

# Black-Box Optimization Benchmarking Template for the Bi-Objective BBOB Test Suite

Draft version <sup>\*</sup>

Forename Name

## ABSTRACT

to be written

## Keywords

Benchmarking, Black-box optimization, Bi-objective optimization

## 1. CPU TIMING

In order to evaluate the CPU timing of the algorithm, we have run the [ibea on bbob-biobj budget0002xD-008](#) with restarts on the entire bbob-biobj test suite [?] for 2D function evaluations. The [C/Java/Matlab/Octave/Python](#) code was run on a [Mac Intel\(R\) Core\(TM\) i5-2400S CPU @ 2.50GHz](#) with 1 processor and 4 cores. The time per function evaluation for dimensions 2, 3, 5, 10, 20, 40 equals [\*x.x\*](#), [\*x.x\*](#), [\*x.x\*](#), [\*xxx\*](#), and [\*xxx\*](#) seconds respectively.

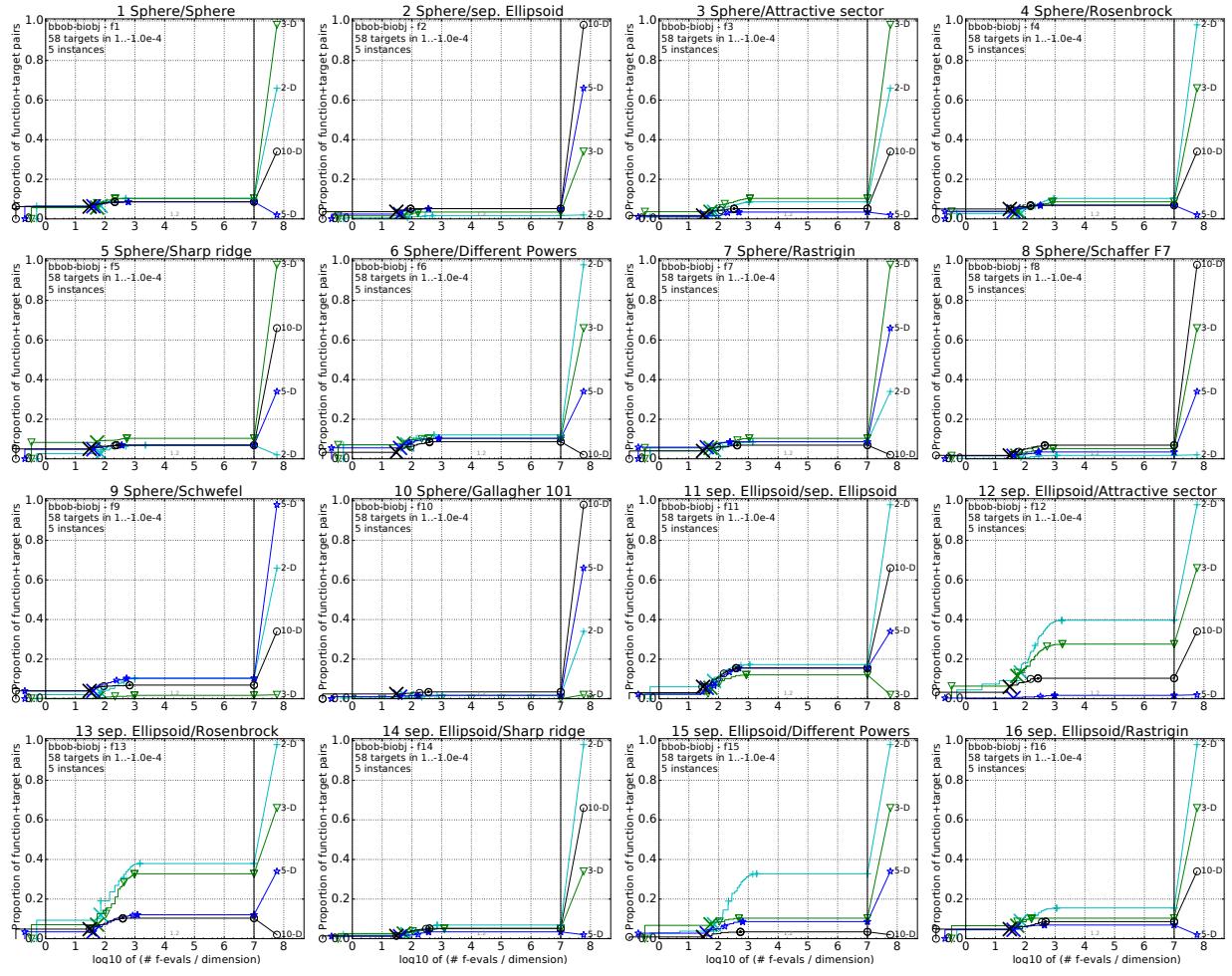
## 2. RESULTS

Results of ibea on bbob-biobj budget0002xD-008 from experiments according to [?], [?] and [?] on the benchmark functions given in [?] are presented in Figures ??, ??, ??, and ??, and in Table ?. The experiments were performed with COCO [?], version [1.0.1](#), the plots were produced with version [1.0.4](#).

