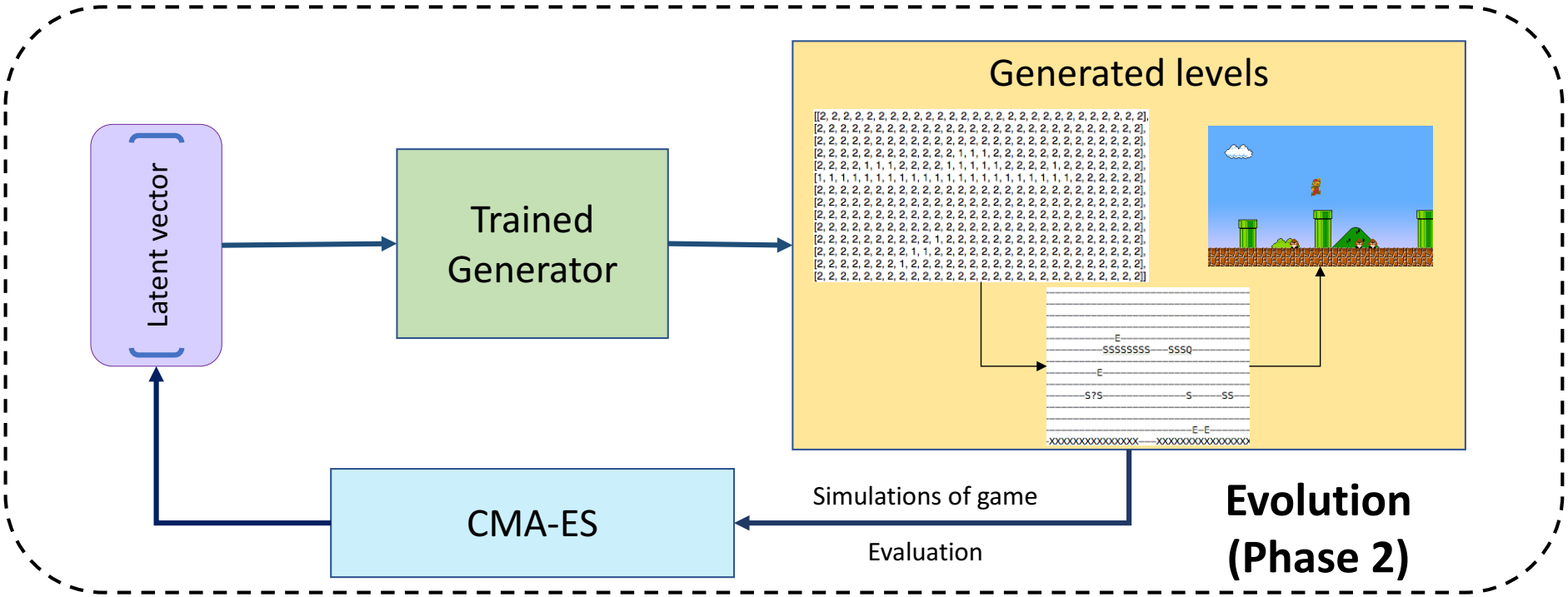
Procedural Level Generator for Mario



Vanessa Volz, Jacob Schrum, Jialin Liu, Simon M. Lucas, Adam Smith, Sebastian Risi. 2018. Evolving Mario Levels in the Latent Space of a Deep Convolutional Generative Adversarial Network. In Genetic and Evolutionary Computation Conference (GECCO 2018). ACM Press, New York, NY. To appear.

Example

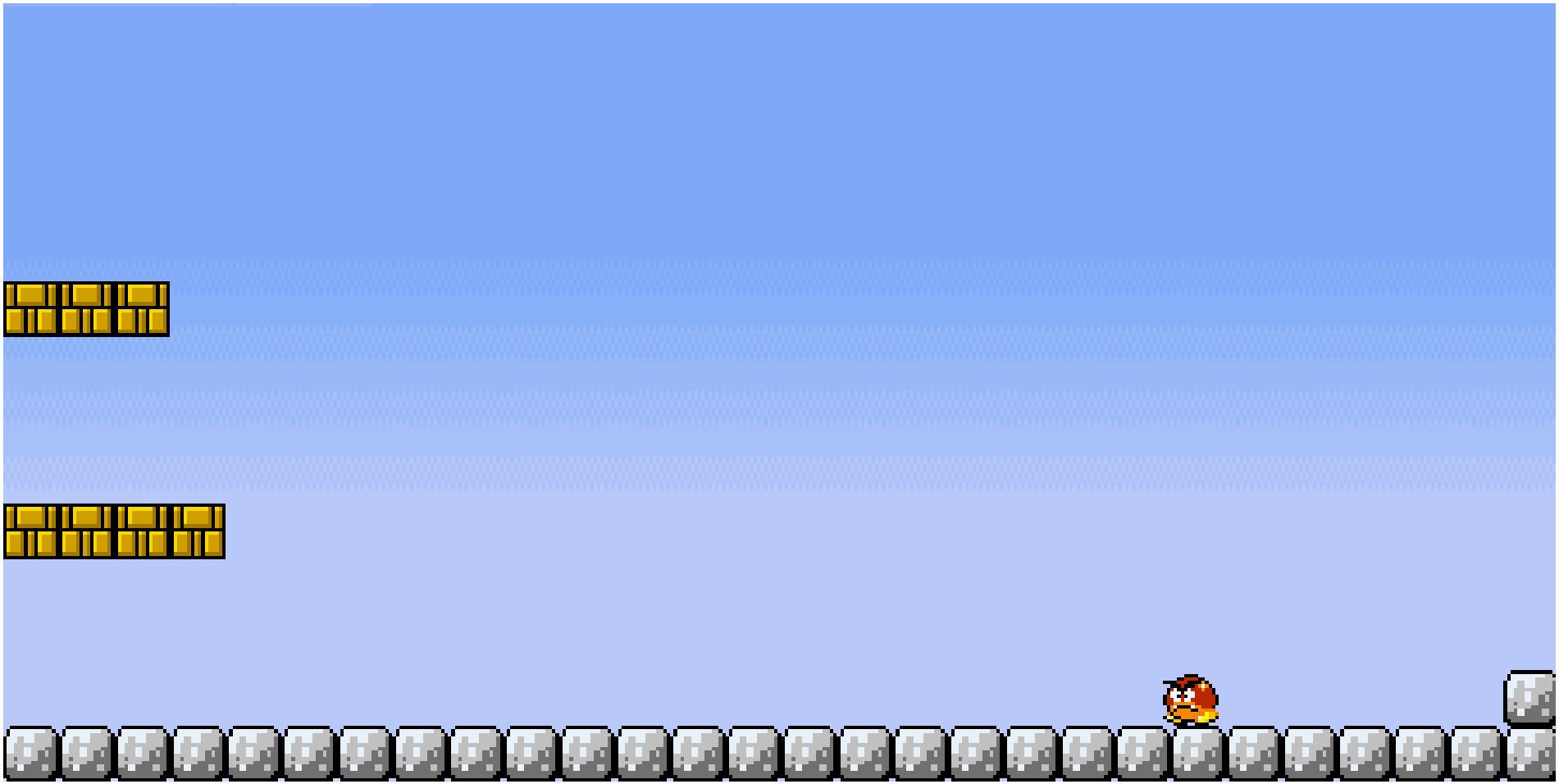
Latent Vector

```
[0.3709652843542860 5, 0.4875451956823884, 0.5442587474115113,
-0.4297413700372004, -0.1731070560552397 4, 0.1556140941080517 4,
0.3066673035284892, 0.1026991981701613 6, 0.0819530588727184,
-0.6667159059020512]
```

