Bounding the population size of IPOP-CMA-ES on the Noiseless BBOB Testbed + Testing impact of tuning + Expensive optimization scenarios

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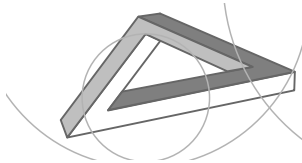

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Motivation

bounding population size

- IPOP-CMA-ES increases population size exponentially
- Question: are very large population useful?
- particular motivation:
  - Chen et al., 2012: large pop. size can be unhelpful in EAs
  - Wessing et al., 2011: when parameter tuning actually is parameter control

$\mapsto$ examine bounds on maximum population size

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$\mapsto$ examine bounds on maximum population size

tuning, expensive

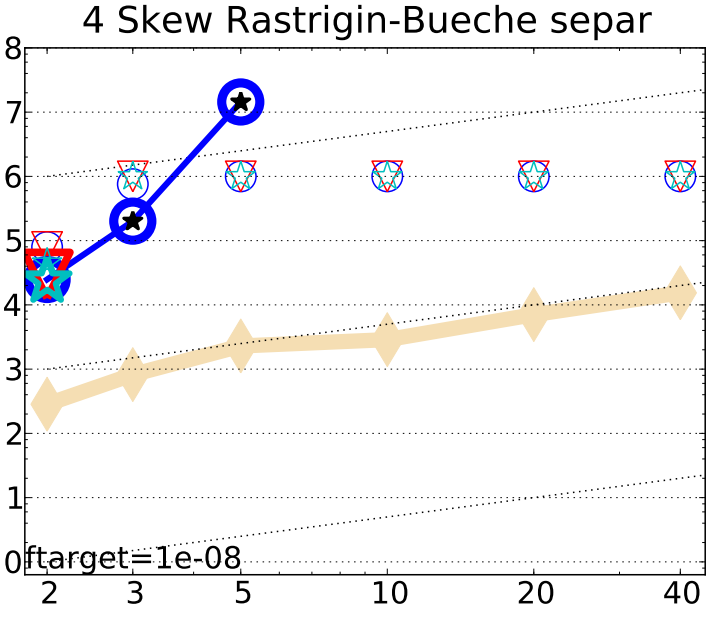
- tuning incurs only very light effort (in our case here)
- expensive functions: different look at data