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<sup>\*</sup>Submission deadline: April 3rd.

$\Delta f$	1e+0	1e-1	1e-2	1e-3	1e-4	1e-5	#succ
f <sub>1</sub> 51(100)	∞	∞	∞	∞	∞	∞	0/5
f <sub>2</sub> 135(302)	∞	∞	∞	∞	∞	∞ 200	0/5
f <sub>3</sub> 302(452)	∞	∞	∞	∞	∞	∞ 200	0/5
f <sub>4</sub> 1	8	8	8	8	8	8	0/5
f <sub>5</sub> 1	8	8	8	8	8	8	0/5
f <sub>6</sub> 51(100)	8	8	8	8	8	8	0/5
f <sub>7</sub> 1	8	8	8	8	8	8	0/5
f <sub>8</sub> 302(402)	8	8	8	8	8	8	0/5
f <sub>9</sub> 51(151)	8	8	8	8	8	8	0/5
f <sub>10</sub> 302(251)	8	8	8	8	8	8	0/5
f <sub>11</sub> 135(754)	8	8	8	8	8	8	0/5
f <sub>12</sub> 805(1005)	8	8	8	8	8	8	0/5
f <sub>13</sub> 302(312)	8	8	8	8	8	8	0/5
f <sub>14</sub> ∞	8	8	8	8	8	8	0/5
f <sub>15</sub> 135(201)	8	8	8	8	8	8	0/5
f <sub>16</sub> 302(301)	8	8	8	8	8	8	0/5
f <sub>17</sub> 302(402)	8	8	8	8	8	8	0/5
f <sub>18</sub> 302(312)	8	8	8	8	8	8	0/5
f <sub>19</sub> ∞	8	8	8	8	8	8	0/5
f <sub>20</sub> 302(704)	8	8	8	8	8	8	0/5
f <sub>21</sub> 302(402)	8	8	8	8	8	8	0/5
f <sub>22</sub> 51(100)	8	8	8	8	8	8	0/5
f <sub>23</sub> 1	8	8	8	8	8	8	0/5
f <sub>24</sub> 302(804)	8	8	8	8	8	8	0/5
f <sub>25</sub> 51(100)	8	8	8	8	8	8	0/5
f <sub>26</sub> 805(1156)	8	8	8	8	8	8	0/5
