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Fondamentaux de l'IA et domaines d'application

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Fondamentaux de l'IA et domaines d'application

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Inria's white paper (2021): for more information...

Artificial Intelligence

Current challenges and Inria's engagement



Inria | WHITE PAPER | N°01 | SECOND EDITION 2021 |

<https://www.inria.fr/fr/livre-blanc-inria-intelligence-artificielle>

AI definition

Artificial intelligence (AI) is the field of study of intelligent agents, which refer to any system that perceives its environment and takes actions that maximizes its chance of achieving its goals.

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

A brief history

Computing power (1)

- mid-1950s: workshop at Dartmouth (1956), symbolic AI
- 1973: Lighthill report, 1st AI Winter

(1') + new languages (2)

- 198x: Prolog, List, edpert systems
- 1997: collapse of the Lisp Machine market, 2nd AI Winter

(1'') + (2') + data deluge (3)

- 20xx: data from the web, deep learning (triumph of CNN)
- 202x: towards a 3rd AI Winter?

Goals involved by AI

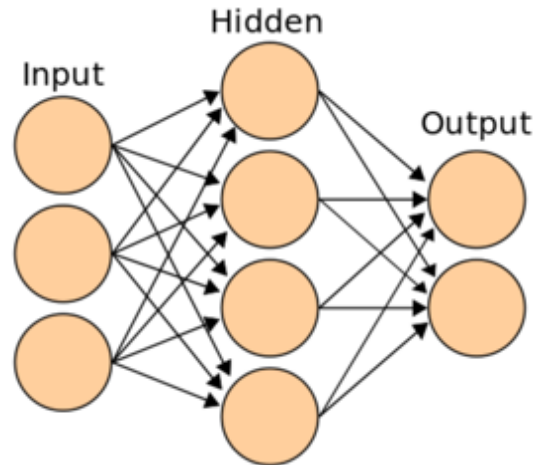
- **Reasoning, problem-solving** (but combinatorial explosion)
- **Knowledge representation** (answer questions intelligently and make deductions)
- Planning (**optimization** of the utility of successive choices)
- **Machine learning** (unsupervised, supervised, reinforcement, transfer)
- **Natural language processing/NLP** (read and understand human language)
- Machine perception (**sensors** to deduce aspects of the world)
- Motion and manipulation (**robotics**)
- ...

Applications: thousands of successful ones...

- Game playing (Deep Blue, AlphaGo)
- NLP (with the enormous RNN for GPT-3)
- Computer vision
- Transportation
- Medical sciences
- Industry
- ...

Tools involved by AI

- **Many tools:** optimization, logic, probability, statistics, control, languages...
- “The winner is”: **artificial neural networks (CNN, RNN...)**



Deep supervised learning (in 1 slide)

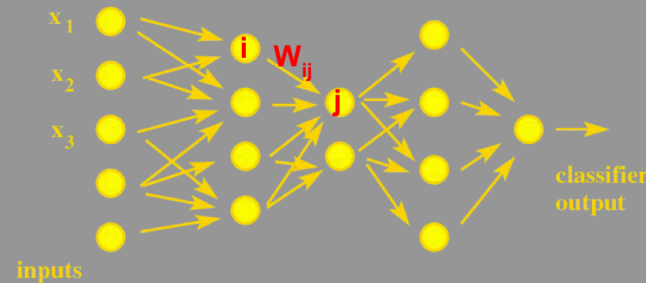
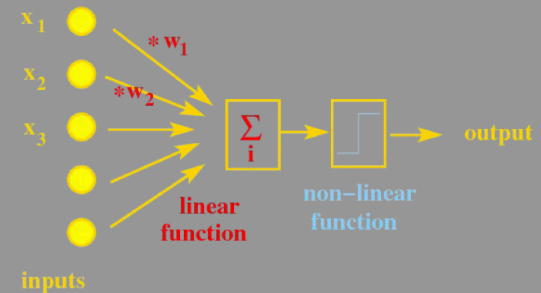
(Deep) Neural Networks = (just) a classification/regression model
 Learning = fit the model to (many) labeled examples $(x_1, x_2, \dots, x_n, y)$.