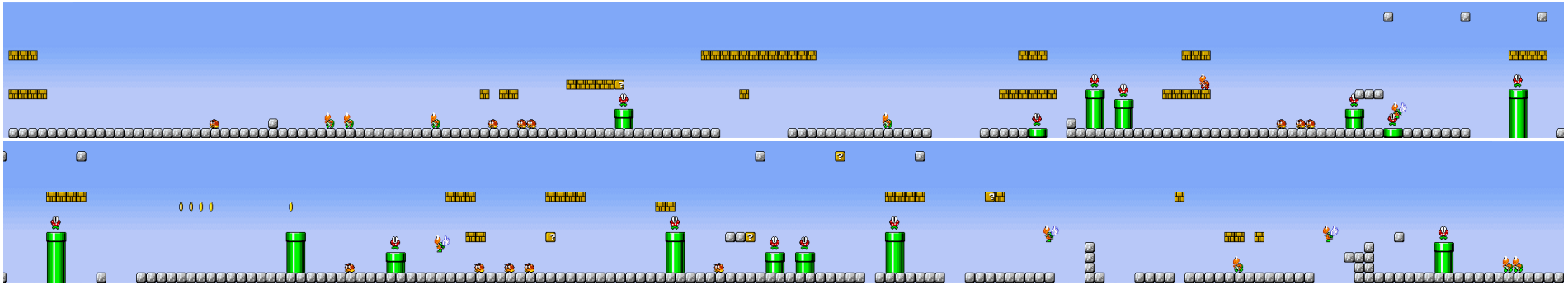
GAN output

```
[[2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2],
[2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2],
[2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2],
[2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2],
[2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2],
[1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2],
[2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2],
[2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2],
[2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2],
[1, 1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2],
[2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 10, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2],
[2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2],
[2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 9, 2, 2, 2, 2, 2, 0],
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]]
```

Example cont'd



In action



Fitness Functions, Dimensions and Instances

Trained GANs

- latent vector dimensions: 10, 20, 30, 40
- output dimension: 28 x 14
- sample sets:
  - Super Mario Bros: overworld lvls
  - Super Mario Bros: underground lvls
  - Super Mario Bros: overworld lvls + Super Mario Bros 2 (Japan): overworld lvls
- Random seed (instances)

Fitness Functions

- 6 direct fitness functions*
- 4 simulated: AStar Agent and REALM†
- Concatenation

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*Adam Summerville, Julian R. H. Mariño, Sam Snodgrass, Santiago Ontañón, Levi H. S. Lelis. 2017. Understanding mario: an evaluation of design metrics for platformers. In Foundations of Digital Games (FDG 2017). ACM Press, New York, NY. 8:1-8:10.

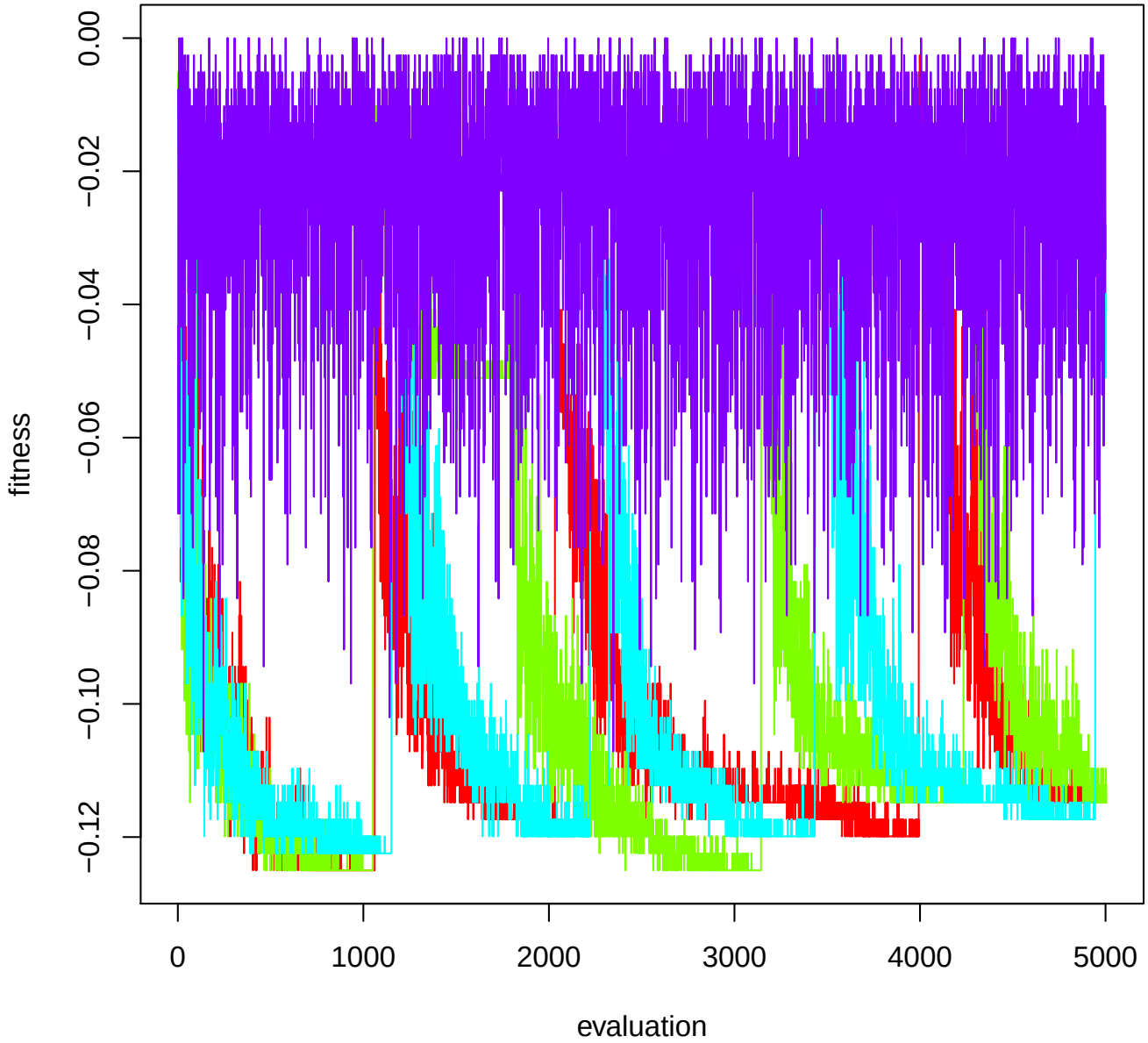
†Agents by R. Baumgarten and S. Bojarski, C. B. Congdon, MarioAI Competition

