

Music Machine Learning

0 – Introduction (AI)

Master ATIAM - Informatique

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Artificial intelligence

- Artificial *intelligence* ?
- Requires to first understand what intelligence is !
- Must have something to do with *thinking*

Thinking

Artificial intelligence

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- Requires to first understand what intelligence is !
- Must have something to do with ***thinking***
- But in a broader sense, might also be about *perception* and *action*
- In terms of philosophy, we would talk about problems involving these
- However, we *try to understand the mechanisms of our thinking itself*
- *So here, we seek **models** targeted at thinking, perception and actions*

Thinking, perception and action

Artificial intelligence

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- Hence, here we will try to construct a *model of thinking*

This might even help you in understanding your own thinking process ☺

Models targeted at
Thinking, perception and action

Artificial intelligence

- **Thinking** « *Man can only desire what he has already perceived* »
- Creation ex-nihilo can not really exist ... **William Blake**

Intelligence: « the capacity to assemble two ideas that seemed heterogeneous »

Models targeted at
Thinking, perception and action

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Intelligence: « the capacity to assemble two ideas that seemed heterogeneous »

- We exist (morphologically) since ~200 kYears, and around ~50 kY ...
« *Take two concepts and create a third one without impairing the two first* »
Noam Chomsky

- So thinking is finding similarity, discriminating and seeing common patterns

NB: *Frames of Mind: the Theory of multiple intelligence* – **Howard Gardner**

(logico-mathematic, spatial, inter-personal, corporal, linguistic, intra-personnal, musical, ecologist, existential)

- In order to have a model, you need a *representation*

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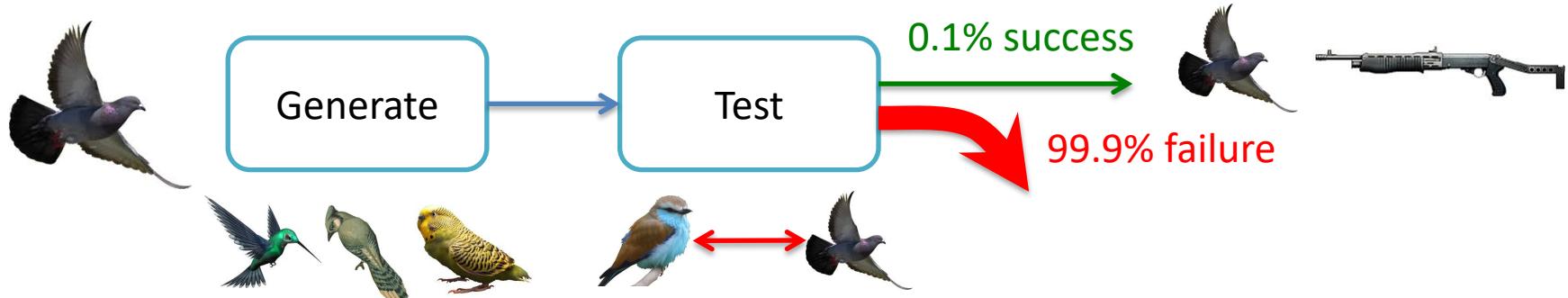
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- In order to have a model, you need a *representation*
 - *A representation that supports a model that allows to understand thinking*

