

# Parameter Control in Search-Based Generation of Unit Test Suites

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```
@Test
public void test9() throws Throwable {
    SpearmansCorrelation spearmansCorrelation0 = new SpearmansCorrelation();
    double[][] doubleArray0 = new double[1][1];
    // Undeclared exception!
    try {
        RealMatrix realMatrix0 = spearmansCorrelation0.computeCorrelationMatrix(doubleArray0);
        fail("Expecting exception: IllegalArgumentException");

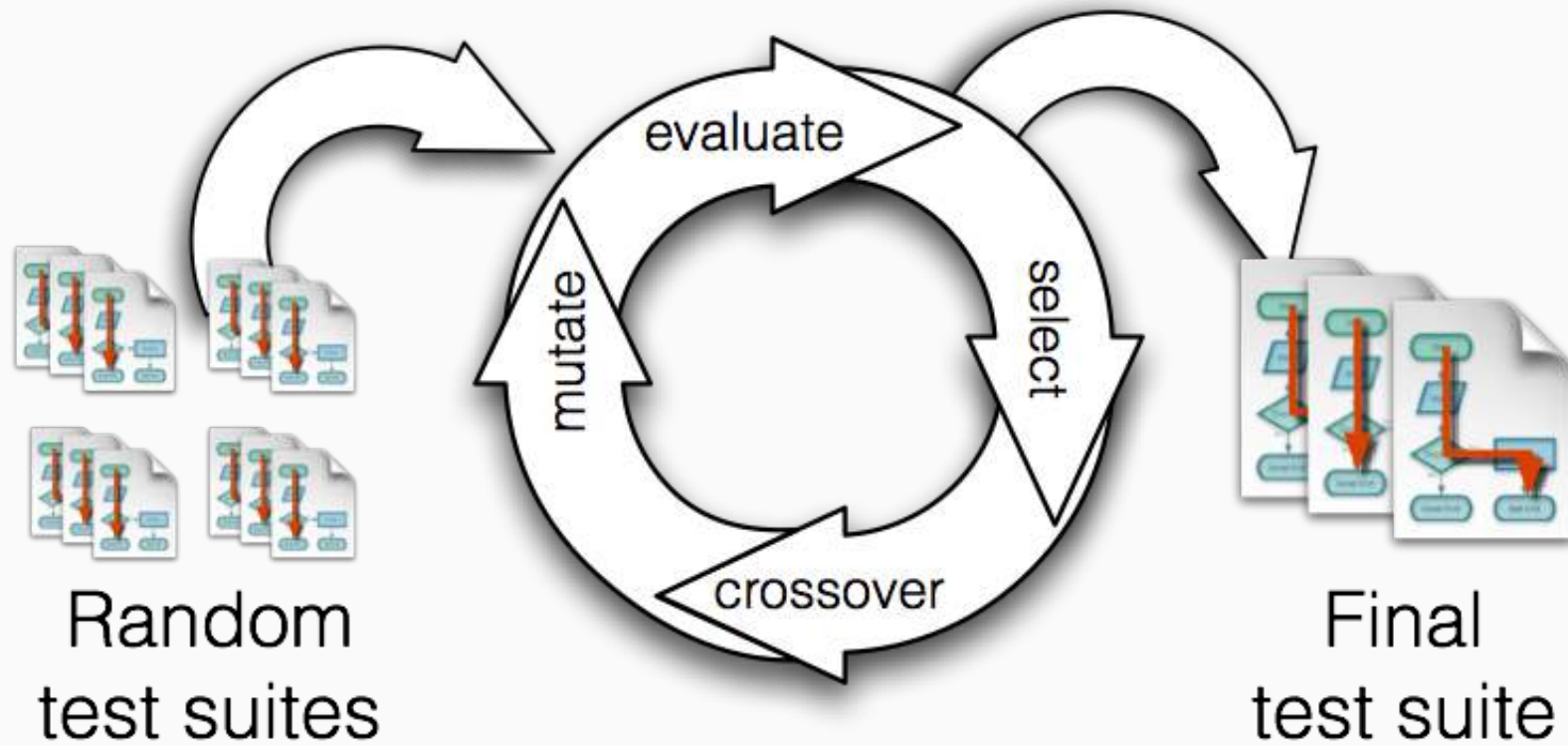
    } catch (IllegalArgumentException e) {
        //
        // insufficient data: only 1 rows and 1 columns.
        //
    }
}
```



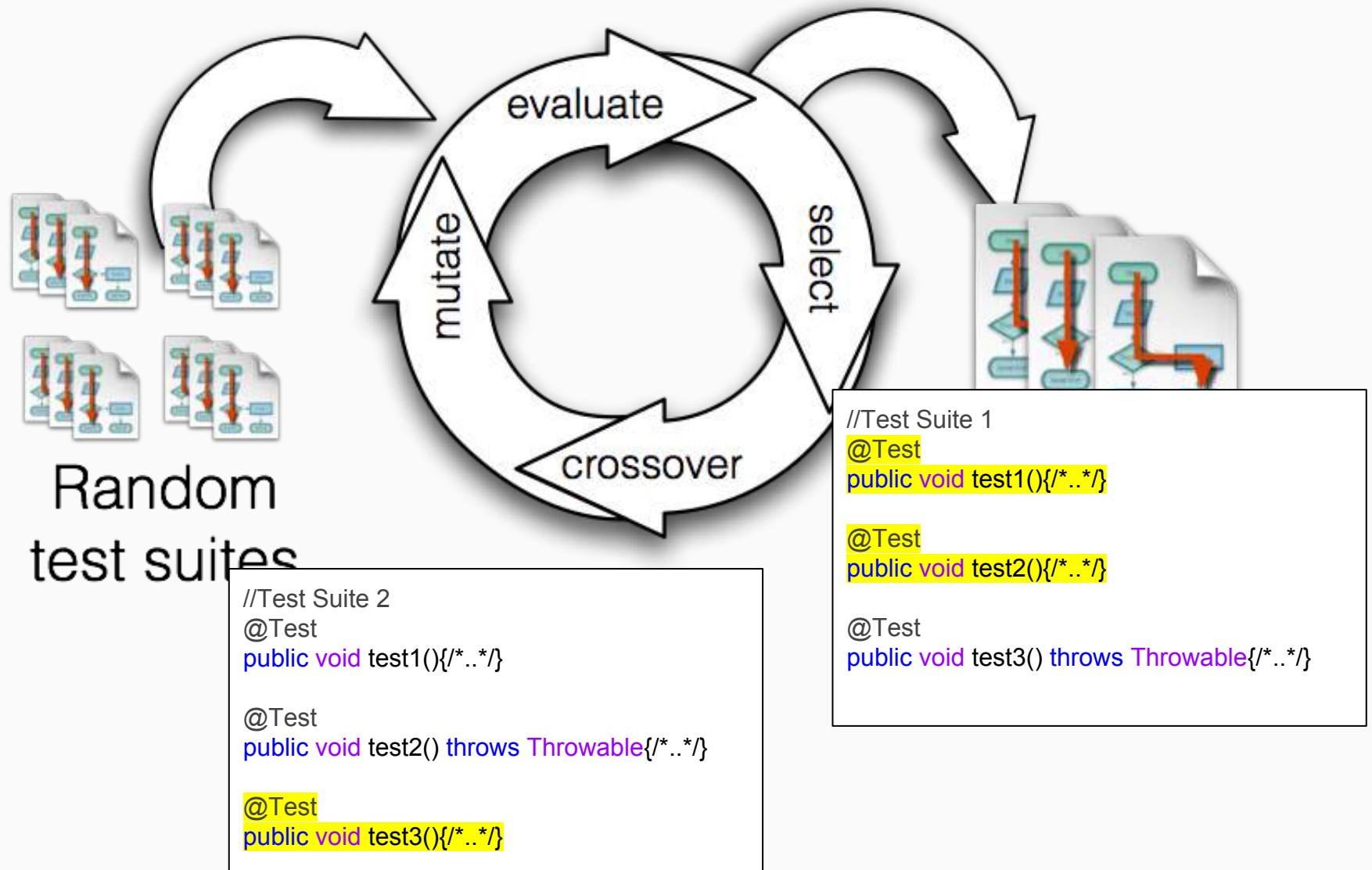
The  
University  
Of  
Sheffield.

