DSE with Genetic Algorithms in INTO-CPS & Other Improvements

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with help from John Fitzgerald (john.fitzgerald@newcastle.ac.uk),

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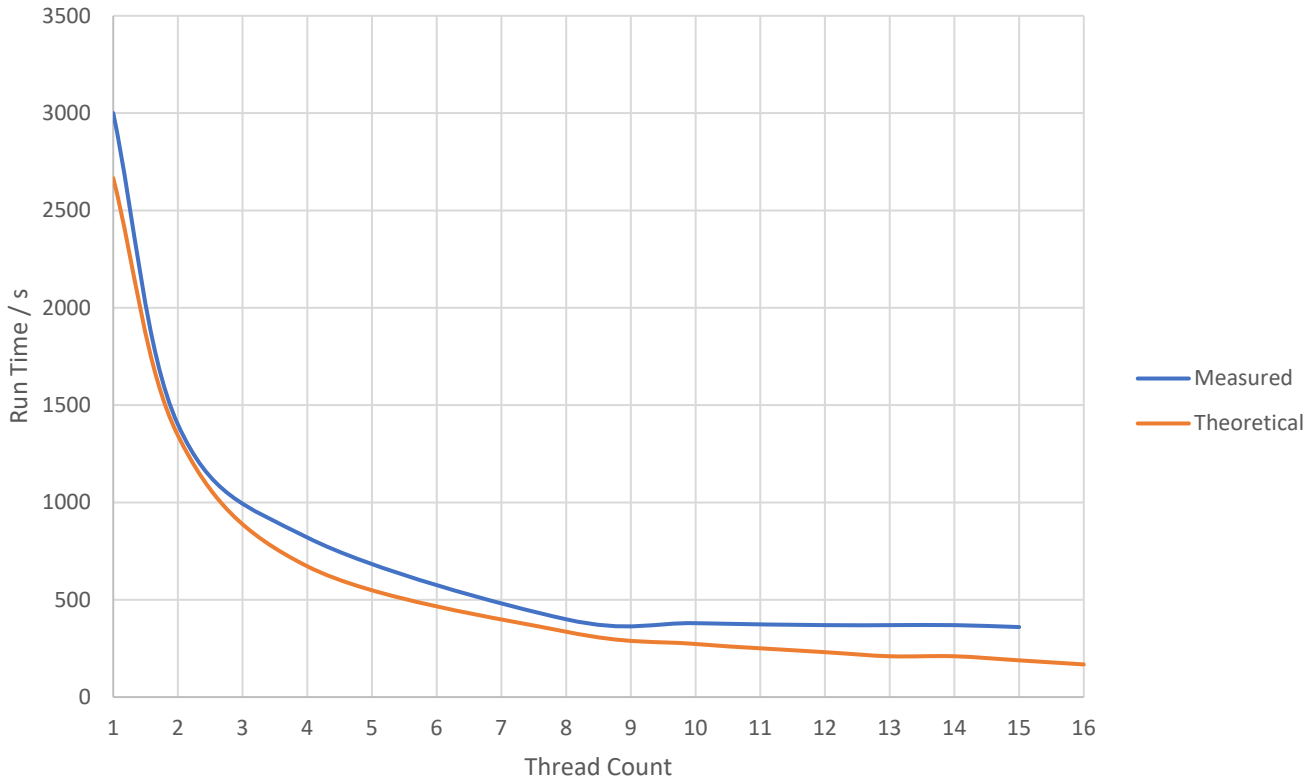
Other Improvements

