Le rôle de la complexité et de la simplicité dans l'émergence des capacités cognitives

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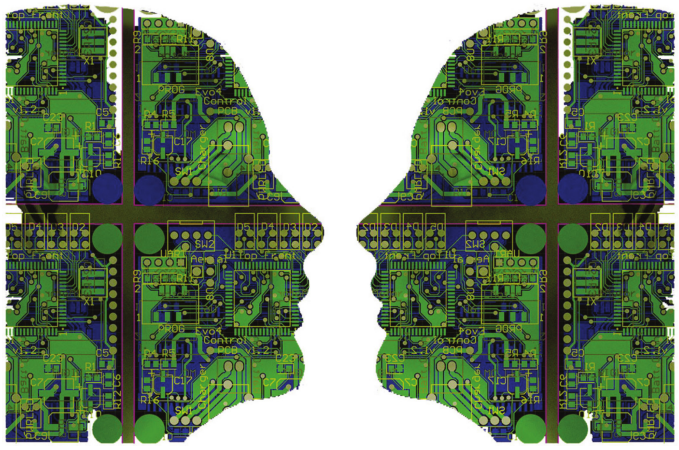
Journée « Philosophie des sciences et intelligence artificielle »
le 2 février 2017, à l'École normale supérieure



Organisée par l'AFIA, la SPS et le DEC

Responsables scientifiques :
Robin Lamarche-Perrin et Daniel Andler

AfIA Association française pour l'Intelligence Artificielle
société de philosophie des sciences SPS
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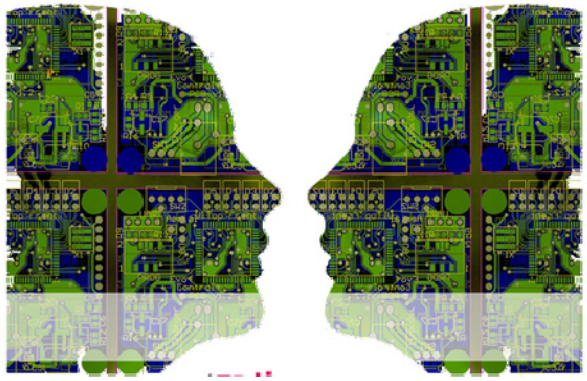
IEC INSTITUT D'ETUDE DE LA COGNITION

Philosophie des Sciences & Intelligence Artificielle



mercredi 8 février 2017

Le rôle de la complexité et de la simplicité dans l'émergence des capacités cognitives

Pourquoi l'intelligence humaine n'a-t-elle pas évolué comme l'IA?

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TELECOM ParisTech

BBC NEWS

2 December 2014 Last updated at 13:02 GMT

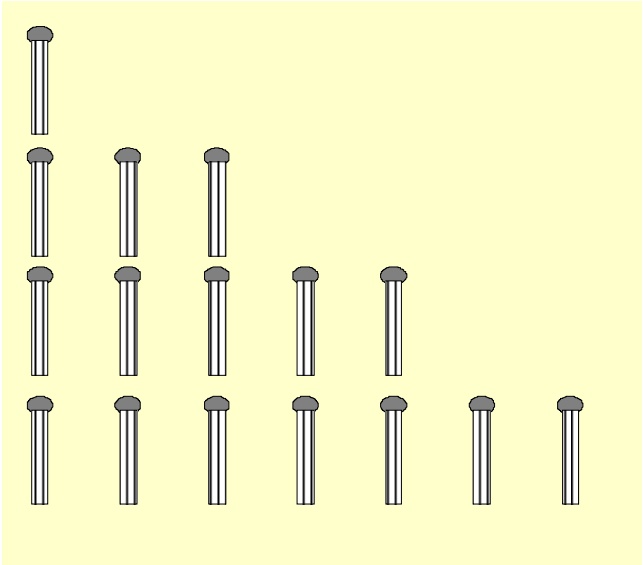
Stephen Hawking warns artificial intelligence could end mankind

Bill Gates

« Google AI algorithm masters ancient game of Go »

B=250; D=150

- Exemple du jeu de Nim



Le jacquet (Gerry Tesauro 1992, 1995)

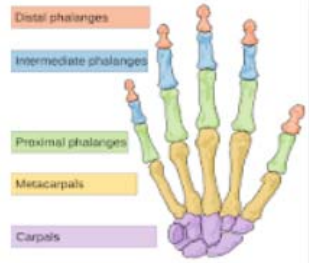
How many phalanges in a Human body ?