EVASUITE

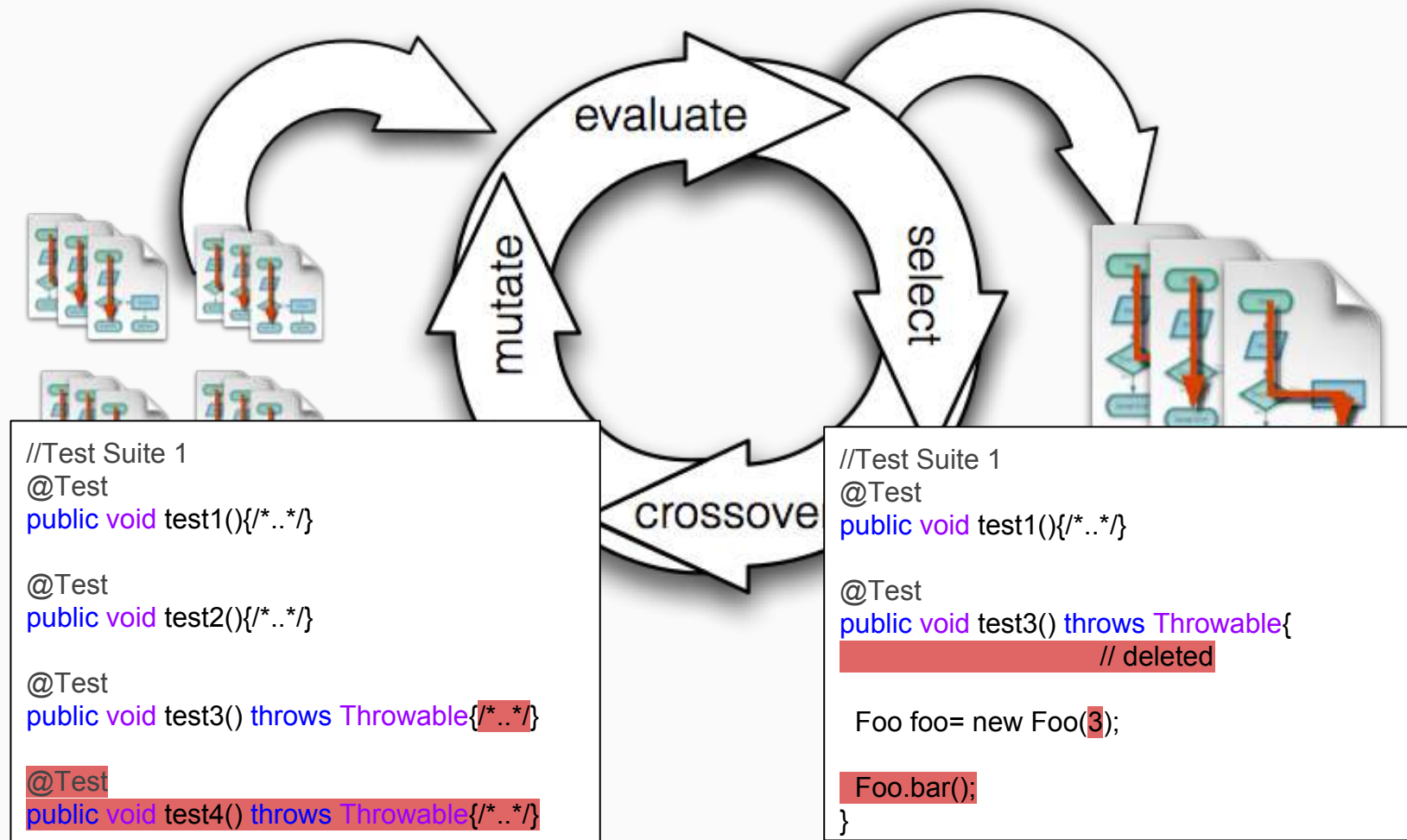
# EVOSUITE



# EVOSUITE



# EVOSUITE



# Parameters in a GA

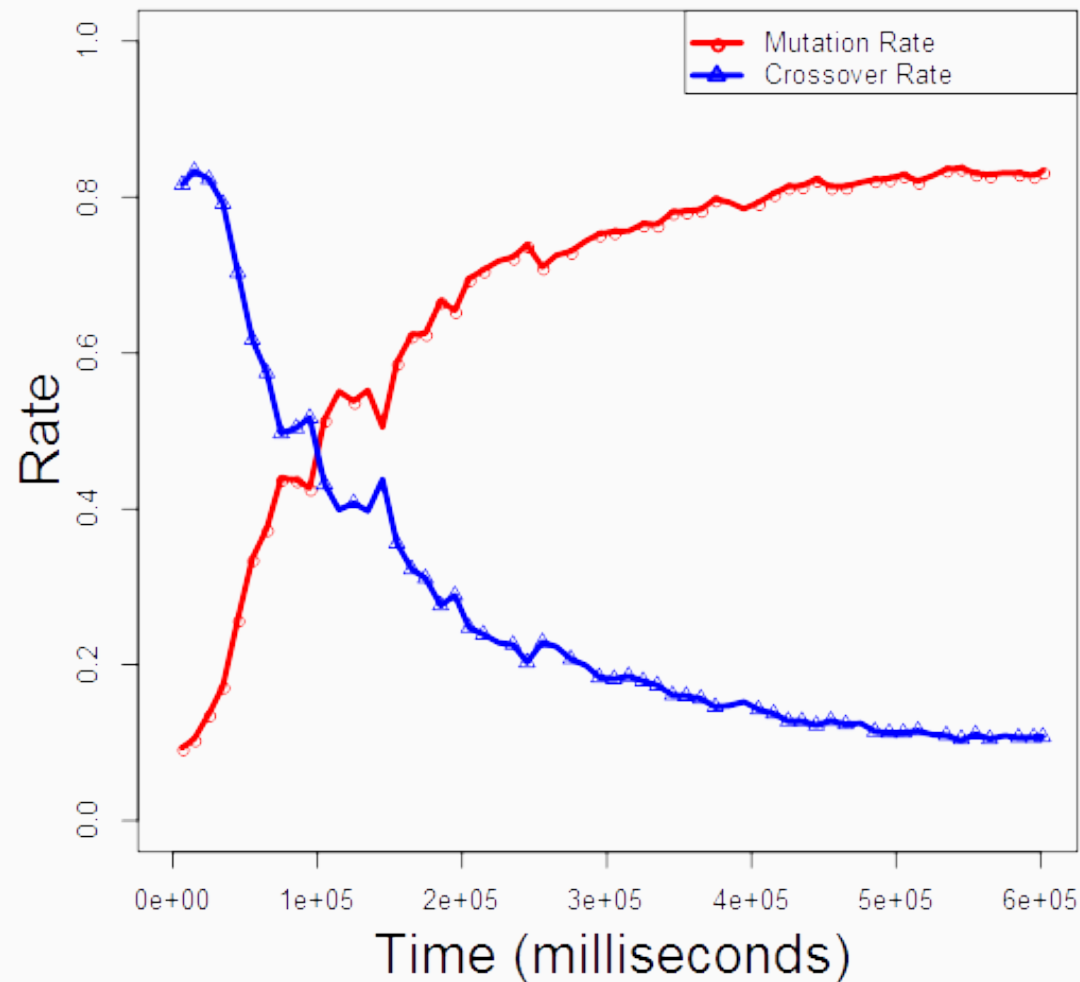


A. Arcuri and G. Fraser, "On parameter tuning in search based software engineering," in *Proceedings of the Third International Conference on Search Based Software Engineering*, Berlin, Heidelberg, 2011, pp. 33-47.

# Parameter Control

Adapts parameters during runtime.

Adaptive Parameter Control





# Experiment Set-up

Project	Class	Lines of Code (LOC)	Coverable branches
org.apache.commons.cli	CommandLine	152	49
	GnuParser	62	21
	HelpFormatter	416	143
	Option	227	98
	Options	106	33
	Parser	206	75
org.apache.commons.collections4	ListUtils	248	89
org.apache.commons.csv	CSVFormat	424	190
	CSVParser	209	69
	Lexer	245	141

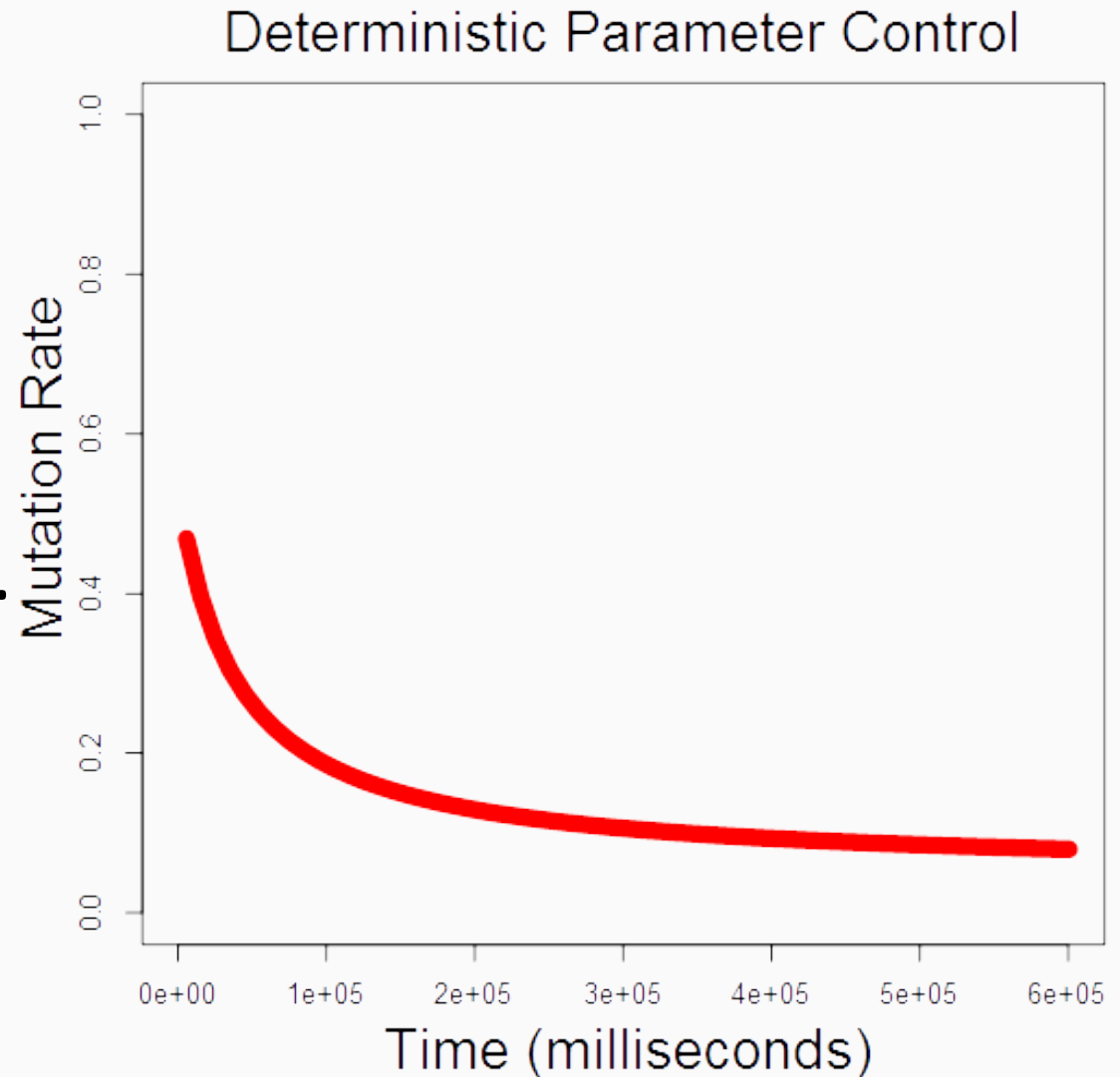


**Apache Commons**<sup>TM</sup>  
<http://commons.apache.org/>

# Deterministic

Modifies parameter values based on a schedule.

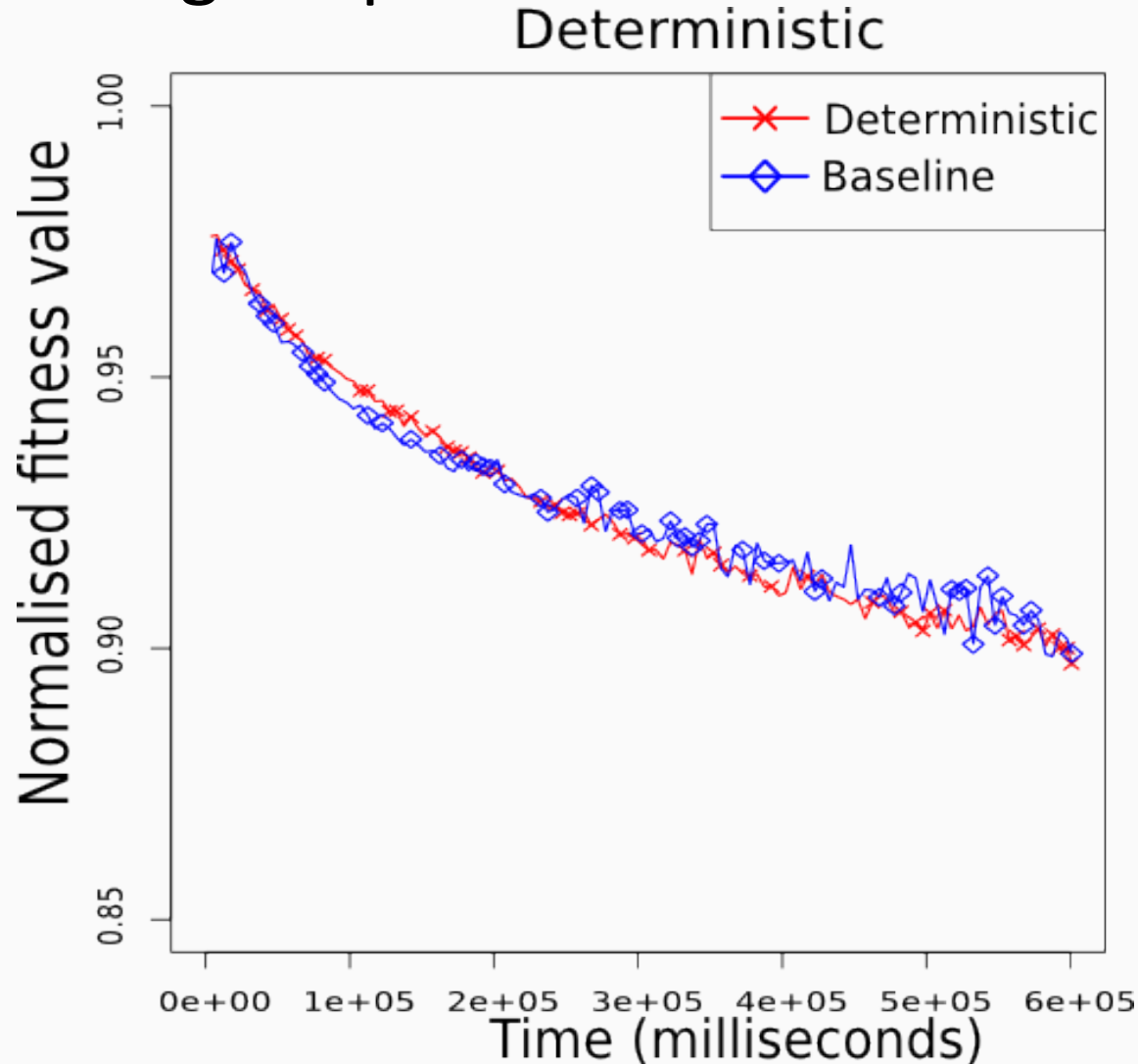
Values are predictable.