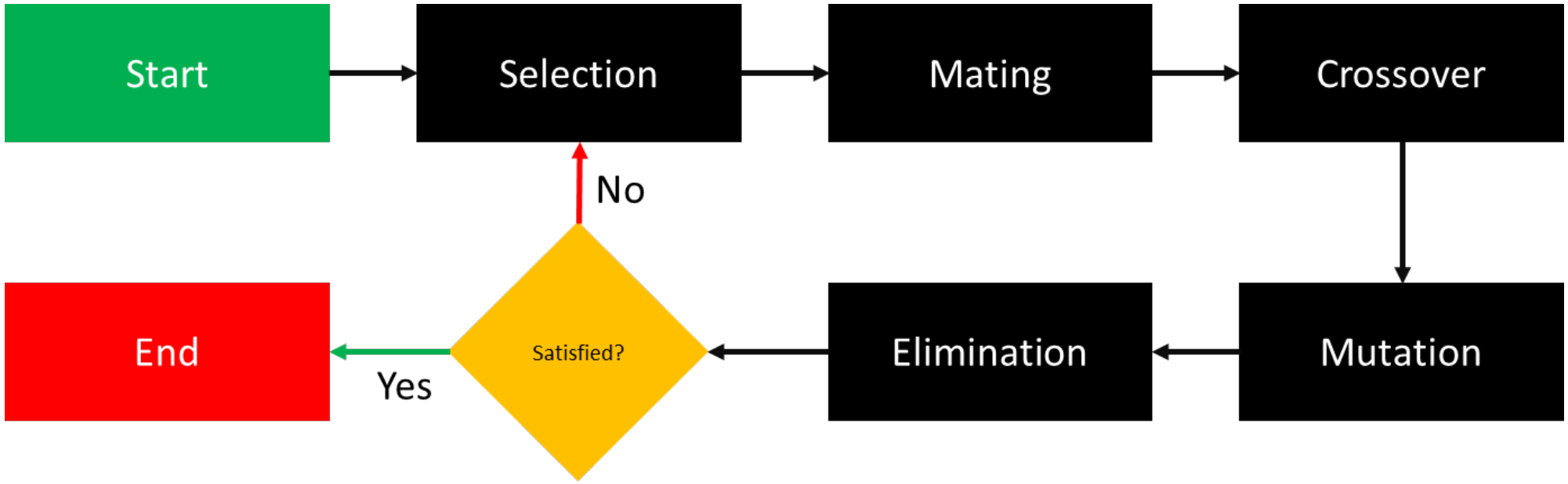
- Python 3
- Threading
- Options

```
-t Thread count (1)
-noCSV Don’t generate CSV Results file (false)
-noHTML Don’t generate HTML Results file (false)
-u URL to COE (http://localhost)
-p Port to COE (8082)
-d Show debug output (false)
```



What are Genetic Algorithms?

- Based on evolution
- Main stages



What is the Point in Using GAs?

- GA vs Exhaustive Search
- Limitations of GAs

The Implementation in INTO-CPS

- Standard JSON configuration
- Can add custom functions
- GitHub: https://github.com/INTO-CPS-Association/dse_scripts

Example JSON Configuration

```
{
    "algorithm": {
        "type": "genetic"
    },
    "parameterConstraints": [
        "{fmu}.equations.x > -2 and {fmu}.equations.x < 2",
        "{fmu}.equations.y > -2 and {fmu}.equations.y < 2",
        "{fmu}.equations.z > -2 and {fmu}.equations.z < 2"
    ],
    "parameters": {
        "{fmu}.equations.x": [
            -2,
             2
        ],
        "{fmu}.equations.y": [
            -2,
             2
        ],
        "{fmu}.equations.z": [
            -2,
             2
        ]
    },
    "geneticArguments":
    {
        "popSize": 50,
        "scenario": "nGens",
        "maxGenerations": 100,
        "mutationChance": 0.2,
        "elitismKeep": 0.1,
        "rankingFunctionArgs": [false, "equationResult"],
        "useRawRanking": true,
        "selectionFunction": "Tournamentmin",
        "selecitonFunctionArgs": [0, 3]
    }
}
```

Example “Organism”

```
{
    "{fmu}.equations.x": 1.33,
    "{fmu}.equations.y": 1.23,
    "{fmu}.equations.z": -1.02
}
```

