Towards Metrics and Visualizations Sensitive to Coevolutionary Failures

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AAAI 2005 Fall Symposium:
Coevolutionary and Coadaptive Systems

Outline

Motivation

Coevolutionary Fitness

- No objective fitness function required

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Coevolutionary Fitness

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- No objective fitness function available

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Coevolutionary Fitness

- No objective fitness function required
- No objective fitness function available
- How to best monitor performance?

Notation

From (Bucci & Pollack)

- Candidate population C, Test population T

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- Candidate population C, Test population T
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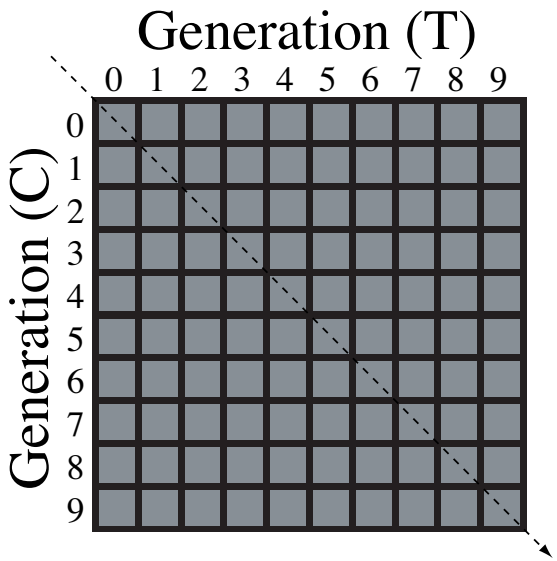
- Outcome is an element of some ordered set R
  $R = \{CandidateFailedTest < CandidateTiedTest < CandidatePassedTest\}$

Generation-Table Analysis



- CIAO data (Cliff and Miller)

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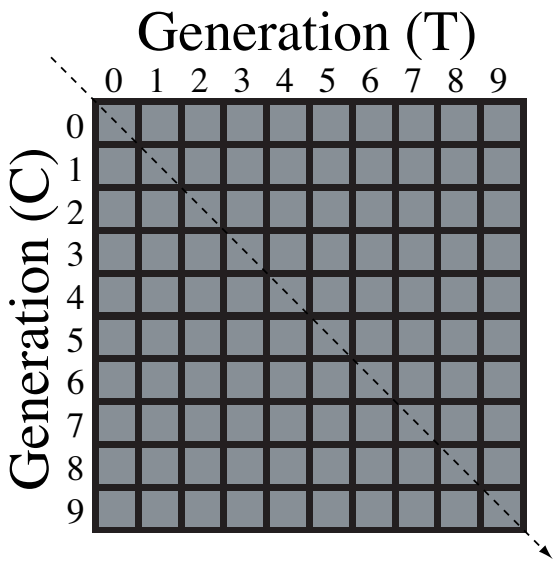
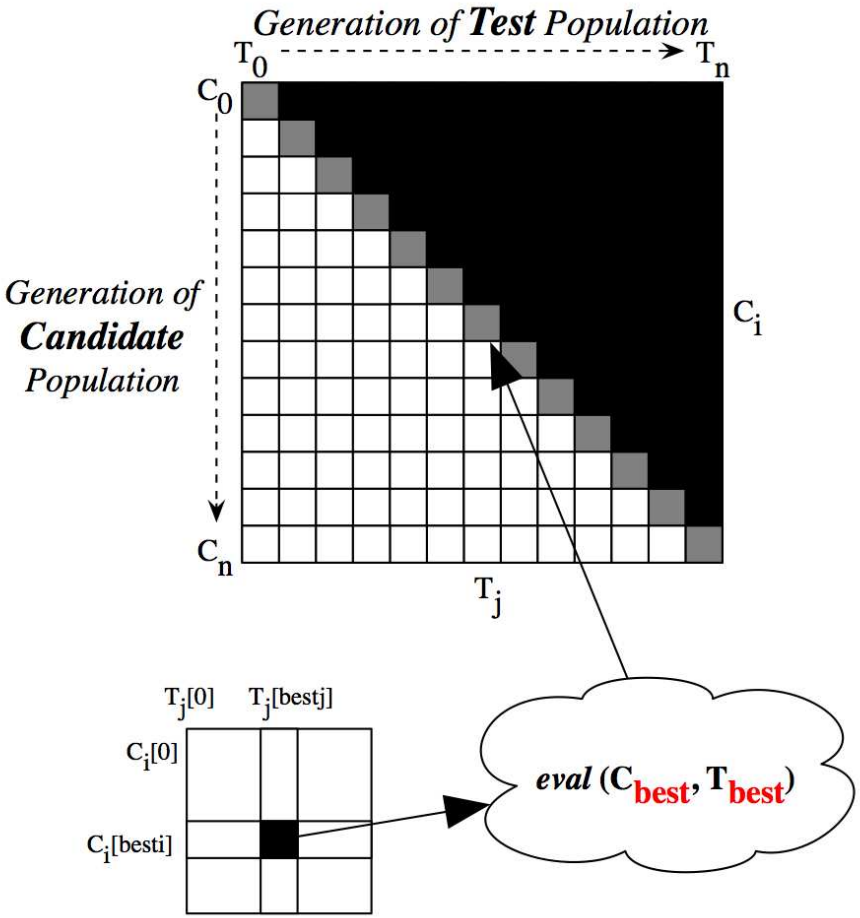


- CIAO data (Cliff and Miller)
- Dominance Tournament (Stanley and Miikkulainen)
- Master Tournament (Nolfi and Floreano)
- Hall-of-Fame (Rosin and Belew)