f <sub>27</sub> 302(693)	8	8	8	8	8	8	0/5
f <sub>28</sub> 35	8	8	8	8	8	8	0/5
f <sub>29</sub> 135(251)	8	8	8	8	8	8	0/5
f <sub>30</sub> 51(151)	8	8	8	8	8	8	0/5
f <sub>31</sub> 51(100)	8	8	8	8	8	8	0/5
f <sub>32</sub> 302(553)	8	8	8	8	8	8	0/5
f <sub>33</sub> 302(352)	8	8	8	8	8	8	0/5
f <sub>34</sub> 302(402)	8	8	8	8	8	8	0/5
f <sub>35</sub> 51(50)	8	8	8	8	8	8	0/5
f <sub>36</sub> 51(100)	8	8	8	8	8	8	0/5
f <sub>37</sub> 51(151)	8	8	8	8	8	8	0/5
f <sub>38</sub> 135(201)	8	8	8	8	8	8	0/5
f <sub>39</sub> 51(402)	8	8	8	8	8	8	0/5
f <sub>40</sub> 302(402)	8	8	8	8	8	8	0/5
f <sub>41</sub> 51(100)	8	8	8	8	8	8	0/5
f <sub>42</sub> 51(100)	8	8	8	8	8	8	0/5
f <sub>43</sub> 302(754)	8	8	8	8	8	8	0/5
f <sub>44</sub> 1	8	8	8	8	8	8	0/5
f <sub>45</sub> 302(553)	8	8	8	8	8	8	0/5
f <sub>46</sub> 135(302)	8	8	8	8	8	8	0/5
f <sub>47</sub> 135(151)	8	8	8	8	8	8	0/5
f <sub>48</sub> 805(1407)	8	8	8	8	8	8	0/5
f <sub>49</sub> 805(502)	8	8	8	8	8	8	0/5
f <sub>50</sub> 51(201)	8	8	8	8	8	8	0/5
f <sub>51</sub> 1	8	8	8	8	8	8	0/5
f <sub>52</sub> 135(251)	8	8	8	8	8	8	0/5
f <sub>53</sub> 51(100)	8	8	8	8	8	8	0/5
f <sub>54</sub> 302(352)	8	8	8	8	8	8	0/5
f <sub>55</sub> 805(1005)	8	8	8	8	8	8	0/5