# Deterministic

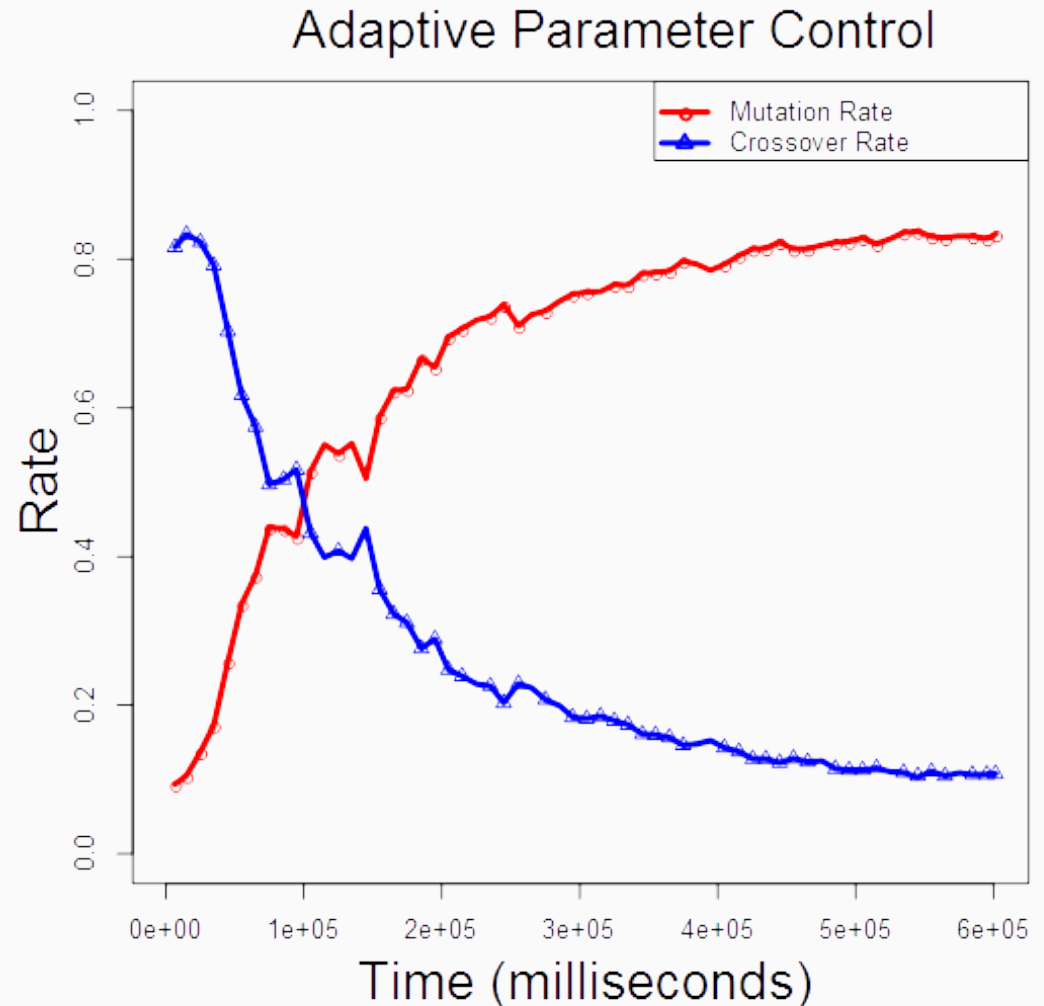
Gave a marginal performance increase in EVOSUITE.



# Adaptive

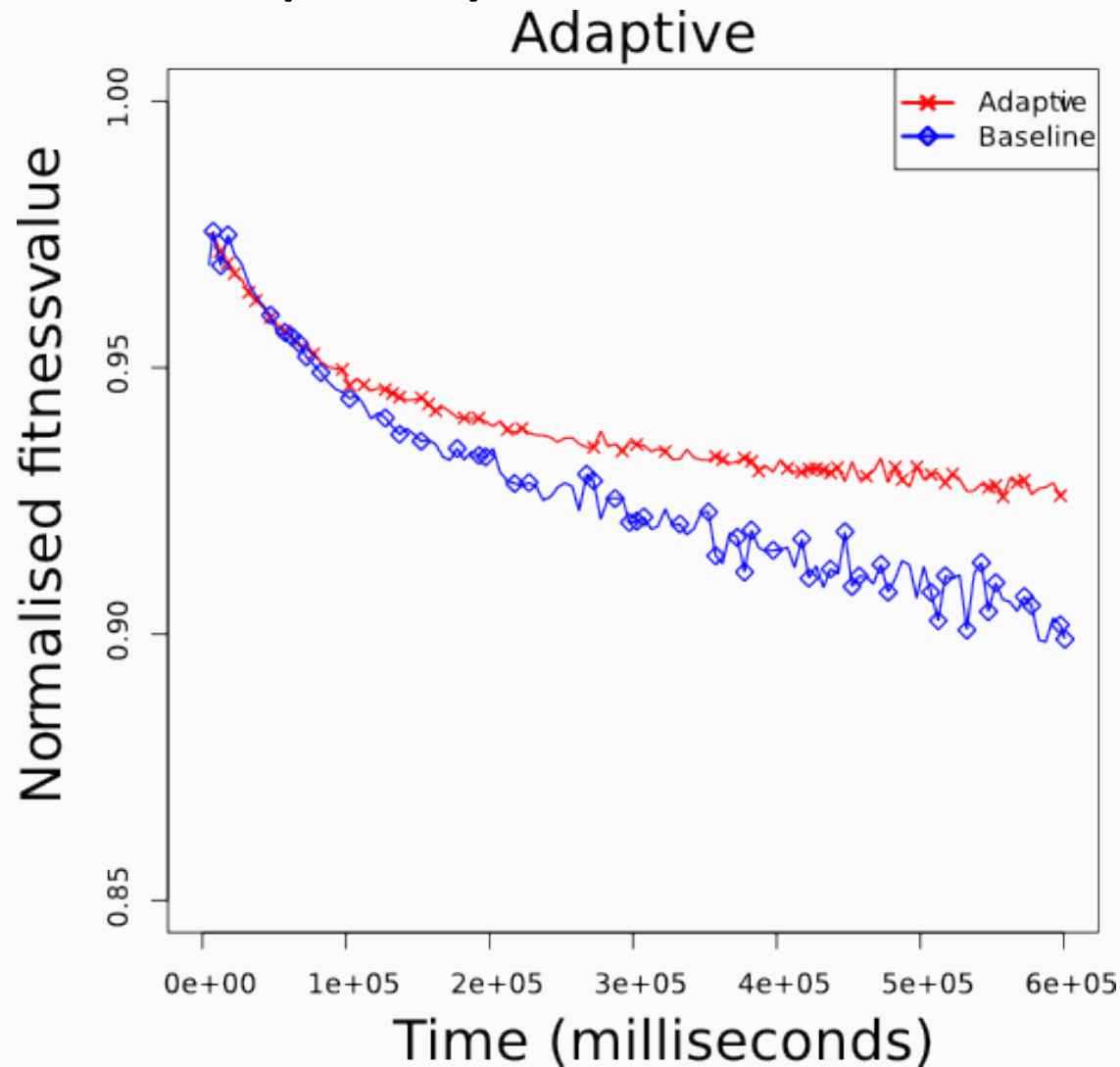
Modifies parameter values using current and past states of the GA.

High mutation rate meant more fitness evaluations per iteration.



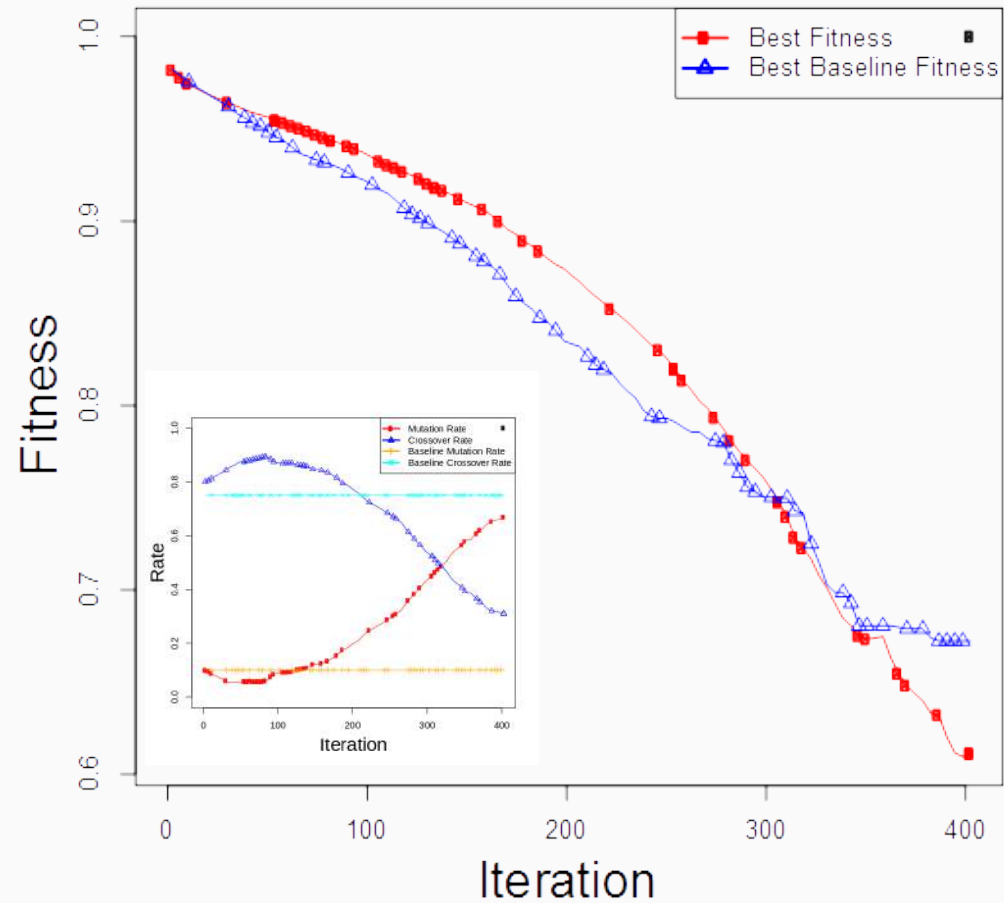
# Adaptive

Performed poorly due to stunted evolution.