Selected Fitness Functions

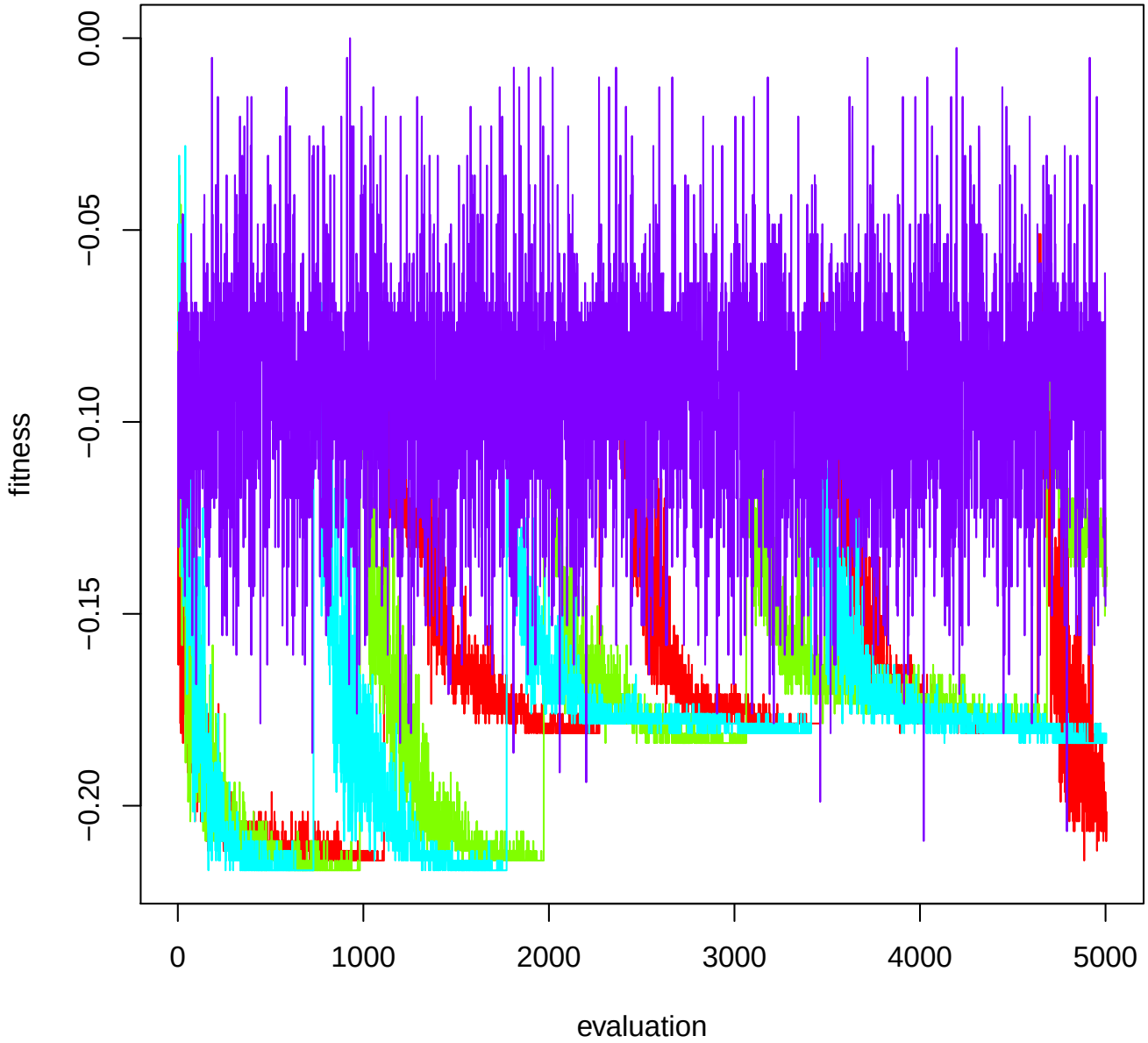
id	name	description	range
9	decorationPerc	percentage of *pretty* tiles	[0,1]
12	negativeSpace	percentage of tiles you can stand on	[0,1]

id	name	description	range
21 / 33	levelProgress	level progress x-wise	[0,1]
24 / 36	basicFitness	lengthOfLevelPassedPhys - timeSpentOnLevel + numberOfGainedCoins + marioStatus*5000)/5000	?
27 / 39	jumpFraction	percentage of jump actions	[0,1]
30 / 42	totalActions	number of actions total	[0,?]

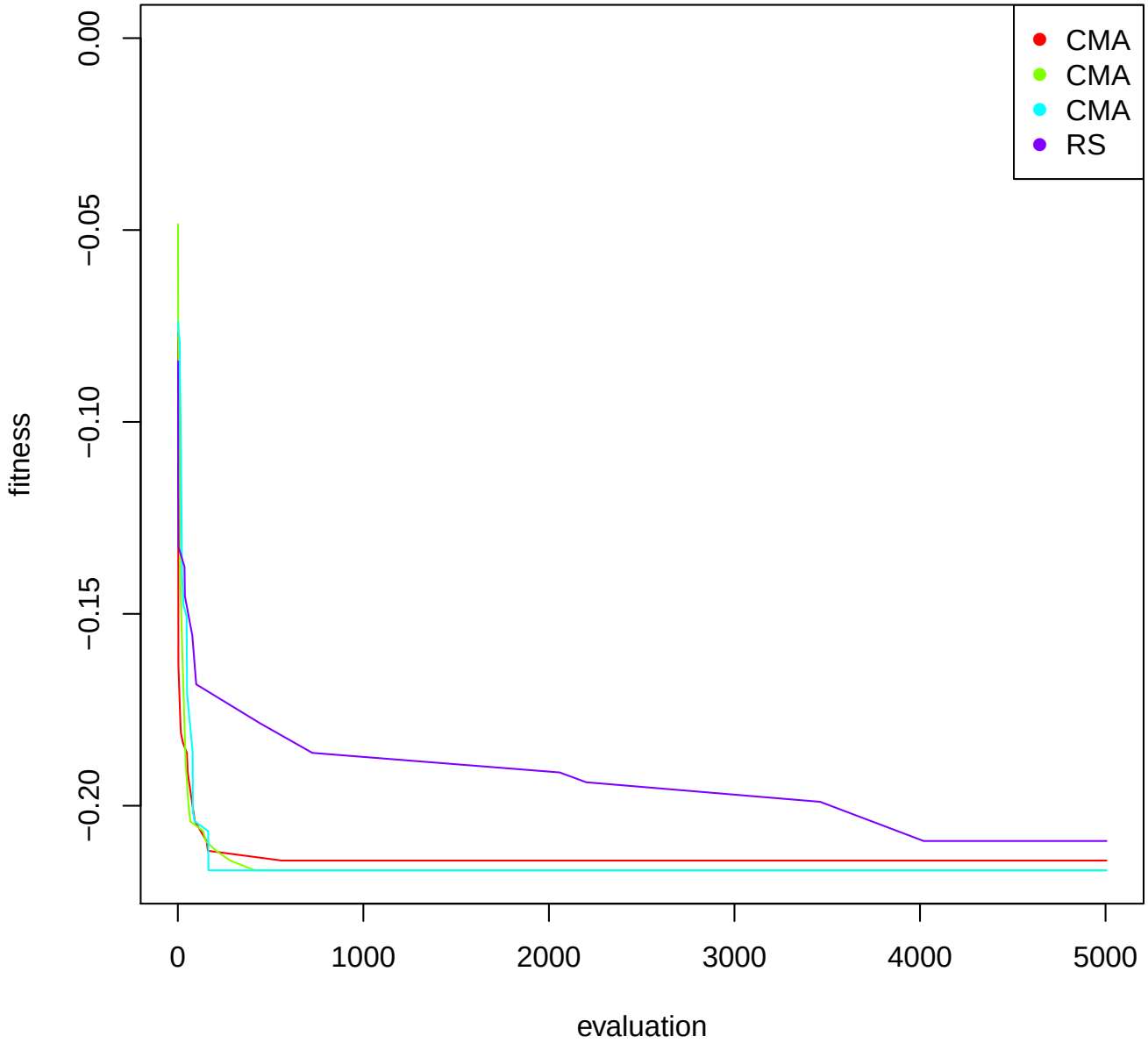
Algorithm Performance: decorationPerc, dim 10, [0,1]