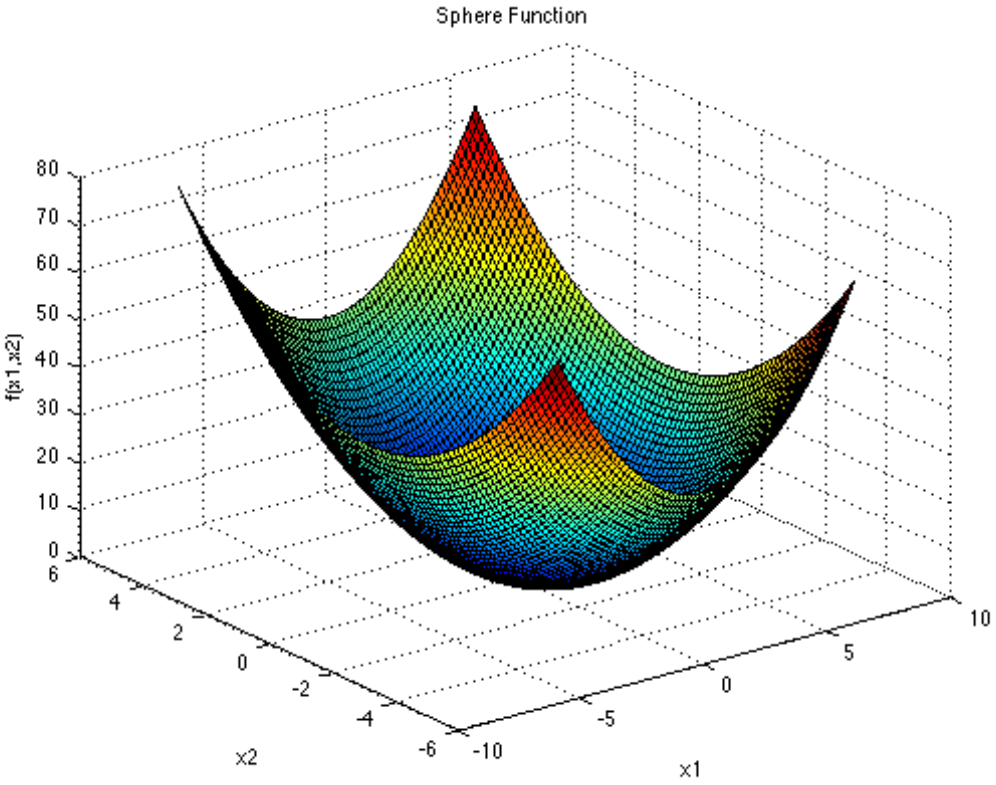
Ranking


```
[
    {
      1,
      [
        {
         "{fmu}.equations.x": 1.33,
         "{fmu}.equations.y": 1.23,
          "{fmu}.equations.z": -1.02
        },
        {
         "{fmu}.equations.x": 1.7,
         "{fmu}.equations.y": -1.4,
         "{fmu}.equations.z": 1.02
        }
       ]
    }
    {
      2,
      [
        {
         "{fmu}.equations.x": 0.33,
         "{fmu}.equations.y": 0.23,
         "{fmu}.equations.z": -0.02
        }
       ]
    }
]
```

Test Results

- What were the test functions
- How did the tests perform

Function	Mean	Best	Deviation
x^2	790	1023.978	163.326
Sphere	1.084×10^{-33}	9.683×10^{-35}	1.117×10^{-33}
Rosenbrock	0.311	0.298	0.028
Rastrigin	1.421×10^{-16}	0.000	6.962×10^{-16}