**Figure 1: Empirical cumulative distribution of simulated (bootstrapped) runtimes in number of objective function evaluations divided by dimension (FEvals/DIM) for the 58 targets  $\{-10^{-4}, -10^{-4.2}, -10^{-4.4}, -10^{-4.6}, -10^{-4.8}, -10^{-5}, 0, 10^{-5}, 10^{-4.9}, 10^{-4.8}, \dots, 10^{-0.1}, 10^0\}$  for functions  $f_1$  to  $f_{16}$  and all dimensions.**

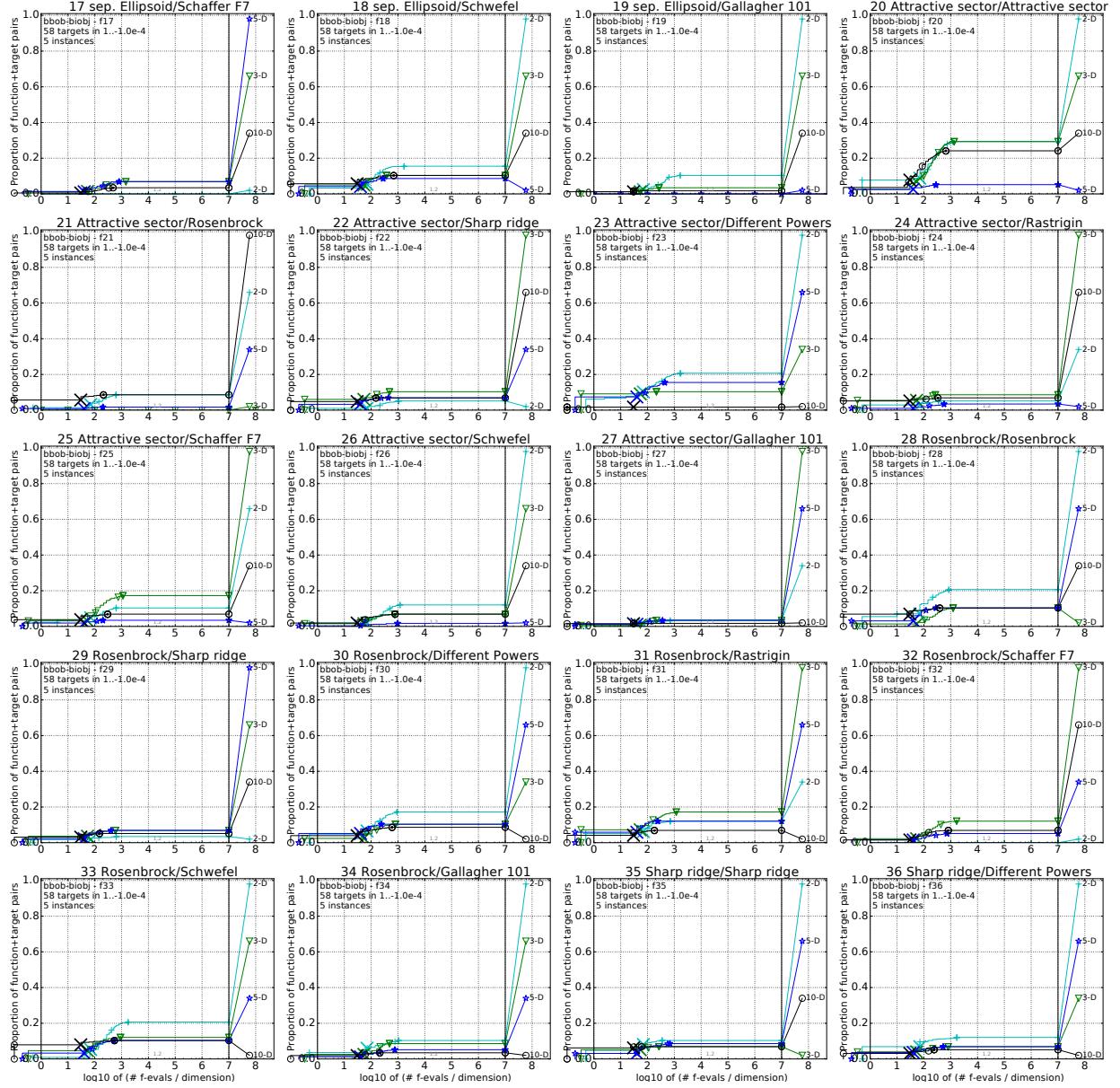
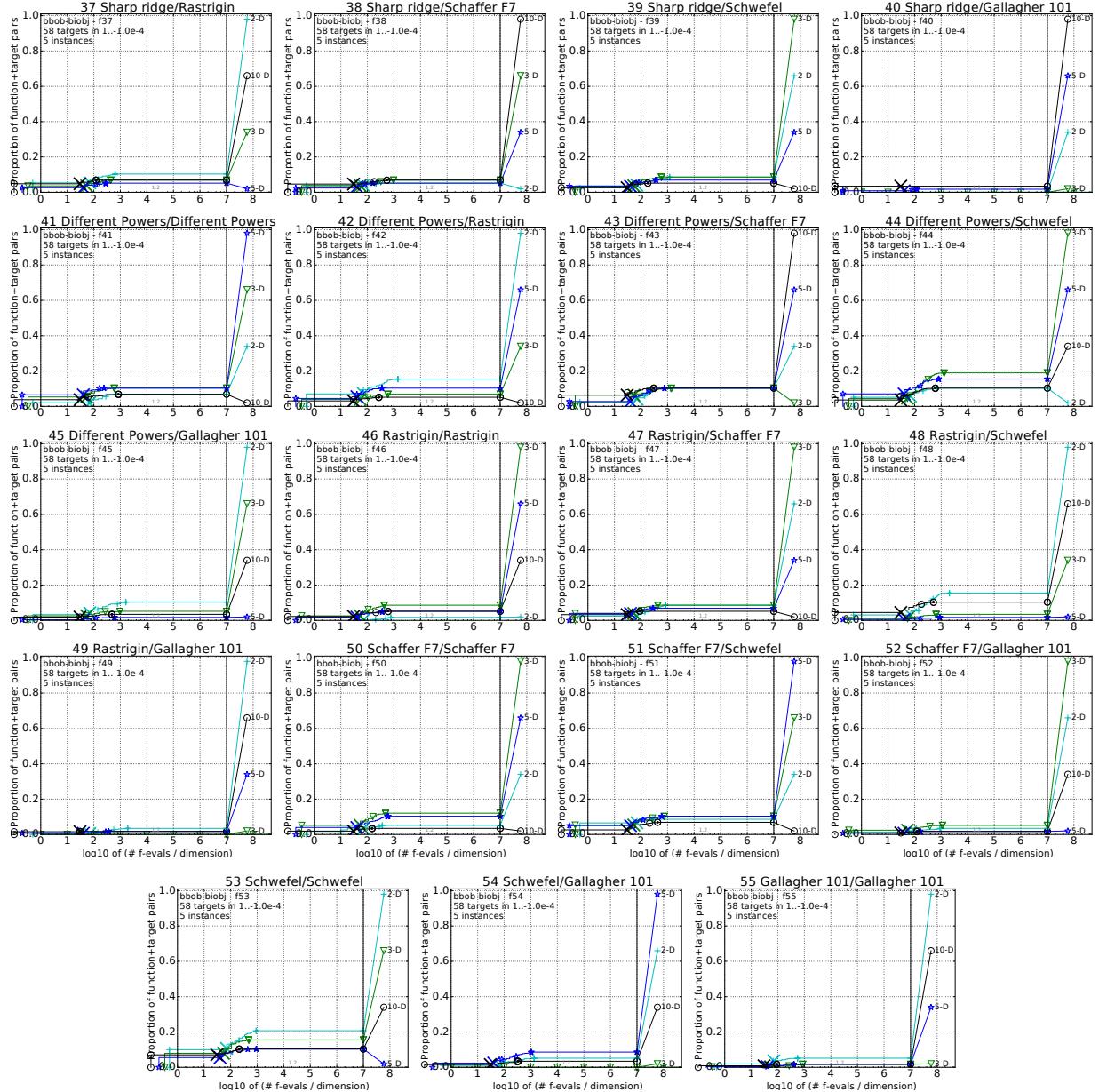
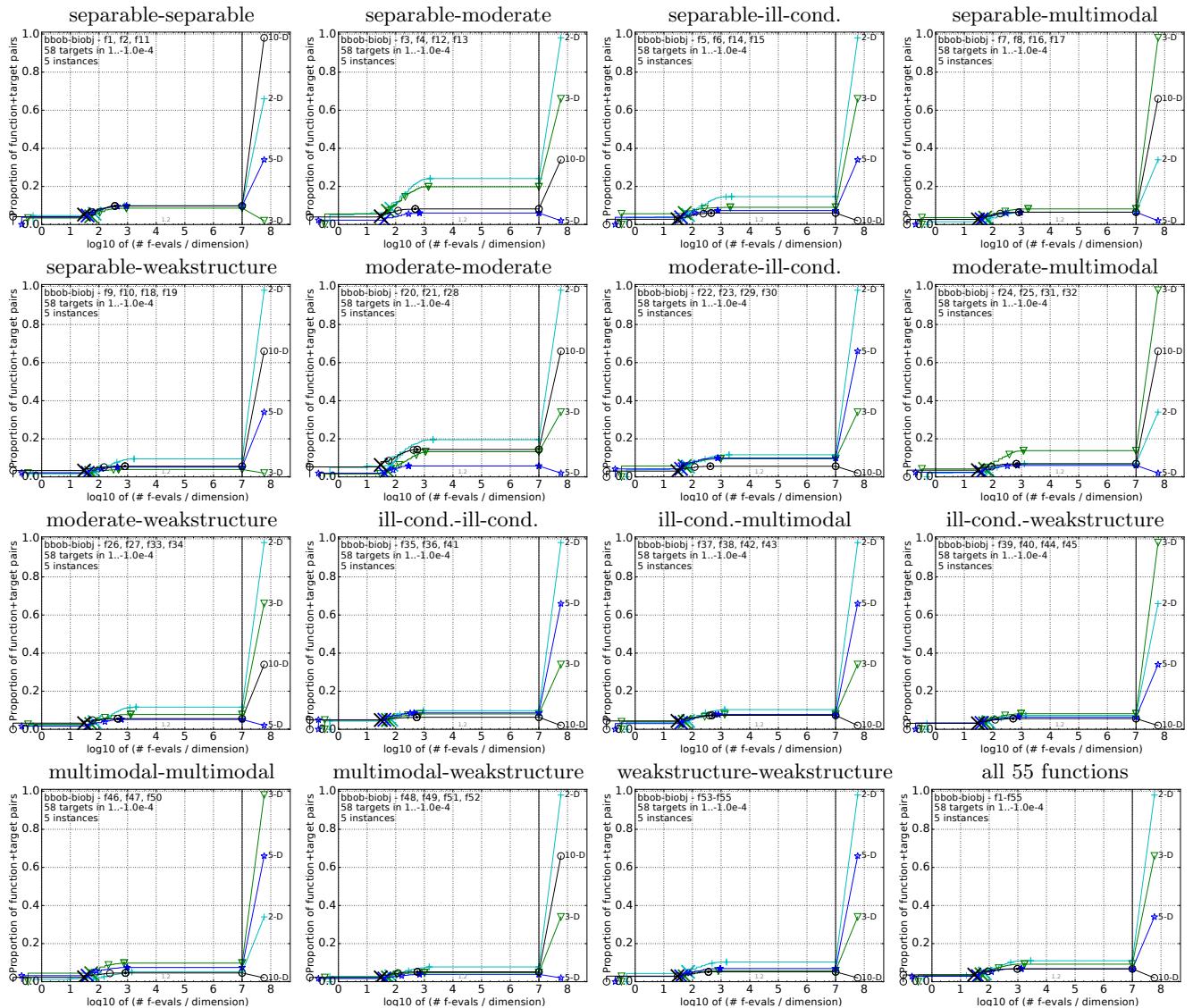


