

Uma breve introdução a Inteligência Artificial para Programadores

Fabio Galuppo, M.Sc.

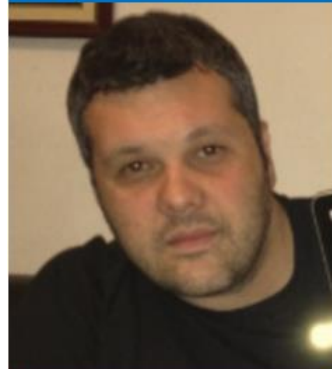
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Microsoft MVP Visual Studio and Development Technologies

<https://mvp.microsoft.com/en-us/PublicProfile/9529>



Award Categories
Visual Studio and Development
Technologies

First year awarded:
2002

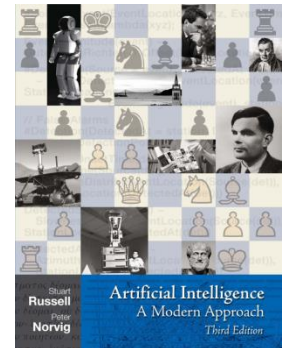
Number of MVP Awards:
14

O que é Inteligência Artificial?

O que é *Machine Learning*?

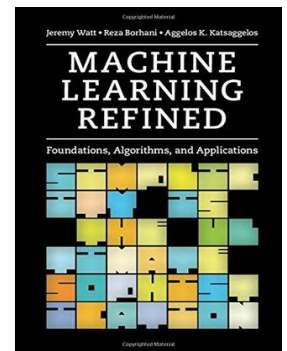
- **AI: *Systems that act rationally***
 - that which is expected to ***maximize goal achievement***, given the available information

[Artificial Intelligence: A Modern Approach](#)