Best-of-Generation (BOG) Approach

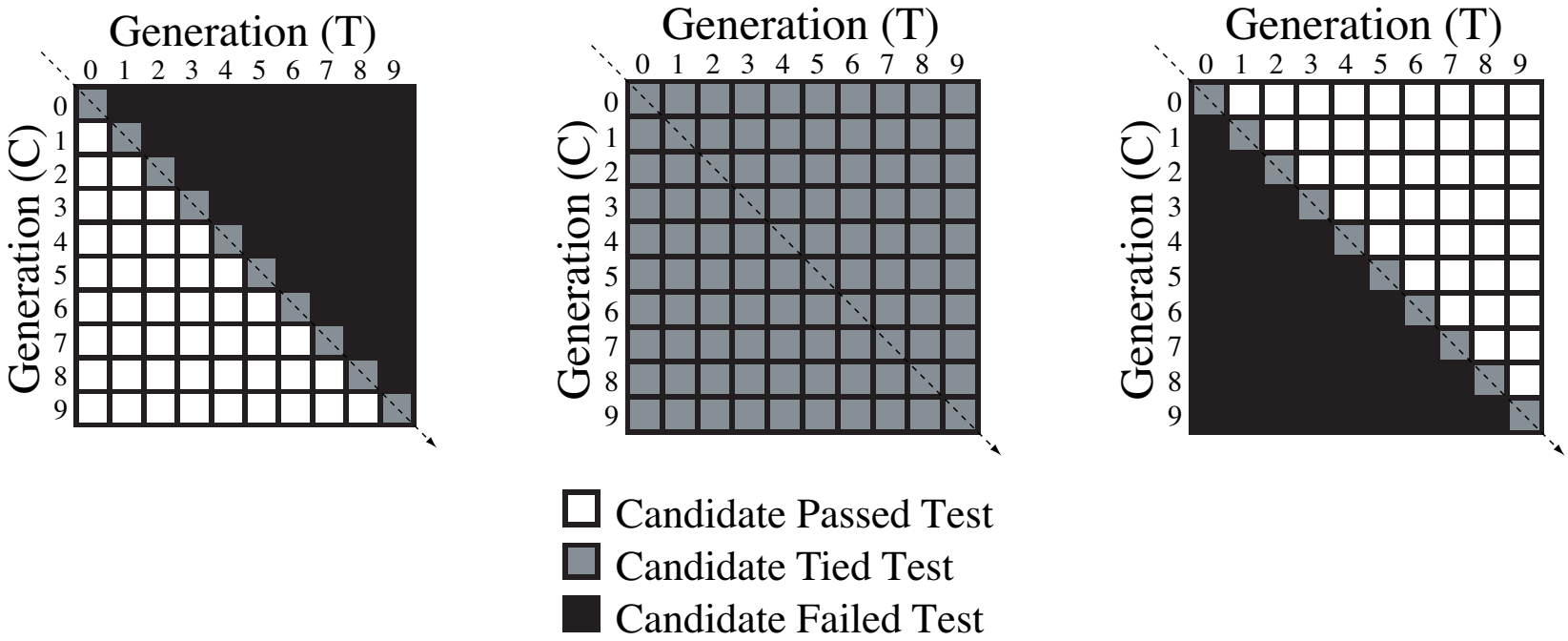
Evaluation



Candidate Passed Test
Candidate Tied Test
Candidate Failed Test

”Instantaneous Fitness”

”Red Queen” Dynamics



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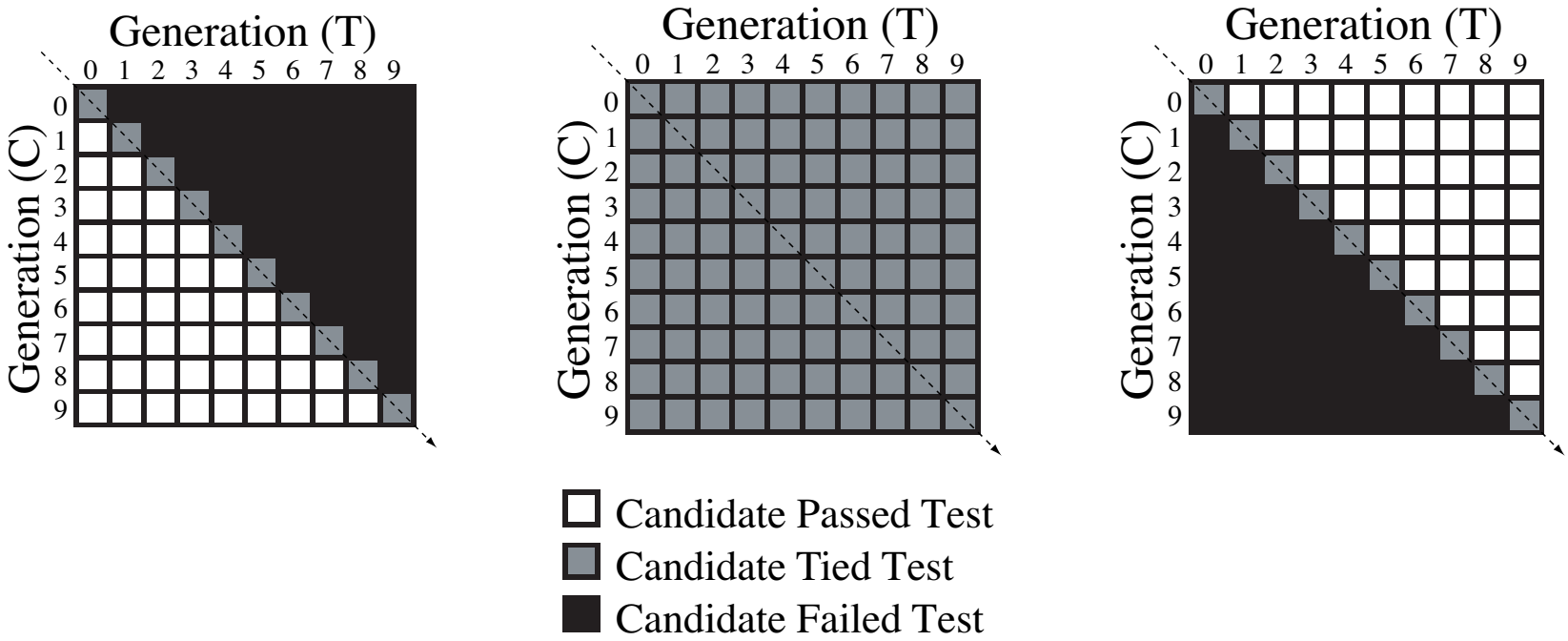

Simulations may drastically differ, yet may generate identical ”instantaneous fitness” profiles