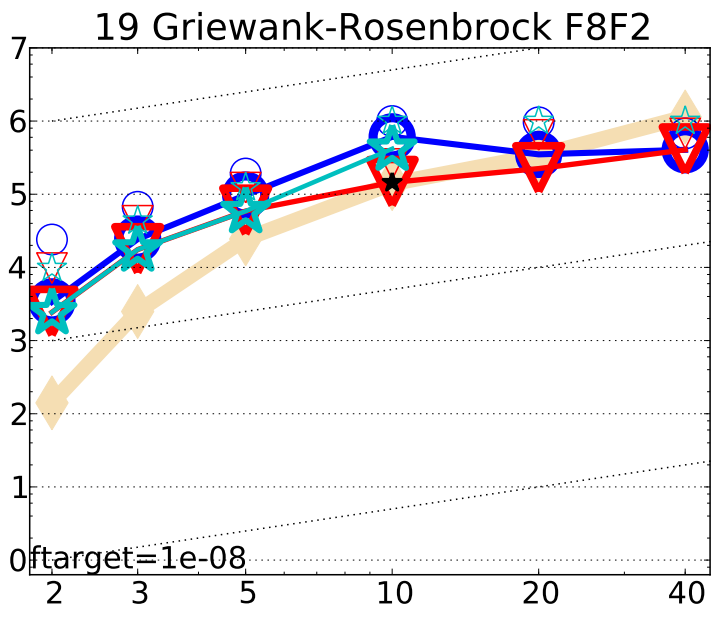
Bounded population size

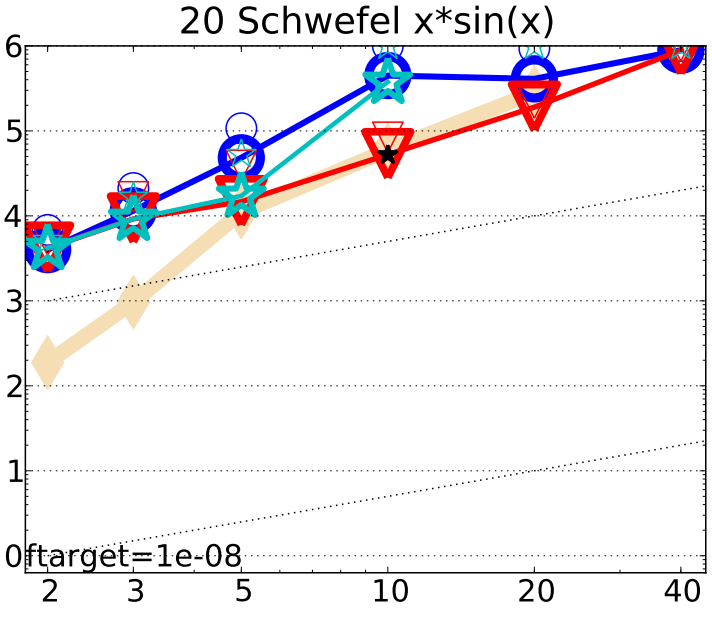
Experimental setup

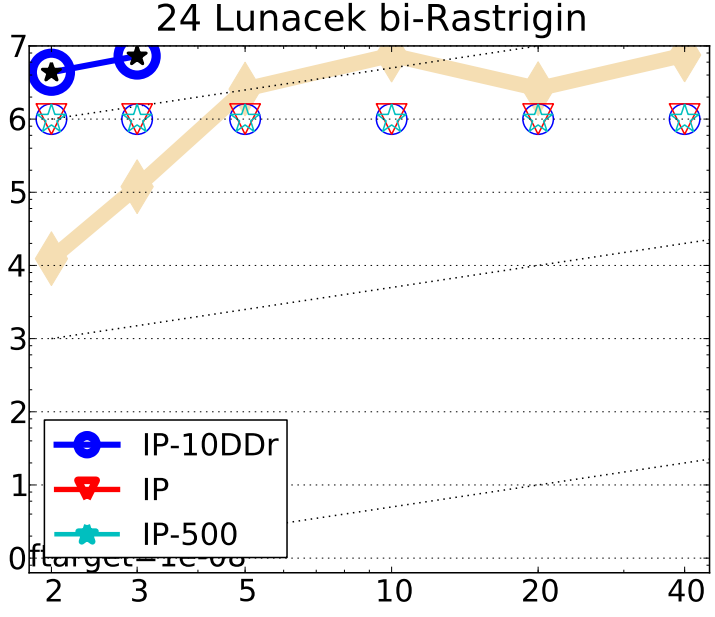
- IPOP-CMA-ES default version (C version, 10/16/10), modified to clamp bounds and limit maximum pop. size
- Recall pop-size settings of IPOP-CMA-ES
  - initial: $\lambda = 4 + \lfloor 3 \ln(D) \rfloor$
  - restart: $\lambda = 2 \cdot \lambda \mapsto \lambda_i = 2^i \cdot \lambda_0$
- poplation size bounds (limited experience, ad hoc)
  - fixed maximum to 500
  - dimension-dependent maximum of $10D^2$
- once maximum is reached, restart scheme at initial value