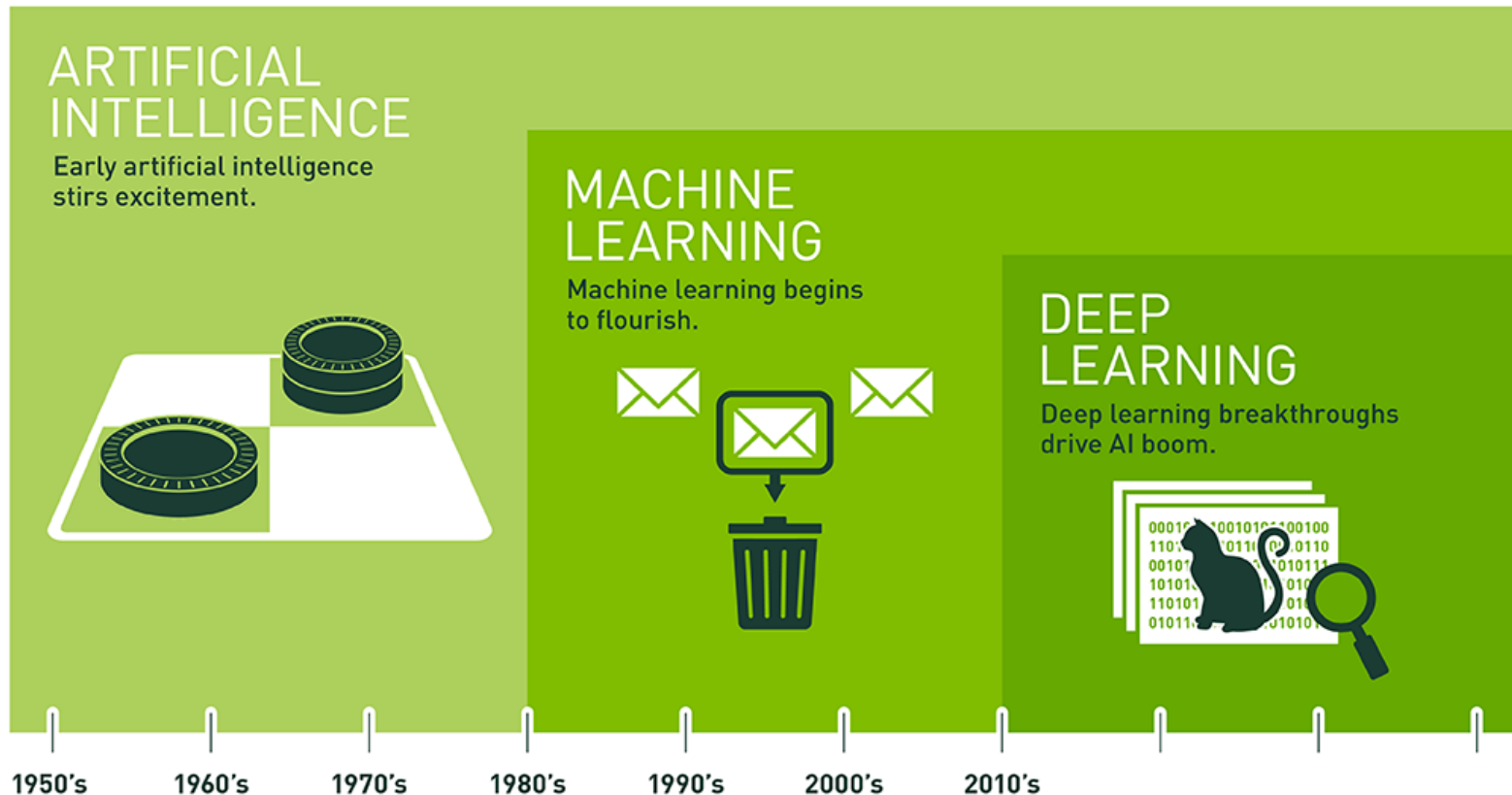


- ***Machine learning*** is a rapidly growing field of study whose primary concern is the ***design and analysis of algorithms*** which ***enable computers to learn***.

[Machine Learning Refined](#)



AI, ML, and Deep Learning

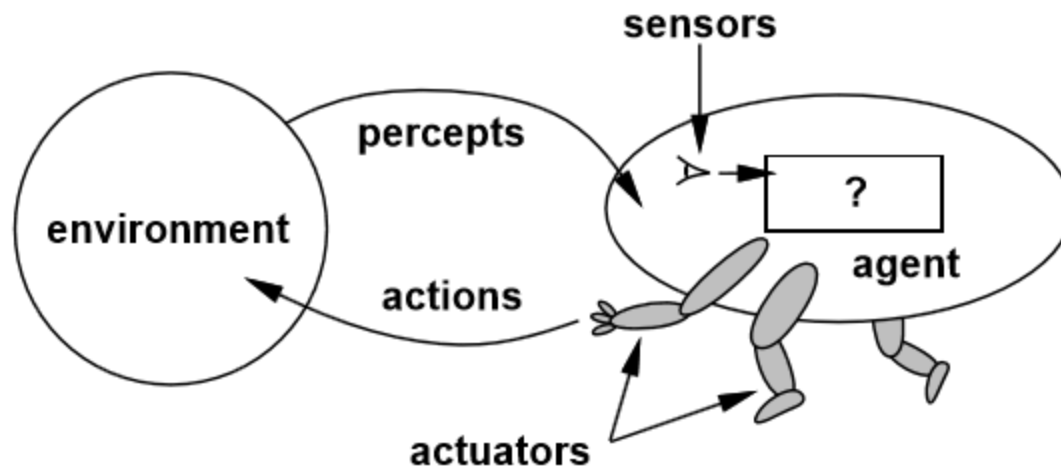


Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

<https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/>

Intelligent Agents

- **Agents** interact with environments through **actuators** and **sensors**



- The **agent function** describes what the agent does in all circumstances

```
function ReactiveAgent(State) : Action
  perception ← perception(state)
  action ← action(perception)
  return action
```

