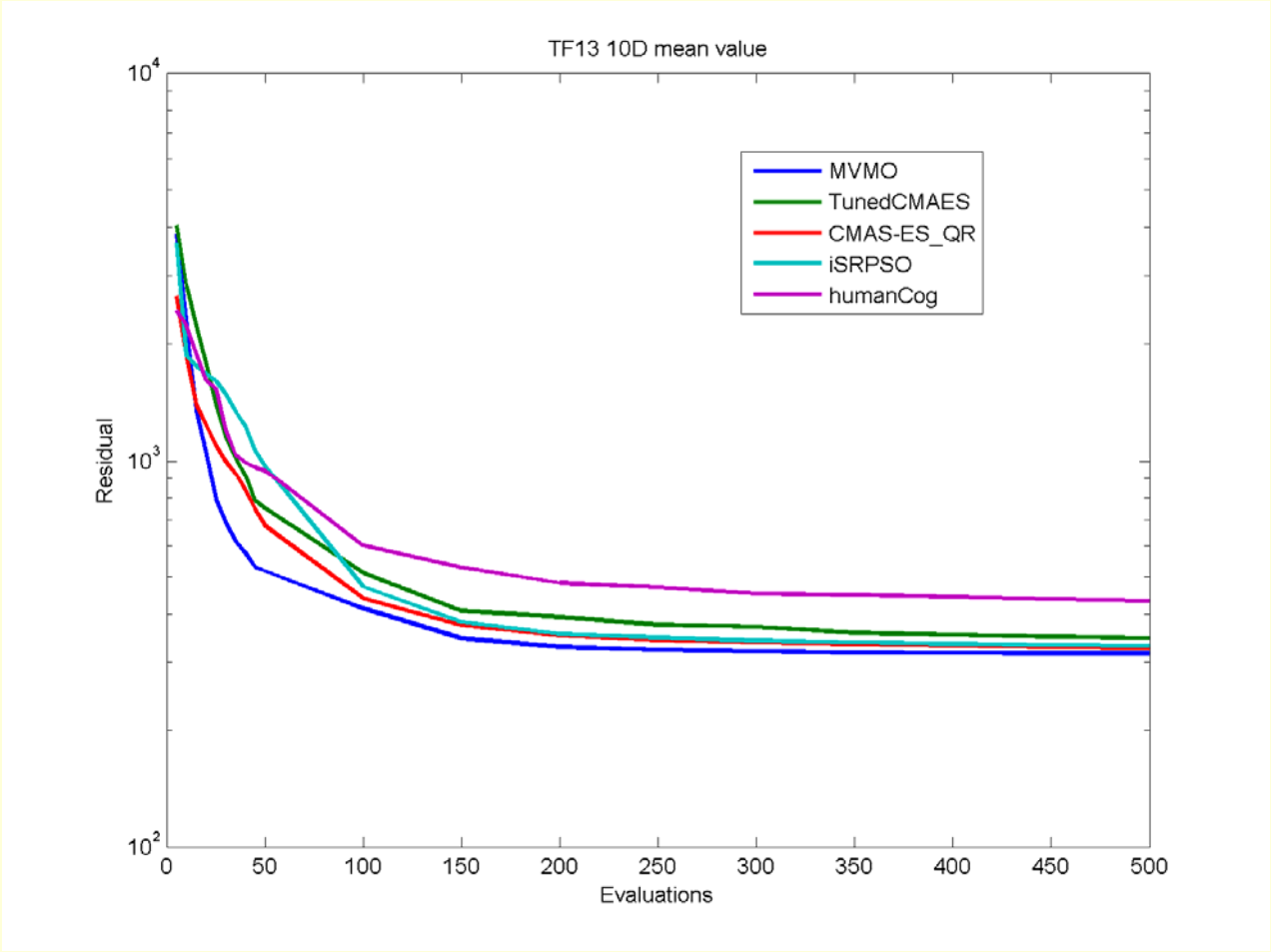
Hybrid functions



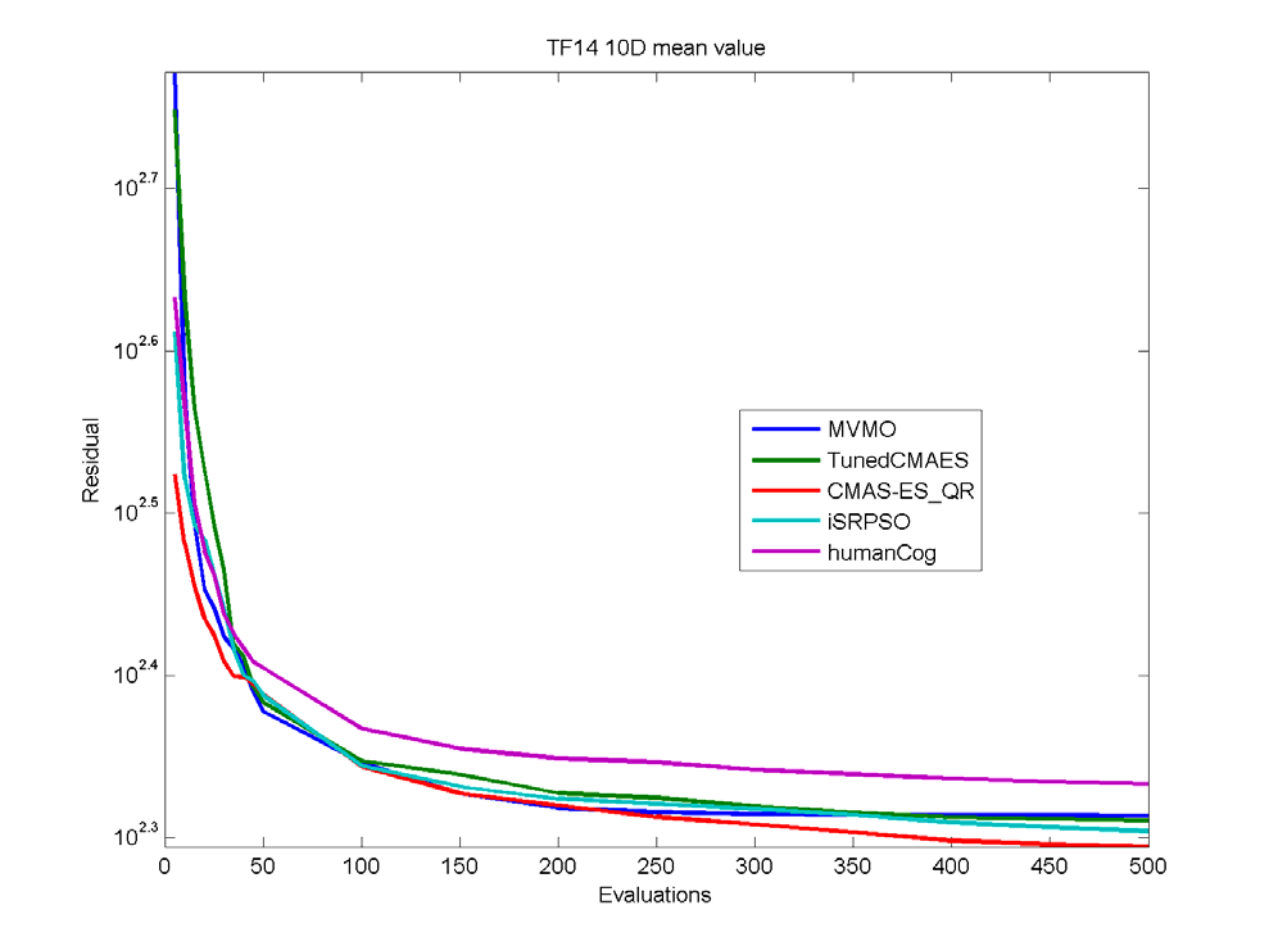
Hybrid functions



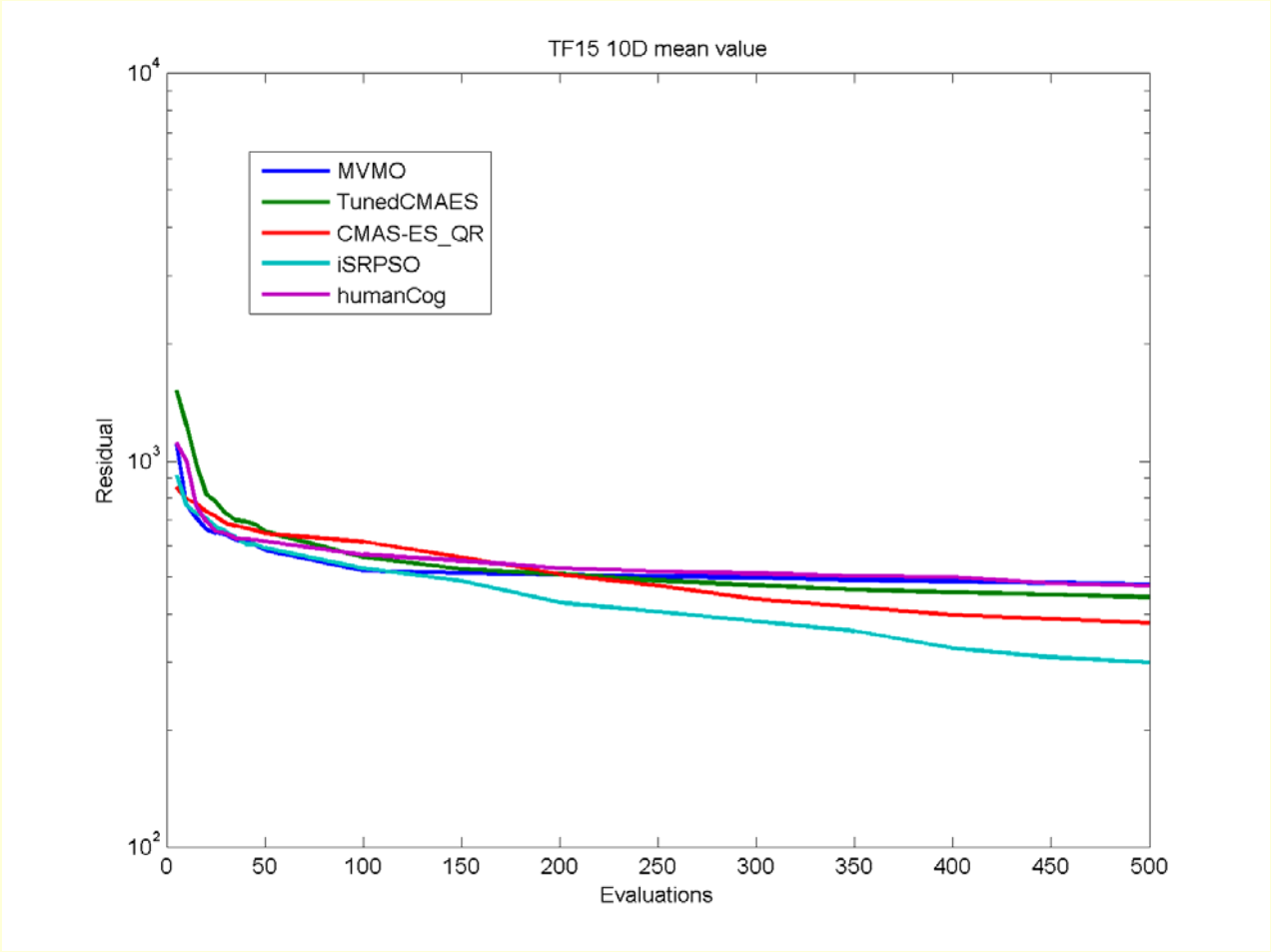
Composition functions



Composition functions



Composition functions



Performance analysis

- Comparison for different types
  - Unimodal functions: TF1, TF2
  - Simple Multimodal functions: TF3-TF9
  - Hybrid functions: TF10, TF11, and TF12
  - Composition functions: TF13, TF14, and TF15
- Dimension factor

Unimodal functions

	TF1		TF2	
	10d	30d	10d	30d
MVMO	**1.93E+02**	**2.09E+03**	**1.68E-02**	**6.93E-03**
TunedCMAES	1.17E+06	1.52E+06	4.78E+04	1.44E+05
CMAS-ES_QR	4.43E+06	8.50E+05	2.58E+04	9.17E+04
iSRPSO	7.40E+06	7.19E+08	3.19E+04	7.67E+04
humanCog	3.27E+09	4.74E+10	7.80E+04	1.13E+05