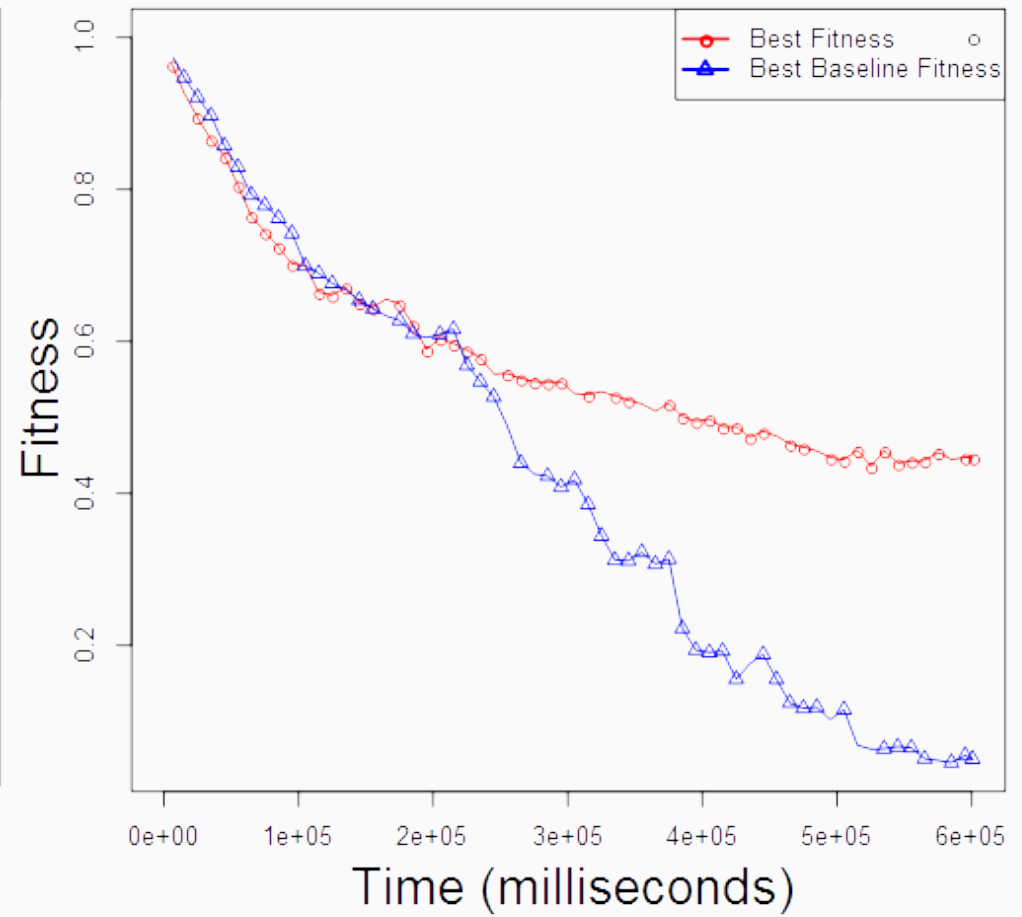


# Adaptive Iteration vs. Time

Adaptive Parameter Control  
org.apache.commons.cli.Option (Iteration)



Adaptive Parameter Control  
org.apache.commons.cli.Option (Time)

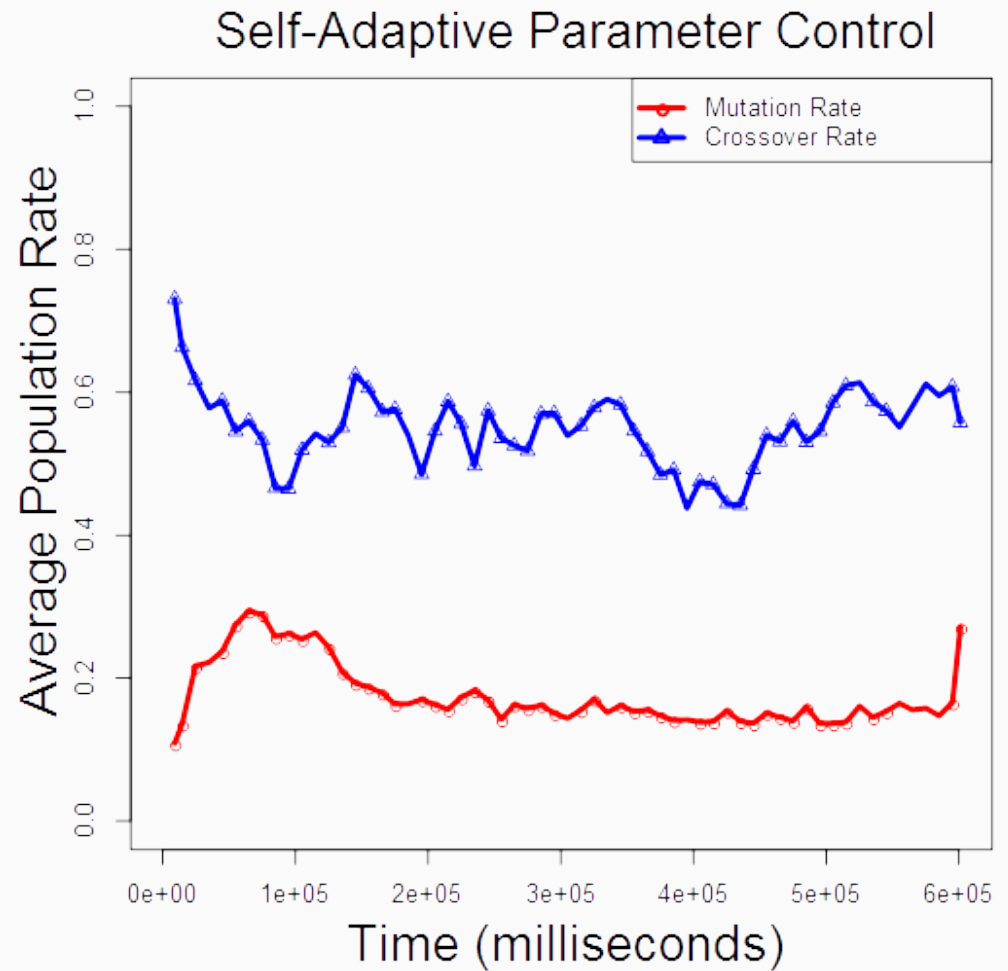


# Self-Adaptive

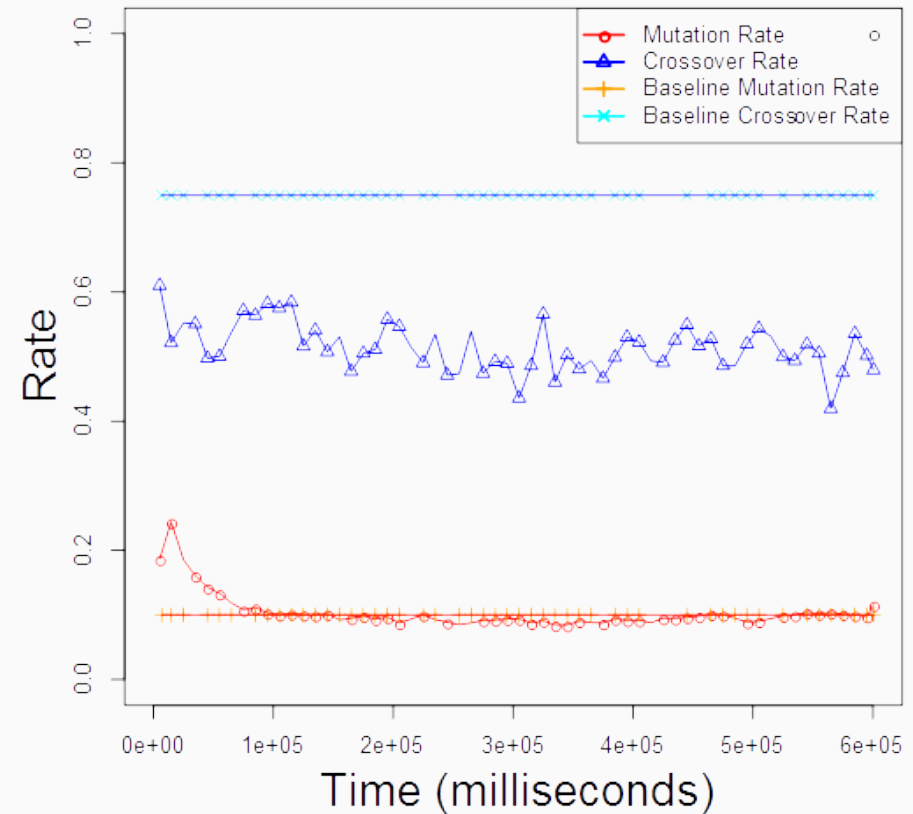
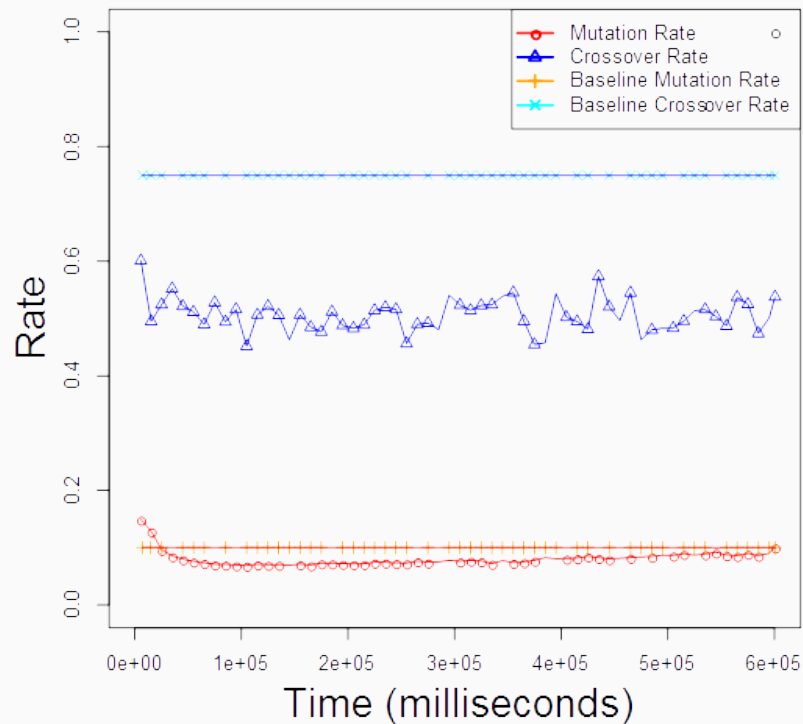
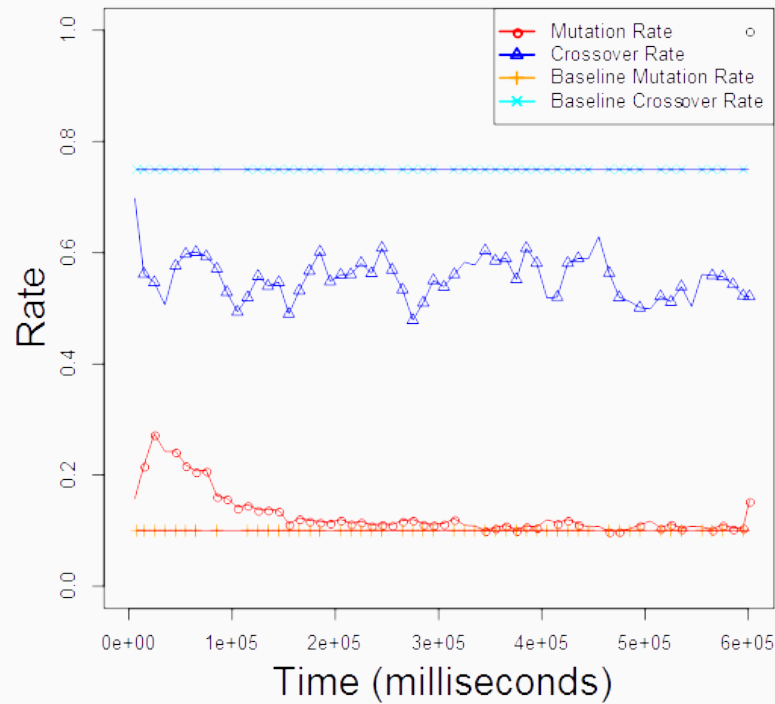
Embeds parameters into the individuals of the population.