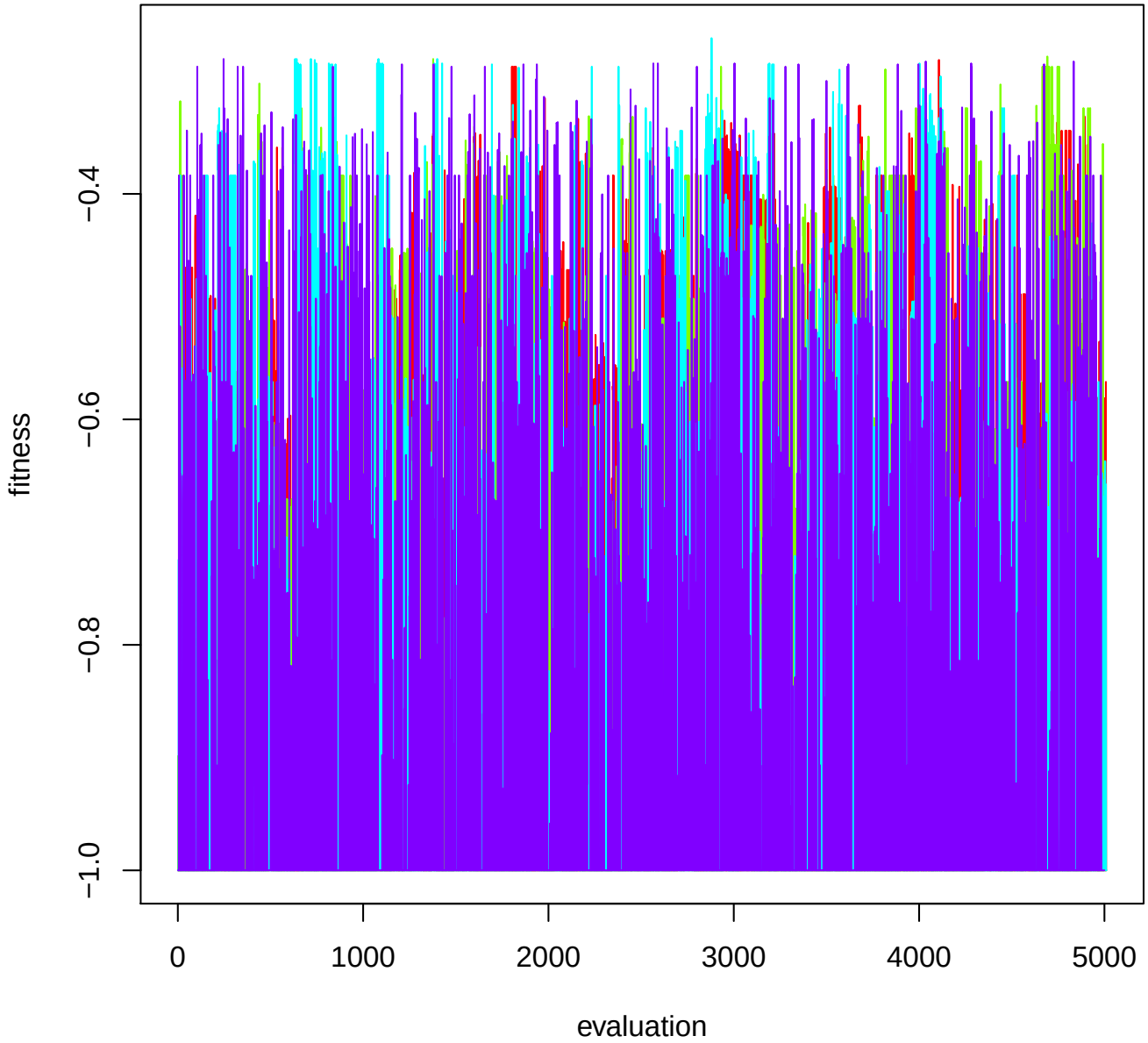
Algorithm Performance: negativeSpace, dim 10, [0,1]



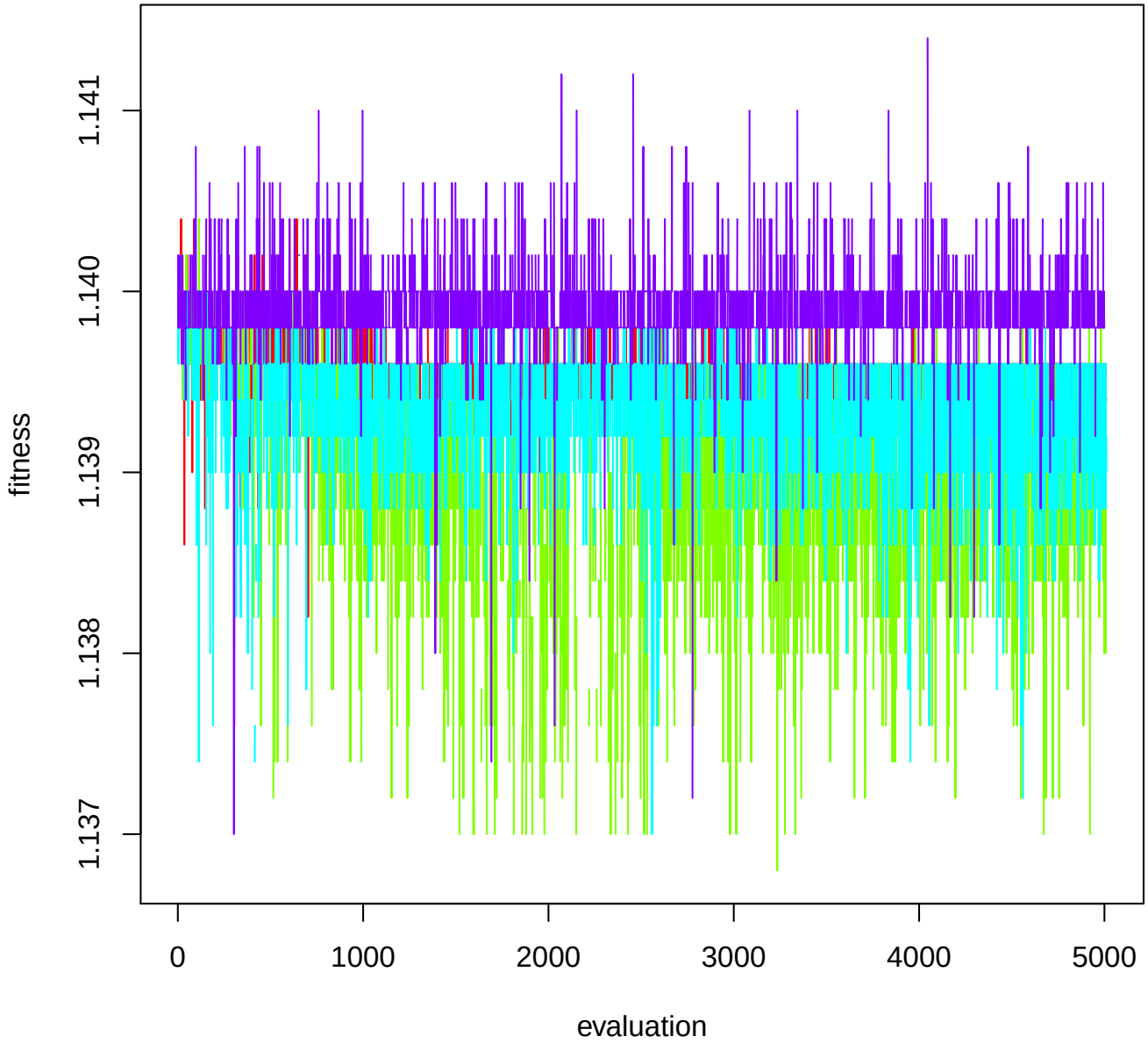
Algorithm Performance: negativeSpace, dim 10, [0,1]