Significant differences ERT

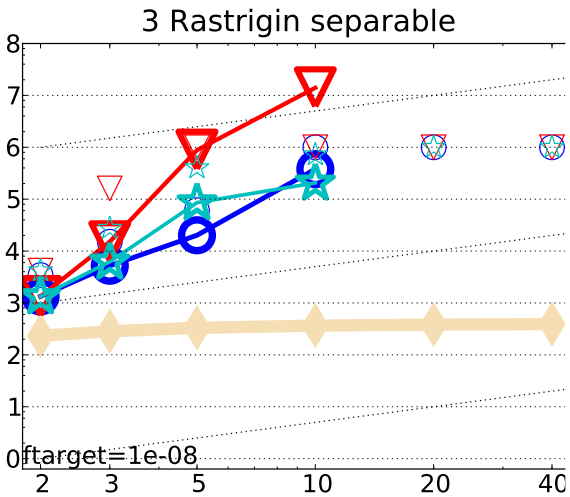


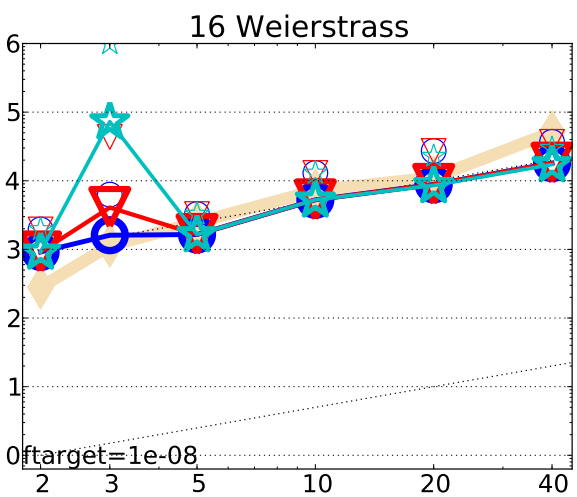


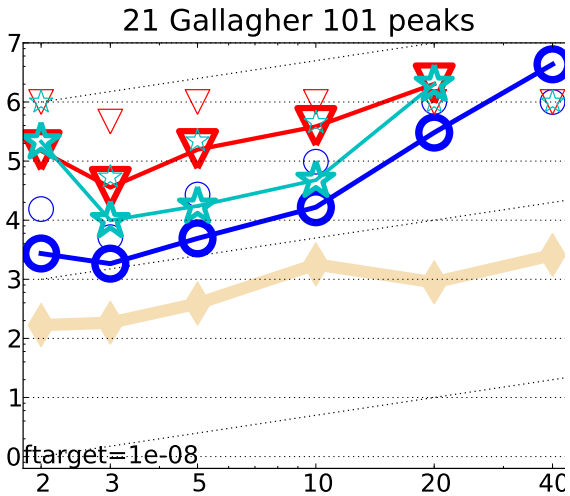


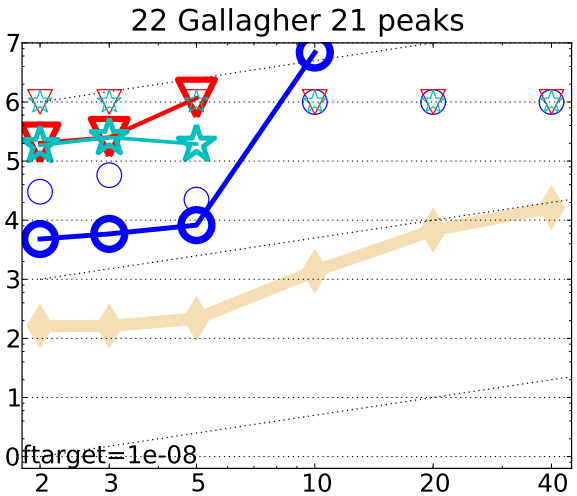


“Visible” differences









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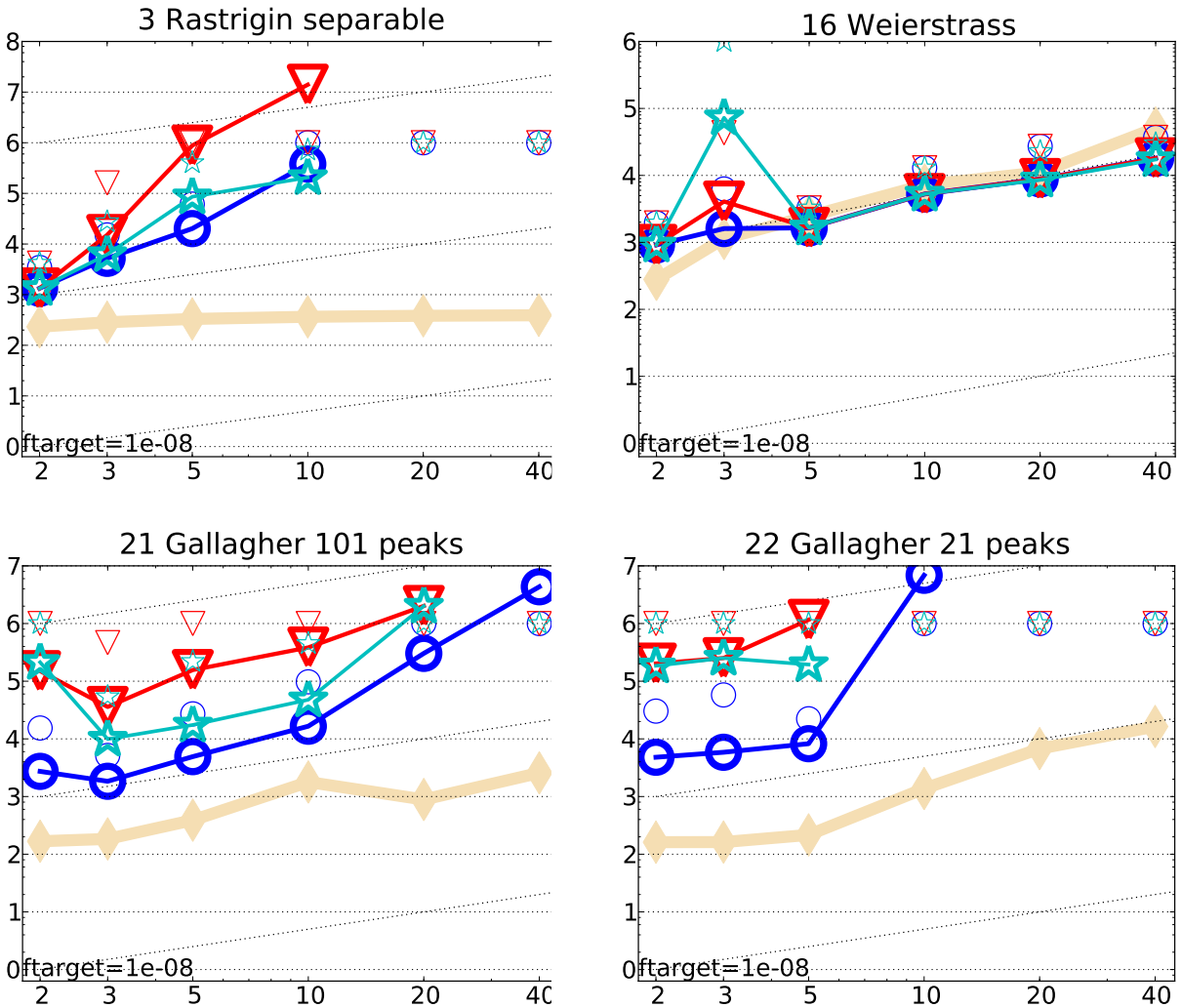

On many functions population-size bounds too loose to make an effect (apparently $f1, f2, f4 - f15, f17, f18$)

Tuning IPOP-CMA-ES

Tuning setup

- use $D = 10$ functions from SOCO special issue
- removed Sphere, Rosenbrock, Rastrigin, Schwefel 1.2 from SOCO set *error :-(Schaffer, f17*
- default version of `irace`
- tuning budget: 5000 runs of IPOP-CMA-ES each of $100D = 1000$ function evaluations
- short runs because same tuned version is used for expensive scenario
- measured cost function: evaluation function value at end of trial

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we are aware: wrong target for BBOB, not many parameters tuned, maybe wrong algorithm overall, etc.

Tuning IPOP-CMA-ES

Parameter	Internal parameter		default	tuned
a	Init pop size: λ_0	$= 4 + \lfloor a \ln(D) \rfloor$	3	2.675
b	Parent size: μ	$= \lfloor \lambda / b \rfloor$	2	1.351
c	Init step size: σ_0	$= c \cdot (B - A)$	0.5	0.102
d	IPOP factor: *ipop*	$= d$	2	2.88
e	*stopTolFun*	$= 10^e$	-12	-8.607
f	*stopTolFunHist*	$= 10^f$	-20	-14.77
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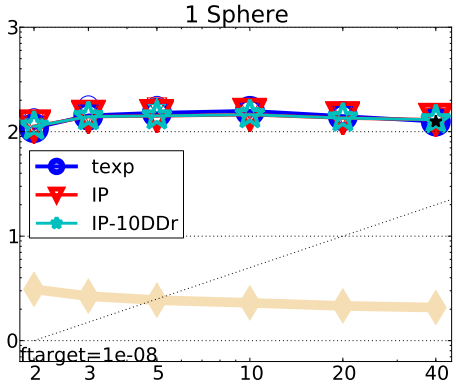
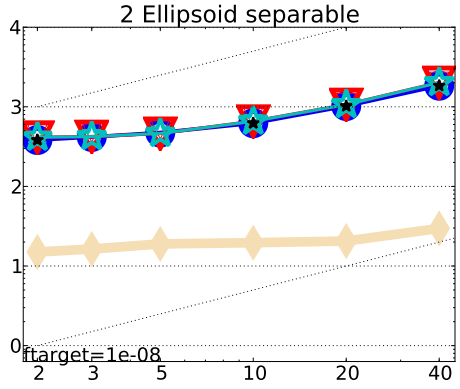
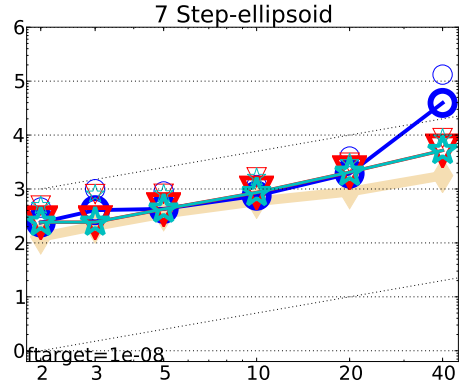
Following comparison

