

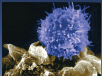
A Case Study of On-The-Fly Calibration for Artificial Immune Network Algorithms

Elizabeth Montero

Universidad Técnica Federico Santa María

Joint Workshop on Automated Selection and Tuning of Algorithms,

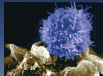
Part B) Discrete Search Spaces - Focus on Parameter Selection



Introduction

Outline

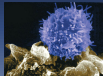
- 1 Introduction
- 2 Artificial Immune Systems
- 3 Proposal
- 4 Experiments and Results



Motivation

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To extend the adaptive approach presented for clonal selection immune algorithms to a sophisticated immune network algorithm that solves hard constraint satisfaction problems



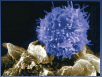
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Questions

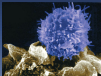
- ▶ If tuning process selects different values for some parameters when tuned for different instances
 - ▶ then there is possible to detect the need of controlling the more sensible parameters of the algorithm?
- ▶ It is possible to reduce the number of parameters of an algorithm by controlling some of them?
- ▶ Incorporates parameter control to an algorithm can improve its efficiency?



Artificial Immune Systems

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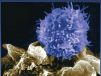


Artificial Immune Systems

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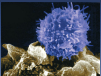
- ▶ A new bio-inspired approach to Artificial Intelligence
- ▶ Based on the capabilities of the adaptive immune system of vertebrate organisms
 - ▶ Uniqueness
 - ▶ Extern recognition
 - ▶ Anomaly detection
 - ▶ Distributed detection
 - ▶ Imperfect detection
 - ▶ Reinforcement learning and memory
- ▶ Used in optimization and machine learning



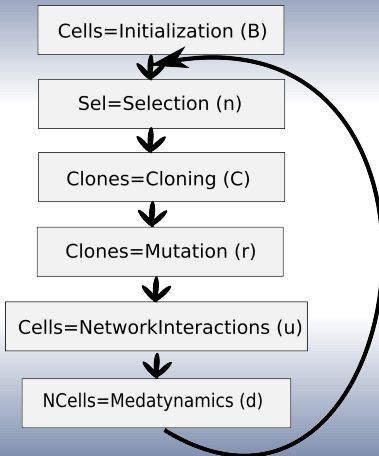
Artificial Immune Processes

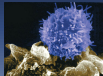
Artificial Immune Processes

- ▶ Positive/Negative Selection
 - ▶ T-cells determination
- ▶ Clonal Selection process
 - ▶ Infection response
- ▶ Artificial immune networks
 - ▶ Balance methods
- ▶ Danger Theory
 - ▶ Danger detection in organisms



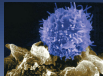
Artificial Immune Networks





CD-Nais parameters

- B** Number of cells in repertoire
- n** Number of cells selected for cloning
- C** Number of clones generated from cells
- r** Mutation rate (Mutation rates)
- u** Network interactions threshold
- d** Number of new random cells incorporated each iteration



Proposal

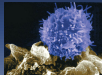
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Proposal

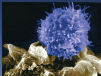
Our proposal

Idea

- ▶ Award good actions and punish bad actions
 - ▶ balance diversification and intensification of search process

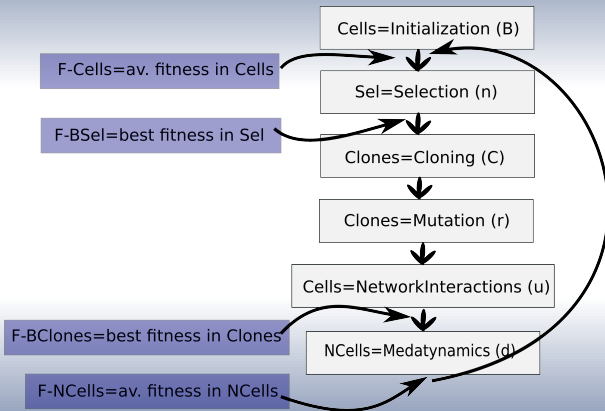
What to control?