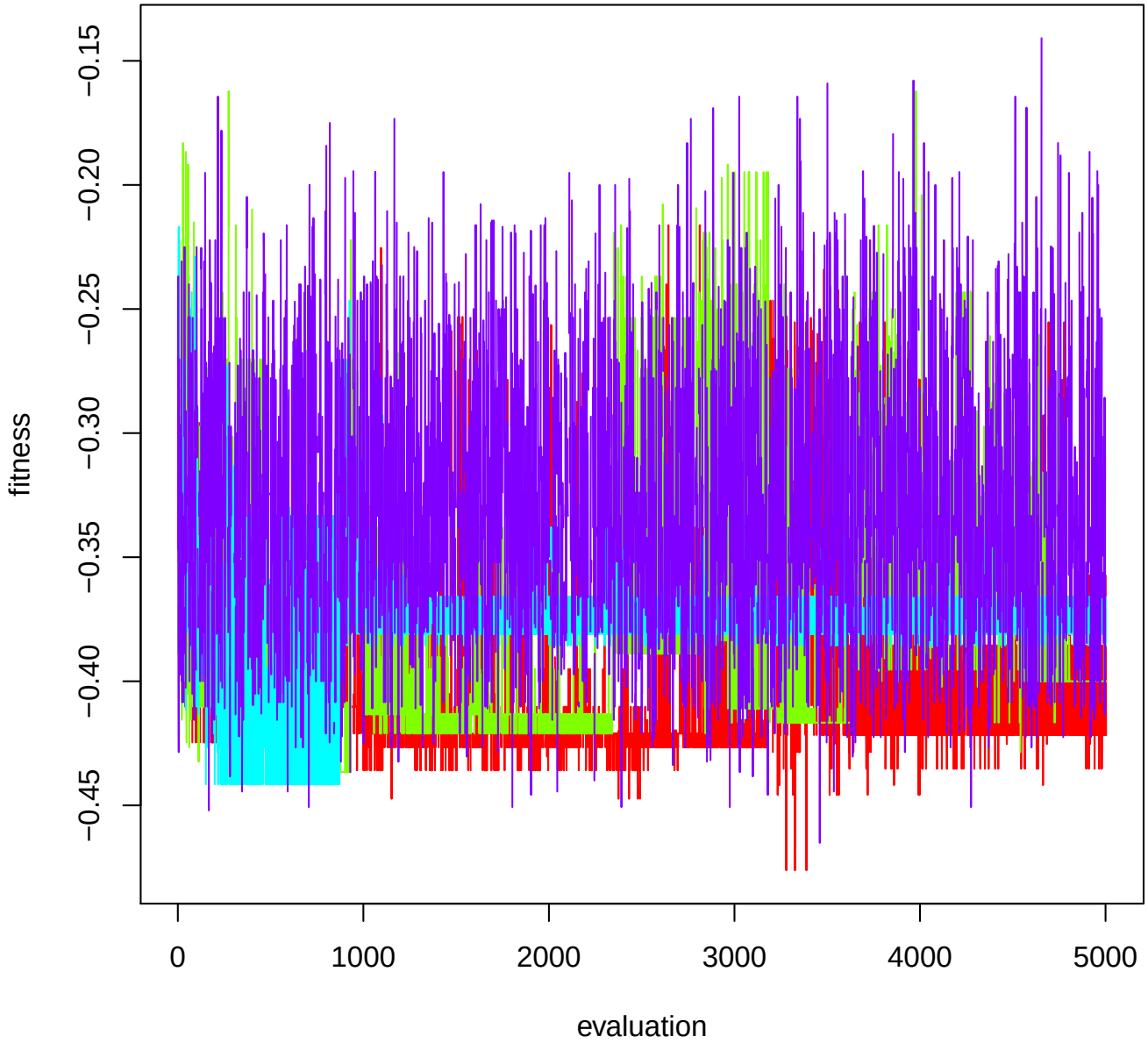
Algorithm Performance: levelProgress AStar, dim 10, [0,1]



