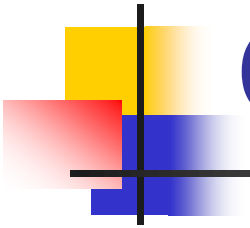
The Architecture of a Software Framework for Biologically-Inspired Optimization Algorithms

Florin Leon, Silvia Curteanu

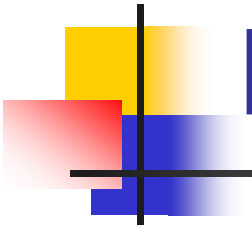
"Gheorghe Asachi" Technical University of Iași, Romania

{florin.leon, silvia.curteanu}@academic.tuiasi.ro



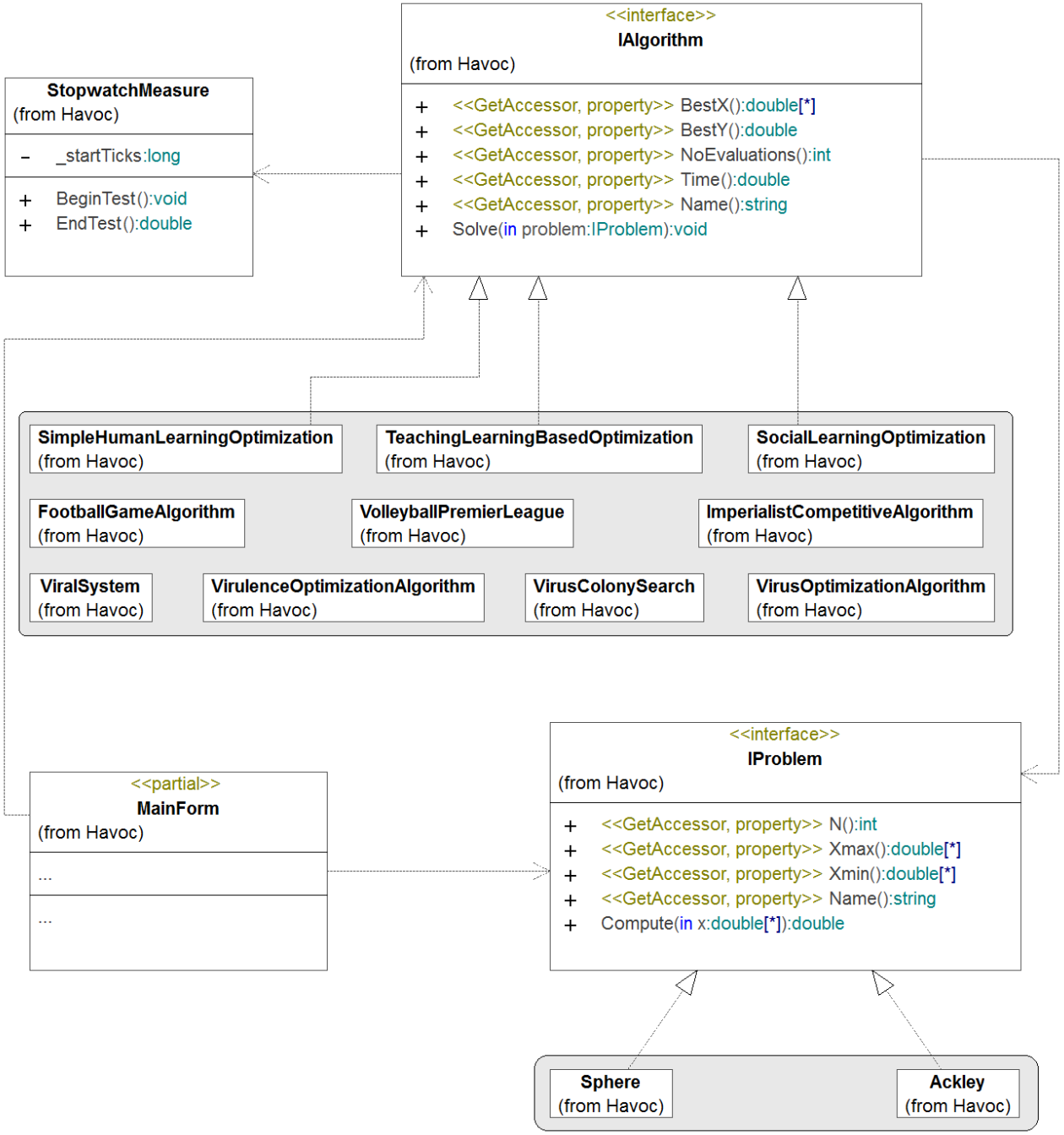
Overview

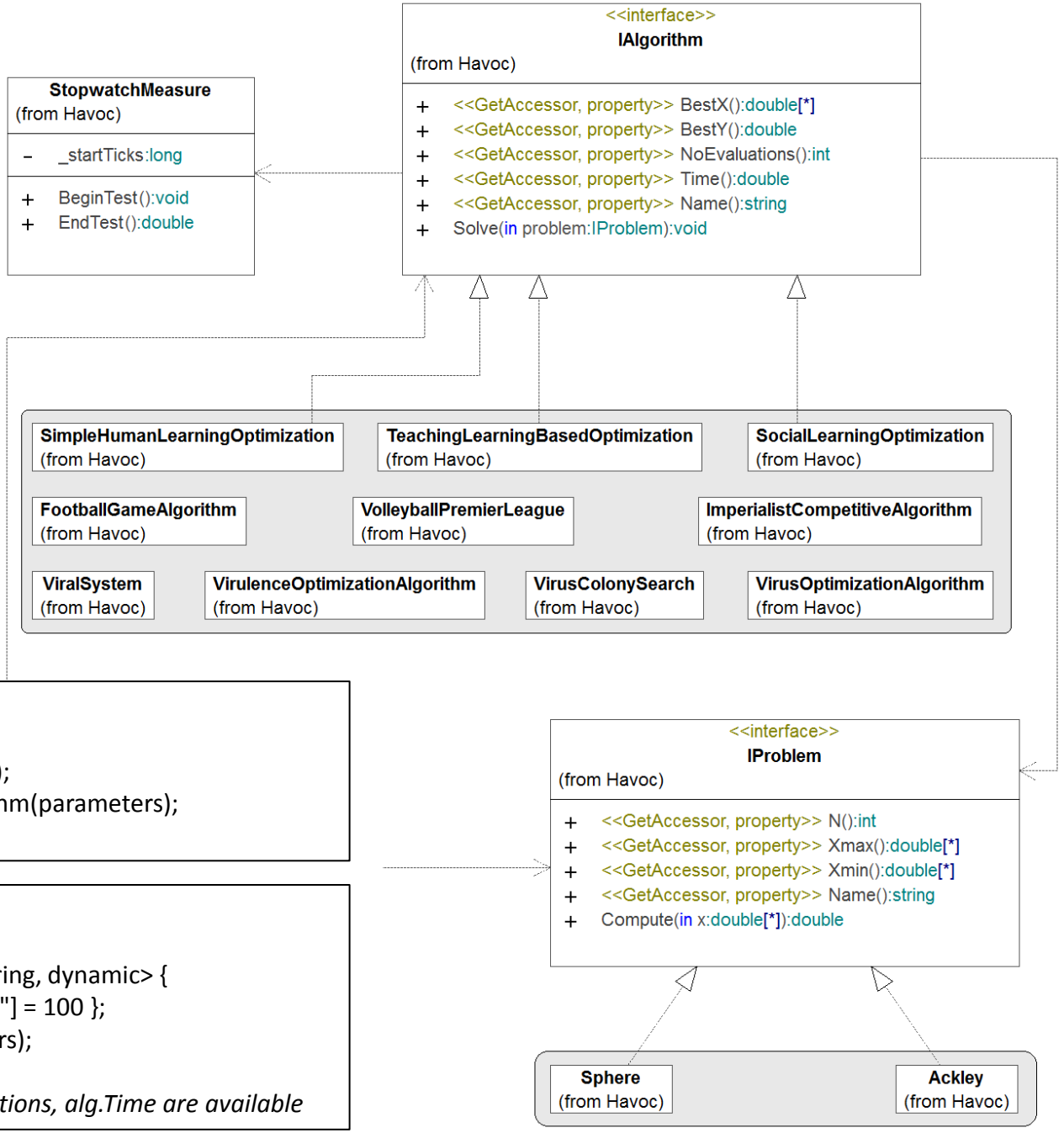
- Motivation
- System architecture
- The algorithms
- Conclusions and future work