Same principle as a Genetic Algorithm

- The fitter values survive and evolve further

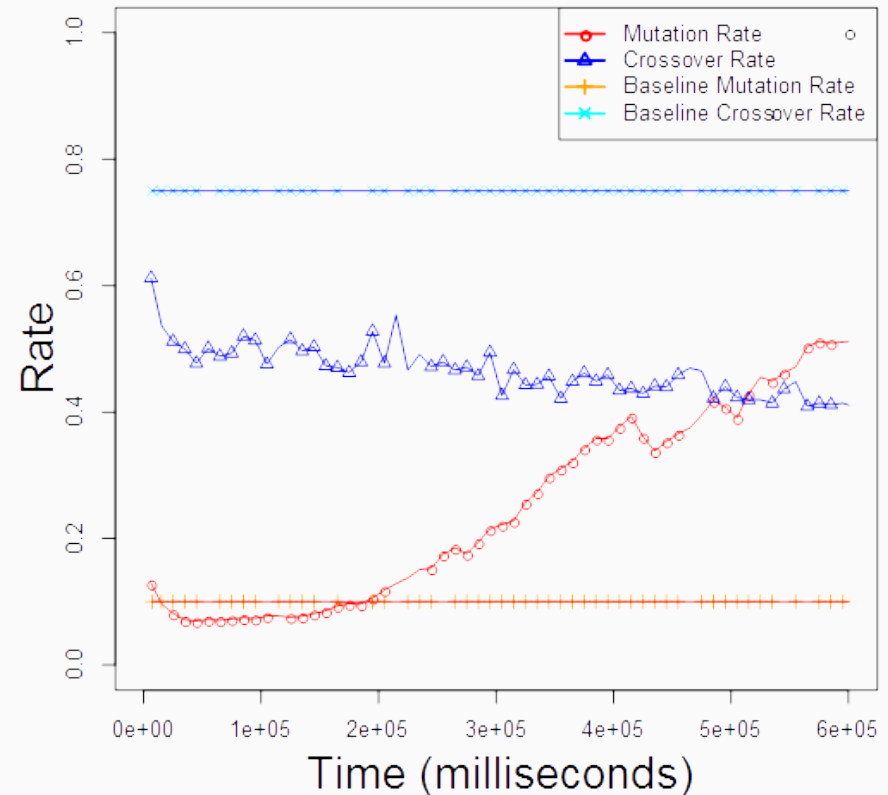
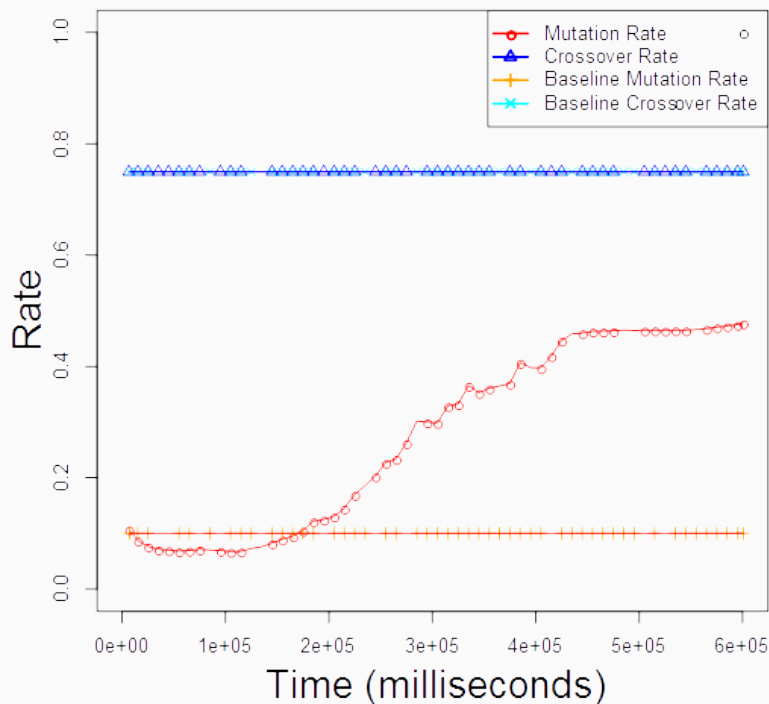
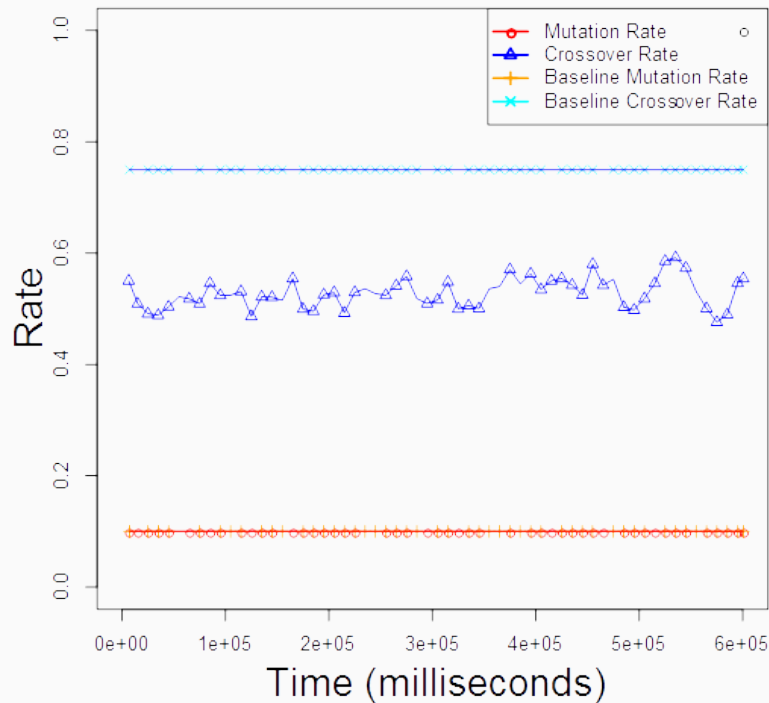


# Self-Adaptive Observations



Self-Adaptive method controlling both parameters on 3 unique classes

# Self-Adaptive Observations

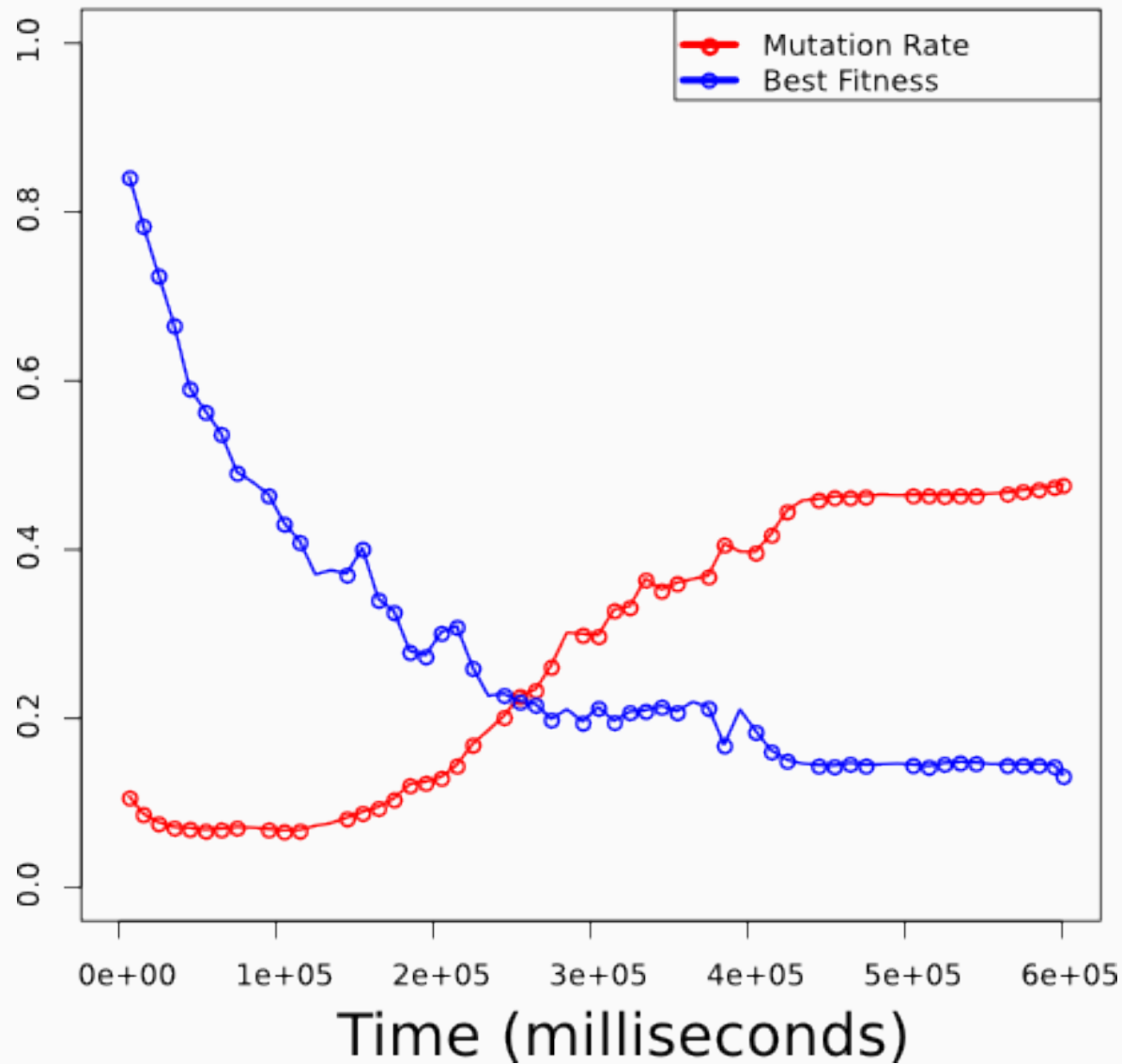


Self-Adaptive method controlling different parameters on the Options class