Representations supporting Models targeted at Thinking, perception and action

Artificial intelligence

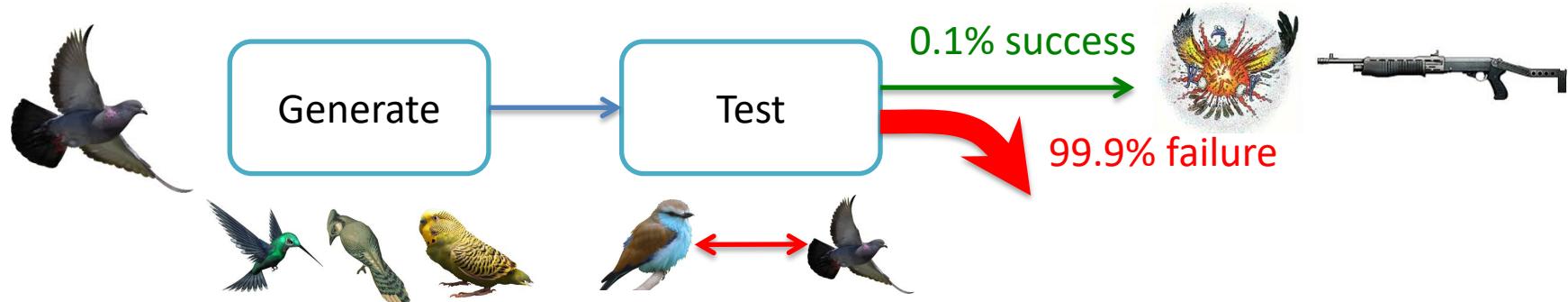
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- Generate and test method (cf. trying to find a bird from a book)



**Representations supporting
Models targeted at
Thinking, perception and action**

Artificial intelligence

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Once you have a name for it, you can start talking about it, you have **power over it**

- Symbolic labels give us power over concepts

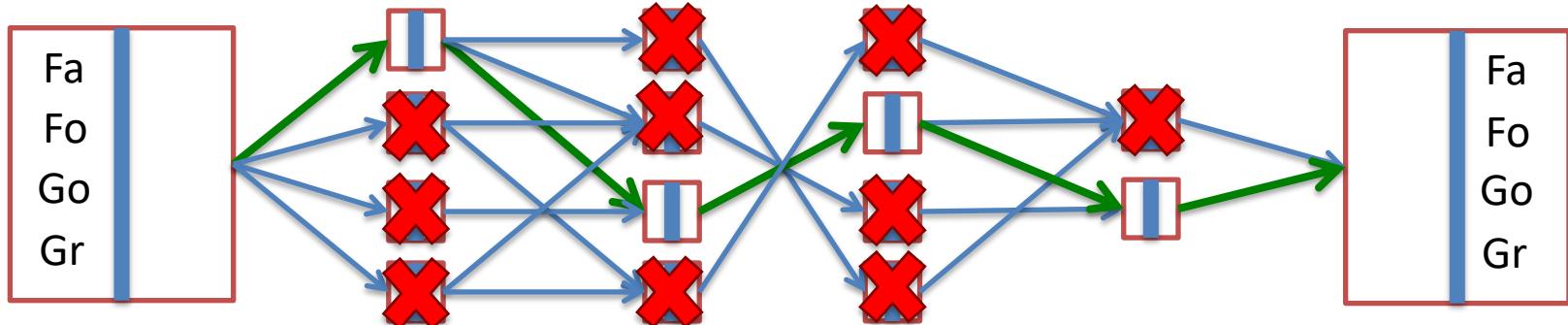
The Rumpelstiltskin tale

« *Once you can name something you have power over it* »