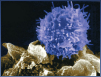
- ▶ Diversity: Number of selected cells (n)
 - ▶ Decrease the number of selected cells implies to increase the amount of random cells incorporated to population
- ▶ Intensification: Number of clones (C)
 - ▶ Increase the amount of clones generated by each selected cells implies to increase the intensification level



Proposal

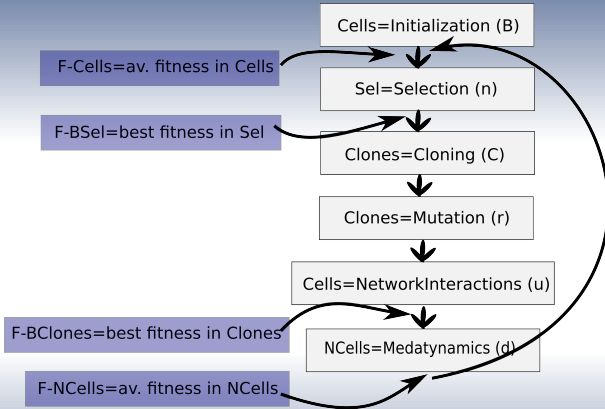
Adaptive CD-Nais algorithm





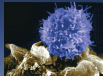
Proposal

Adaptive CD-Nais algorithm



```

Succes(C)=F-BClones - F-BSel
Stuck(B)=F-NCells - F-Cells
IF(Succes(C)>0) THEN C = C + 1;
  ELSE IF (C >1) THEN C = C - 1;
IF((Succes(C)>0) && (Stuck(B) < 0)) THEN n = n +1;
  ELSE IF (n>1) THEN n = n - 1;
  
```

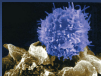


Proposal

In summary

Summary

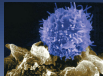
- ▶ Improvement due to mutation procedure implies an increase of Intensification process.
- ▶ Deterioration in the whole population quality, implies a reduction of the amount of random antibodies incorporated to the population, reducing the diversity of the population.



Experiments and Results

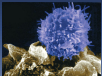
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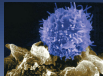
Constraint Satisfaction Problems

- ▶ Classical benchmark problems
- ▶ Problem:
 - ▶ Set of Variables
 - ▶ Set of Domains
 - ▶ Set of Constraints
 - ▶ Objective: To find an assignment of values to variables that satisfies all constraints
- ▶ 3-coloring problem instances
 - ▶ 30, 45, 60, 75, 90, 105, 120, 180 vars



Tests on 3-Coloring problems

- ▶ Controlled version shown a better performance than static version specially in largest instances.



Tests on 3-Coloring problems

- ▶ Controlled version shown a better performance than static version specially in largest instances.
- ▶ Further analysis make us suspect about the irrelevance of parameter (u) in adaptive CD-Nais

Final Survivors:

```
params/configuracion8.param 0.0625 0.0566733
params/configuracion0.param 0.135417 0.0989402
params/configuracion10.param 0.135417 0.0989402
params/configuracion1.param 0.125 0.0882764
params/configuracion2.param 0.125 0.0833682
params/configuracion3.param 0.145833 0.100459
params/configuracion4.param 0.135417 0.0900236
params/configuracion5.param 0.114583 0.0911859
params/configuracion6.param 0.114583 0.070321
params/configuracion7.param 0.104167 0.0679408
params/configuracion9.param 0.104167 0.0679408
Total Experiments: 1056
```

Table: F-Race results

Answers

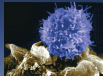
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 - ▶ Controlling parameter values can produce direct and indirect effect over other parameters of the algorithm allowing the reduction of the total number of parameters.

Answers

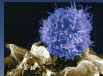
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- ▶ Incorporates parameter control to an algorithm can improve its efficiency?
 - ▶ Yes, it can reduces the effort spent in tuning processes.



Experiments and Results

Questions?

Any question?



References I



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