Motivation

- Biologically-inspired optimization algorithms: general, simple, and robust techniques that can be used when other mathematical optimization methods cannot be applied
- There are many classes of such algorithms
- There are many separate implementations
- Our goal is to integrate algorithms from diverse classes, from human social and learning behavior to virus behavior, into a consistent .NET optimization framework (HAVOC)


<<interface>>
IAlgorithm
(from Havoc)
+ <<GetAccessor, property>> BestX():double[*]
+ <<GetAccessor, property>> BestY():double
+ <<GetAccessor, property>> NoEvaluations():int
+ <<GetAccessor, property>> Time():double
+ <<GetAccessor, property>> Name():string
+ Solve(in problem:IProblem):void
StopwatchMeasure
(from Havoc)
- _startTicks:long
+ BeginTest():void
+ EndTest():double
SimpleHumanLearningOptimization
(from Havoc)
TeachingLearningBasedOptimization
(from Havoc)
SocialLearningOptimization
(from Havoc)
FootballGameAlgorithm
(from Havoc)
VolleyballPremierLeague
(from Havoc)
ImperialistCompetitiveAlgorithm
(from Havoc)
ViralSystem
(from Havoc)
VirulenceOptimizationAlgorithm
(from Havoc)
VirusColonySearch
(from Havoc)
VirusOptimizationAlgorithm
(from Havoc)
<<partial>>
MainForm
(from Havoc)
...
...
<<interface>>
IProblem
(from Havoc)
+ <<GetAccessor, property>> N():int
+ <<GetAccessor, property>> Xmax():double[*]
+ <<GetAccessor, property>> Xmin():double[*]
+ <<GetAccessor, property>> Name():string
+ Compute(in x:double[*]):double
Sphere
(from Havoc)
Ackley
(from Havoc)



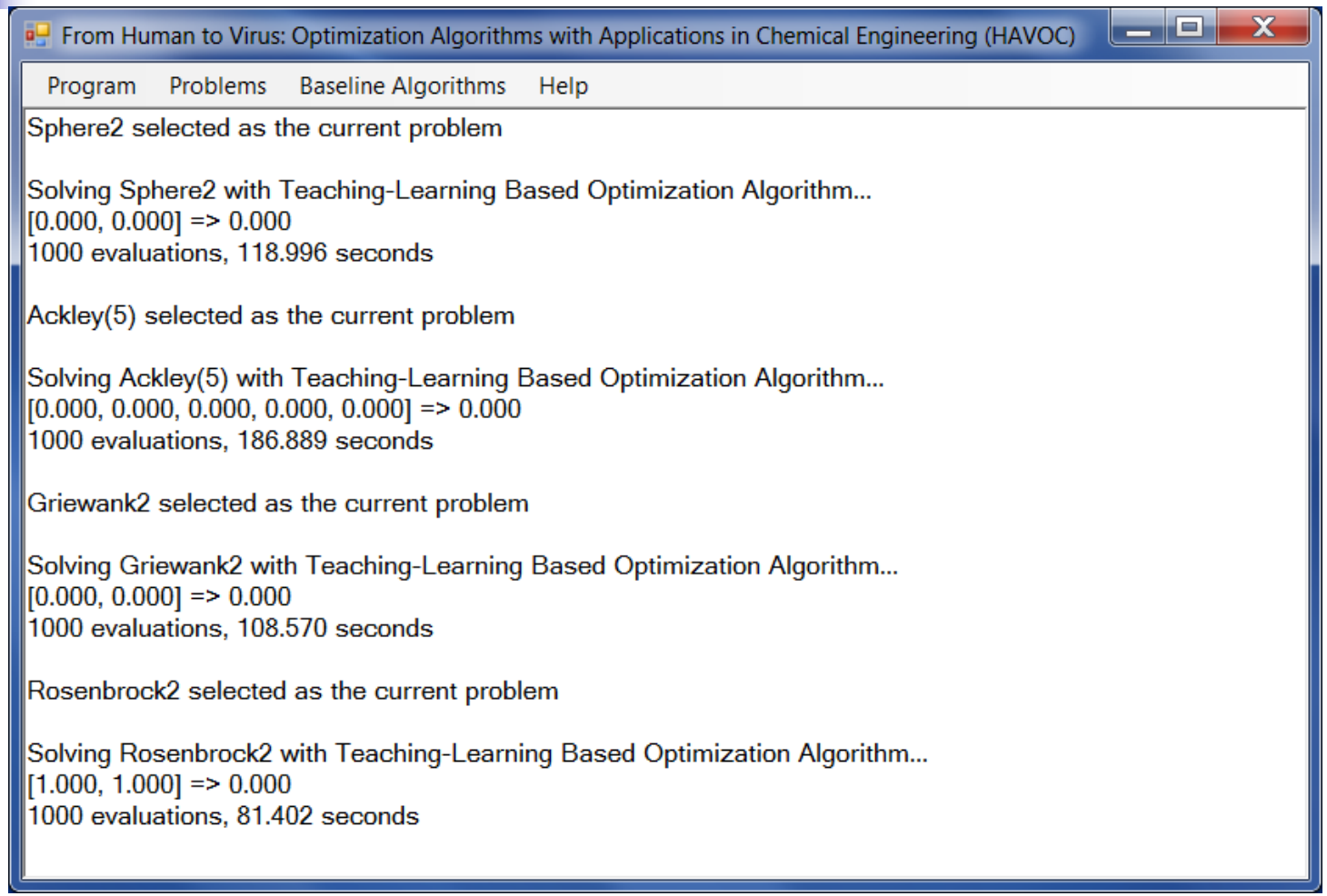
Code snippet 1

```
IProblem problem = new XProblem();
IAlgorithm algorithm = new YAlgorithm(parameters);
algorithm.Solve(problem);
```