**Representations supporting
Models targeted at
Thinking, perception and action**

Artificial intelligence

- The right representation? Exemple of the farmer, fox, goose and grain

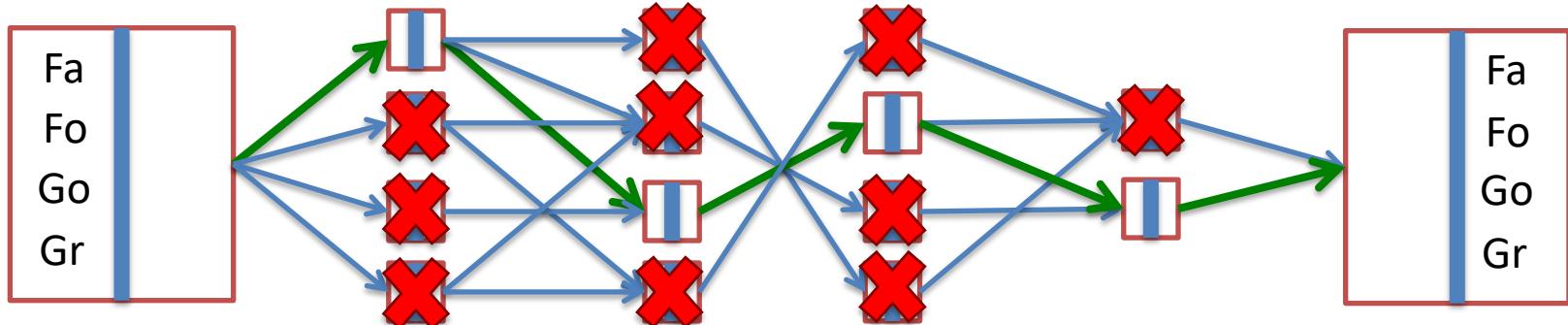


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**Representations supporting
Models targeted at
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Artificial intelligence

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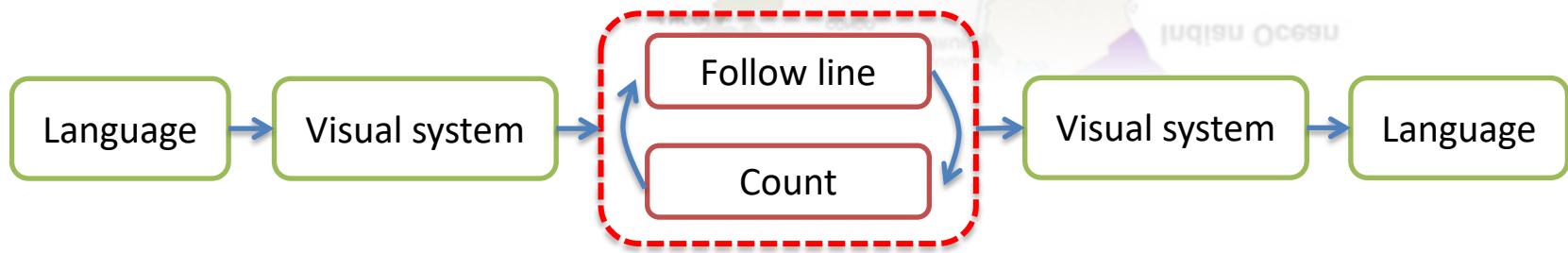


- Normally 16 possibles, but some are impossible (someone gets eaten)
- By drawing as the *right representation* (a graph), it **exposes the constraints**

Constraints exposed by
Representations supporting
Models targeted at
Thinking, perception and action

Artificial intelligence

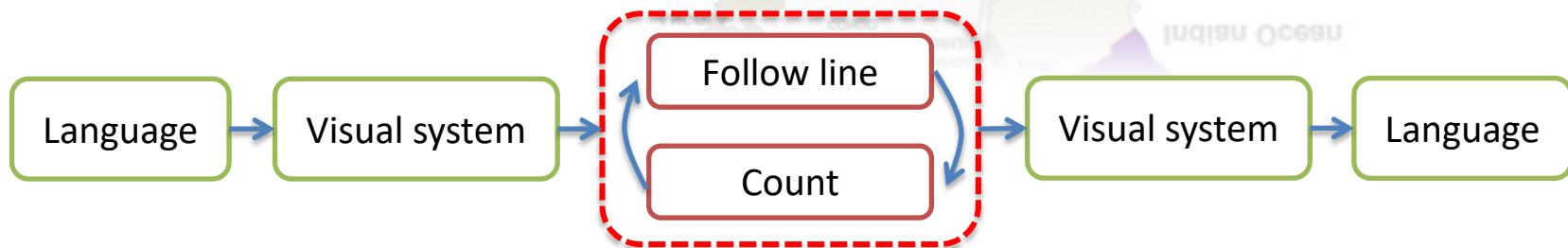
How many countries are crossed by the equator in Africa ?