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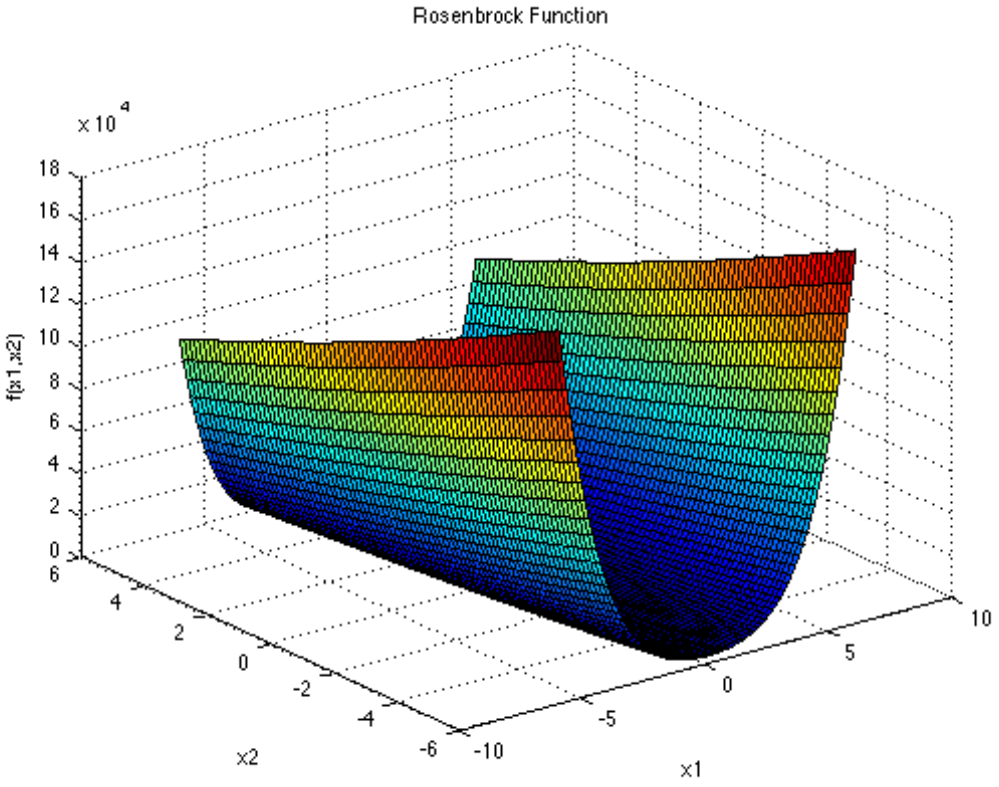

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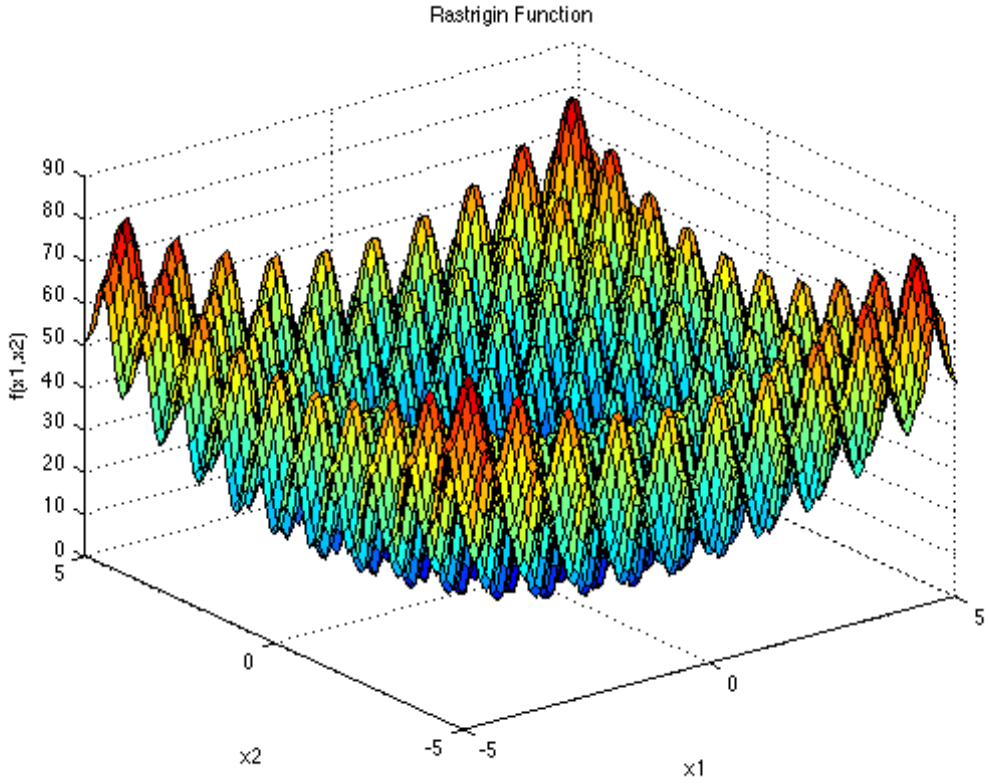