Google How many phalanges in a Human body

All Images Shopping News Videos More Search tools

About 381,000 results (1.24 seconds)

There are **56 phalanges** in the human body, with **fourteen** on each hand and foot. **Three phalanges** are present on each finger and toe, with the exception of the thumb and large toe, which possess only two. The middle and far phalanges of the fourth and fifth toes are often fused together (symphalangism).



Phalanx bone - Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/**Phalanx**_bone

Feedback

how many phalanges does a human have? | Yahoo Answers
https://answers.yahoo.com/question/index?qid...
Feb 12, 2008 - Hanesh Kumar. Total no: of **phalanges in a human** is .... 56 are **phalanges** what percent of the bones in the **body** are **phalanges**? Did you know ...

How many phalanges are in the **body**? 12 Mar 2013
How many phalanges do we have in our skeleton? 18 Dec 2007
More results from answers.yahoo.com

Phalanx bone - Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/**Phalanx**_bone
There are **56 phalanges** in the human body, with **fourteen** on each hand and foot

- Calcul

vs.

- Statistiques

- One-shot learning

*« Comment vas-tu,
depuis que tu es
encore [au] CNRS ? »

« sans nouvelles
depuis hier, elle est
encore partie »

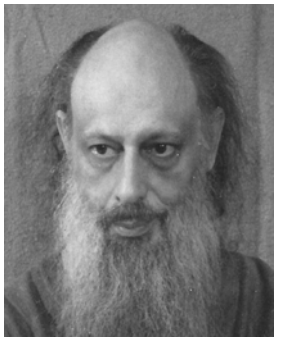
« je sais
depuis qu'elle a
encore gagné »

most probable continuation?

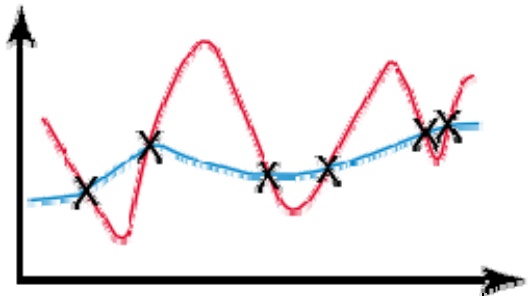
1 2 2 3 3 3 4 4 4 4 5 5 5 5 5

n^{*n}

c minimal
→ max. prob.



Ray Solomonoff



Search: seq:1,2,2,3,3,3,4,4,4,4

Displaying 1-10 of 46 results found.

n appears n times; floor(sqrt(2n) + 1/2).
1, 2, 2, 3, 3, 3, 4, 4, 4, 4, 5, 5, 5, 5, 5, 6, 6, 6, 6, 6, 6, 7, 7, 7, 7, 7, 7, 7, 8, 8, 8, 8, 8, 8, 8, 8, 9, 9, 9, 9, 9, 9, 9, 9, 9, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 13, 13, 13, 13, 13, 13

n appears partition(n) times.
0, **1, 2, 2, 3, 3, 3, 4, 4, 4, 4,** 4, 5, 5, 5, 5, 5, 5, 5, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 10

Number of digits in lazy-Fibonacci-binary representation of n.
1, **1, 2, 2, 3, 3, 3, 4, 4, 4, 4,** 4, 5, 5, 5, 5, 5, 5, 5, 5, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 8, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9, 9