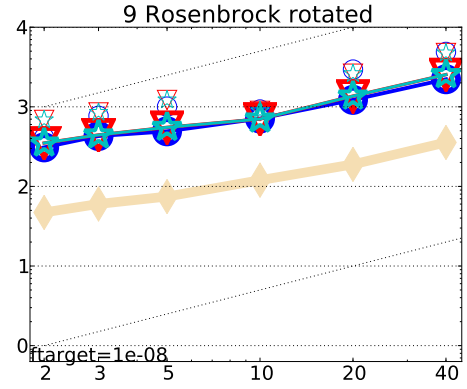
- default IPOP-CMA-ES
- IPOP-CMA-ES with pop. size bound $10D^2$
- IPOP-CMA-ES with pop. size bound $10D^2$, tuned

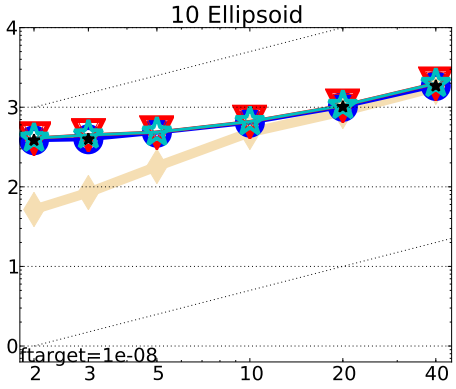
Significant differences ERT

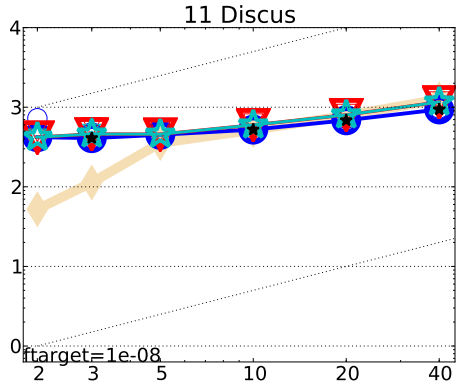


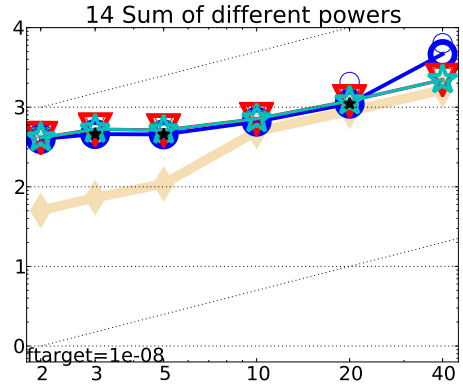


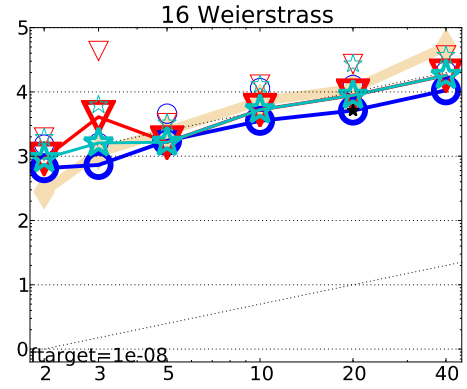


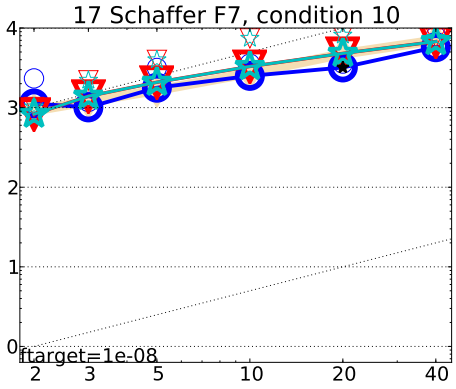


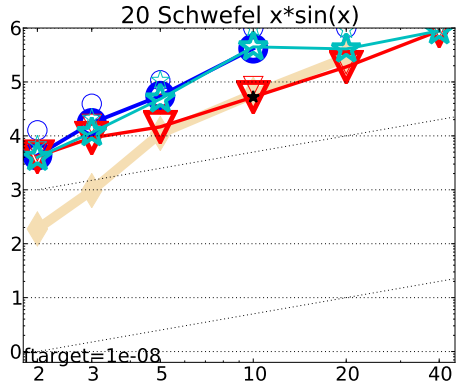