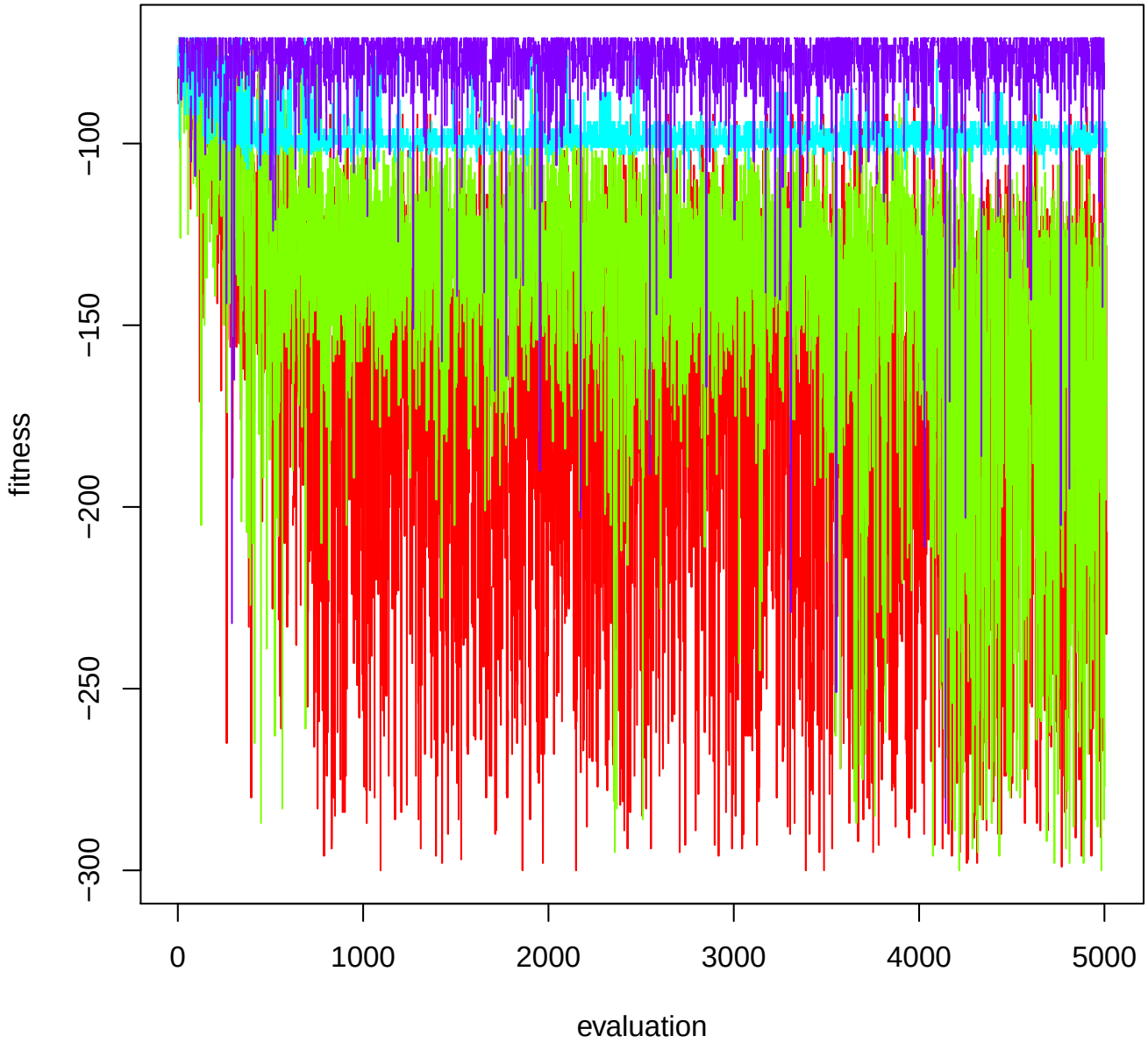
Algorithm Performance: basicFitness AStar, dim 10, [0,1]



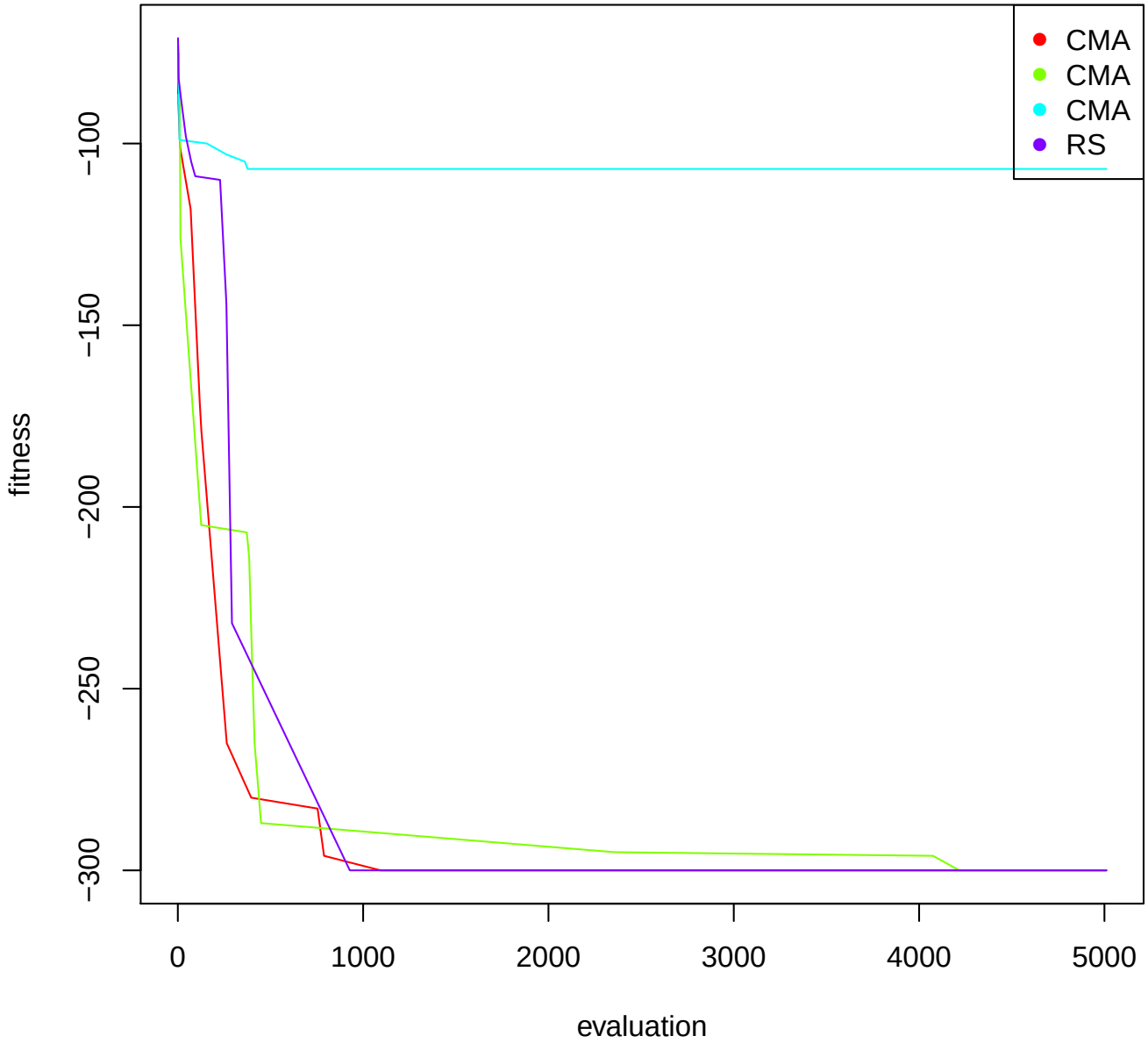
Algorithm Performance: jumpFraction AStar, dim 10, [0,1]