Tipos de algoritmos de *Machine Learning*

- ***Supervised Learning***

- algorithms make predictions based on a set of examples

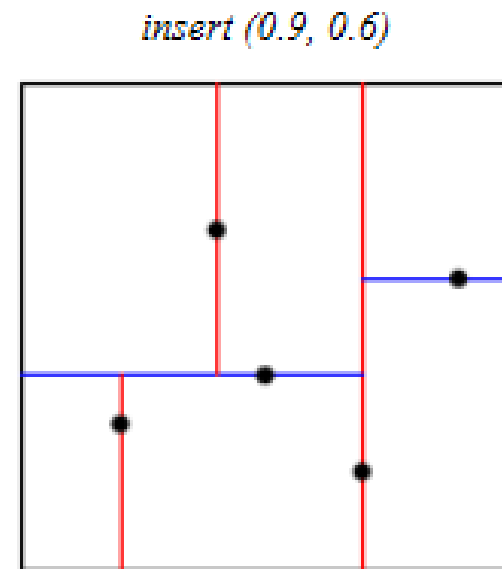
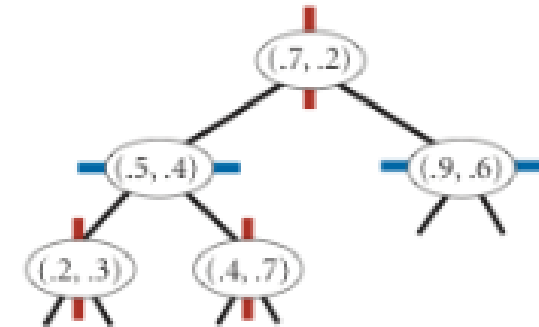
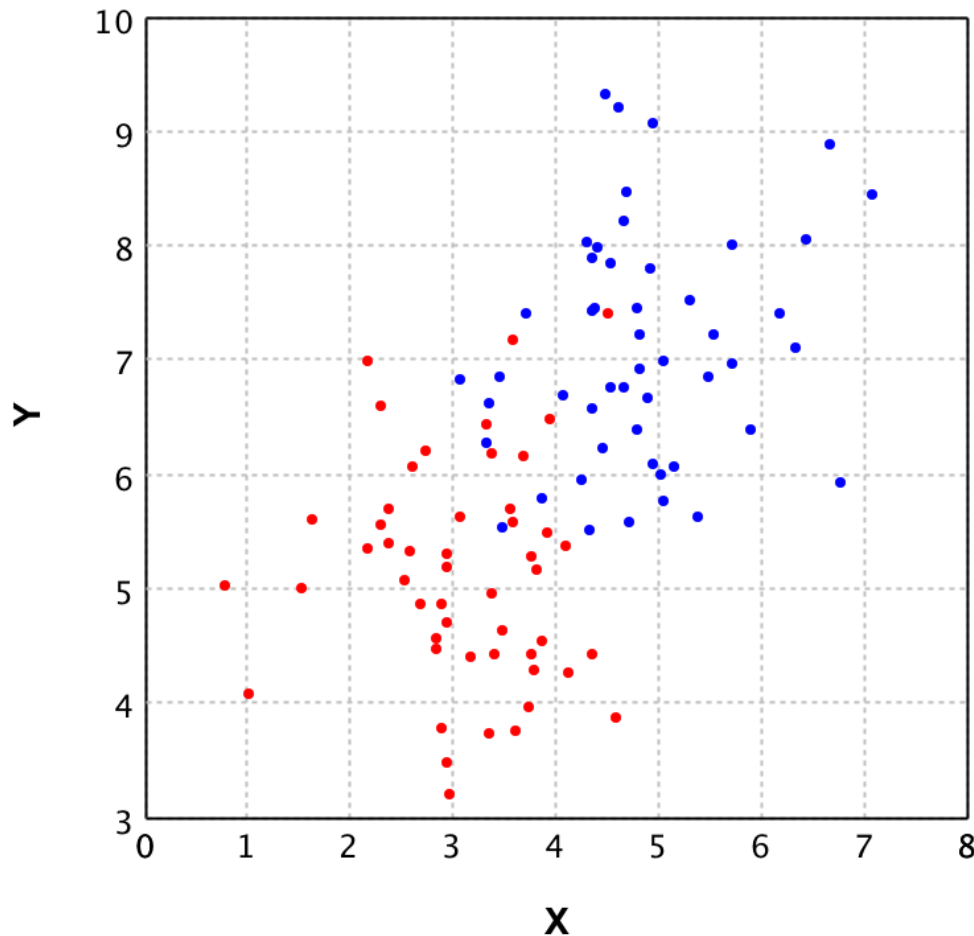
- *Classification*
 - *Regression*
 - *Forecasting*

- ***Unsupervised Learning***

- It is asked to discover the intrinsic patterns that underlies the data

- *Clustering*
 - *Dimension reduction*

KdTree e Classificação



<http://coursera.cs.princeton.edu/algs4/assignments/kdtree.html>

<https://xyclade.github.io/MachineLearning/#labeling-isps-based-on-their-downupload-speed-k-nn-using-smile-in-scala>