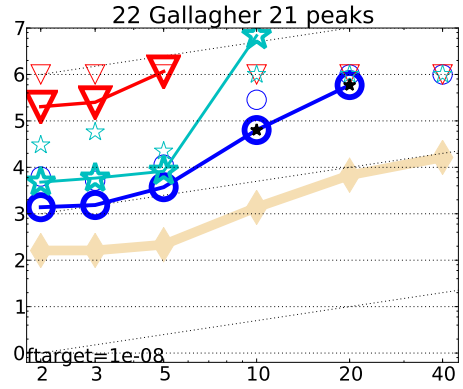


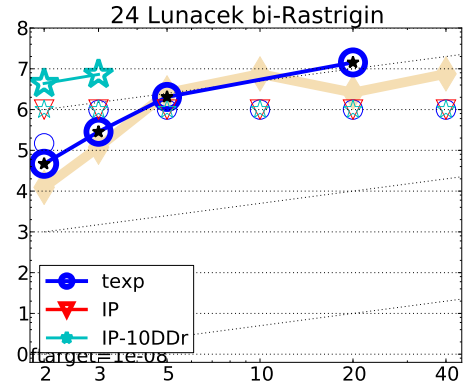




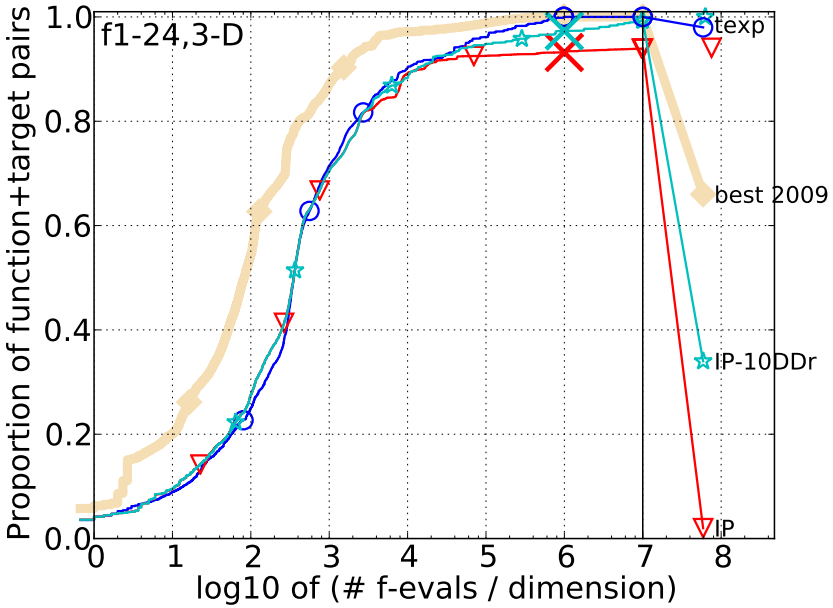


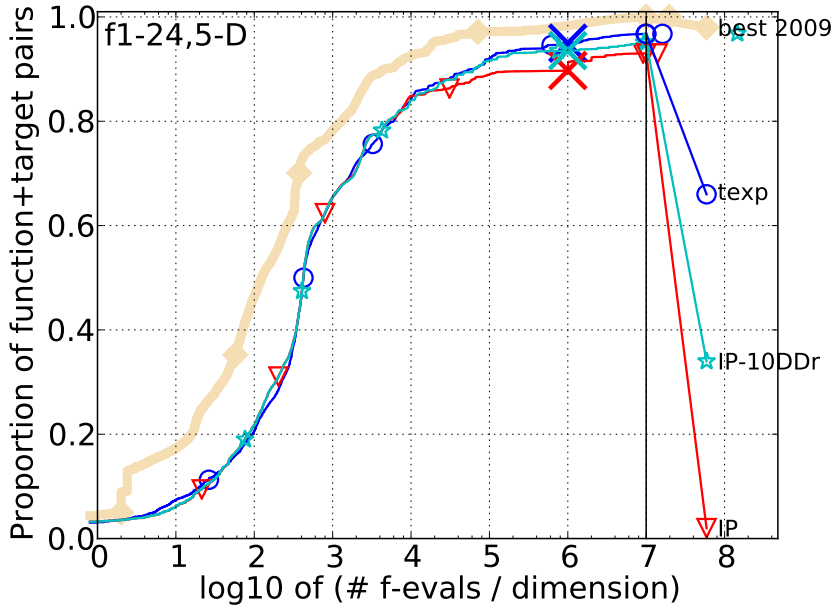


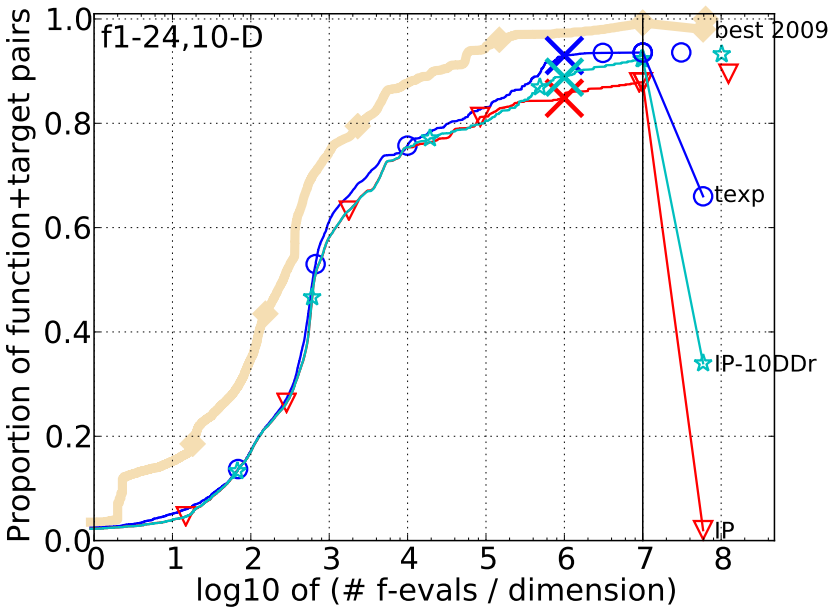


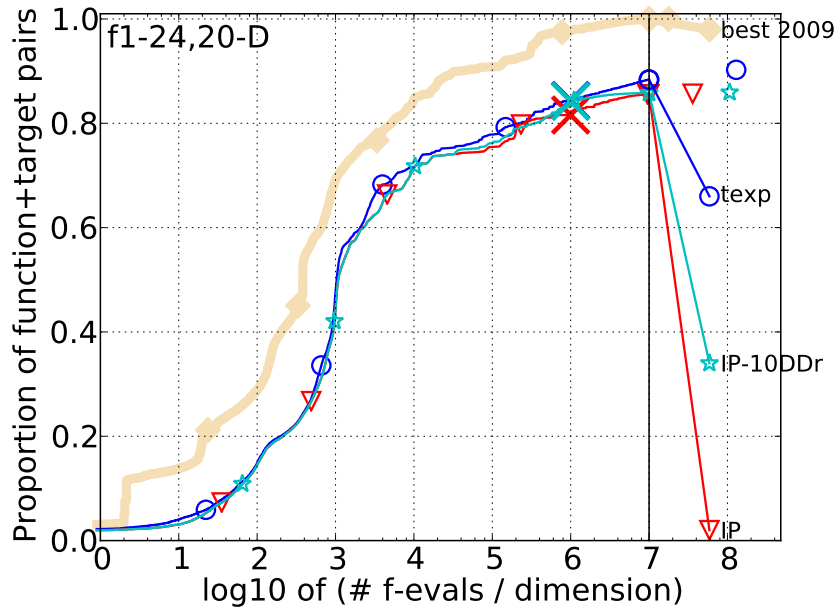


General scenario









Expensive scenario

no changes, same algorithm (tuned IPOP-CMA-ES with maximum population size bound (here not effective)