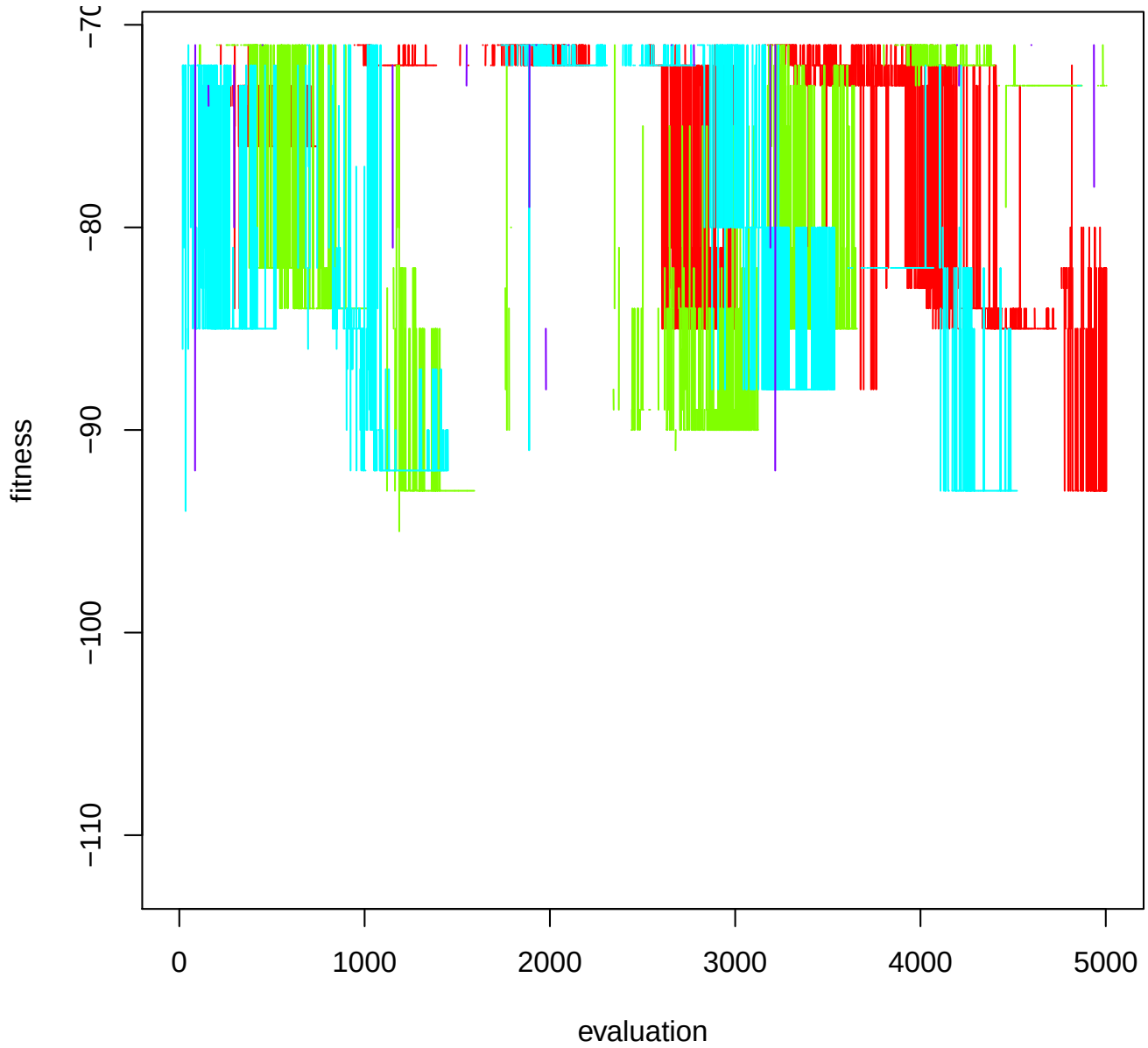
Algorithm Performance: totalActions AStar, dim 10, [0,1]



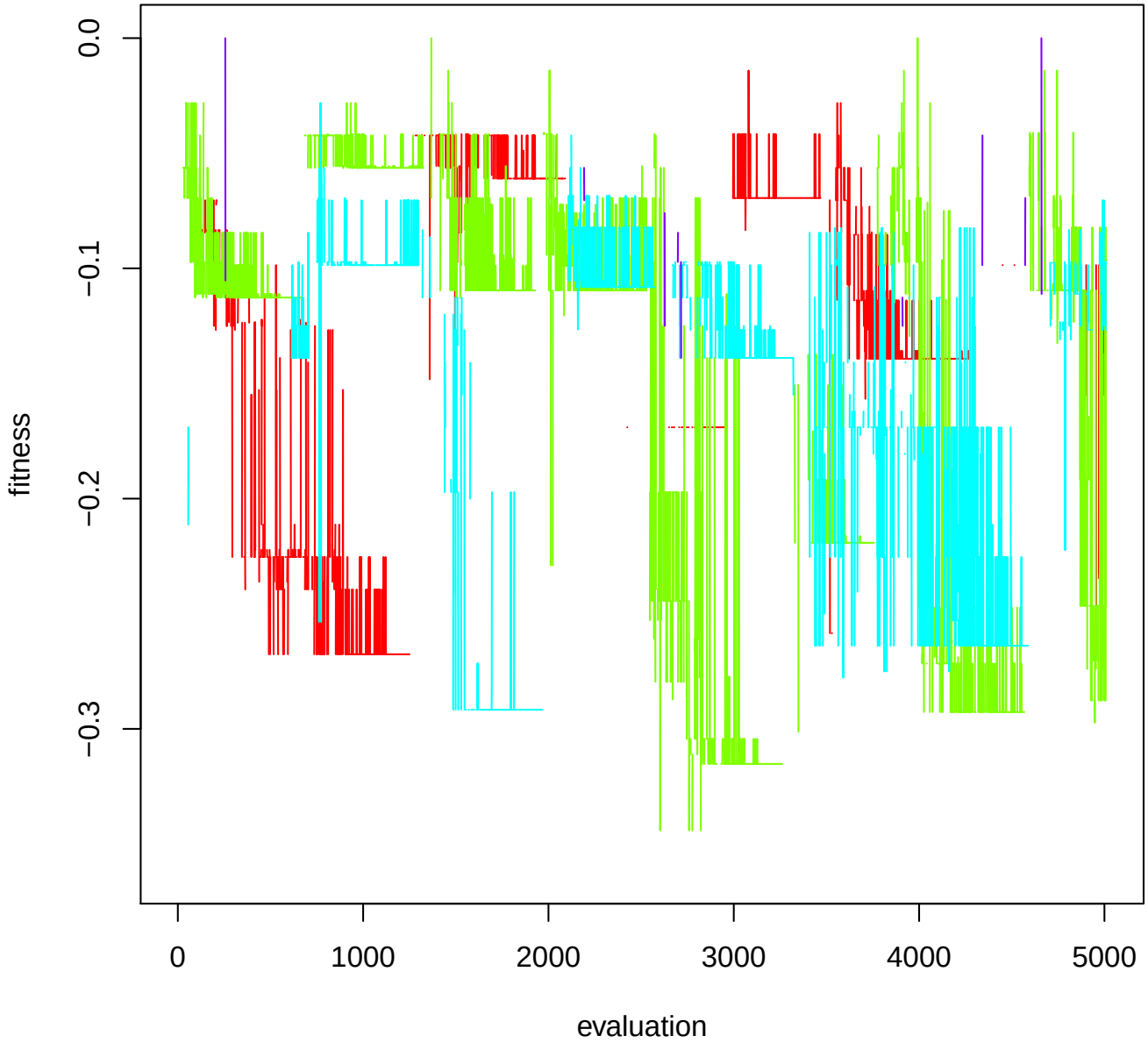
Algorithm Performance: totalActions AStar, dim 10, [0,1]