**Constraints exposed by
Representations supporting
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Artificial intelligence

How many countries are crossed by the equator in Africa ?



**Algorithms enabled by
Constraints exposed by
Representations supporting
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Artificial intelligence

- Imagine you are running down the street with a bowling ball ?
- ... What will happen to you?
- You can know the consequences, without having any prior experience !
- **Trivial is not simple.** Warning on the confusion ...
- Some people think that ideas are only good if they are complicated

Simple ideas are usually the best and most powerful (**Occam's razor**)

- As there is wide controversies about AI (weak vs. strong, feasible vs. fake)
- ... we will only dwell in the world of ***machine learning***.
- But first let's look at **historical approaches of artificial intelligence**

Algorithms enabled by
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Why learning ?

- Some things computers do ...
... *That we can not*
(Try beating a computer at PI decimals)
 - Some things we do almost instantly ...
... *That computer fails miserably*
(Typical conversation with a computer)
-
- 60+ years of ongoing research in AI
 - (face recognition, content segmentation, etc...)

Artificial intelligence

So why developing and using AI in general?

Engineer « Building smarter programs »

Scientist « Build a computational account of intelligence »

1842: *Lady Ada Lovelace*, the first ever programmer

(even decades before computers even existed)

« *The analytical engine has no pretensions to originate anything, it can do whatever we know how to order it to perform* »

1950s: Alan Turing - « the Turing test »

Marvin Minski - « Steps towards artificial intelligence »

1960s: *Early dawn age* (age of speculation)

Symbolic integration

ELIZA chatbot

ELIZA Program

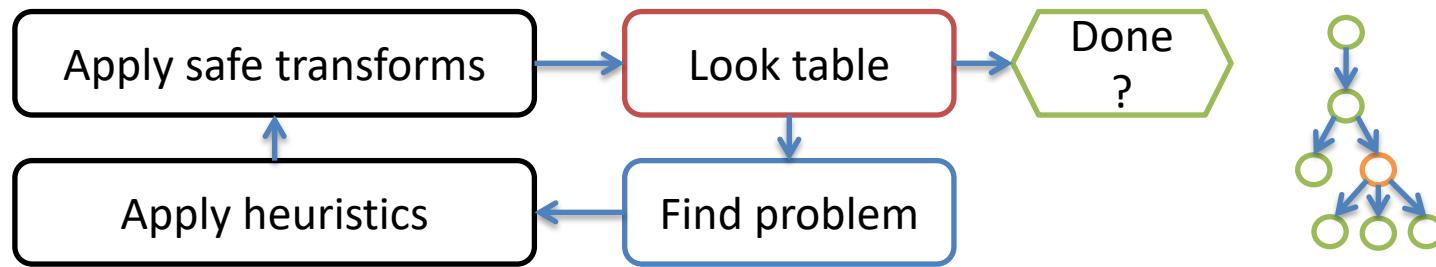
- The first ever implemented chatbot (1966)
 - Eliza emulates a *Rogerian psychotherapist*.
 - No intelligence whatsoever, but a lot of interesting tricks
 - Uses string substitution and keywords canned response
 - Beginning of the Natural Language Processing (NLP) field
-
- **Live demonstration**

<https://www.masswerk.at/elizabot/>

Early dawn age: symbolic integration

$$\int \frac{-5x^4}{(1-x^2)^{5/2}} dx \quad \longrightarrow \quad \int (y^2 - 1 + \frac{1}{1+y^2}) dx$$