Write n = C(i,3)+C(j,2)+C(k,1) with i>j>k>=0; sequence gives j values.
1, 1, 2, 2, 1, 2, 2, 3, 3, 3, **1, 2, 2, 3, 3, 3, 4, 4, 4, 4, 1, 2, 2, 3, 3, 3, 4, 4, 4, 4,** 5, 5, 5, 5, 5, **1, 2, 2, 3, 3, 3, 4, 4, 4, 4,** 5, 5, 5, 5, 5, 6, 6, 6, 6, 6, 6, **1, 2, 2, 3, 3, 3, 4, 4, 4, 4,** 5, 5, 5, 5, 5, 6, 6, 6, 6, 6, 6, 7, 7, 7, 7, 7, 7, 7, **1, 2, 2, 3, 3, 3, 4, 4, 4, 4,** 5, 5, 5, 5, 5, 6, 6, 6, 6, 6, 6, 7, 7, 7, 7, 7, 7, 7, 8, 8, 8, 8, 8, 8, 8, 8, 1, 2, 2

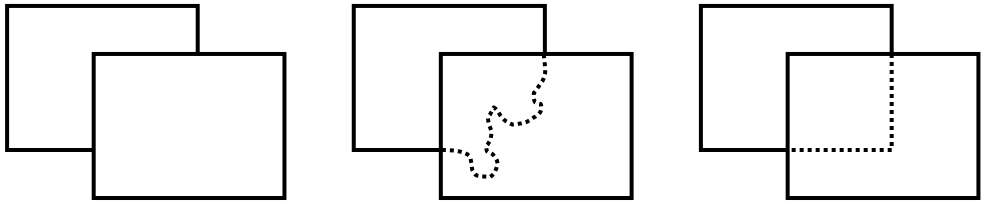
Positive integers a for which there is a 10-Pythagorean triple (a,b,c) satisfying a<=b.
1, 2, 2, 3, 3, 3, 4, 4, 4, 4, 5, 5, 5, 5, 5, 6, 6, 6, 6, 6, 7, 7, 7, 7, 7, 8, 8, 8, 8, 8, 8, 9, 9, 9, 9, 9, 10, 10, 10, 10, 10, 10, 10, 10, 10, 11, 11, 11, 11, 11, 12, 12, 12, 12, 12, 12, 12, 12, 13, 13, 13, 13, 14, 14, 14, 14, 14, 14, 14, 14, 15, 15, 15, 15, 15, 15, 15, 15

The Kruskal-Macaulay function M_2(n).
0, **1, 2, 2, 3, 3, 3, 4, 4, 4, 4,** 5, 5, 5, 5, 5, 6, 6, 6, 6, 6, 6, 7, 7, 7, 7, 7, 7, 7, 8, 8, 8, 8, 8, 8, 8, 8, 9, 9, 9, 9, 9, 9, 9, 9, 9, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 11, 11, 11, 11, 11, 11, 11, 11, 11, 11, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 12, 13, 13, 13, 13, 13, 13

Triangle read by rows in which row n contains a finite triangle as shown below.
1, 1, 2, 2, 2, 3, 2, 1, 2, 2, 1, 1, 2, 2, 3, 3, 3, 3, 4, 4, 3, 3, 4, 5, 4, 3, 2, 3, 4, 4, 3, 2, 1, 2, 3, 3, 3, 2, 1, **1, 2, 2, 3, 3, 3, 4, 4, 4, 4,** 4, 5, 5, 5, 4, 4, 5, 6, 6, 5, 4, 4, 5, 6, 7, 6, 5, 4, 3, 4, 5, 6, 6, 5, 4, 3, 2, 3, 4, 5, 5, 5, 4, 3, 2, 1, 2, 3, 4, 4, 4, 4, 3, 2, 1, **1, 2, 2, 3, 3, 3, 4, 4, 4, 4,** 5

Description complexity

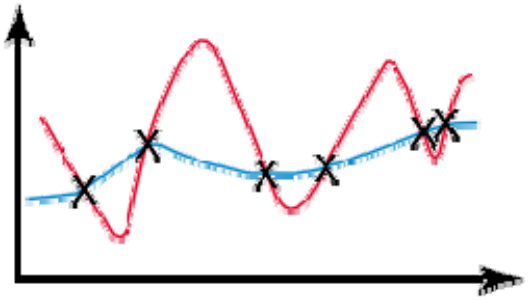
Complexity $C(s)$ of s :
size of the smallest available description of s