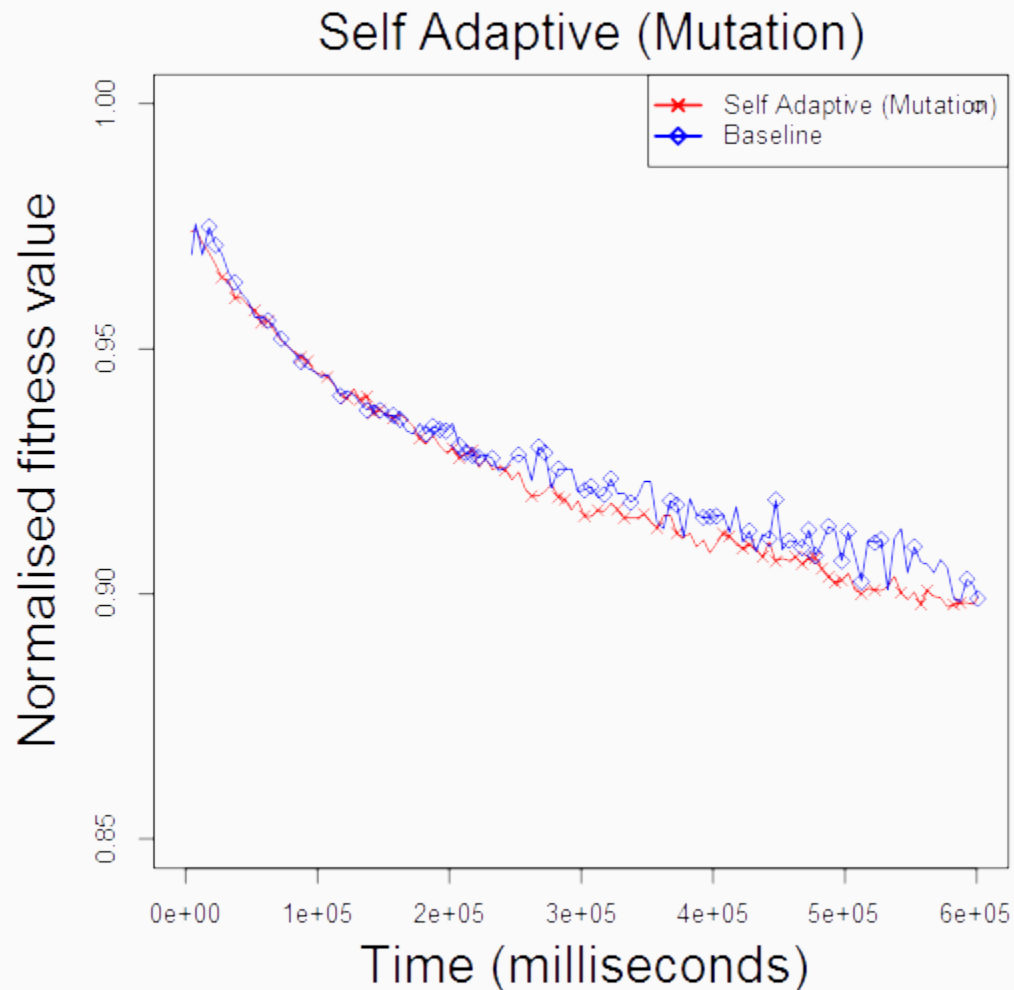
# Self-Adaptive Observations

Self-Adaptive (Mutation) PC



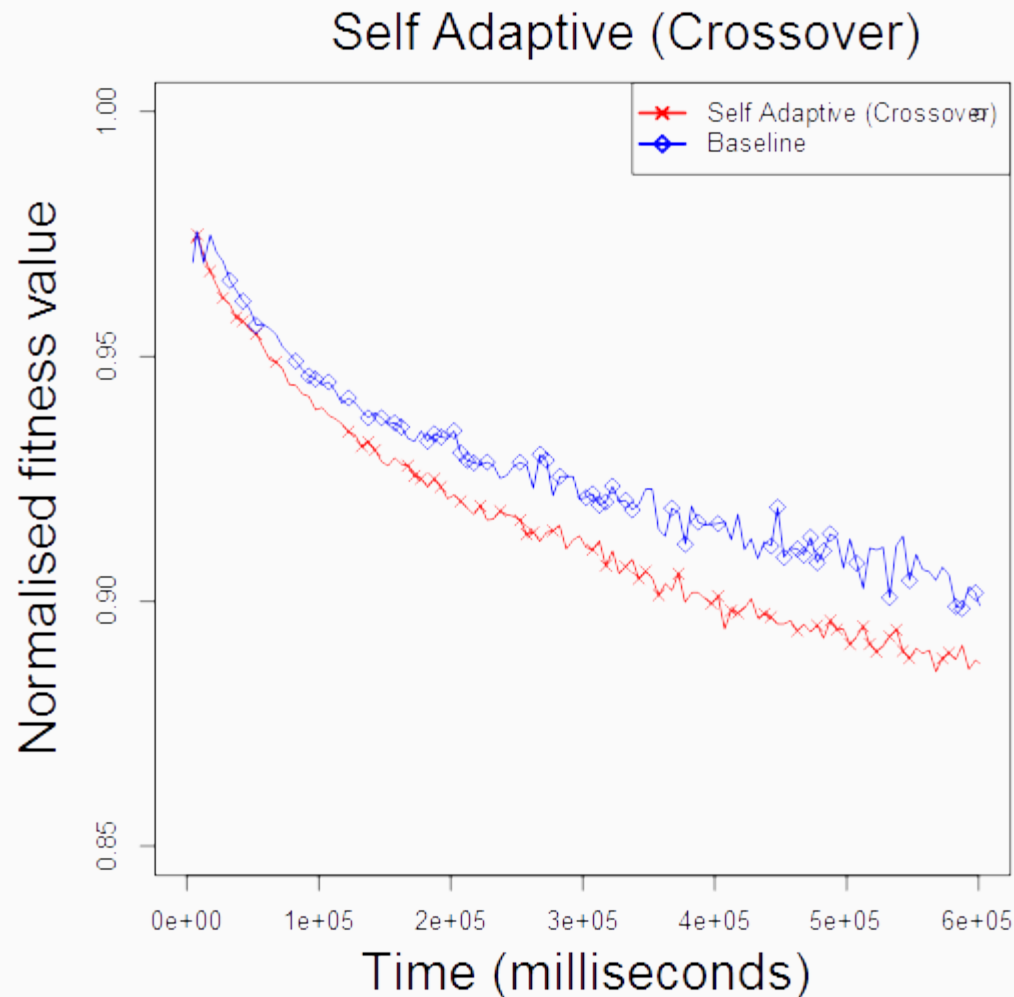
# Self-Adaptive (Mutation)

Gave a fractional performance decrease in EVOSUITE.



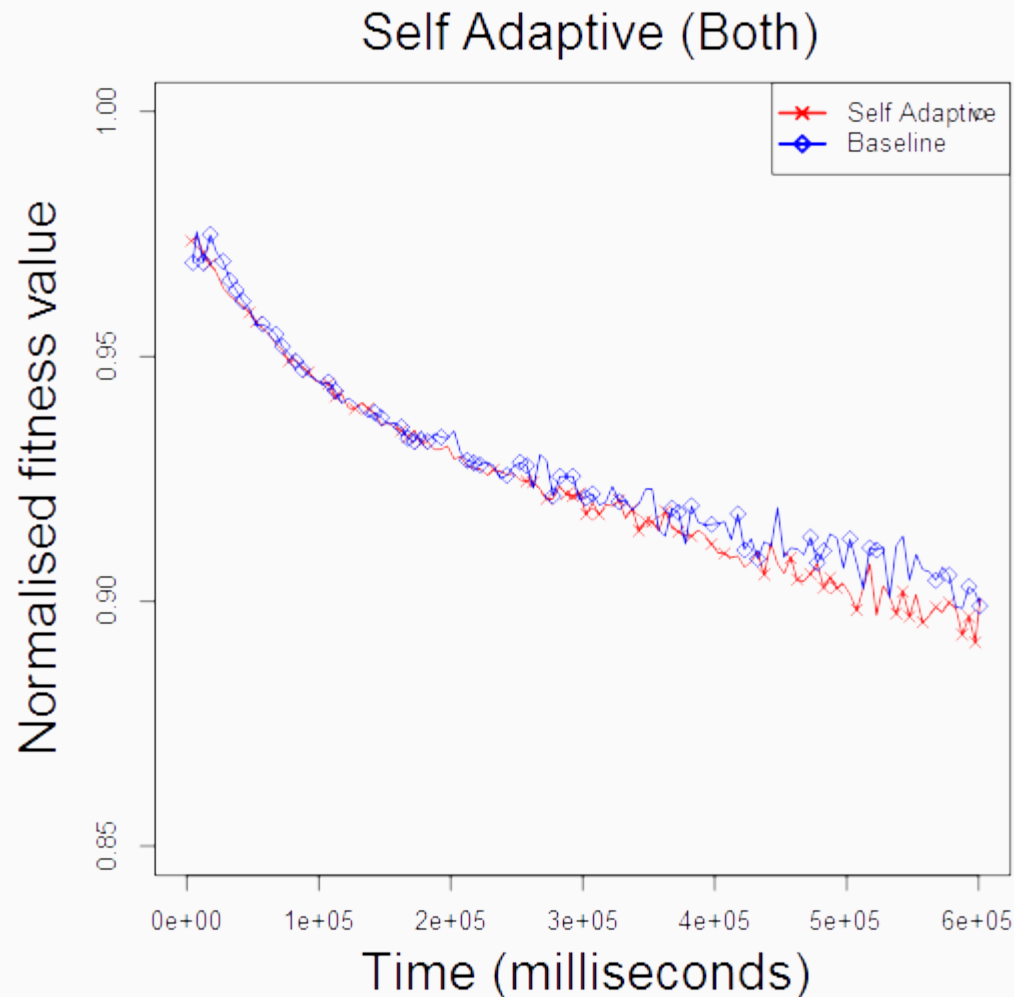
# Self-Adaptive (Crossover)

Gave a moderate performance increase in EVOSUITE.



# Self-Adaptive (Mutation and Crossover)

Gave a fractional performance increase in EVOSUITE.