Best-of-Generation (BOG) Approach

- Low computational cost

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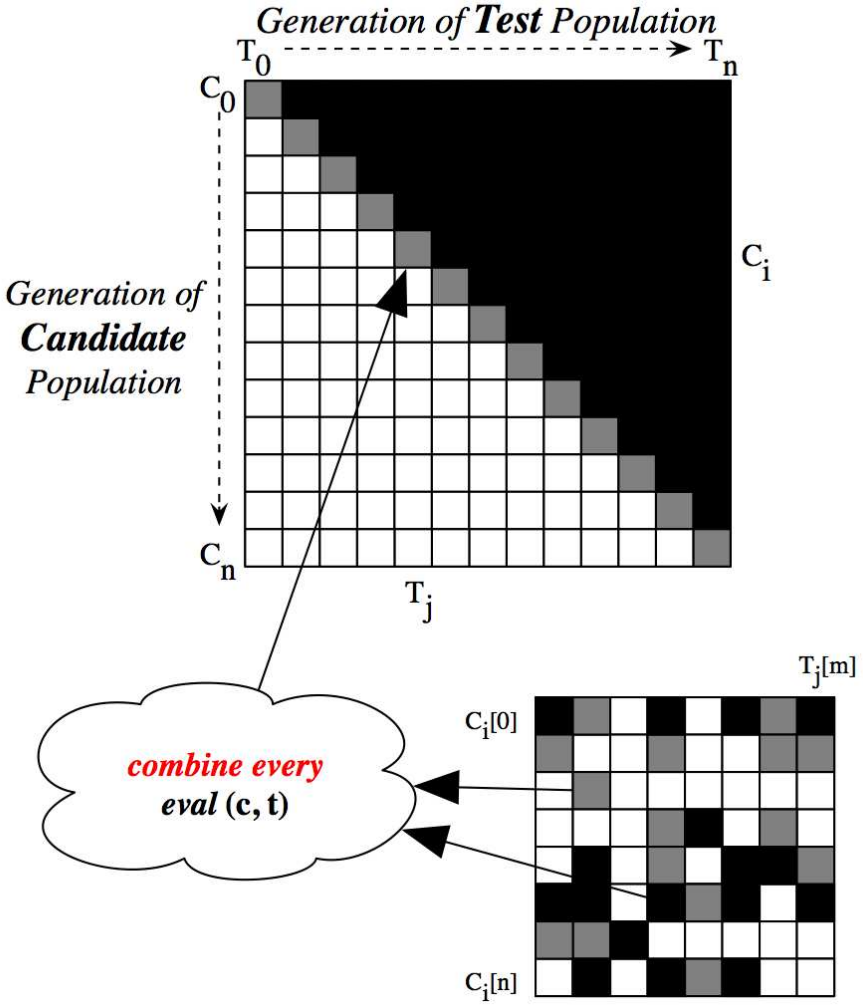
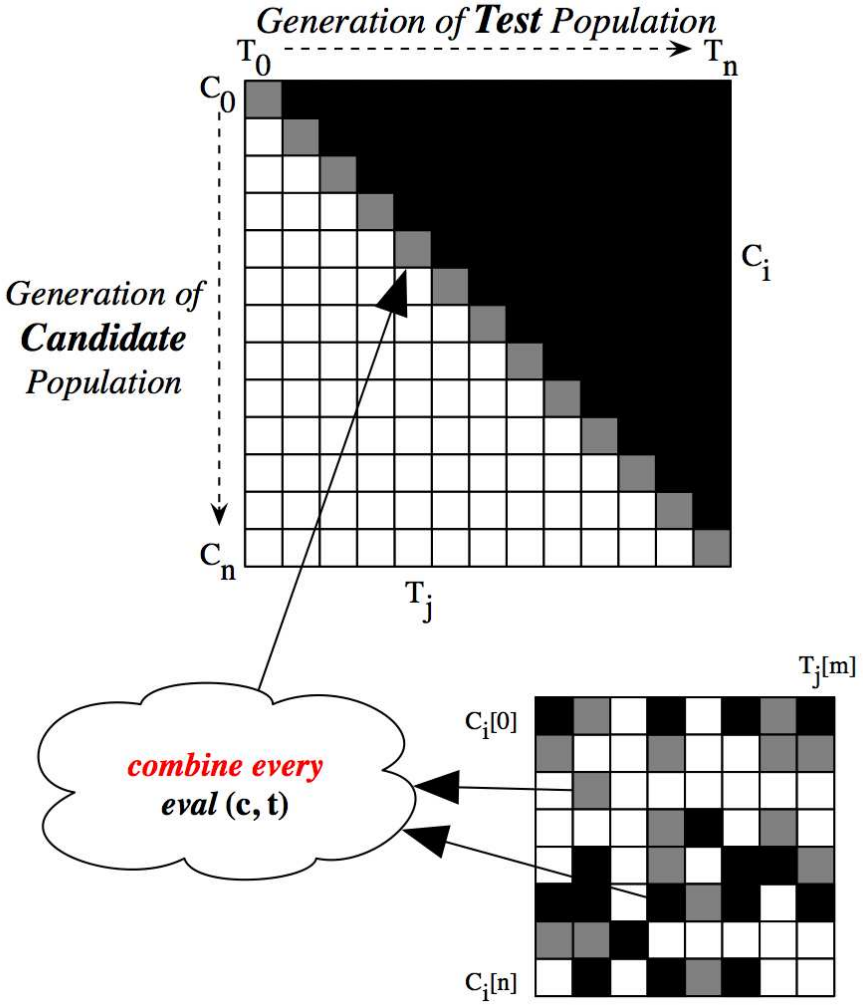
- Low computational cost
- Definition of ”best” is pre-defined
- Only reflects behavior of ”best” individuals
- High sensitivity to coevolutionary success
  Low sensitivity to coevolutionary failure
- Not appropriate for examining failures in coevolution.
  All-of-Generation (AOG) based analysis is a response...

All-of-Generation: Population-Grained Evaluation



All Candidates Passed All Tests
All Candidates Failed All Tests

All-of-Generation: Population-Grained Evaluation



All Candidates Passed All Tests
All Candidates Failed All Tests

Here: simple average of outcome values

BOG vs. AOG Differentiating Example

0	1	2	3	4	5	6	7	8	9
0	-1	-2	-3	-4	-5	-6	-7	-8	-9
0	-1	-2	-3	-4	-5	-6	-7	-8	-9
0	-1	-2	-3	-4	-5	-6	-7	-8	-9
0	-1	-2	-3	-4	-5	-6	-7	-8	-9
0	-1	-2	-3	-4	-5	-6	-7	-8	-9
0	-1	-2	-3	-4	-5	-6	-7	-8	-9
0	-1	-2	-3	-4	-5	-6	-7	-8	-9
0	-1	-2	-3	-4	-5	-6	-7	-8	-9
0	-1	-2	-3	-4	-5	-6	-7	-8	-9

0	0	0	0	0	0	0	0	0	0
1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2	-2	-2	-2	-2	-2	-2	-2	-2	-2
3	-3	-3	-3	-3	-3	-3	-3	-3	-3
4	-4	-4	-4	-4	-4	-4	-4	-4	-4
5	-5	-5	-5	-5	-5	-5	-5	-5	-5
6	-6	-6	-6	-6	-6	-6	-6	-6	-6
7	-7	-7	-7	-7	-7	-7	-7	-7	-7
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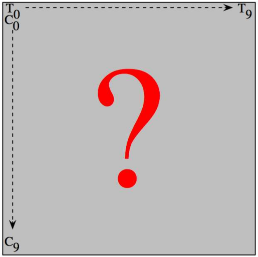
9	-9	-9	-9	-9	-9	-9	-9	-9	-9



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	0	1	2	3	4	5	6	7	8	9
0	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
1	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
2	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
3	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
4	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
5	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
6	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
7	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
8	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
9	0	-1	-2	-3	-4	-5	-6	-7	-8	-9

0	0	0	0	0	0	0	0	0	0	0
1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4
5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5
6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6
7	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7
8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8
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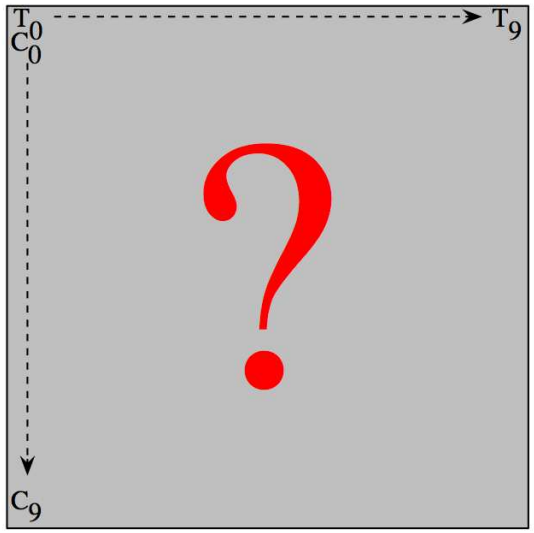