Figure 2: Empirical cumulative distribution of simulated (bootstrapped) runtimes, measured in number of objective function evaluations, divided by dimension (FEvals/DIM) for the targets as given in Fig. ?? for functions  $f_{17}$  to  $f_{36}$  and all dimensions.



**Figure 3: Empirical cumulative distribution of simulated (bootstrapped) runtimes, measured in number of objective function evaluations, divided by dimension (FEvals/DIM) for the targets as given in Fig. ?? for functions  $f_{37}$  to  $f_{55}$  and all dimensions.**



**Figure 4: Empirical cumulative distribution of simulated (bootstrapped) runtimes, measured in number of objective function evaluations, divided by dimension (FEvals/DIM) for the 58 targets  $\{-10^{-4}, -10^{-4.2}, -10^{-4.4}, -10^{-4.6}, -10^{-4.8}, -10^{-5}, 0, 10^{-5}, 10^{-4.9}, 10^{-4.8}, \dots, 10^{-0.1}, 10^0\}$  for all function groups and all dimensions. The aggregation over all 55 functions is shown in the last plot.**

## **APPENDIX**

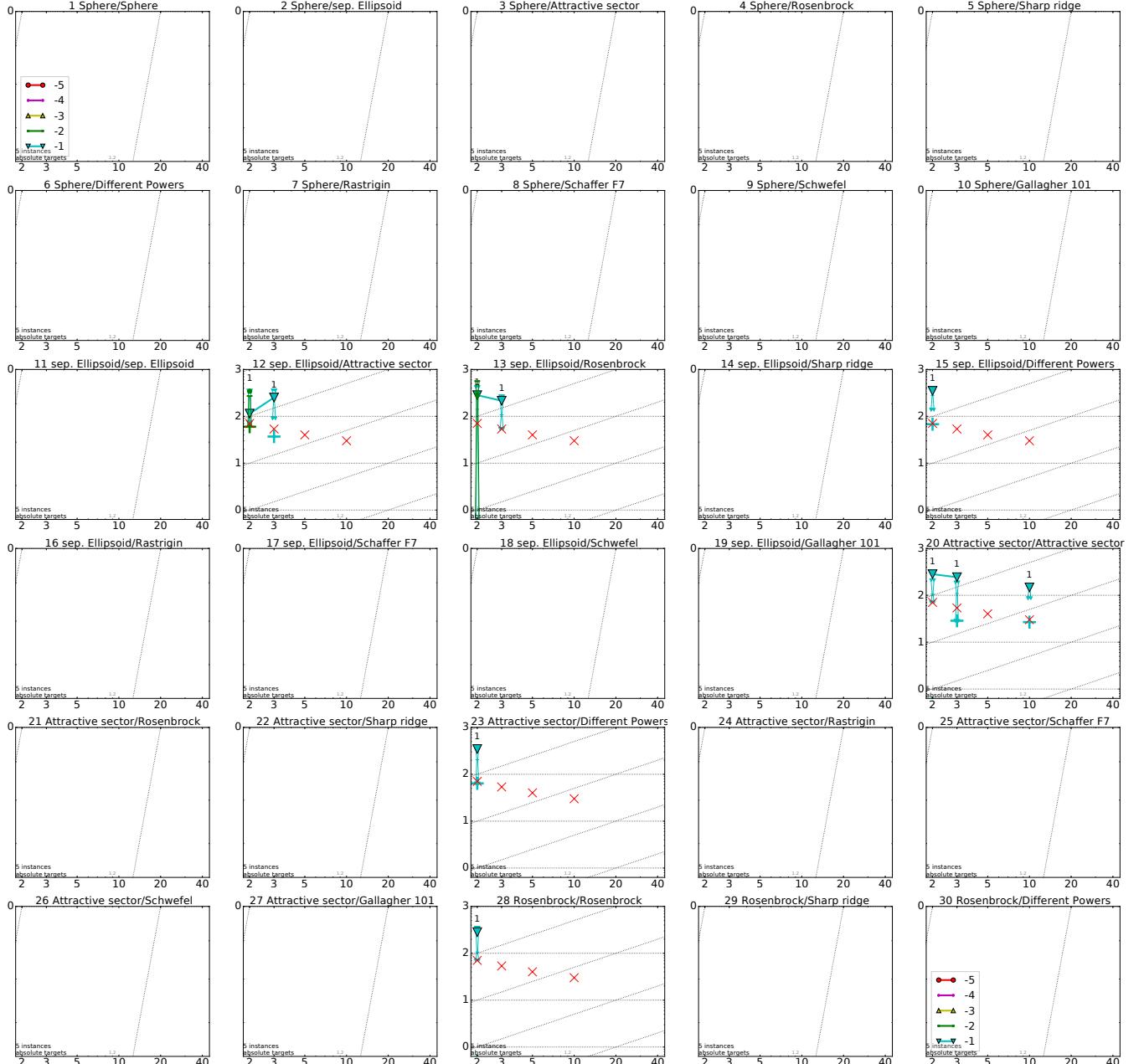


Figure 5: Scaling of runtime to reach  $HV_{ref} + 10^{\#}$  with dimension; runtime is measured in number of  $f$ -evaluations and  $\#$  is given in the legend; Lines: average runtime (aRT); Cross (+): median runtime of successful runs to reach the most difficult target that was reached at least once (but not always); Cross (x): maximum number of  $f$ -evaluations in any trial. Notched boxes: interquartile range with median of simulated runs; All values are divided by dimension and plotted as  $\log_{10}$  values versus dimension. Numbers above aRT-symbols (if appearing) indicate the number of trials reaching the respective target. Horizontal lines mean linear scaling, slanted grid lines depict quadratic scaling.