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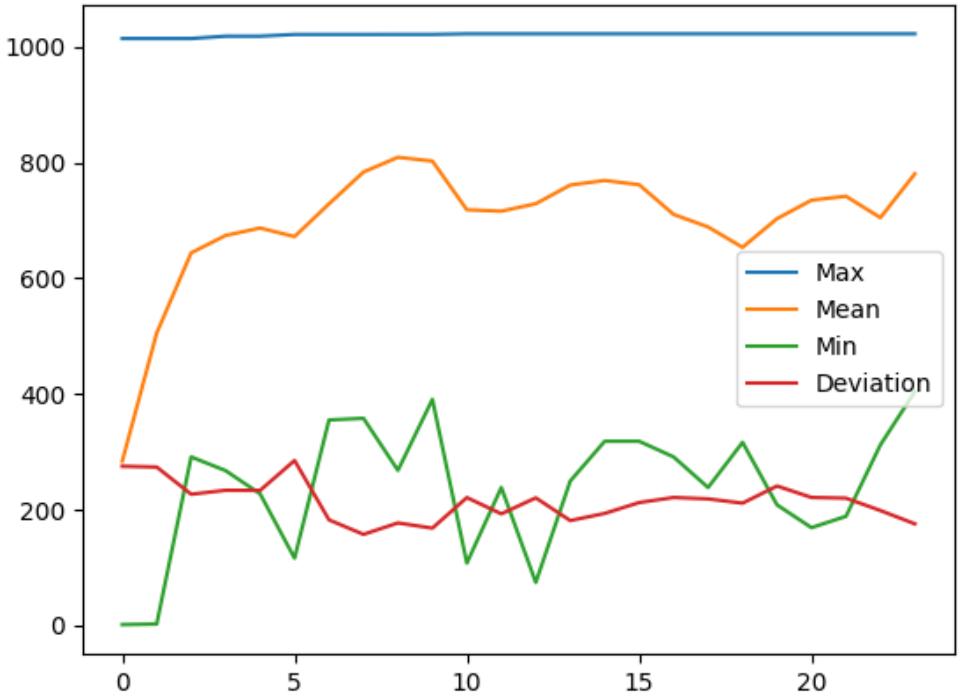