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just a different look at the same data

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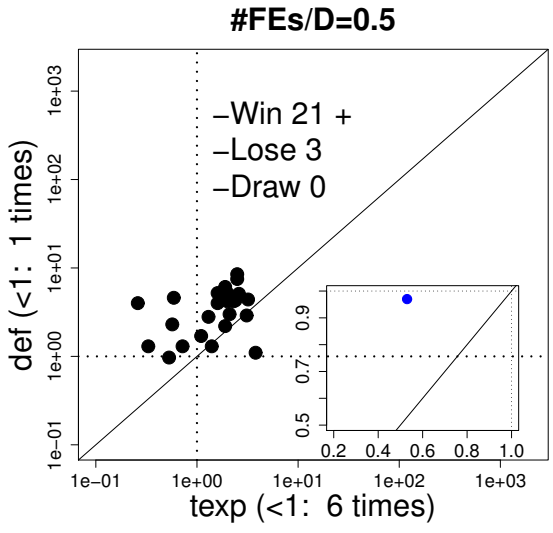
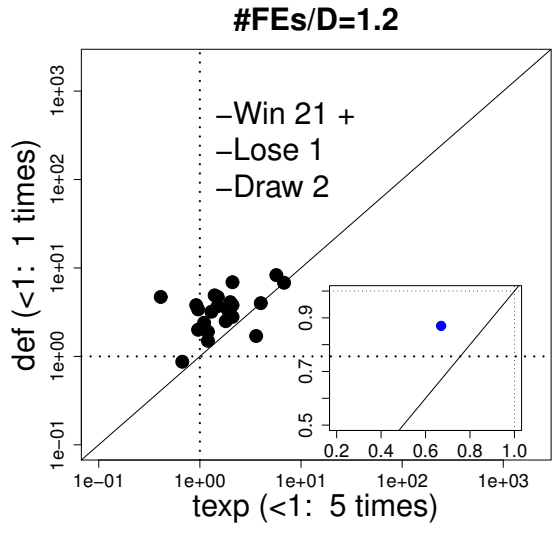
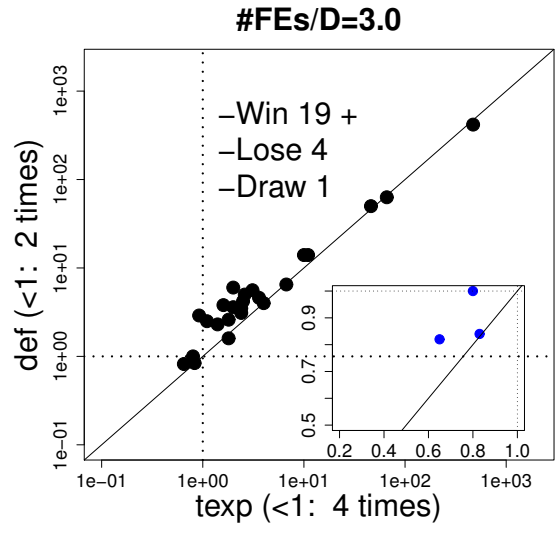
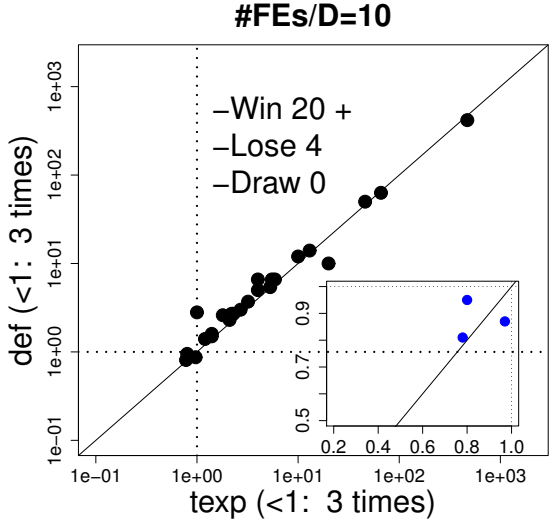
Motivation: direct search may not be so bad after all . . .

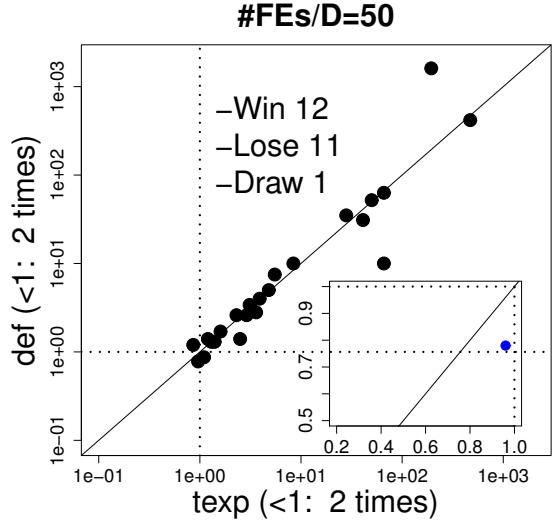
Expensive scenario, comparison to default IPOP-CMA-ES