# Results

Average Code Coverage across 50 runs

Class	Baseline	Deterministic	Adaptive	SA/Mutation	SA/Crossover	SA/Both
CSVFormat	0.95	0.95	0.91	0.95	0.96	0.94
CSVParser	0.74	0.72	0.69	0.72	0.72	0.72
CommandLine	0.97	0.98	0.98	0.98	0.98	0.98
GnuParser	0.94	0.97	0.94	0.95	0.97	0.96
HelpFormatter	0.87	0.88	0.86	0.87	0.88	0.86
Lexer	0.78	0.76	0.66	0.73	0.8	0.72
ListUtils	0.91	0.91	0.89	0.9	0.91	0.9
Option	1	1	0.98	1	1	1
Options	1	1	1	0.99	0.99	0.99
Parser	0.75	0.8	0.62	0.81	0.85	0.84
AVG Coverage	0.891	0.897	0.853	0.89	0.906	0.891

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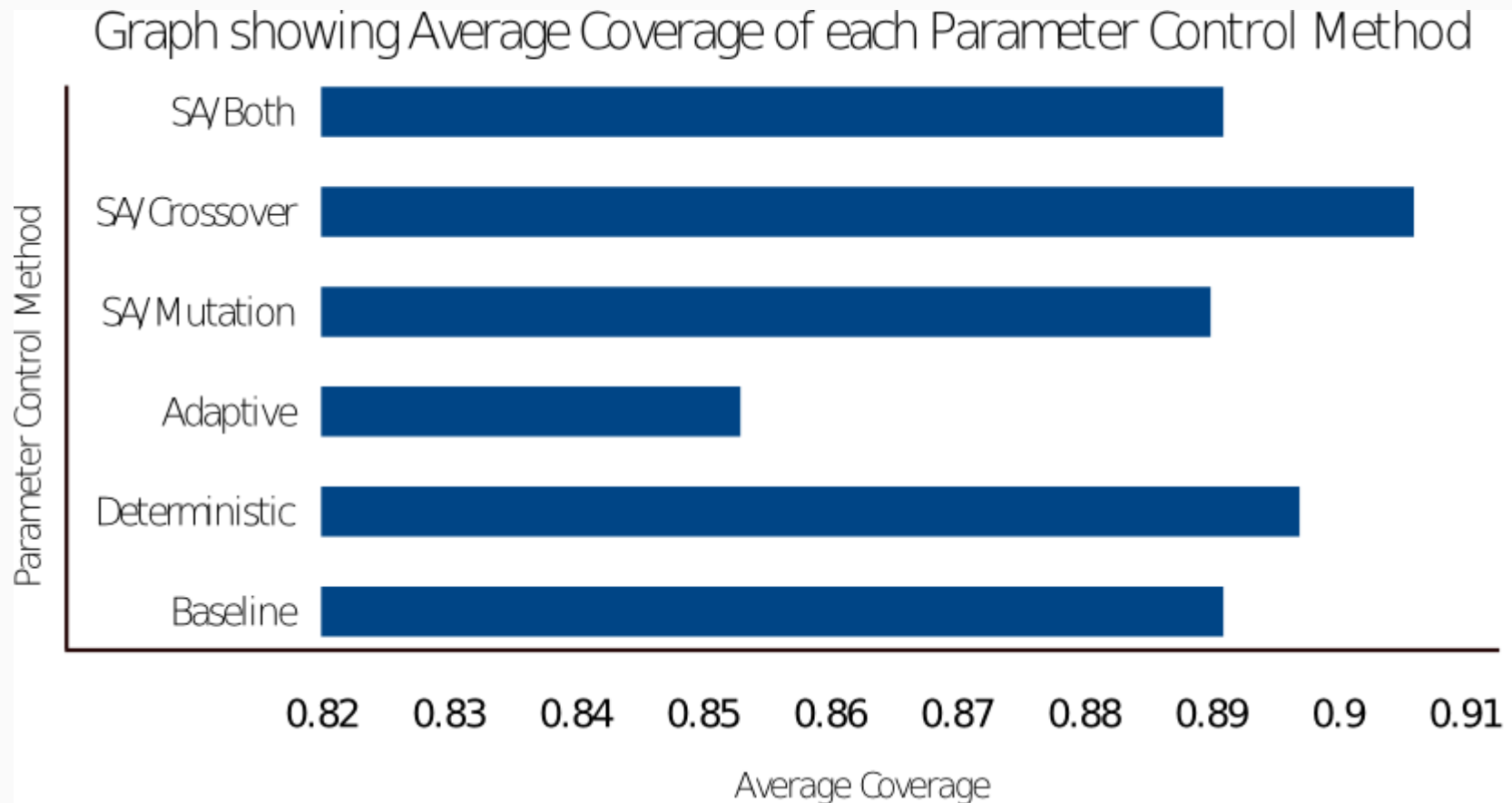


# Results

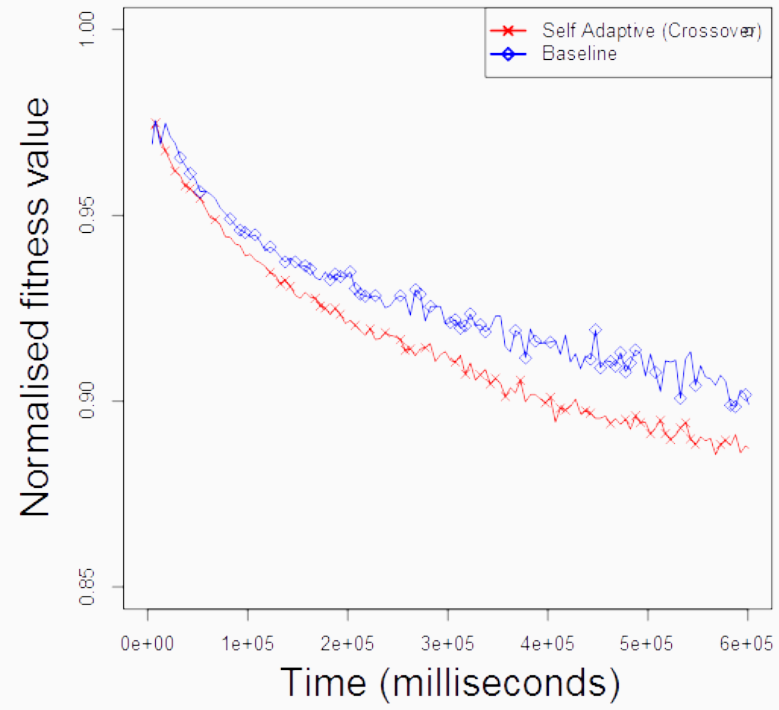
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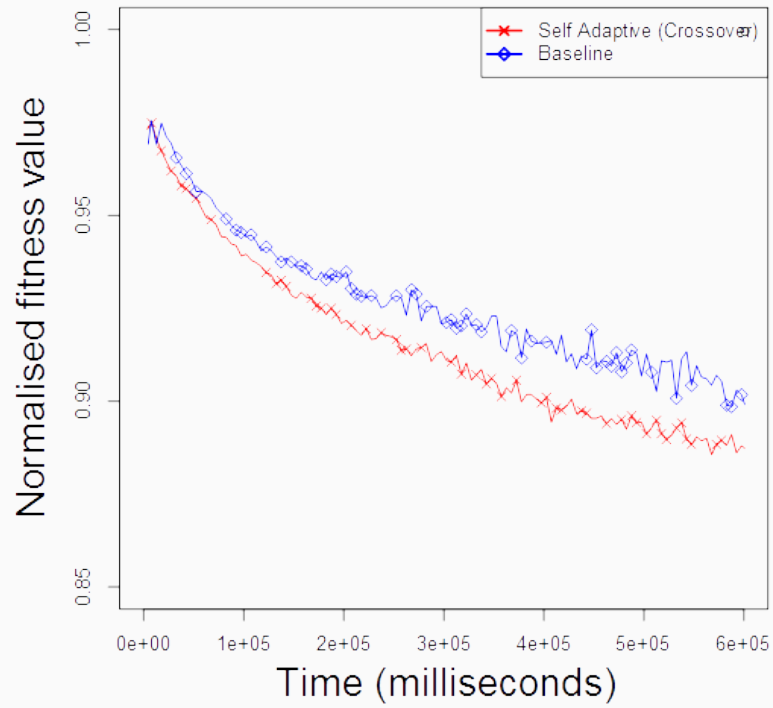
# Results



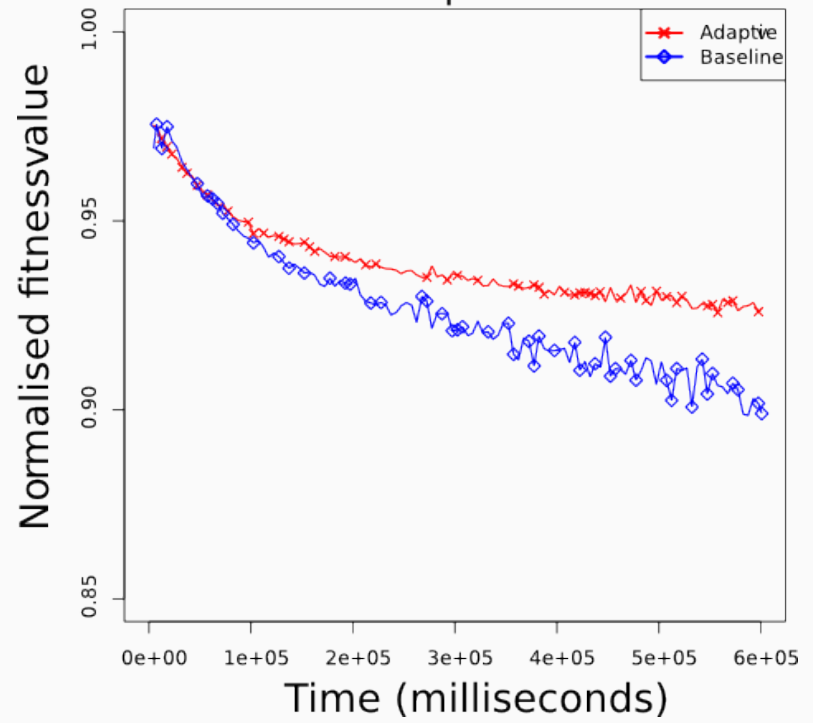
Self Adaptive (Crossover)



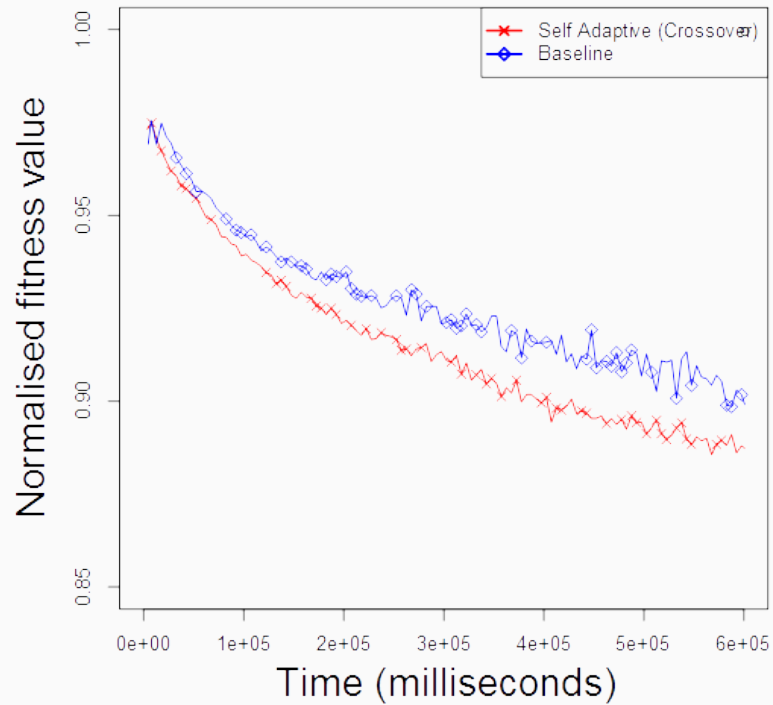
Self Adaptive (Crossover)



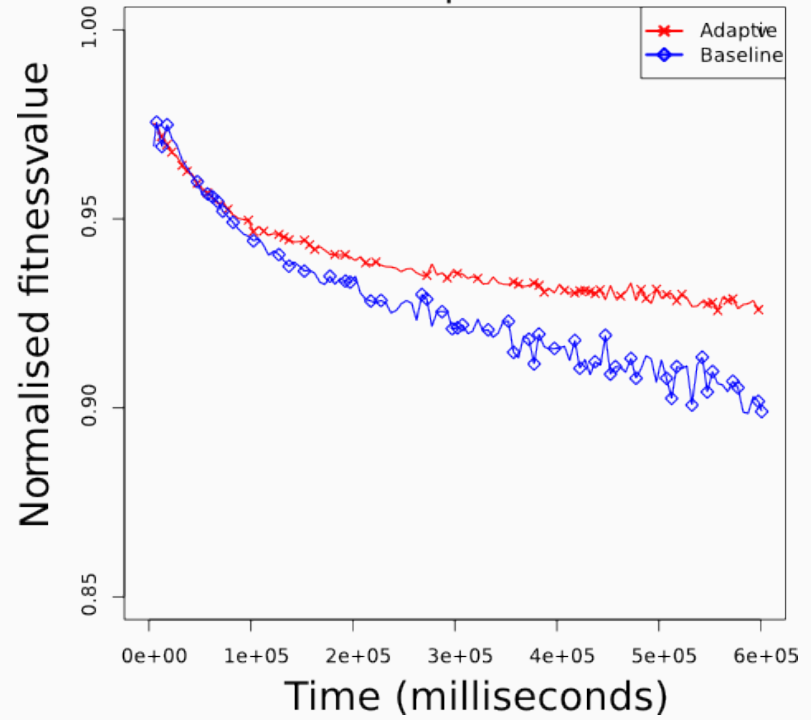
Adaptive



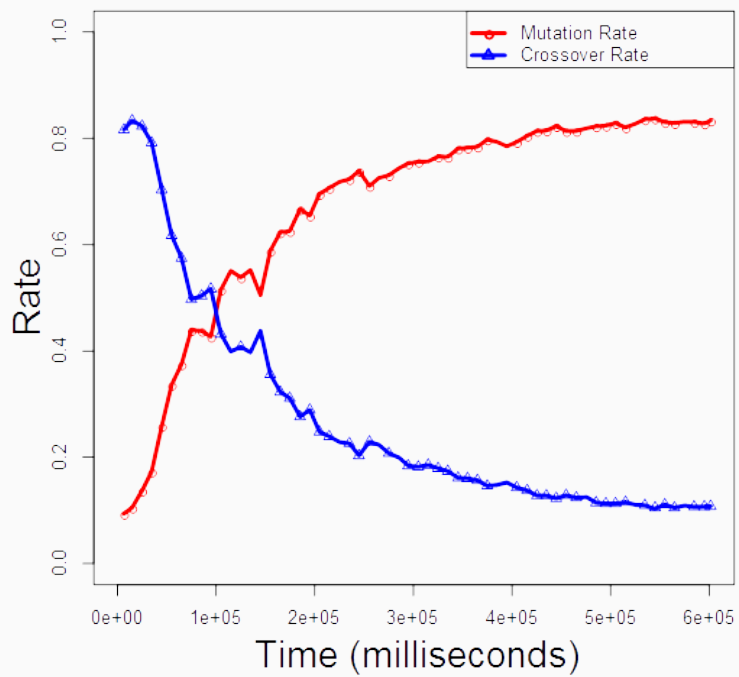
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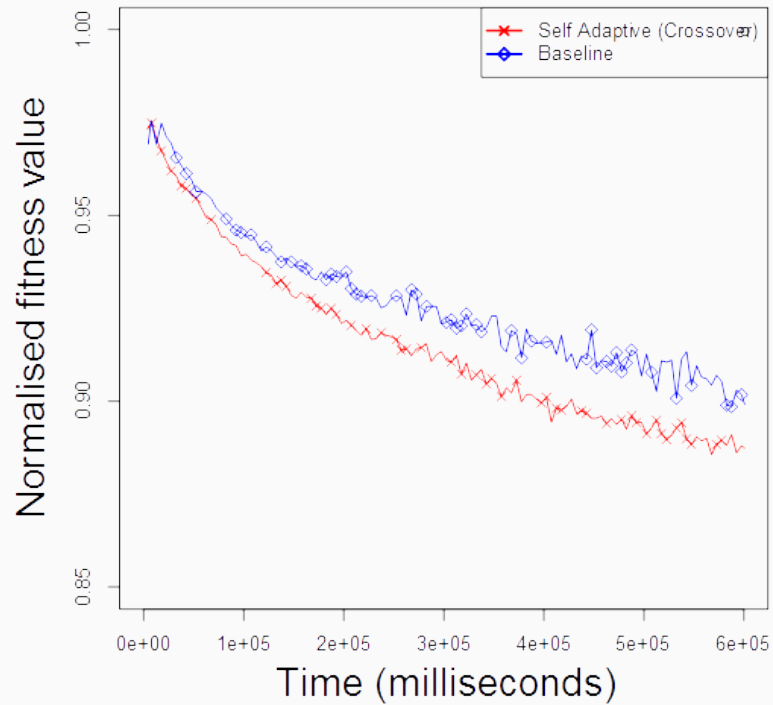
Adaptive



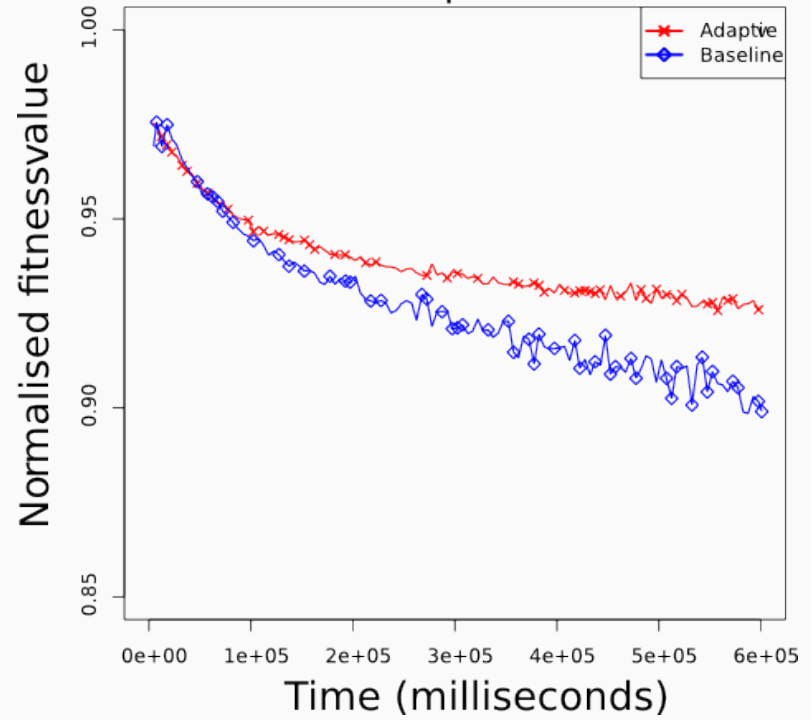
Adaptive Parameter Control