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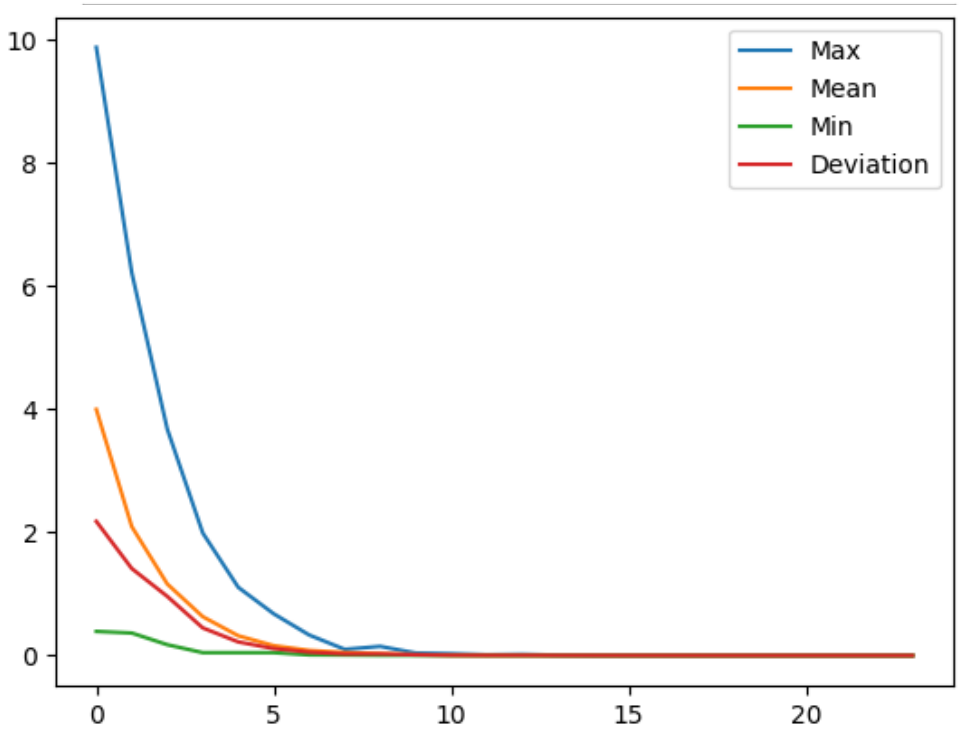

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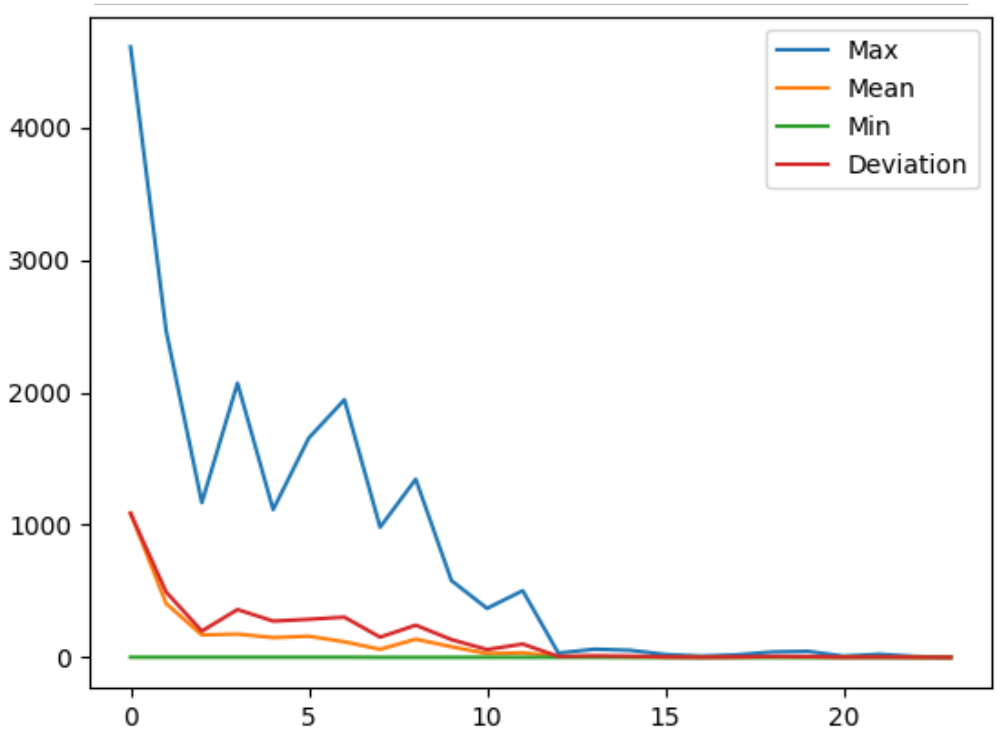