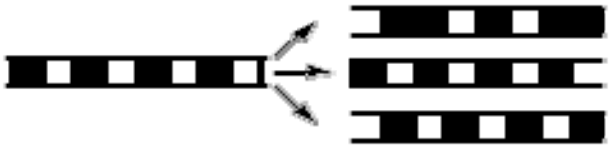


Simplicity: a unifying principle in cognitive science?
(Chater & Vitányi 2003)

def

pi





$$C(x) = \min_p \{ l(p) : M(p) = x \}$$

Reconnaître des structures

- Analogies (D. Hofstadter)

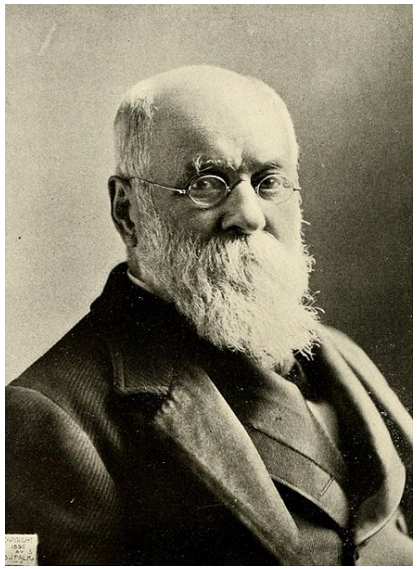
a b c → a b d

x y z → w y z

$\alpha \rightarrow \beta$
$\gamma \rightarrow x$

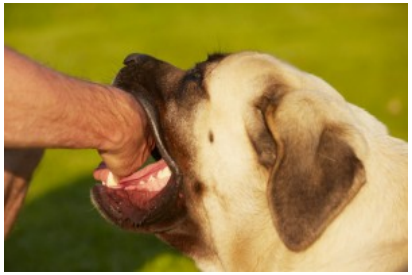
$x = \text{argmin}(C(\alpha, \beta, \gamma, x))$

- Gestion des exceptions



Charles Dana

WHEN DOG BITES MAN THAT'S NOT NEWS. WHEN MAN BITES DOG, THAT'S NEWS.



Dessalles, J.-L. (2002).
La fonction shannonienne du langage : un indice de son évolution.
Langages, *36* (146), 101-111.

Unexpectedness

Combinations	Complexity	Probability
1 2 3 4 5 6	3	*p*/8 × 10^6
34 35 36 37 38 39	6	*p*/10^6
10 11 12 44 45 46	11	*p*/32768
7 8 9 37 38 39	12	*p*/16384
8 9 26 27 28 29	12	*p*/16384
10 20 30 31 32 33	12	*p*/16384
1 2 5 6 15 49	14	*p*/4096
. . .	. . .	. . .
14 24 36 38 42 44	26	*p*

Dessalles, J.-L. (2006).
A structural model of intuitive probability.
In D. Fum, F. Del Missier & A. Stocco (Eds.),
7th Int. Conf. on Cognitive Modeling, 86-91.
Trieste, IT: Edizioni Goliardiche.

- Information is complexity drop.

$$U(s) = C_w(s) - C(s)$$

- Informative events are *unexpected*, *i.e.* they are
  - Hard to generate
  - Simple to describe

$$p = 2^{-U}$$

ex post probability

$$U(s) = C_w(s) - C(s)$$

$$p = 2^{-U}$$

C_w: generation

$U = C_w - C$

C: description

Angelina Jolie

Louise Monot

A. J.: 82 200 000 hits
L.M.: 201 000 hits

Fortuitous encounters

- To be explained:
  - The coincidence is more impressive if…
    - one meets a close friend
    - one meets a celebrity
  - The coincidence is more impressive if…
    - the place is remote (hard to find)

$$U = C(L) - C(P)$$

$$C_w(L(ego)\ \&\ L(P)) = C_w(L(ego)) + C_w(L(P))$$
$$C_w(L(ego)\ \&\ L(P)) = 2\ C(L)$$
$$C(L(ego)\ \&\ L(P)) = C(L) + C(P)$$
$$U(L(ego)\ \&\ L(P)) = C(L) - C(P)$$