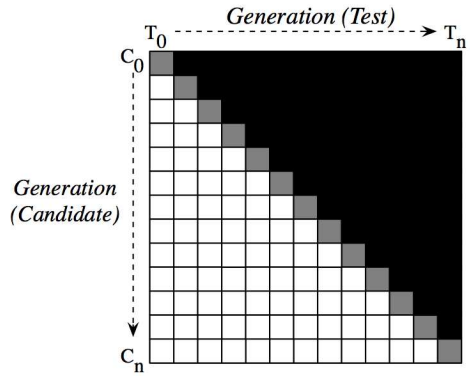

BOG table:

a success!

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3	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
4	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
5	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
6	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
7	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
8	0	-1	-2	-3	-4	-5	-6	-7	-8	-9
9	0	-1	-2	-3	-4	-5	-6	-7	-8	-9

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0	0	0	0	0	0	0	0	0	0	0
1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4
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6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6
7	-7	-7	-7	-7	-7	-7	-7	-7	-7	-7
8	-8	-8	-8	-8	-8	-8	-8	-8	-8	-8
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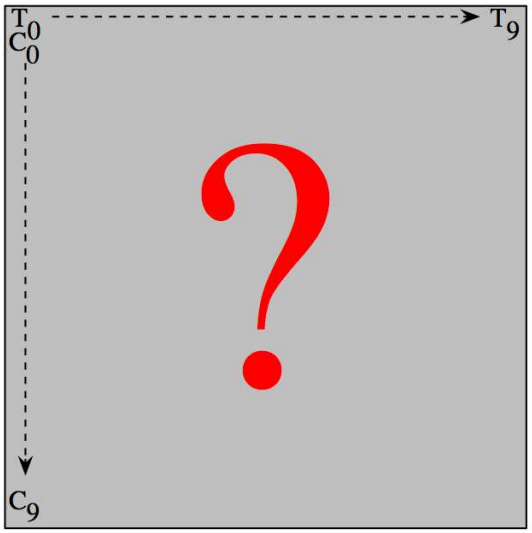
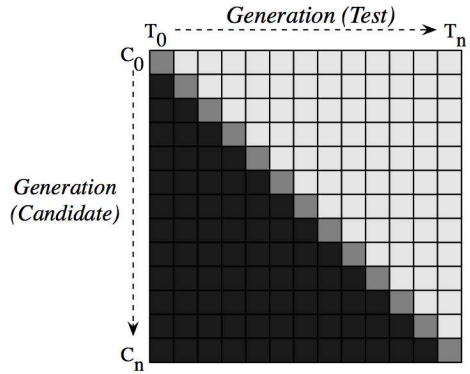
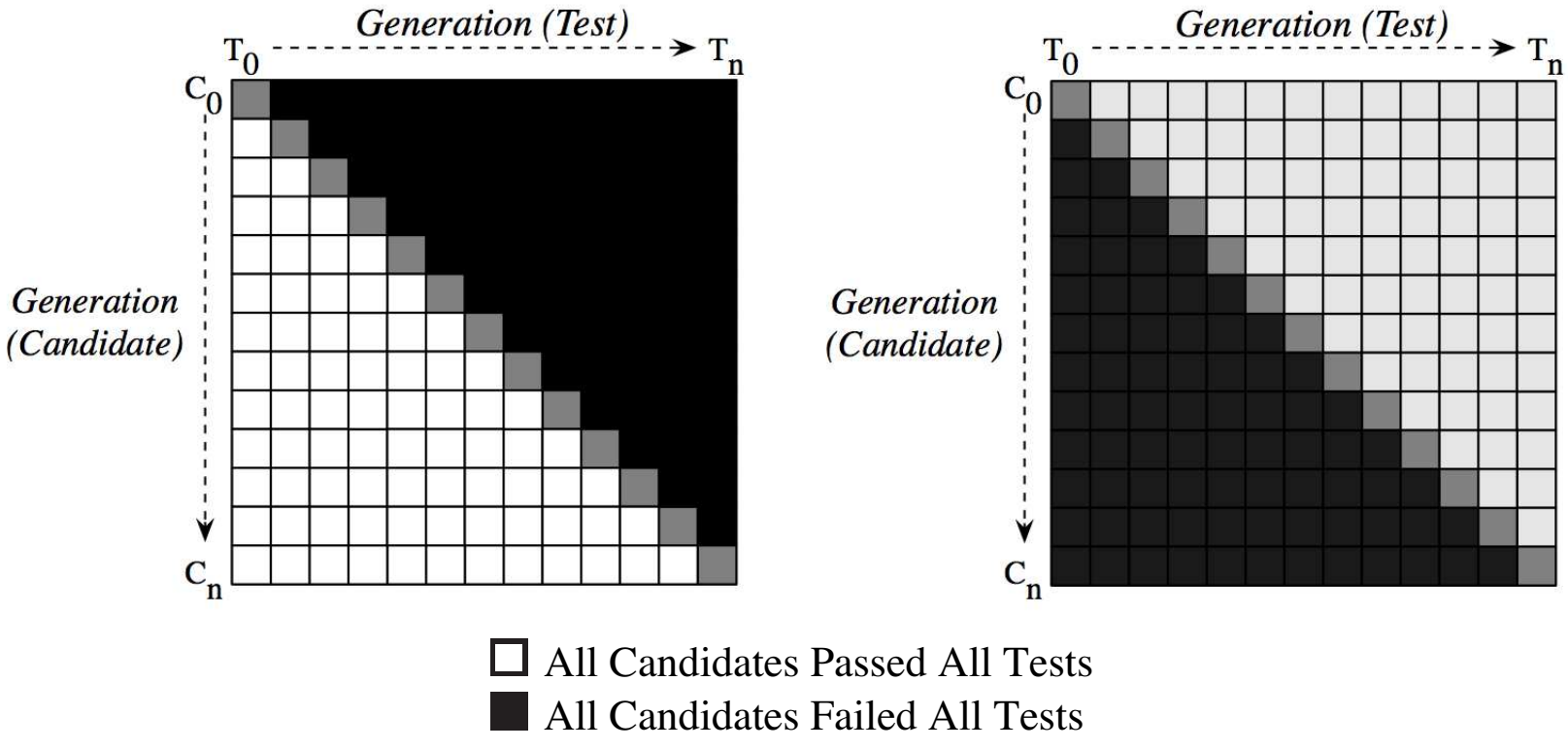




AOG table:
a failure

BOG vs. AOG Differentiating Example

Which is preferable?