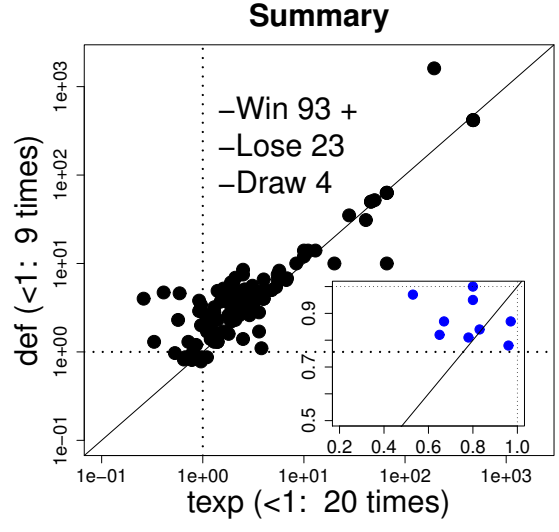




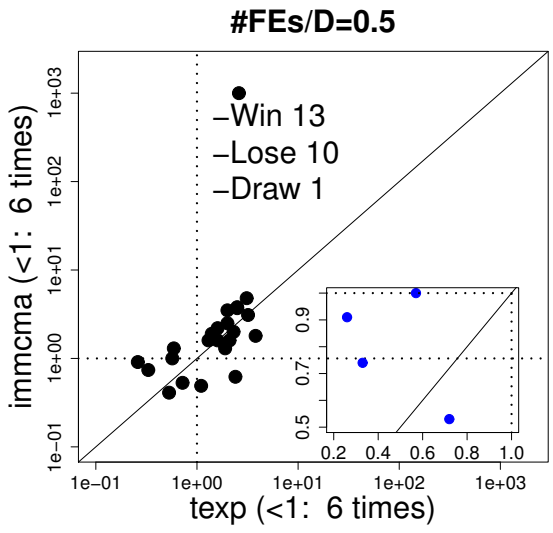


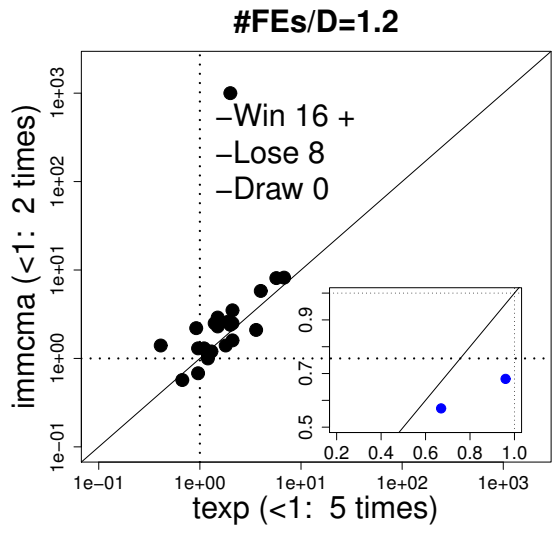


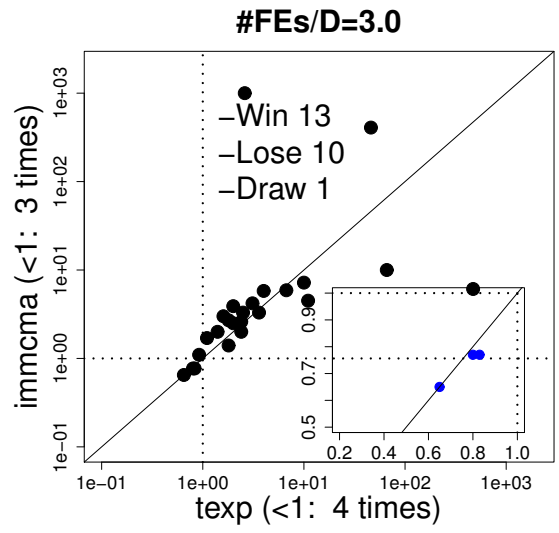


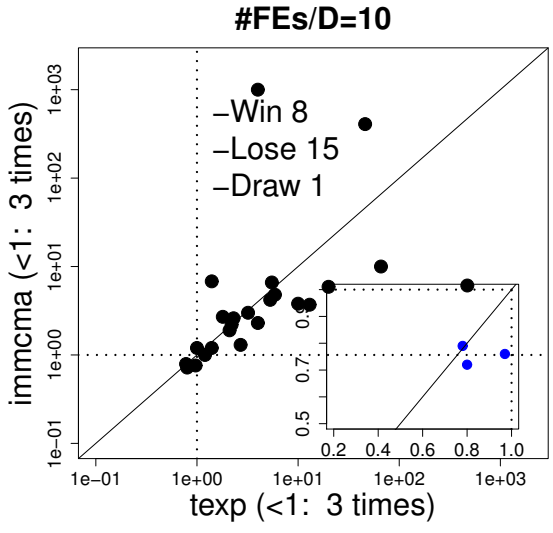


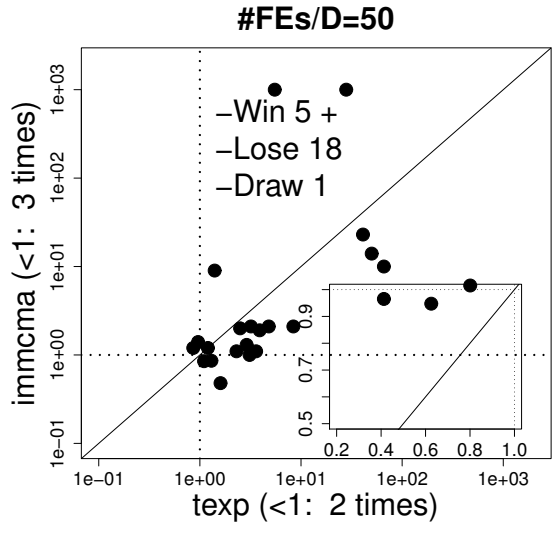
Expensive scenario, comparison to ImmCMA-ES