- Program of symbolic integration written by Joel Moses in 1967 at MIT

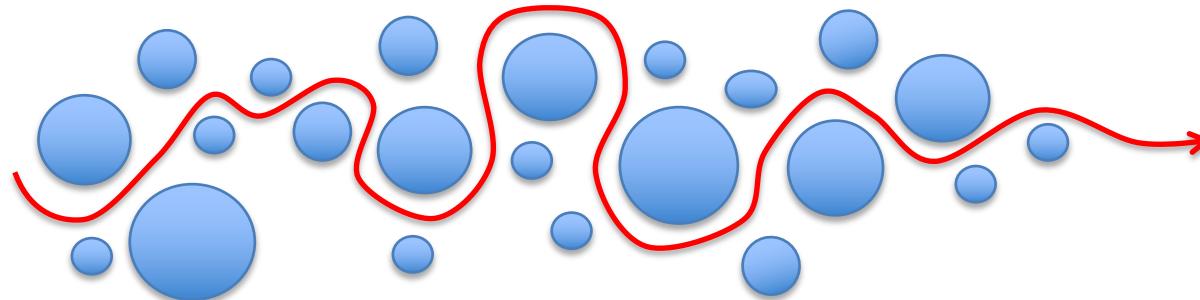


$$(1) \int -f(x) = - \int f(x) \quad (2) \int cf(x)dx = c \int f(x)dx \quad (3) \int \sum_i f_i(x)dx = \sum_i \int f_i(x)dx$$
$$(A) \int [\sin, \cos, \tan, \dots]dx = g([\sin, \cos, \tan, \dots]) \quad (B) \int f(\tan(x))dx = \int \frac{f(y)}{1+y^2}dy$$

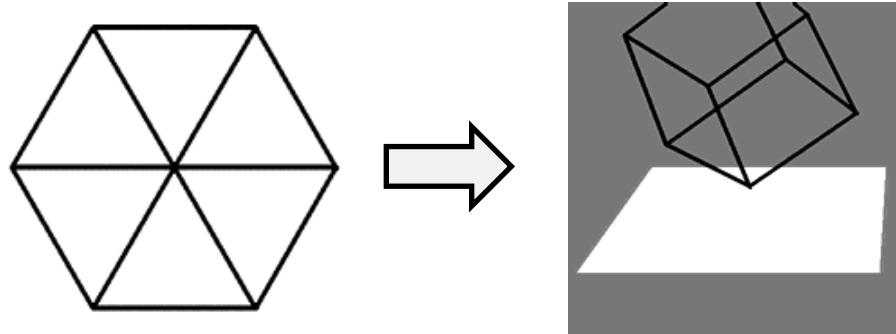
- Intelligence vanish with explanation
- Knowledge is power => **Knowledge over knowledge is power**
- Problem solving by problem transformation (**problem reduction**)
- The rise of goal trees and expert systems

On complexity

- Imagine you observe the path of an ant



- Seems complicated ... you could say the ant is extremely smart
- You look closer, there are rocks that the ant is just avoiding
- Complexity can be consequence of the environment not the program
$$C(\text{behavior}) = \max(C(\text{program}), C(\text{environment}))$$
- Now imagine you are trying to understand this behavior



Notion of problem dimensionality

Now ? The Bulldozer age

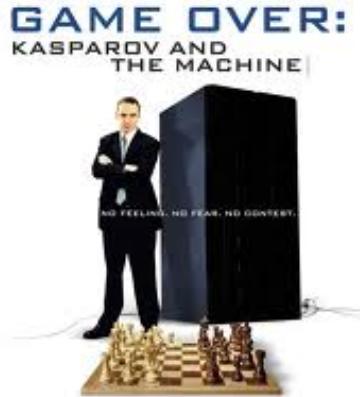
Replacing intelligence by mass computing (parallel and HPC)