Learning Phase

Back-propagation

from the 60s

- For each labeled example $(x_1, x_2, \dots, x_n, y)$
- Compute the error/loss
 - difference between output and label y
- Compute the gradient of the loss w.r.t. w_{ij}
- Adjust the weights w_{ij} using gradient rule
- Loop



Recognition (inference) Phase

Present an unlabelled example, the output of the network is the predicted label

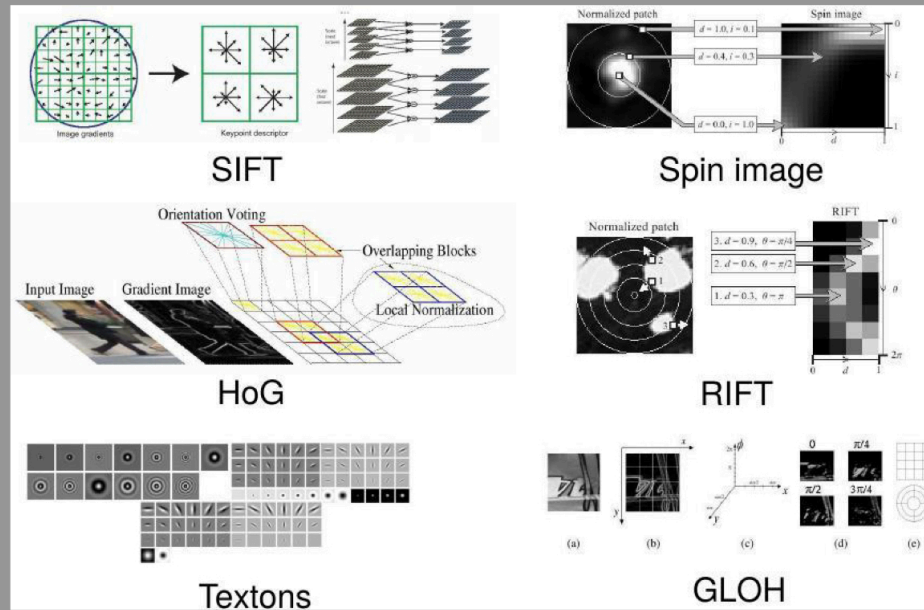
Good old computer vision



Hand-made features

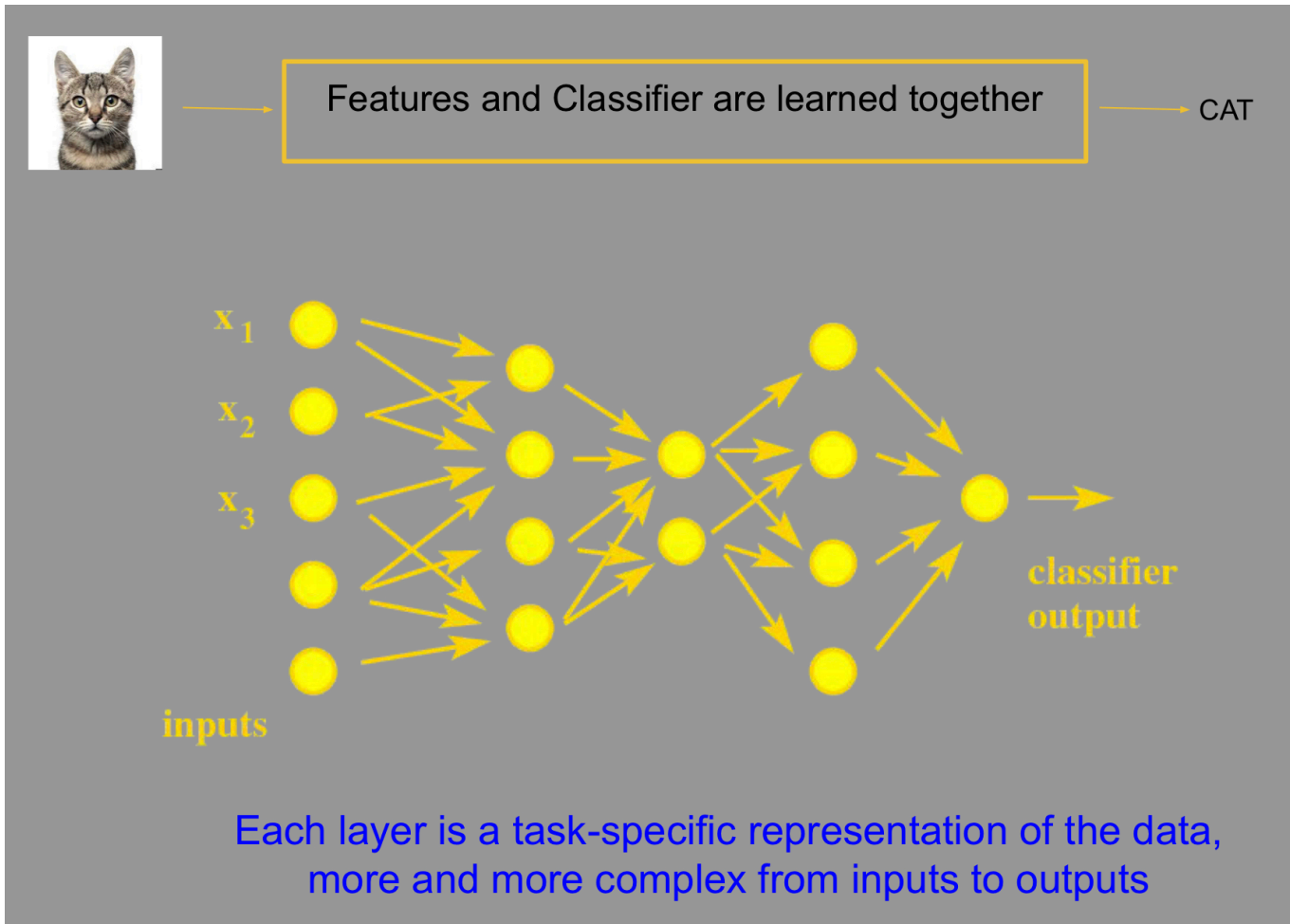
Learned Classifier

CAT



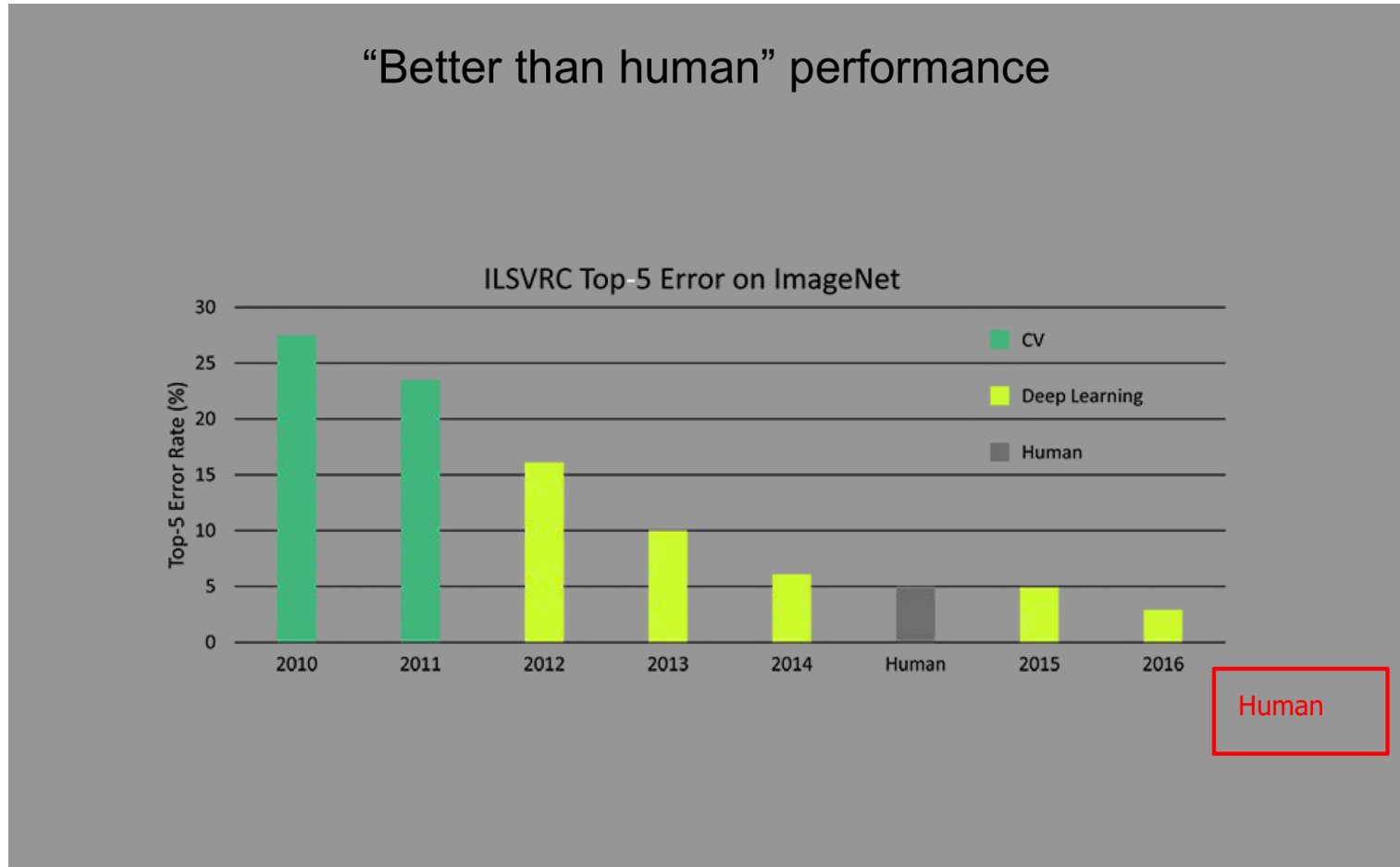
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End-to-end learning