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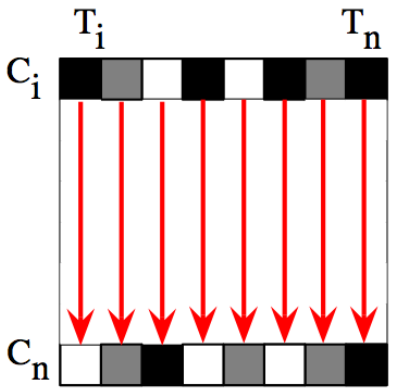

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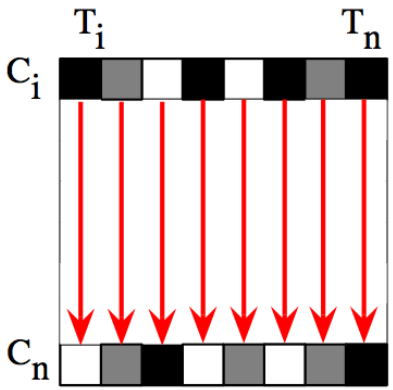

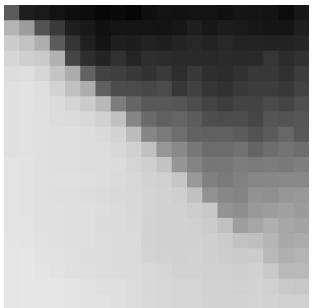

Experimental Domain: ”Numbers Game” Variants

from (Watson & Pollack)

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- 1D variant: Individuals are points on a line. The higher value wins.
- ”Intransitive” variant: Individuals are points on 2D grid. The ”winner” has the higher value in dimension for which the two are closer.
- ”Compare-on-one” variant: Individuals are points on 2D grid. The ”winner” has the higher value in test’s greater dimension.

Profiles of Coevolutionary Failures

Sought to reproduce common coevolutionary behaviors:

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Sought to reproduce common coevolutionary behaviors:

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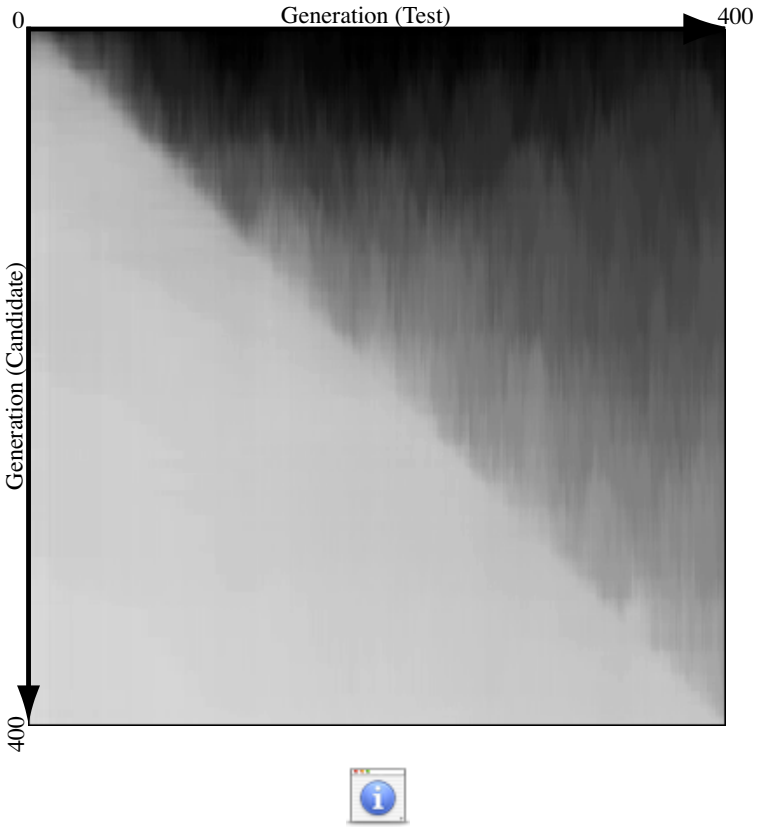
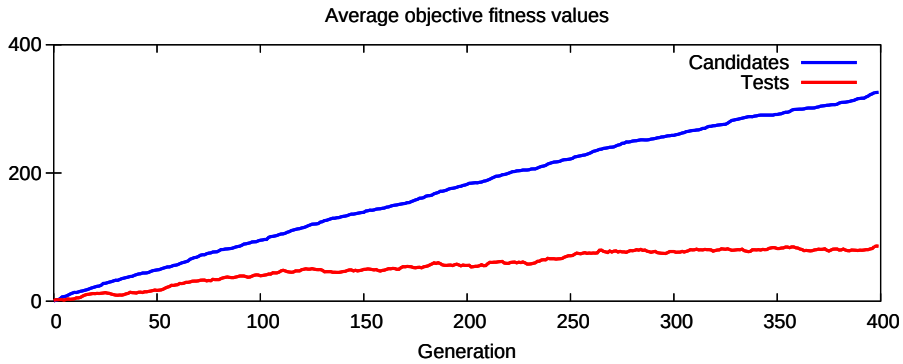
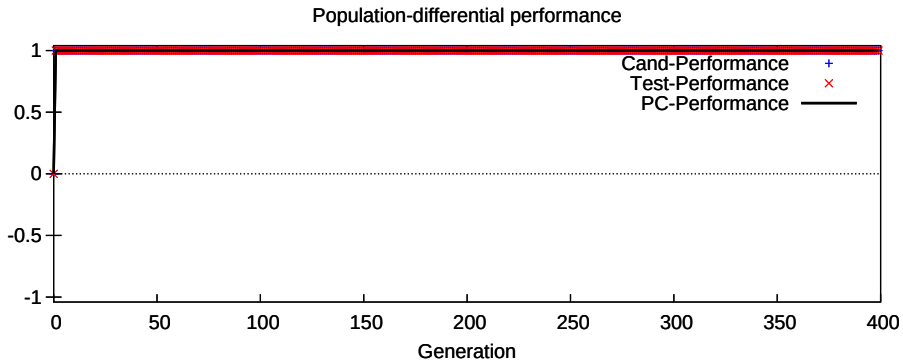
- ”lock-in failure”
- ”variation”
- ”disengagement” (due to lack of gradient)
- ”cycling”