Dendrograma e Clusterização

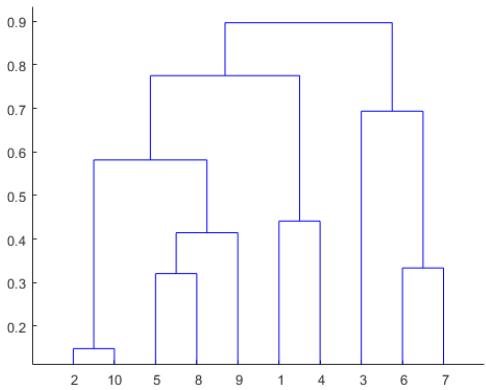
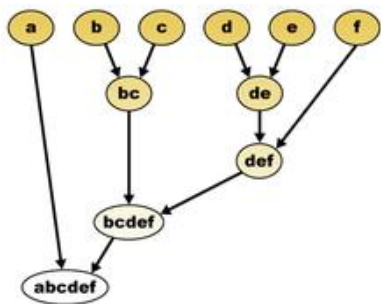
```
let book1 = { Author = list2sortedset(["Donald E. Knuth"]); Title = list2sortedset(["The Art of Computer Programming: Volume 1"]) };;  
let book2 = { Author = list2sortedset(["Donald E. Knuth"]); Title = list2sortedset(["The Art of Computer Programming: Volume 2"]) };;  
let book3 = { Author = list2sortedset(["Donald E. Knuth"]); Title = list2sortedset(["The Art of Computer Programming: Volume 3"]) };;  
let book4 = { Author = list2sortedset(["Donald E. Knuth"]); Title = list2sortedset(["Concrete Mathematics: A Foundation for Computer Science"]) };;  
let book5 = { Author = list2sortedset(["Ronald L. Graham"]); Title = list2sortedset(["Concrete Mathematics: A Foundation for Computer Science"]) };;  
let book6 = { Author = list2sortedset(["Oren Patashnik"]); Title = list2sortedset(["Concrete Mathematics: A Foundation for Computer Science"]) };;  
let book7 = { Author = list2sortedset(["Bjarne Stroustrup"]); Title = list2sortedset(["A Tour of C++"]) };;  
let book8 = { Author = list2sortedset(["Bjarne Stroustrup"]); Title = list2sortedset(["The C++ Programming Language"]) };;
```

```
mergeTopDown (list2mutablelist([book1; book2; book3; book4; book5; book6; book7; book8])) mergeableBooks mergeBooks;;
```

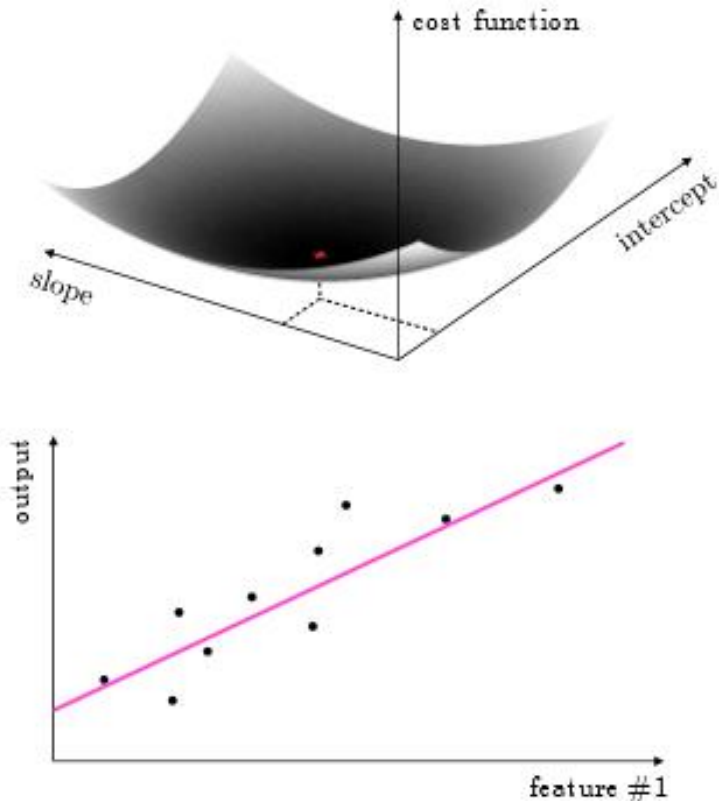
- 1: {Donald E. Knuth, Oren Patashnik, Ronald L. Graham} {Concrete Mathematics: A Foundation for Computer Science}
- 2: {Donald E. Knuth} {The Art of Computer Programming: Volume 1, The Art of Computer Programming: Volume 2, The Art of Computer Programming: Volume 3}
- 3: {Bjarne Stroustrup} {A Tour of C++, The C++ Programming Language}

```
mergeTopDown (list2mutablelist([book4; book5; book6; book1; book2; book3; book7; book8])) mergeableBooks mergeBooks;;
```