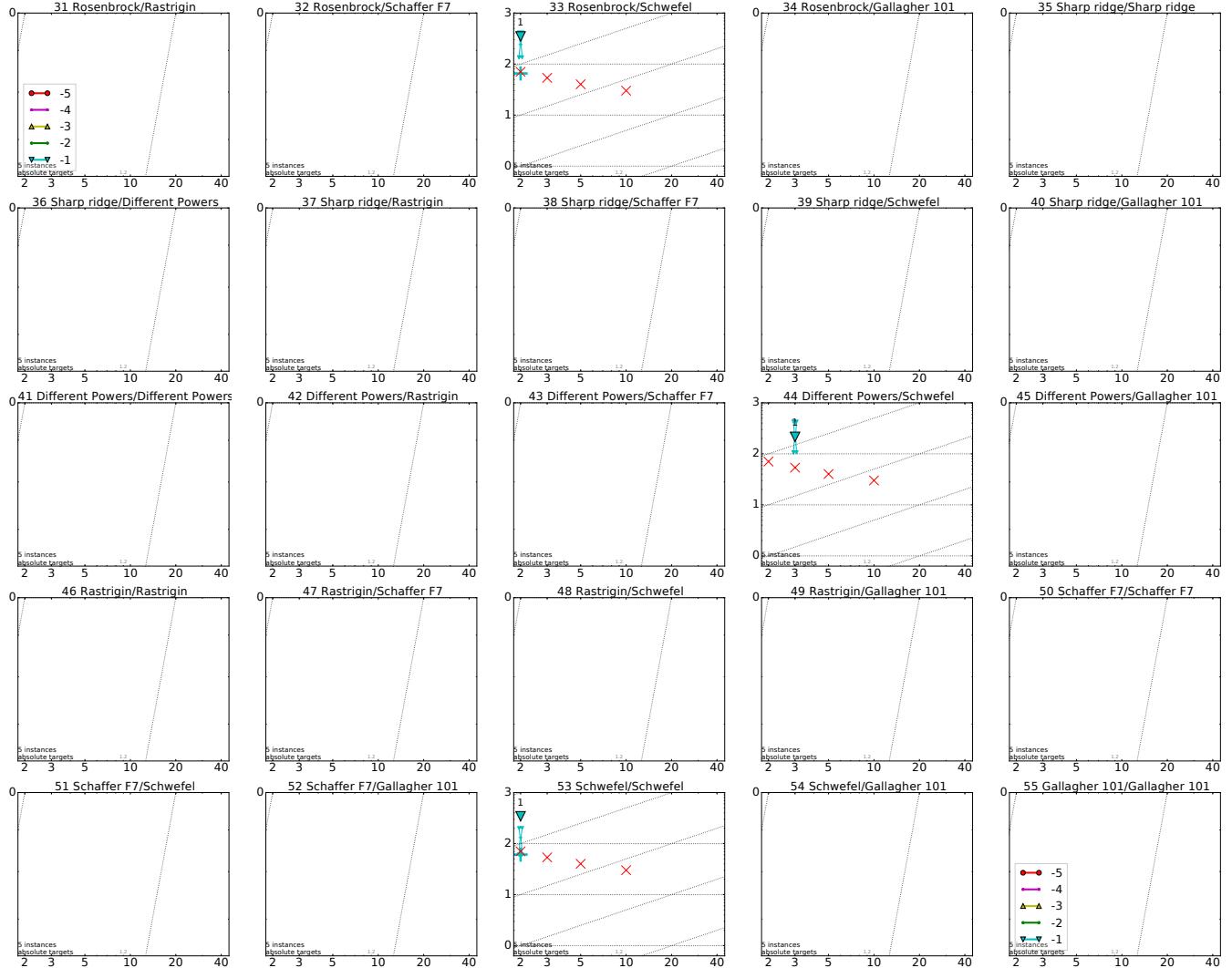


Figure 6: Runtime versus dimension as described in Fig. ??, here for functions  $f_{31}$  to  $f_{55}$ .