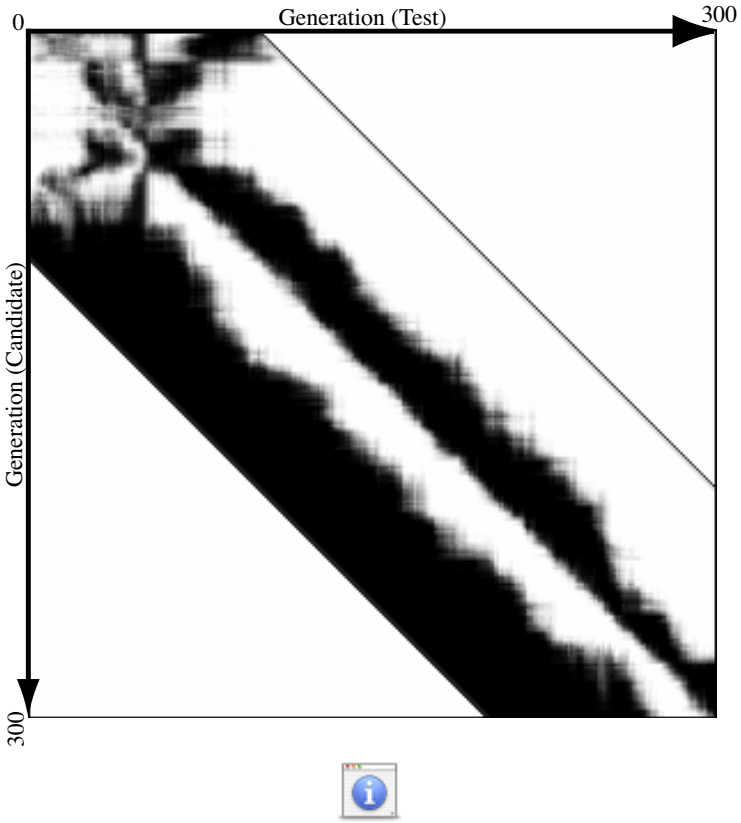
Behavior Example: Arms-Race Dynamics

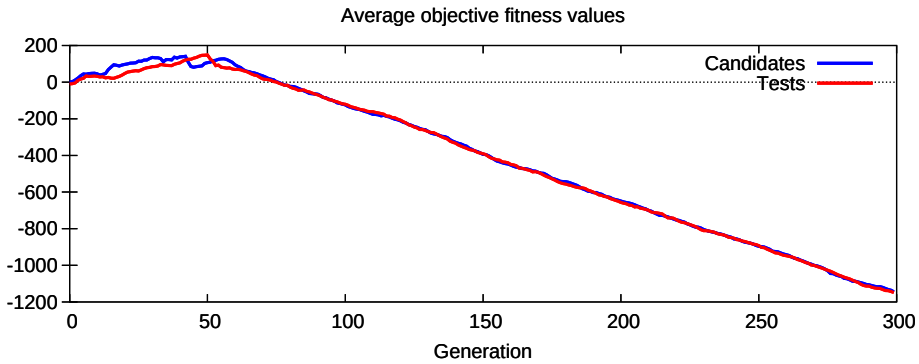


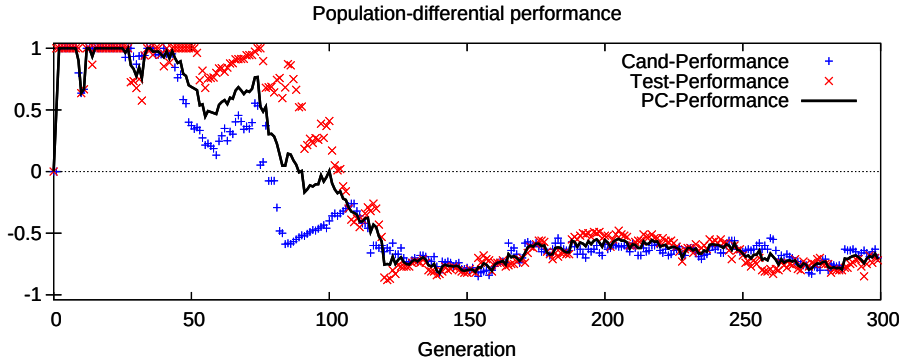




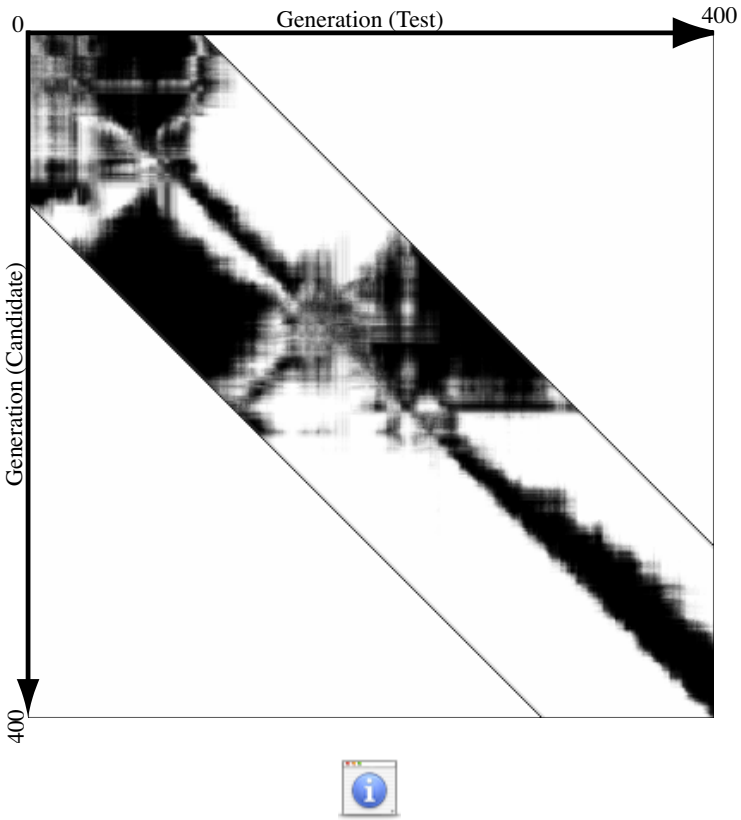
Behavior Example: Lock-In Failure

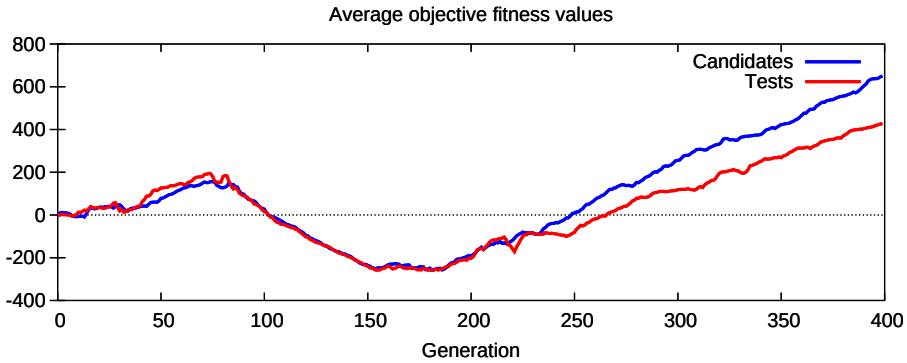


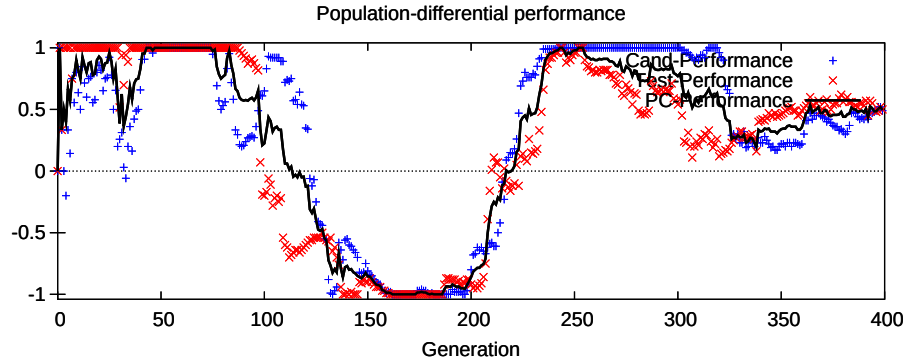




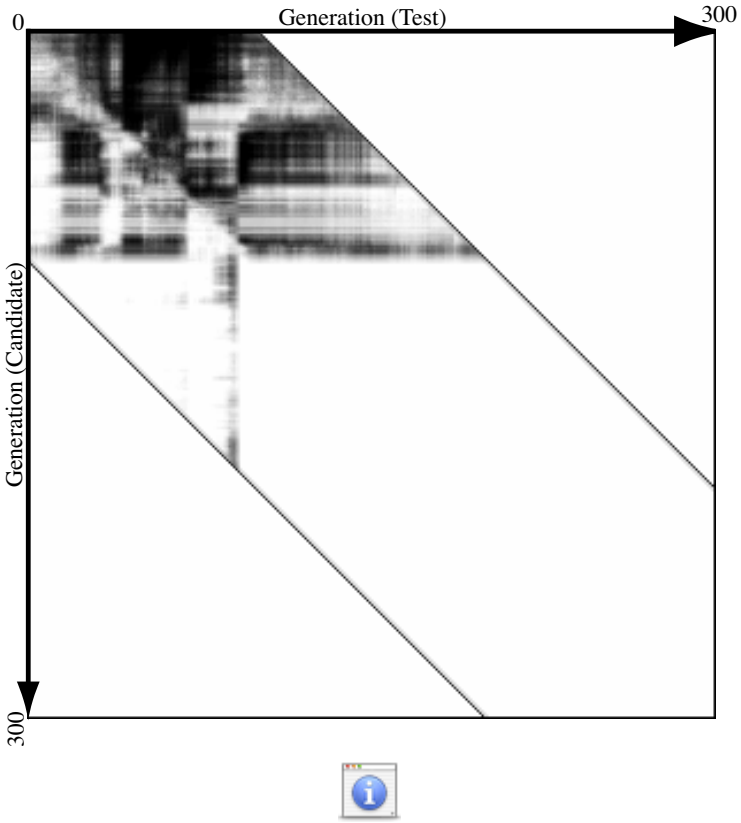
Behavior Example: Variation

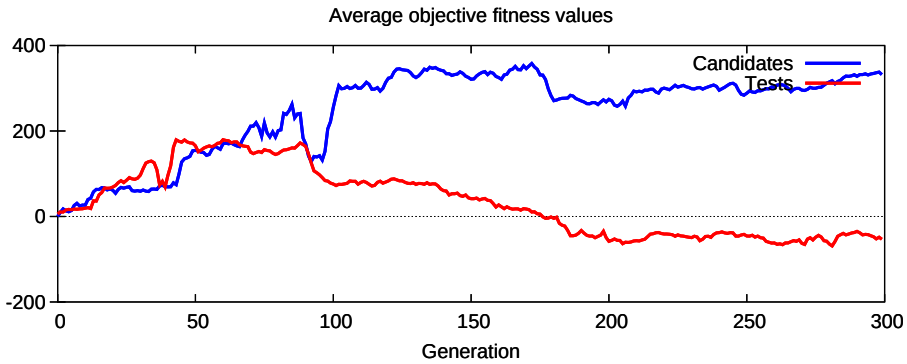


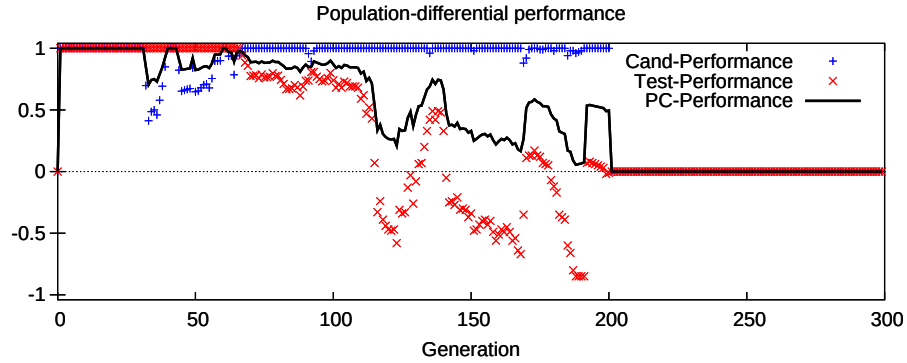




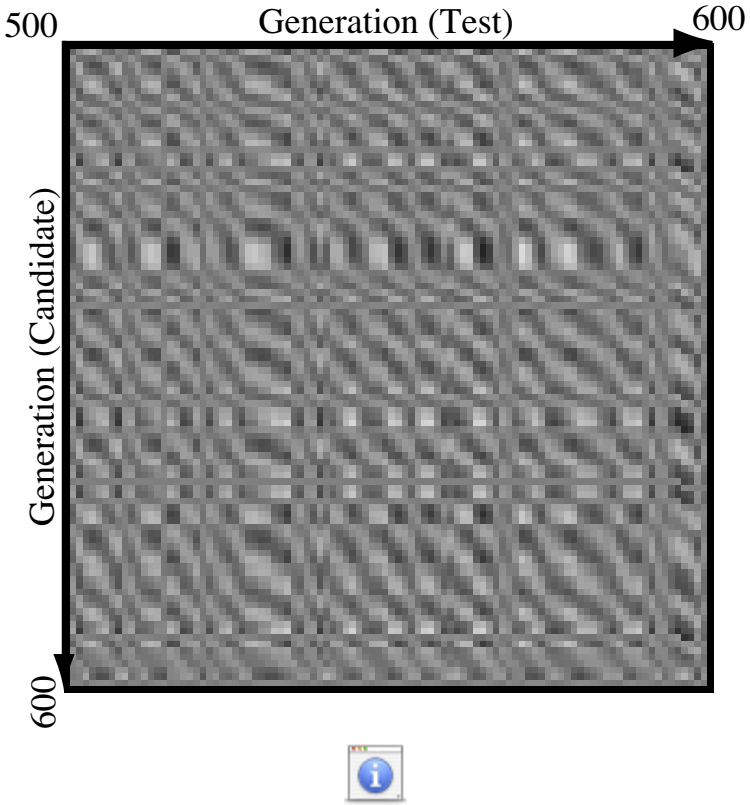