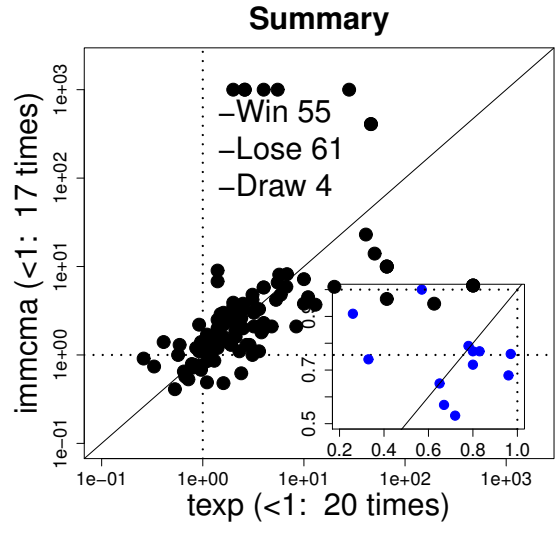




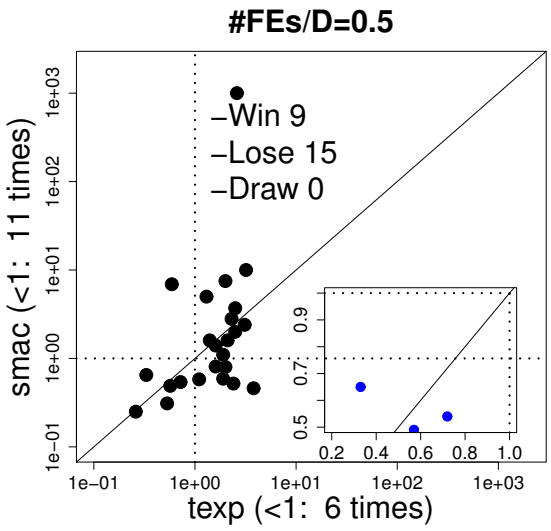


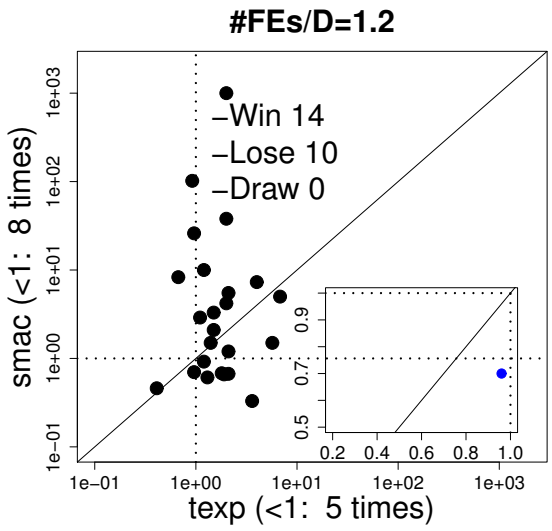


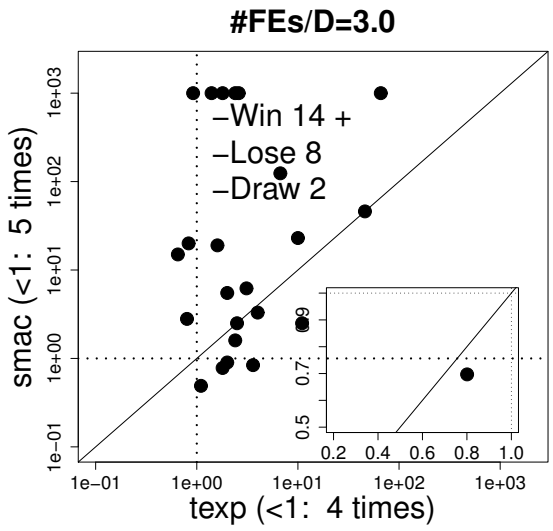


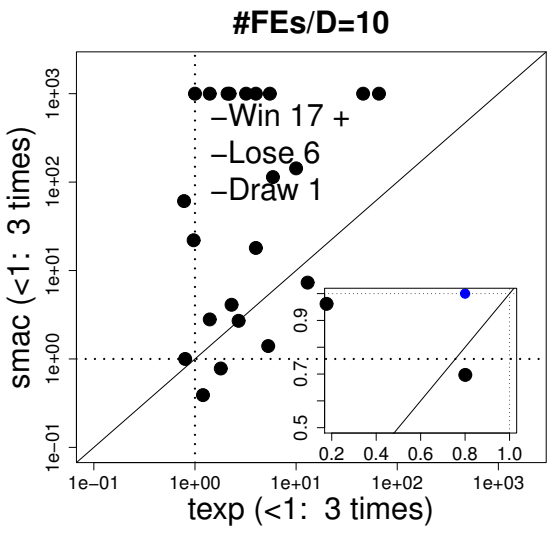


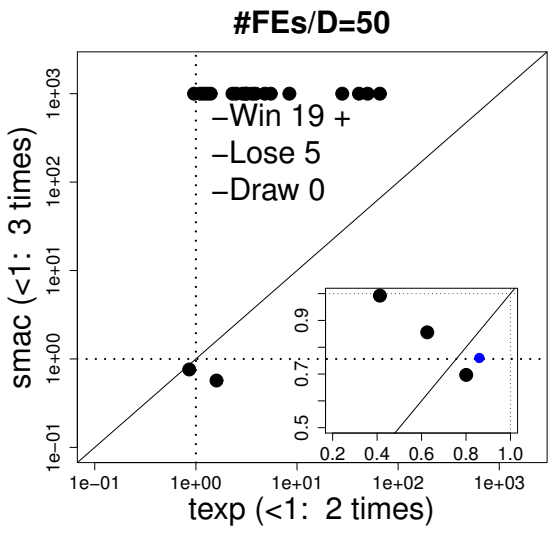
Expensive scenario, comparison to SMAC-BBOB

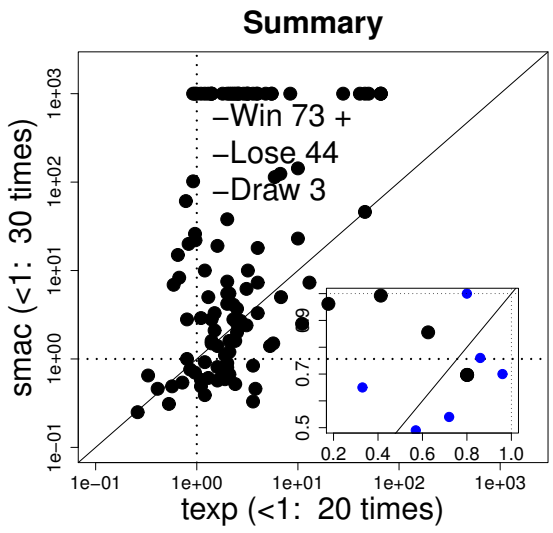












Conclusions

- limiting max. population size of IPOP-CMA-ES can help
- tuning can further improve performance
  - main differences on weakly structured multi-modal functions (also other benchmarks such as CEC'05 / '13)
- IPOP-CMA-ES anyway rather robust