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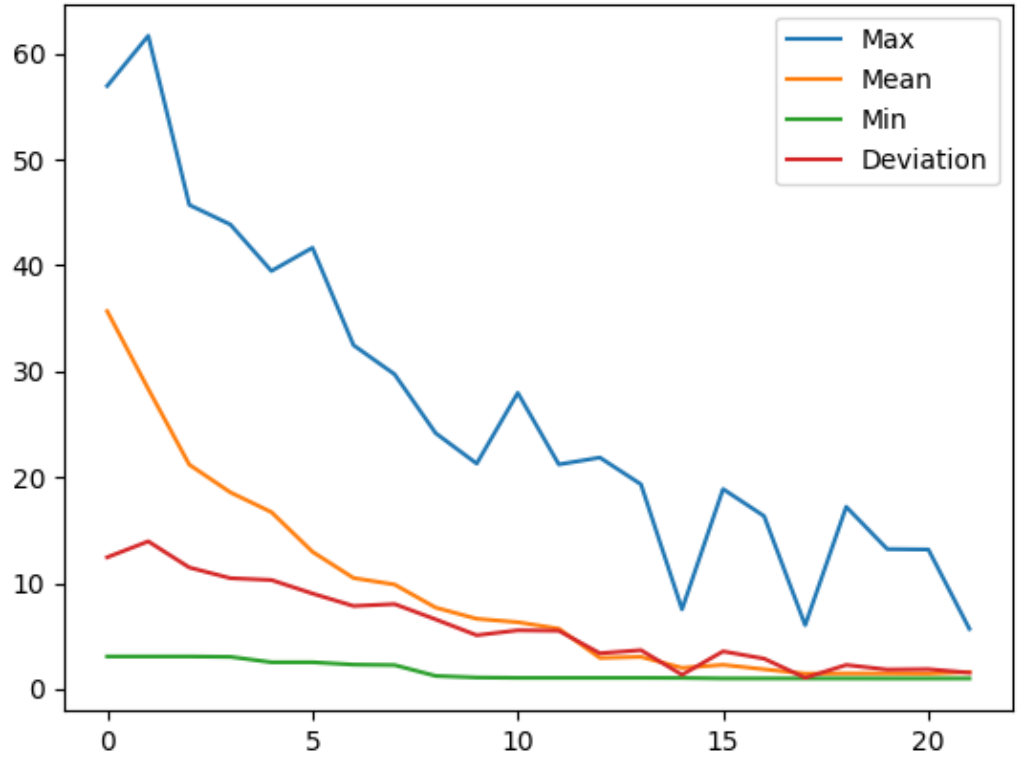


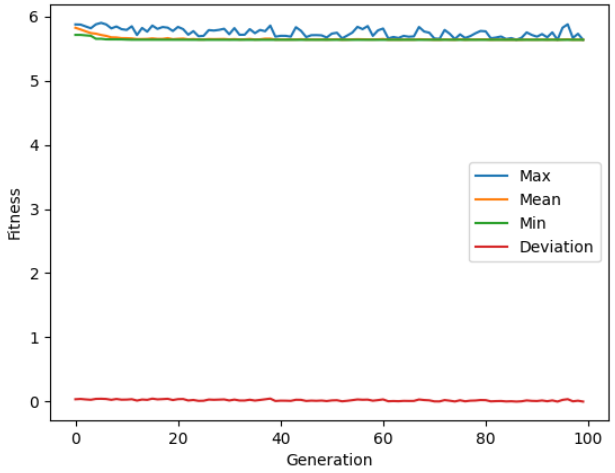
Case Study

- Robotti
- Based on the work done by S. Bogomolov et al in “Tuning Robotti: The Machine-Assisted Exploration of Parameter Spaces in Multi-Models” (https://arxiv.org/pdf/2101.07261.pdf)
- Replicate the results found