Code snippet 2

```
var parameters = new Dictionary<string, dynamic> {
   ["NoIterations"] = 1000, ["PopSize"] = 100 };
IAlgorithm alg = new Tlbo(parameters);
alg.Solve(currentProblem);
// alg.BestX, alg.BestY, alg.NoEvaluations, alg.Time are available
```

GUI and sample results



The algorithms selected for implementation

Category	Algorithm	Encoding
Algorithms inspired by the human behaviors of learning and cooperation	Simplified Human Learning Optimization (SHLO)	binary
	Social Learning Optimization (SLO)	real
	Teaching-Learning based Optimization (TLBO)	real
Algorithms inspired by human competitive behavior	Football Game Algorithm (FGA)	real
	Volleyball Premier League (VPL)	real
	Imperialist Competitive Algorithm (ICA)	real
Algorithms inspired by virus behavior	Viral System (VS)	binary
	Virulence Optimization Algorithm (VOA1)	real
	Virus Colony Search (VCS)	real
	Virus Optimization Algorithm (VOA2)	real

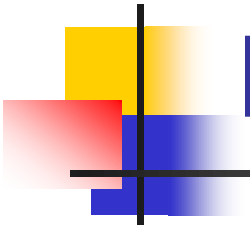
Algorithms inspired by the human behaviors of learning and cooperation

- Simplified Human Learning Optimization (SHLO)
- Social Learning Optimization (SLO)
- Teaching-Learning based Optimization (TLBO)

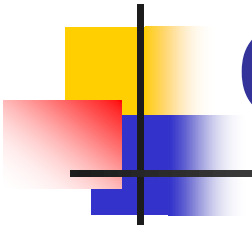
Algorithms inspired by human competitive behavior

- Football Game Algorithm (FGA)
- Volleyball Premier League (VPL)
- Imperialist Competitive Algorithm (ICA)

Algorithms inspired by virus behavior



- Viral System (VS)
- Virulence Optimization Algorithm (VOA1)
- Virus Colony Search (VCS)
- Virus Optimization Algorithm (VOA2)



Conclusions

- HAVOC architecture
  - Extensible
  - Facilitates comparisons on benchmark and real-life problems
  - Uses .NET
- Future work
  - Study of baseline and new algorithm variants
  - Hybridization with other AI techniques
- Applications in chemical engineering
  - Substitute for costly experiments
  - Propose necessary conditions for maximum performance