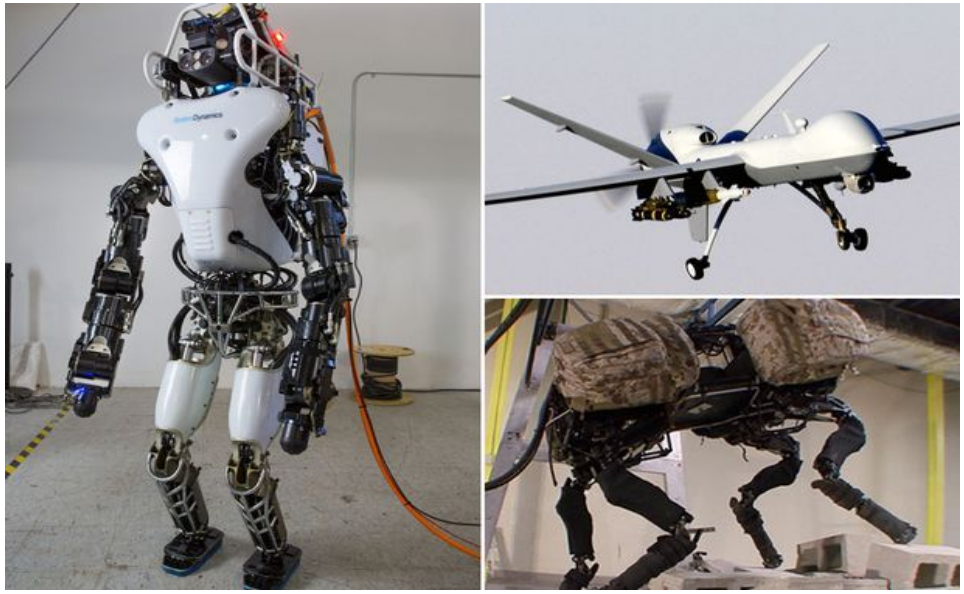
- Calcul

vs.