Behavior Example: Disengagement

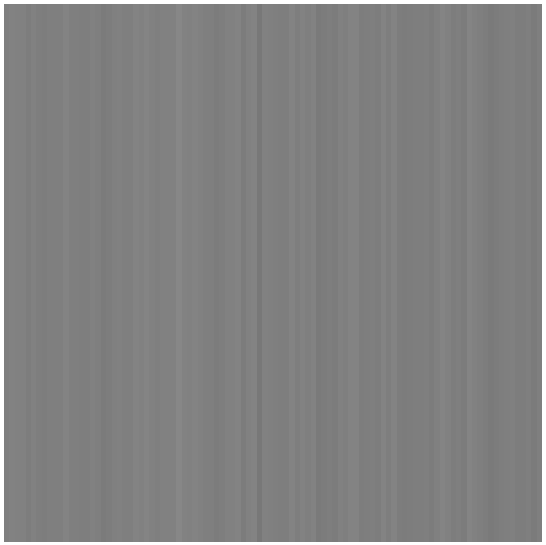


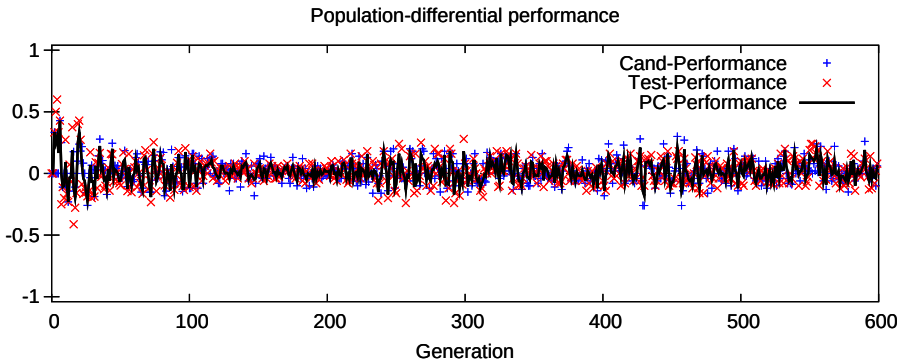




Behavior Example: Cycling







Summary

- BOG-based analysis is good for monitoring successes but not so good for monitoring failures
- AOG-based analysis uses information on the entire population (not just the ”best”)
- The ”Generation-Table approach” to coevolutionary analysis continues to yield useful techniques.

Thank you

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Brandeis University