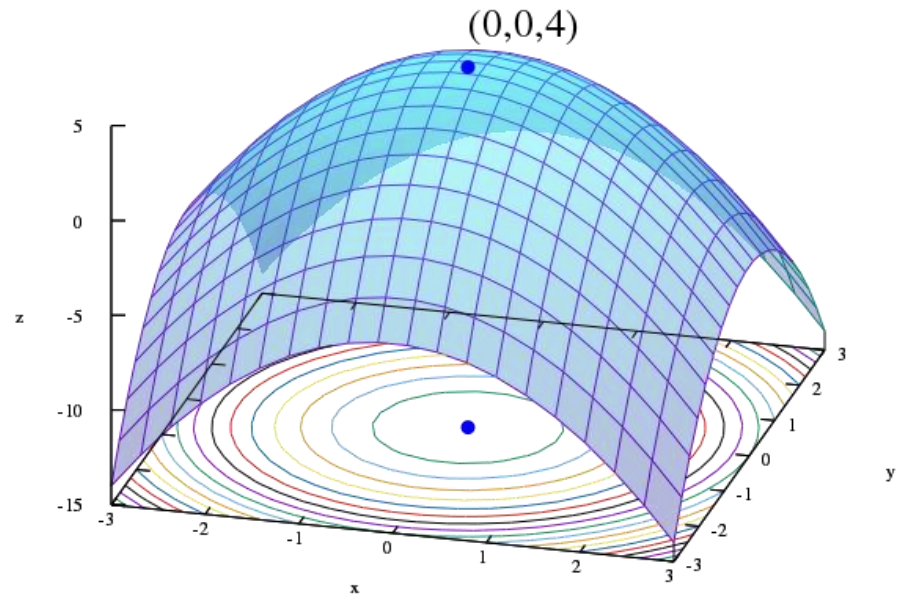
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- 3: {Bjarne Stroustrup} {A Tour of C++, The C++ Programming Language}