- Statistiques

Artificial Intelligence's White Guy Problem

The New York Times

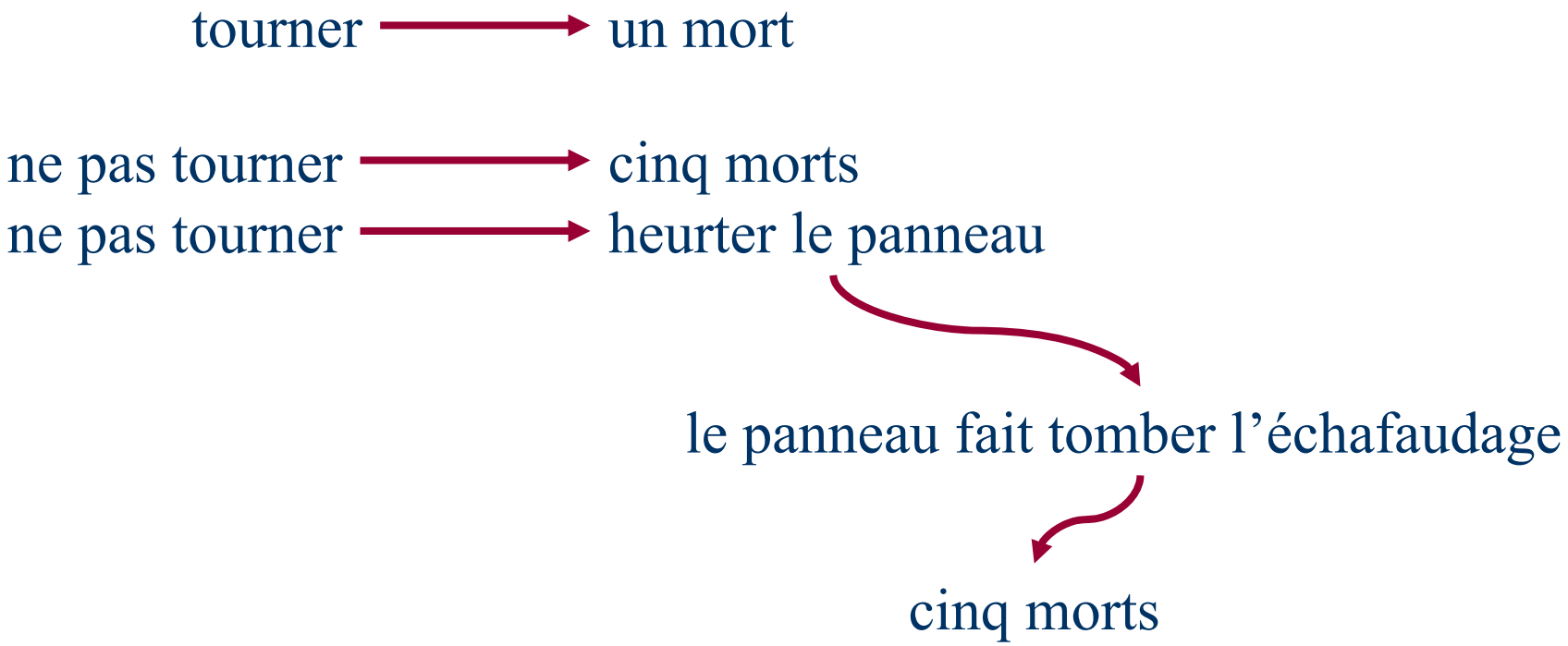


Votre voiture autonome devra-t-elle être programmée pour vous tuer?

Par Soline Roy | Publié le 24/06/2016 à 18:03

129 commentaires

Sacrifier une personne pour en sauver dix ? Dilemme éthique vieux comme le monde… qui devra être résolu pour que les voitures sans conducteur conquièrent l'espace public.


tourner
un mort
ne pas tourner
cinq morts
ne pas tourner
heurter le panneau
le panneau fait tomber l'échafaudage
cinq morts

Responsabilité: $C_w(s) - C_w(s \mid\mid a)$

Négligence: $C_w^A\left(s\middle\|a\right) - C_w^{\downarrow A}\left(s\middle\|a\right)$

Intention: $E^A(s) - C_w^A\left(s\middle\|a\right) - U(a)$

Jugement: $E^J(s) - C_w^{\downarrow A}\left(s\middle\|a\right) - U(a)$

- Prédicats f
- Objets a

  $f(a)$
- Négation $\neg f(a)$
- Pertinence

« le livre qui rouge avec un titre doré »

« le livre qui a 347 pages »

Pertinence:

$$C(b|\, L) \leq C(f|\, L) + C(b|\, L \,\&\, f)$$

Relevance

$$U(s) = C_w(s) - C(s)$$

s is relevant if $U(s) > 0$

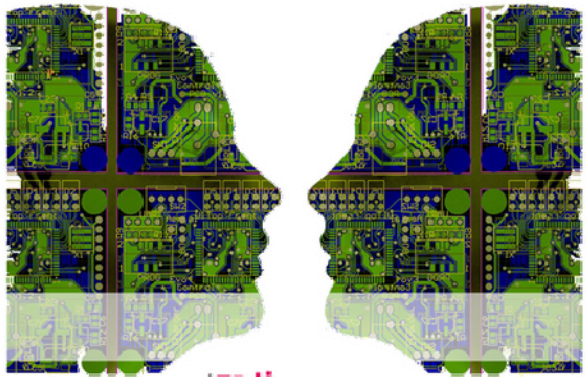
f is relevant w.r.t. s if $U(f(s)) = C_w(f(s)) - C(f) > 0$