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Deep supervised learning



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Some issues with deep learning

- No formal certification (only experimental)
- Black boxes (interpretability, explainability)
- Reproduce the past, poor innovation
- Reproduce bias conveyed by data (fairness)
- Huge computational cost (ecological disaster, irreproducible science)

It explains the risk of a 3rd AI Winter

Road example: a flow of new data is available



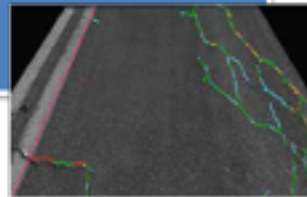
CereMap3D

- Relevé de la chaussée et de son environnement
- Nuages de points et images acquis en continu



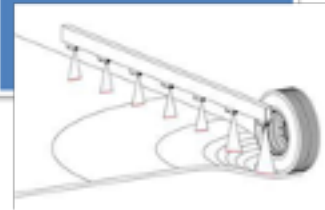
Aigle 3D

- Relevé altimétrique fin de la surface de la chaussée
- Relevé de l'état de déformation de la chaussée ainsi que de son état de dégradation
- Etat « au repos »
- Image de l'état de la chaussée
- Nuages de points acquis en continu



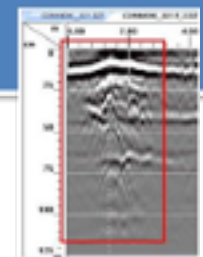
Défectographe

- Etat structurel de la chaussée caractérisé par sa réponse à une sollicitation (déformation) connue
- « Réponse « impulsionnelle »
- Image de l'état de la chaussée
- Bassin de déflexion acquis au pas de 10 m



Radar

- Détection d'interfaces dans la chaussée (délimitations des différentes couches de matériau)
- Epaisseurs acquises en continu
- Image des constituants de la chaussée
- Pointés des profondeurs d'interface



Road example: need help for data analysis

- **Objectifs**
 - Comprendre l'état d'une chaussée ou d'un OA
 - Prédire l'état d'une chaussée ou d'un OA
 - En déduire une politique de maintenance optimisée
- **Verrous scientifiques**
 - Données trop complexes pour une analyse « standard »
 - Technologie des capteurs très évolutive
- **Voie de recherche** : méthodes permettant à la fois des garanties théoriques et des estimations du risque

Merci de votre attention

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