Optimization



minimum of the cost function

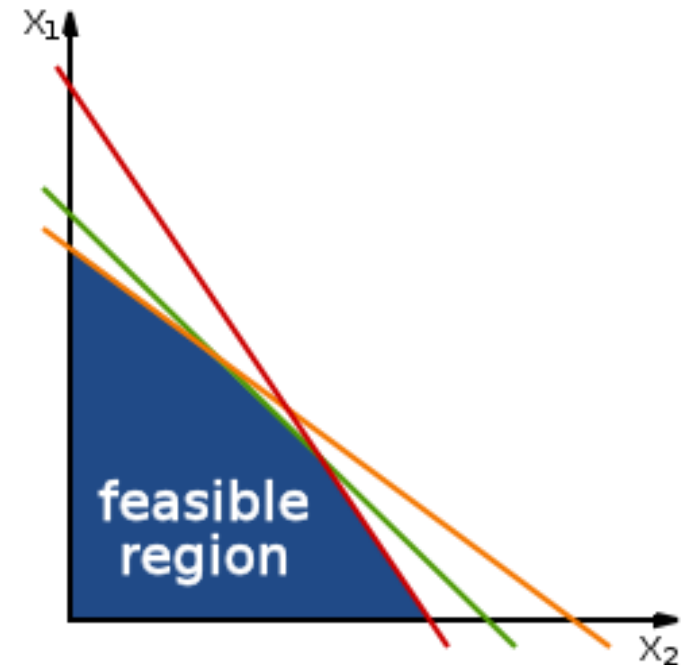


maximum of the paraboloid function

https://en.wikipedia.org/wiki/Mathematical_optimization

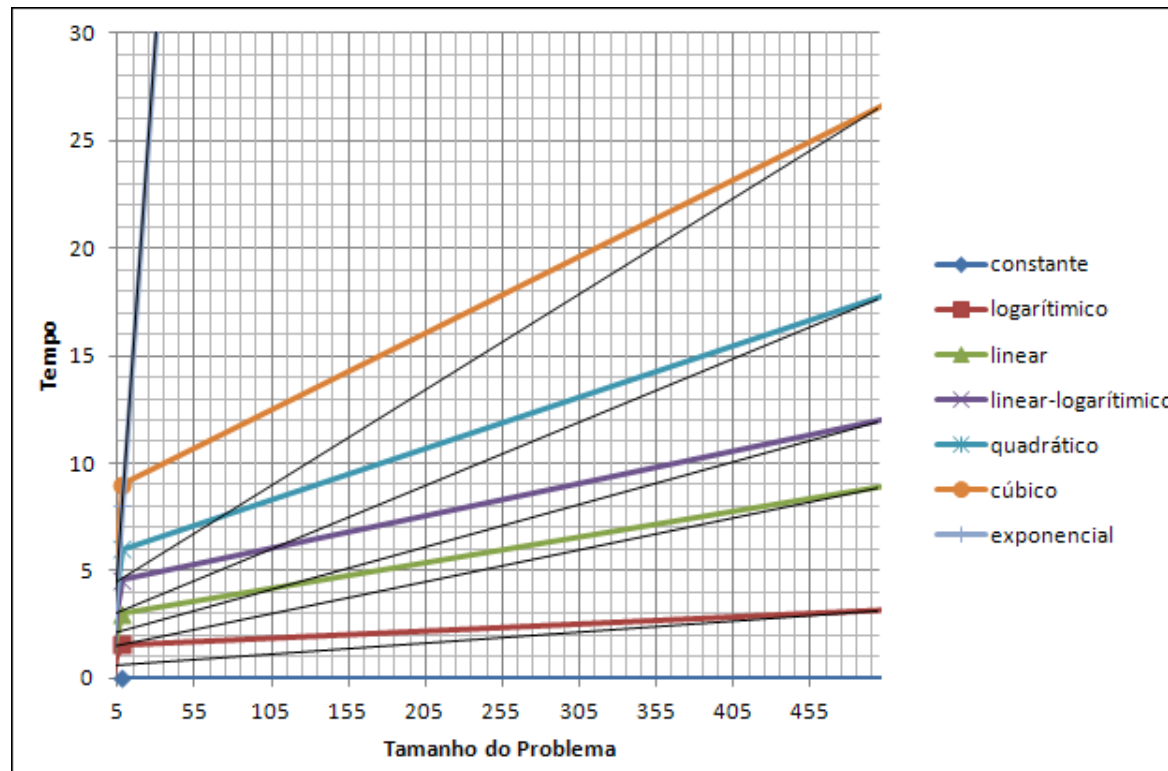
Optimization (Linear Programming)

- Linear programming is a method to achieve the **best outcome** (such as **maximum** profit or **lowest** cost) in a mathematical model whose requirements are represented by linear relationships.
 - linear programming is a technique for the **optimization of a linear objective function, subject to linear equality and linear inequality constraints**.



Intractability

- Um problema é considerado intratável quando não existe um algoritmo conhecido que o resolva deterministicamente em tempo polinomial.



- Este tipo de problema é denominado NP.
 - Aquele que possui tempo polinomial não determinístico.

O Problema do Caixeiro Viajante (PCV)

- Problema de Minimização
 - Encontrar o menor ciclo para um conjunto de cidades a serem visitadas obrigatoriamente e retornando a origem
 - Uma de suas instâncias considera a função objetivo como a distância euclidiana entre as cidades
 - Problema NP, inerentemente intratável
- Intratabilidade
 - Simétrica = $\frac{\Gamma(N)}{2}$
 - Assimétrica = $\Gamma(N)$

```
In[17]:= Gamma[48] / 2
Out[17]= 129 311 620 755 584 090 321 482 177 576 805 989 984 598 816 194 560 000 000 000

In[18]:= Gamma[48]
Out[18]= 258 623 241 511 168 180 642 964 355 153 611 979 969 197 632 389 120 000 000 000

In[19]:= Gamma[49]
Out[19]= 12 413 915 592 536 072 670 862 289 047 373 375 038 521 486 354 677 760 000 000 000
```

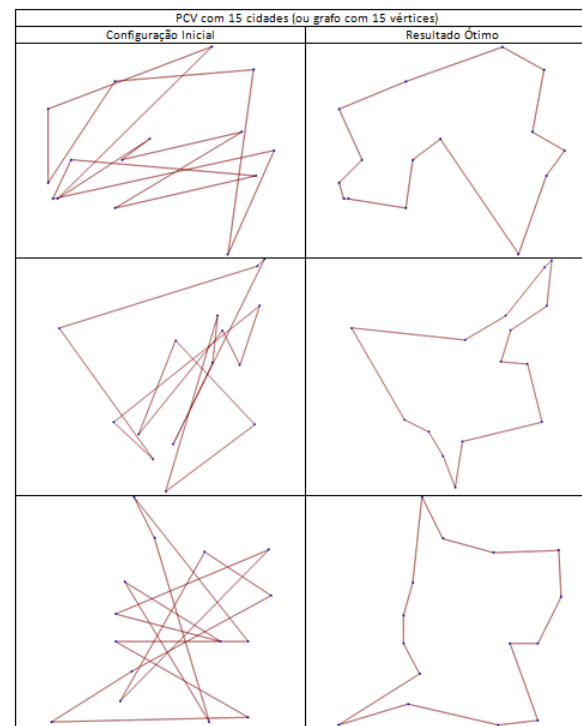
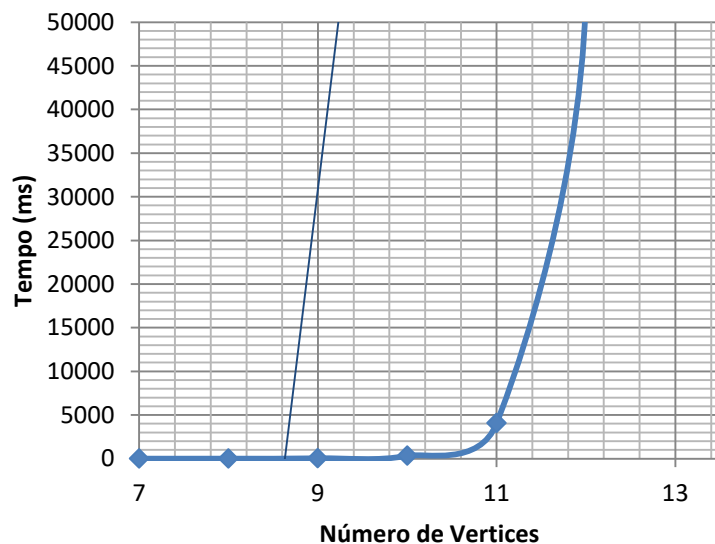
O Problema do Caixeiro Viajante (PCV)