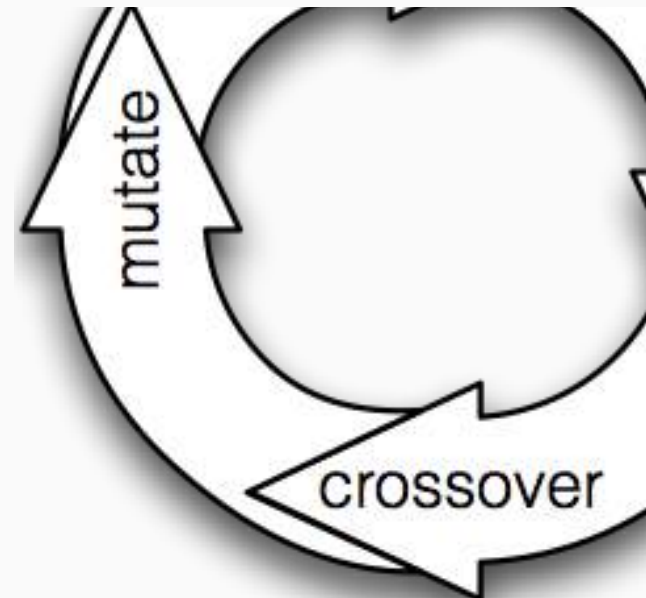
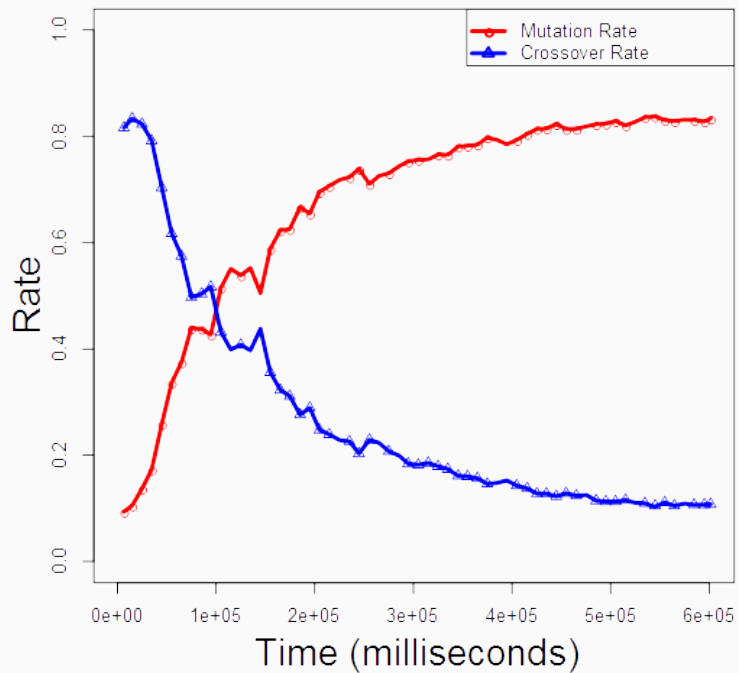
Self Adaptive (Crossover)



Adaptive



Adaptive Parameter Control



Class	Base	Deterministic		Adaptive		SA/Xover		SA/Mut.		Self-Adaptive	
		Cov.	$\hat{A}_{12}$	Cov.	$\hat{A}_{12}$	Cov.	$\hat{A}_{12}$	Cov.	$\hat{A}_{12}$	Cov.	$\hat{A}_{12}$
CSVFormat	0.95	0.95	0.65	<b>0.91</b>	<b>0.01</b>	<b>0.96</b>	<b>0.76</b>	0.95	0.49	0.94	0.52
CSVParser	0.74	0.72	0.32	<b>0.69</b>	<b>0.12</b>	0.72	0.33	<b>0.72</b>	<b>0.30</b>	0.72	0.33
CommandLine	0.97	0.98	0.59	0.98	0.65	0.98	0.56	<b>0.98</b>	<b>0.56</b>	0.98	0.56
GnuParser	0.94	<b>0.97</b>	<b>0.73</b>	0.94	0.52	<b>0.97</b>	<b>0.75</b>	0.95	0.60	<b>0.96</b>	<b>0.71</b>
HelpFormatter	0.87	0.88	0.63	0.86	0.44	0.88	0.63	0.87	0.55	0.86	0.43
Lexer	0.78	0.76	0.44	<b>0.66</b>	<b>0.05</b>	0.80	0.66	0.73	0.31	<b>0.72</b>	<b>0.27</b>
ListUtils	0.91	0.91	0.66	<b>0.89</b>	<b>0.27</b>	0.91	0.65	0.90	0.41	0.90	0.43
Option	1.00	1.00	0.51	<b>0.98</b>	<b>0.21</b>	1.00	0.51	1.00	0.49	1.00	0.45
Options	1.00	1.00	0.50	1.00	0.47	0.99	0.45	0.99	0.42	0.99	0.45
Parser	0.75	0.80	0.65	<b>0.62</b>	<b>0.17</b>	<b>0.85</b>	<b>0.76</b>	0.81	0.66	<b>0.84</b>	<b>0.74</b>