Deep blue

Games, Minmax and alpha-beta

Ex. DeepBlue beating Kasparov



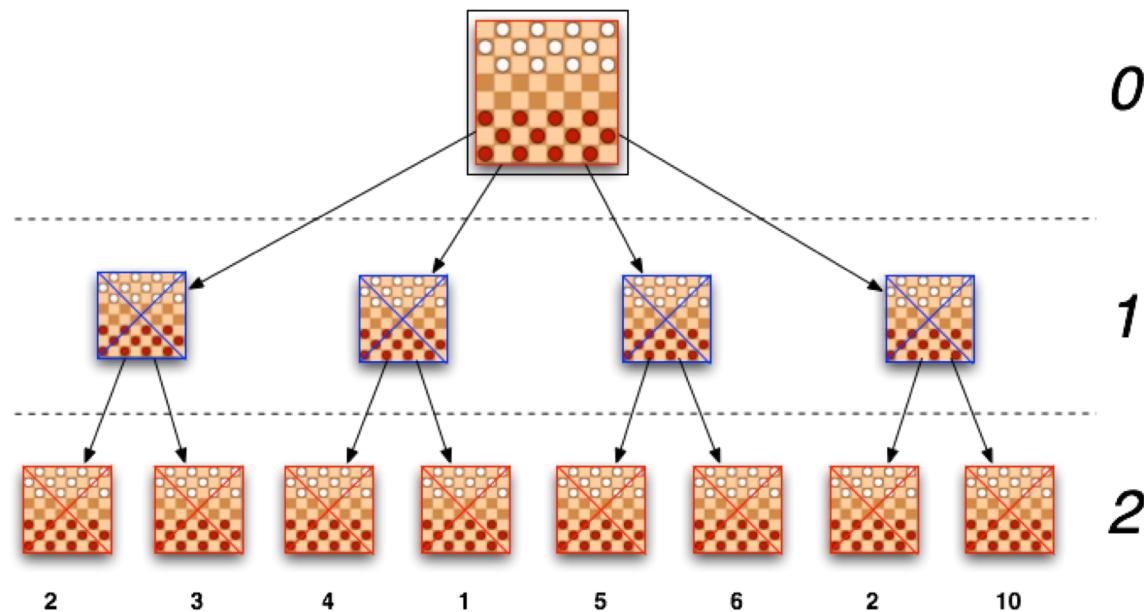
Ways to play

- Analysis/strategy/tactics ?=>? Move
- If/Then rules => Pick the highest current move possible (still lame)
- Look ahead and evaluate the situation (this requires a static value)
 - $S = g(f_1, f_2, \dots, f_n) = w_1.f_1 + w_2.f_2 + \dots + w_n.f_n$ = linear scoring polynomial
- Brute force approach = evaluate the whole tree of possibles
- ... However 10^{120} possible ... leafs !
- So the best way is to look ahead the most possible
- And try to evaluate the highest number of leaves

Games, Minmax and alpha-beta

A computer beats a chessmaster: **Min-max algorithm**

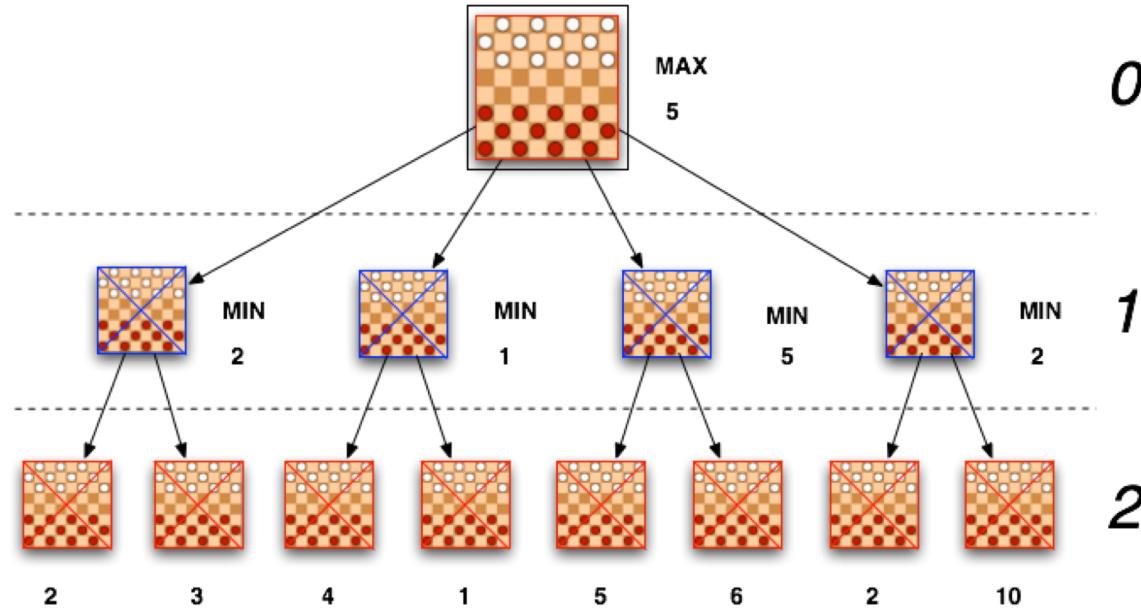
- We have a fitness function and compute the *chess tree*
 - We see the tree from the view of the « Maximizing player »