Complexidade

	Tempo (ms)
Número de Cidades	Força Bruta
13	743691
12	53093
11	4056
10	331
9	39
8	2
7	1

PCV com 15 Cidades		
	Força Bruta	
Solução Ótima	Tempo (ms)	Tempo (h)
359,399	165340592	45,928
317,232	165590540	45,997
368,79	165517424	45,977

PCV com Força Bruta



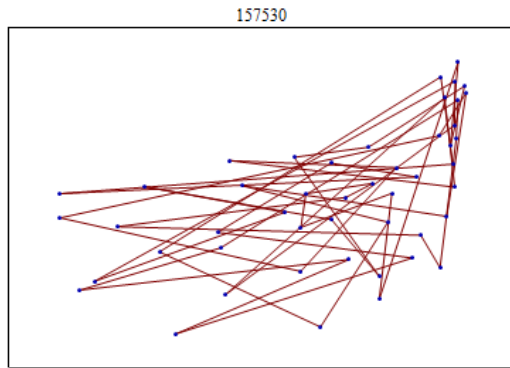
$$47!/2 = 1,29311 \times 10^{59}$$

$$47! = 2,58623 \times 10^{59}$$

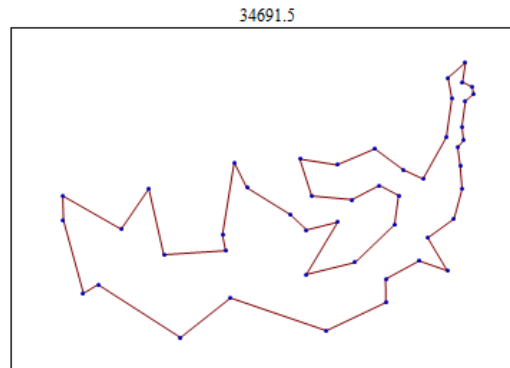
$$48! = 1,24139 \times 10^{60}$$

Solução com composição de algoritmos em paralelo

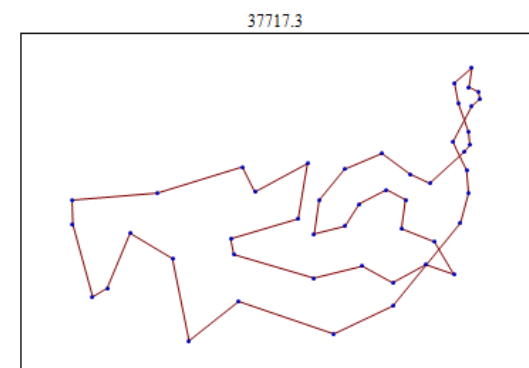
att48.tsp (48 cidades)