if $U(s \mid t) < U(s)$, then t is 2-relevant w.r.t. s

$$p = 2^{-U}$$

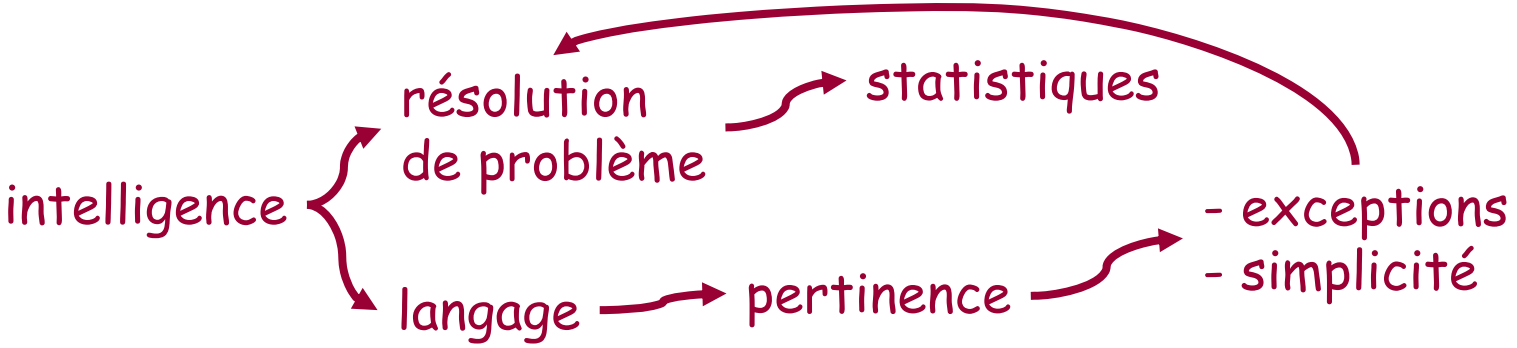
ex post probability

Dessalles, J.-L. (2013). Algorithmic simplicity and relevance.



GOFAI 2.0 ?

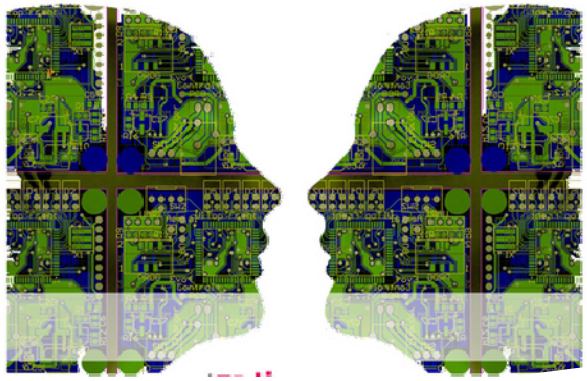
Pourquoi l'intelligence humaine n'a-t-elle pas évolué comme l'IA?



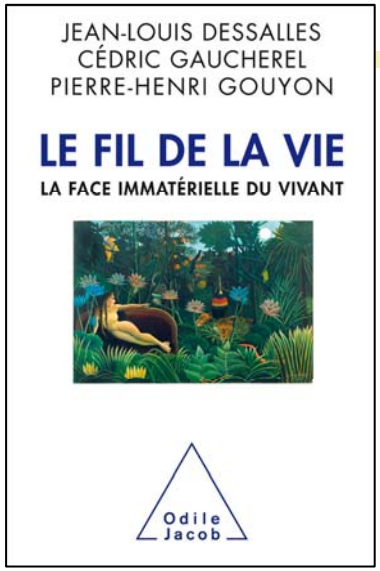
Merci pour votre attention

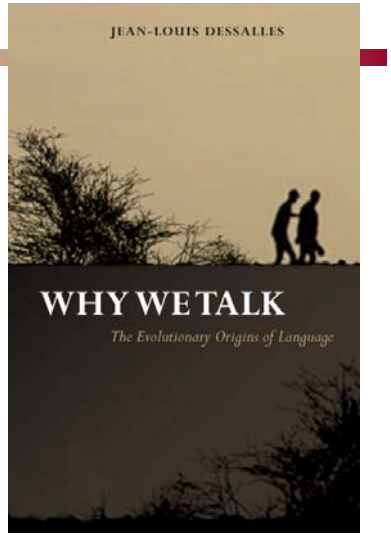
jean-louis @ dessalles.fr
www.dessalles.fr

Philosophie des Sciences & Intelligence Artificielle



Pourquoi l'intelligence humaine n'a-t-elle pas évolué comme l'IA?





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www.simplicitytheory.science