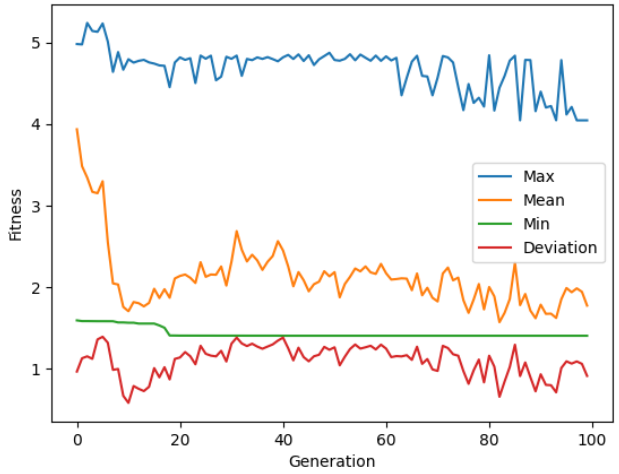
Case Study

Scenario	S. Bogomolov et al			GA Best Combination			Cross track error difference
	cAlphaF	μ	Mass	cAlphaF	μ	Mass	
Sin	20000	0.7	3000	20000	0.70	3000	-1.46×10^{-6}
Speed Ramp	38000	0.4	1000	37019	0.45	1038	8.40×10^{-2}
Speed Step	20000	0.3	1000	34725	0.45	1027	0.00
Turn Ramp	20000	0.3	3000	20000	0.30	3000	-9.21×10^{-7}

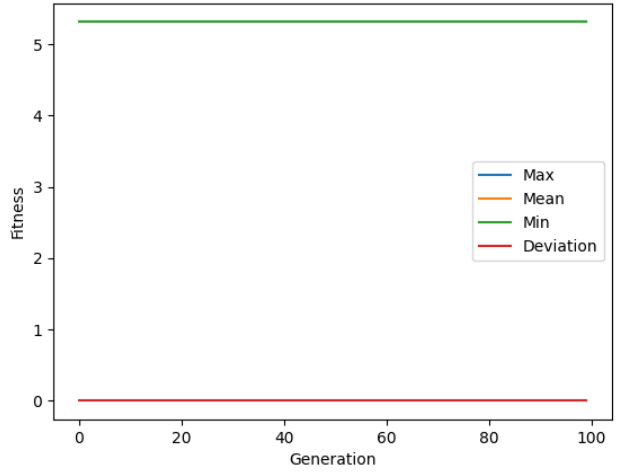
Sin



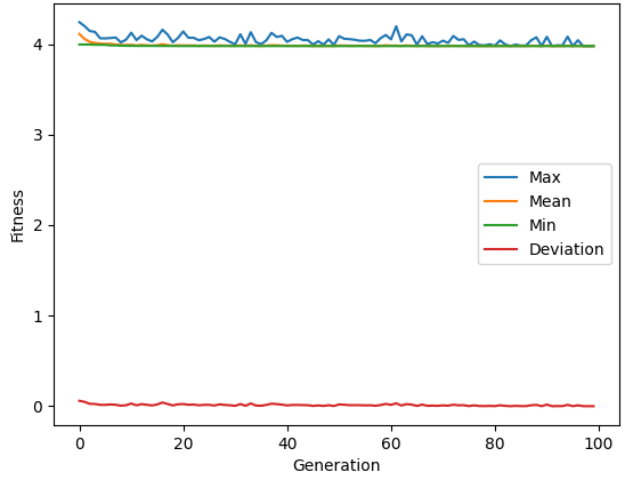
Speed Ramp



Speed Step



Turn Ramp



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Thank you for listening

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