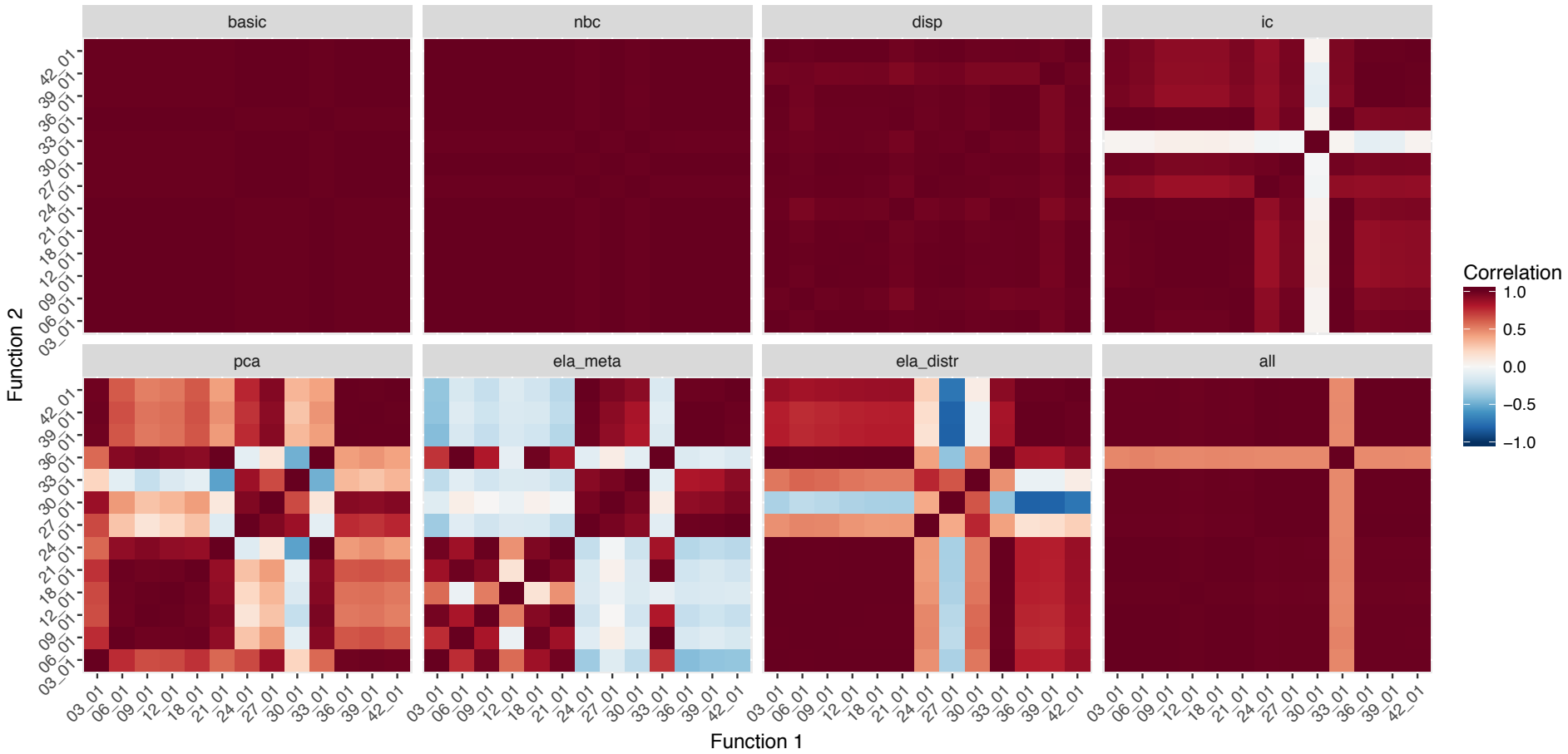
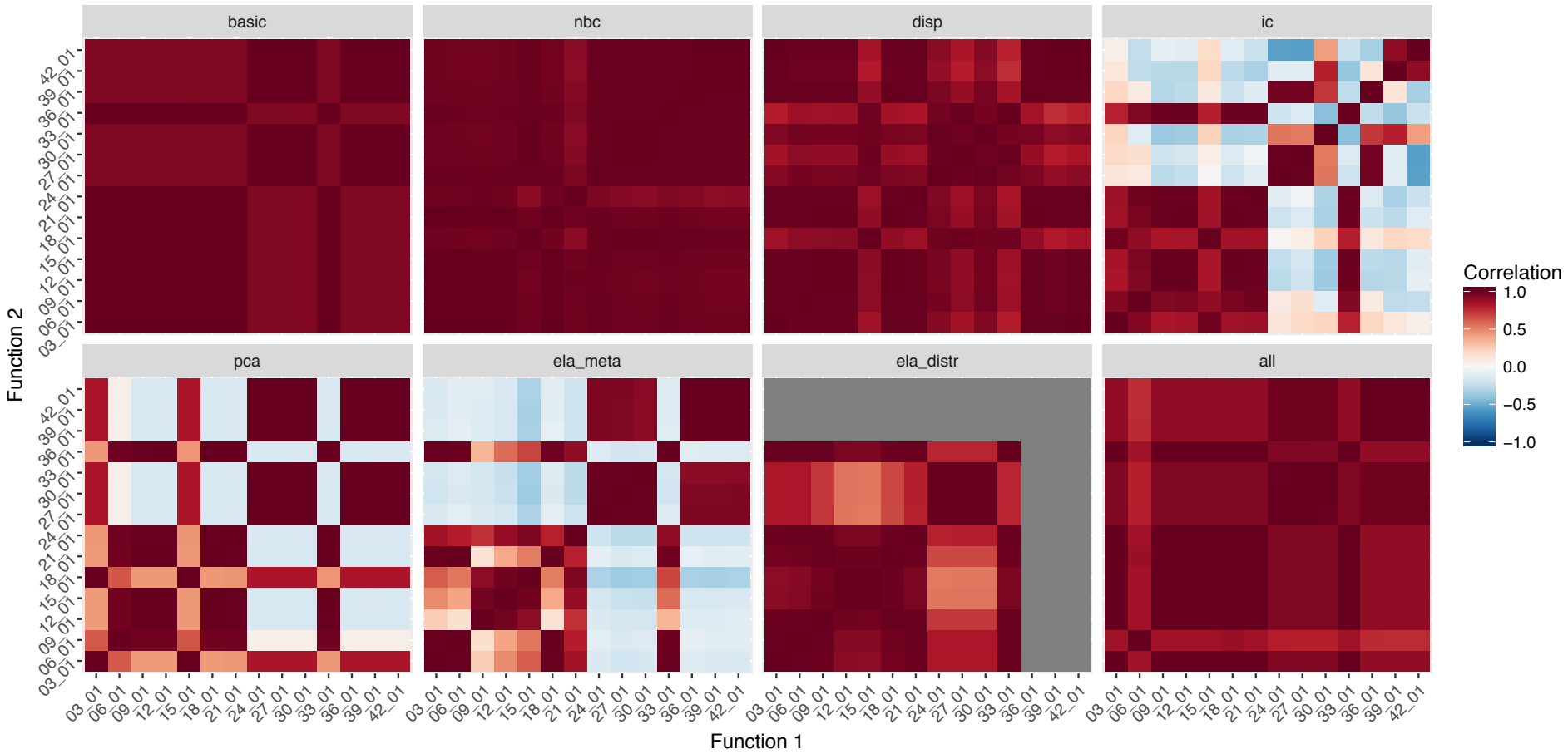
Algorithm Perf.: totalActions REALM, dim 10, [0,1]



Algorithm Perf.: jumpFractions REALM, dim 10, [0,1]



Results: ELA on MarioGAN CMA



Results: ELA on MarioGAN RS