DEMO Lab, Computer Science Department

AAAI 2005 Fall Symposium:
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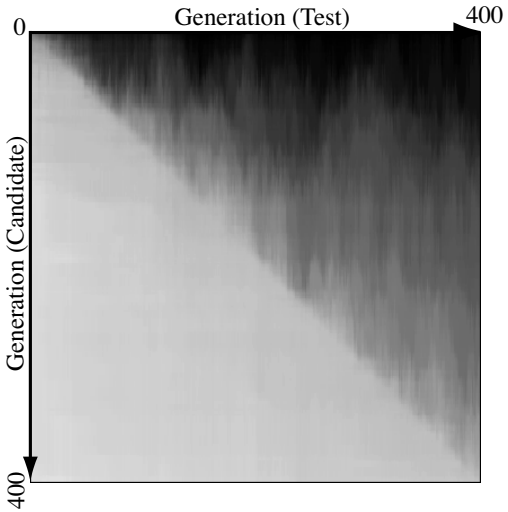
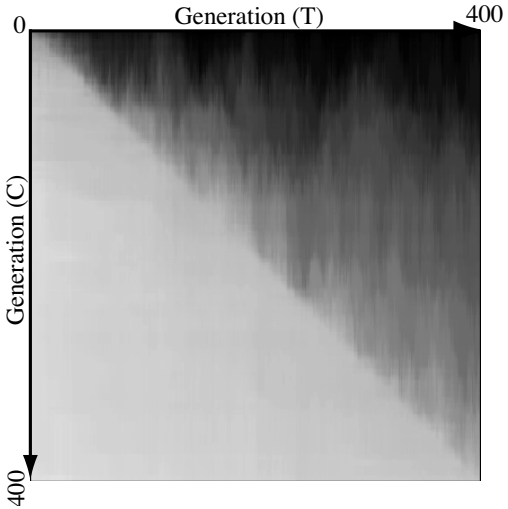
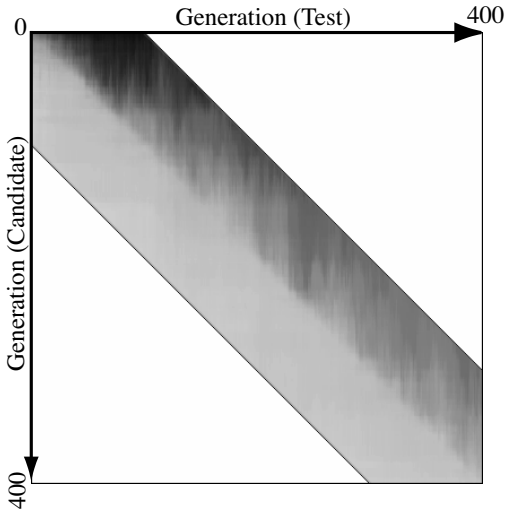
AOG Memory Policies to Reduce Computation

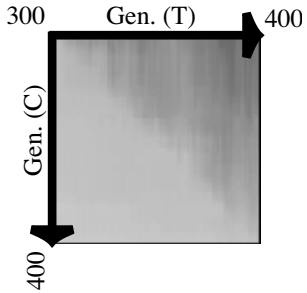
Lossless



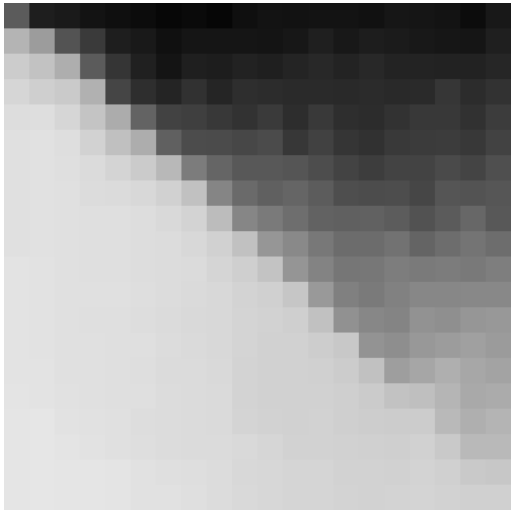


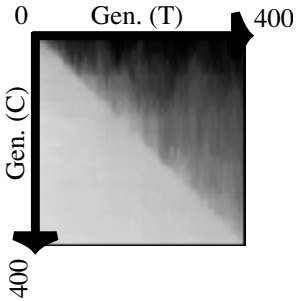
Bounded





Sampled





Memory Size Can Affect Interpretation