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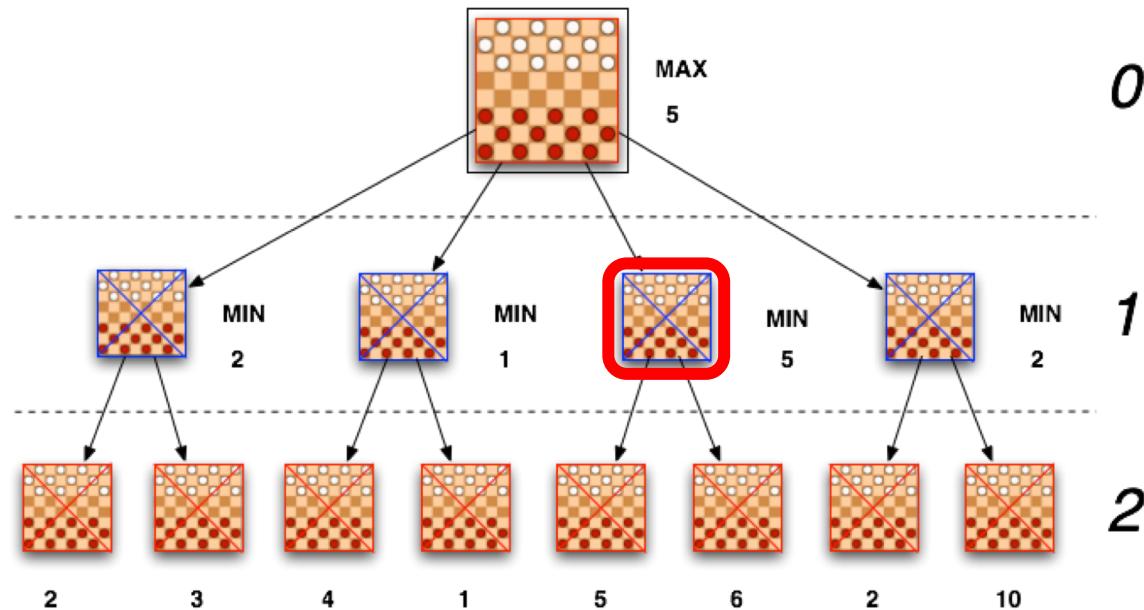
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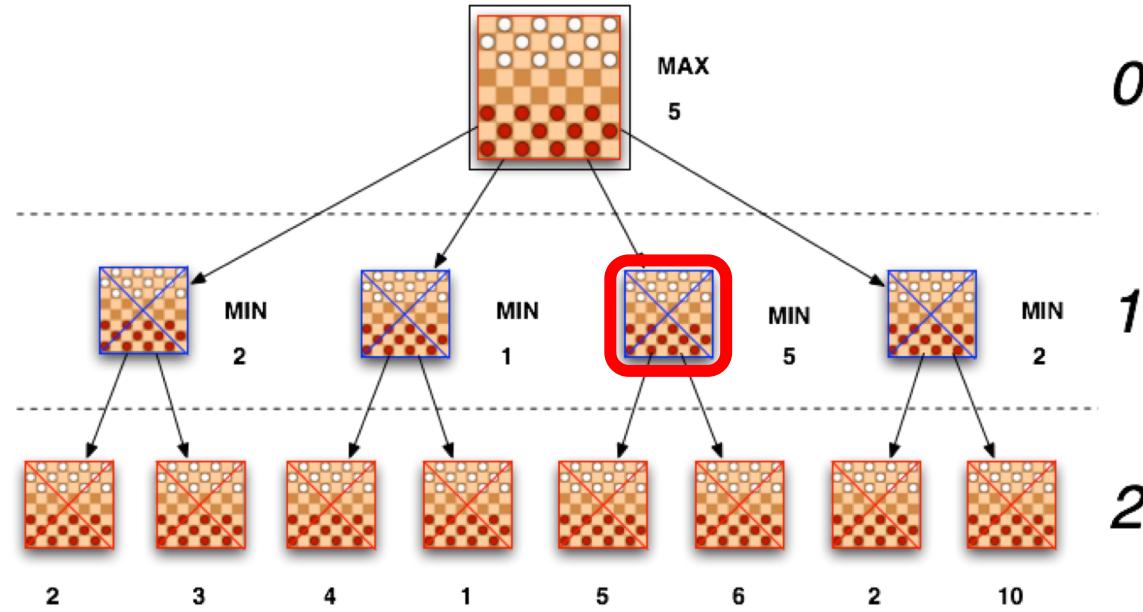
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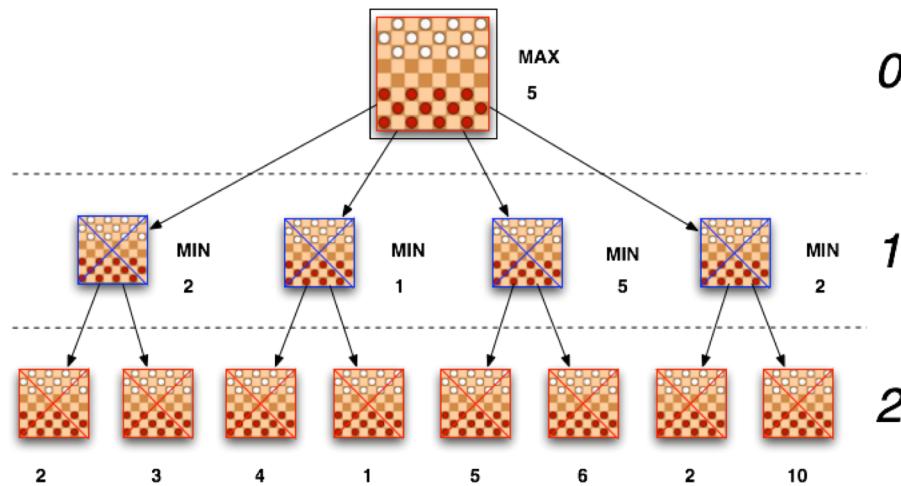
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- Need to go as far down the tree as possible
- 14 levels separates a moron from a master !



Games, Minmax and alpha-beta



- Alpha beta **is layered over** minmax to remove large parts of the tree
- The idea is as soon we find a branch lower than our expected value
- Stop evaluating the other sub-branches and try to go further down the other tree!
- Problem of how deep can we go ? Use an insurance policy on level (d-1)
- This idea is called progressive deepening

Deep blue = all this + parallel computing + books + uneven tree dev.

So deep blue intelligent ? Maybe ... but mostly **bulldozer** intelligence

Remember to avoid overkill => eg. Ressource allocation = Constraints problem