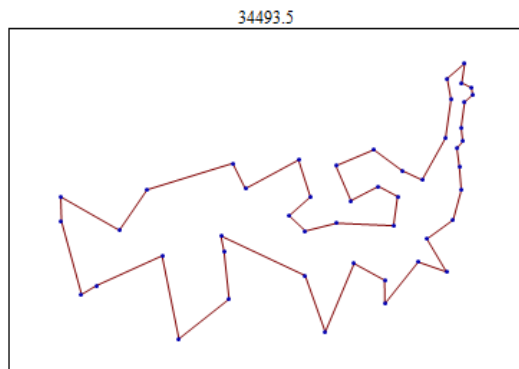
Estado Inicial



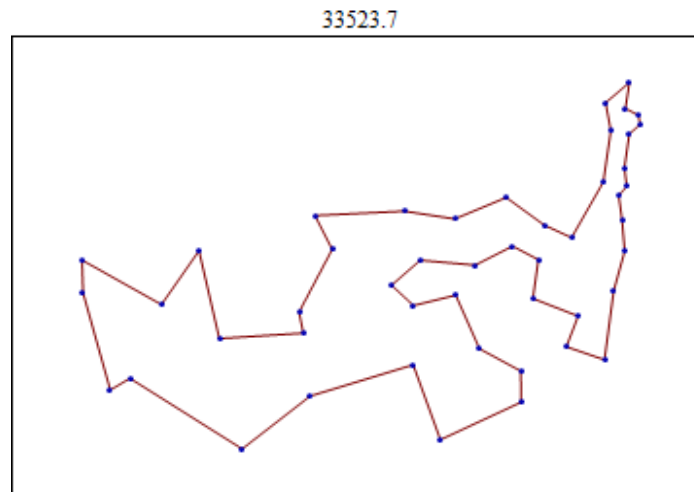
2-opt (8 tarefas)



SA (8 tarefas)



SA ◦ 2-Opt (8 tarefas)
1 geração



SA ◦ 2-Opt (8 tarefas)
10 gerações – resultado ótimo
encontrado na geração 7

```
GENERATION:7
START SOLUTION:
[1] (6734, 1453) : [8] (7265, 1268) :
GraphPlot[0 -> 1, 1 -> 2, 2 -> 3,
CANDIDATE SOLUTIONS:
[1] (6734, 1453) : [16] (6107, 669) :
[1] (6734, 1453) : [8] (7265, 1268) :
[1] (6734, 1453) : [40] (6271, 2135) :
[1] (6734, 1453) : [16] (6107, 669) :
[1] (6734, 1453) : [16] (6107, 669) :
[1] (6734, 1453) : [8] (7265, 1268) :
[1] (6734, 1453) : [22] (6101, 1110) :
[1] (6734, 1453) : [8] (7265, 1268) :
CANDIDATE LENGTHS:
34993.4
34344.2
34155.6
33831.7
34229.1
33600.6
34594
33523.7
33523.7
CANDIDATE LENGTHS (ORDERED):
33600.6
33831.7
34155.6
34229.1
34344.2
34594
34993.4
33523.7
SELECTED SOLUTION:
[1] (6734, 1453) : [8] (7265, 1268) :
GraphPlot[0 -> 1, 1 -> 2, 2 -> 3,
6051 ms
```

Conclusão

- Existem diversas técnicas e abordagens de problemas através da Inteligência Artificial e *Machine Learning*. É desafiador dominar todos eles
- A maioria dos problemas podem ser vistos como problemas de otimização
- Focar o aprendizado em Algoritmos e Estrutura de Dados (este é o diferencial!)
- Escrever (muito) código, entender os dados
 - “Our world, ..., will soon be ‘reduced to data’.”
 - “... and among the winners will be those who code.”
 - <https://news.microsoft.com/apac/features/brief-update-future-bots-code-hot-tubs/>
- Alguns campos da Matemática são essenciais

Se quiser saber mais sobre:

C++
Programação Genérica
Iterators
Policy-based Design
Algoritmos

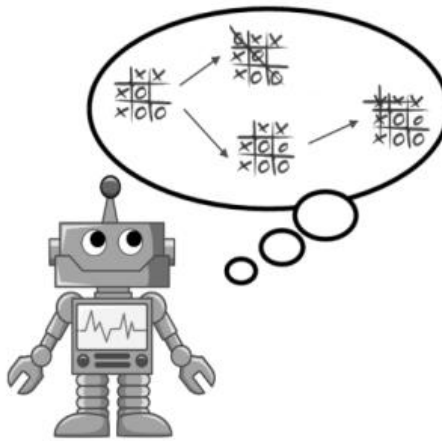
...

visite:

www.simplycpp.com



<http://www.simplycpp.com>



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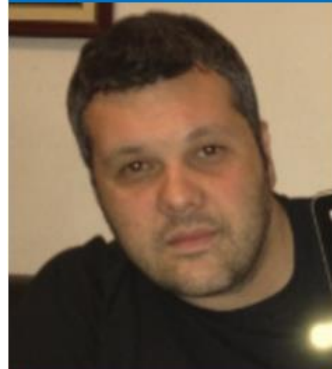
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Technologies

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Number of MVP Awards:
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