For TF1
- narrow ridge
- all 5 algorithms fail to achieve small objective in 50*D evaluation

For TF2
- Only MVMO get good result

Simple Multimodal functions

	TF3		TF4		TF5	
	10d	30d	10d	30d	10d	30d
MVMO	9.40E+00	3.79E+01	**4.65E+02**	**1.43E+03**	**1.13E+00**	**1.68E+00**
TunedCMAES	7.62E+00	2.43E+01	1.34E+03	6.11E+03	2.77E+00	3.13E+00
CMAS-ES_QR	**2.79E+00**	**1.15E+01**	1.73E+03	6.68E+03	3.20E+00	4.55E+00
iSRPSO	6.60E+00	2.57E+01	9.25E+02	5.41E+03	2.46E+00	4.24E+00
humanCog	1.12E+01	4.13E+01	2.09E+03	7.99E+03	2.82E+00	4.39E+00

For TF3 and TF 5
- TF3 differentiable only on a set of points
- TF5 differentiable nowhere

For TF4
- Local optima count is huge and far from the global optimum

Simple Multimodal functions

	TF6		TF7		TF8		TF9	
	10d	30d	10d	30d	10d	30d	10d	30d
MVMO	**3.26E-01**	**5.20E-01**	6.37E-01	**4.39E-01**	4.14E+01	4.03E+02	4.01E+00	**1.34E+01**
TunedCMAES	6.00E-01	7.16E-01	6.31E-01	7.28E-01	3.68E+01	2.84E+01	4.17E+00	1.39E+01
CMAS-ES_QR	4.17E-01	7.28E-01	**5.52E-01**	7.47E-01	**4.68E+00**	**1.74E+01**	3.96E+00	**1.34E+01**
iSRPSO	5.29E-01	6.35E-01	5.71E-01	5.68E-01	5.03E+00	6.26E+02	**3.95E+00**	1.36E+01
humanCog	3.63E+00	5.03E+00	2.74E+01	8.86E+01	7.77E+03	5.24E+06	4.16E+00	1.39E+01

For TF6, TF7, TF8, and TF9

- Top 4 algorithm have equivalent performance
- Acceptable results obtained by top 4 algorithm within 50*d evaluation

Hybrid functions

	TF10		TF11		TF12	
	10d	30d	10d	30d	10d	30d
MVMO	**4.97E+02**	**9.29E+04**	1.17E+01	1.43E+02	2.00E+02	8.60E+02
TunedCMAES	5.38E+05	4.89E+06	7.45E+00	**2.11E+01**	2.39E+02	7.66E+02
CMAS-ES_QR	2.25E+05	3.25E+06	7.63E+00	2.46E+01	2.35E+02	**6.27E+02**
iSRPSO	3.53E+05	6.83E+06	**7.26E+00**	5.09E+01	**1.82E+02**	7.36E+02
humanCog	1.19E+06	5.60E+07	2.16E+01	2.76E+02	3.08E+02	1.60E+03

For TF10
•Dimension effect are more obvious

For TF11 and TF12
•All algorithms have equivalent performance

Composite functions

	TF13		TF14		TF15	
	10d	30d	10d	30d	10d	30d
MVMO	**3.16E+02**	**3.44E+02**	2.06E+02	2.76E+02	4.76E+02	1.19E+03
TunedCMAES	3.47E+02	4.15E+02	2.05E+02	2.47E+02	4.42E+02	8.01E+02
CMAS-ES_QR	3.26E+02	3.80E+02	**1.97E+02**	**2.35E+02**	3.79E+02	**4.90E+02**
iSRPSO	3.31E+02	4.00E+02	2.01E+02	2.65E+02	**3.00E+02**	9.51E+02
humanCog	4.33E+02	8.35E+02	2.15E+02	3.94E+02	4.74E+02	1.49E+03

For TF13, TF14, and TF15

- Dimension effect are not obvious
- All algorithms have equivalent performance