JOURNEES TECHNIQUES ROUTE 2022

Fondamentaux de l'IA et domaines d'application

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RÉPUBLIQUE FRANÇAISE
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Cerema
CLIMAT & TERRITOIRES DE DEMAIN

IDRRIM
INSTITUT DES ROUTES, DES RUES ET DES INFRASTRUCTURES POUR LA MOBILITÉ

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

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

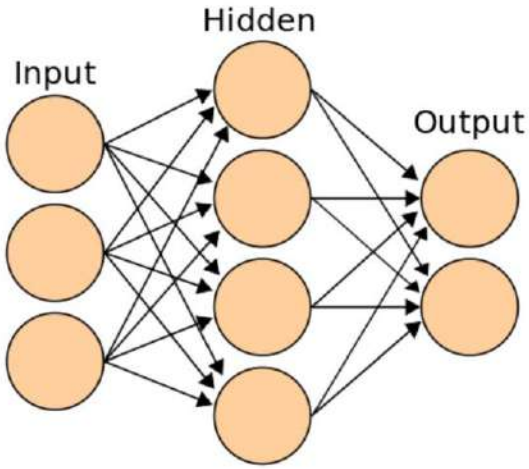
- **Reasoning, problem-solving** (but combinatorial explosion)
- **Knowledge representation** (answer questions intelligently and make deductions)
- Planning (**optimization** of the utility of successive choices)
- **Machine learning** (unsupervised, supervised, reinforcement, transfer)
- **Natural 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…)**



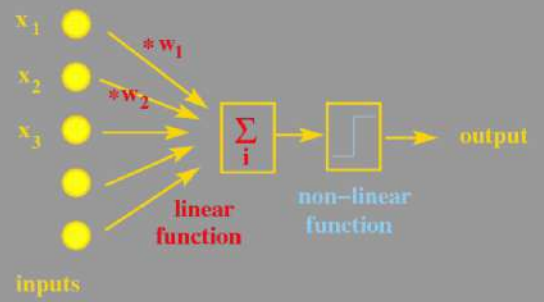
Deep supervised learning (in 1 slide)

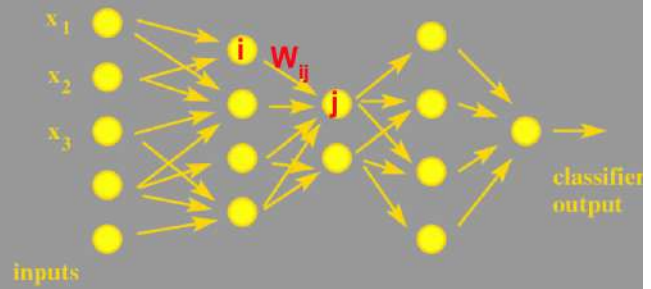
(Deep) Neural Networks = (just) a classification/regression model
Learning = fit the model to (many) labeled examples (x_1 ,x_2 , … x_n , y).

Learning Phase

Back-propagation from the 60s

- For each labeled example (x_1 ,x_2 , … 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

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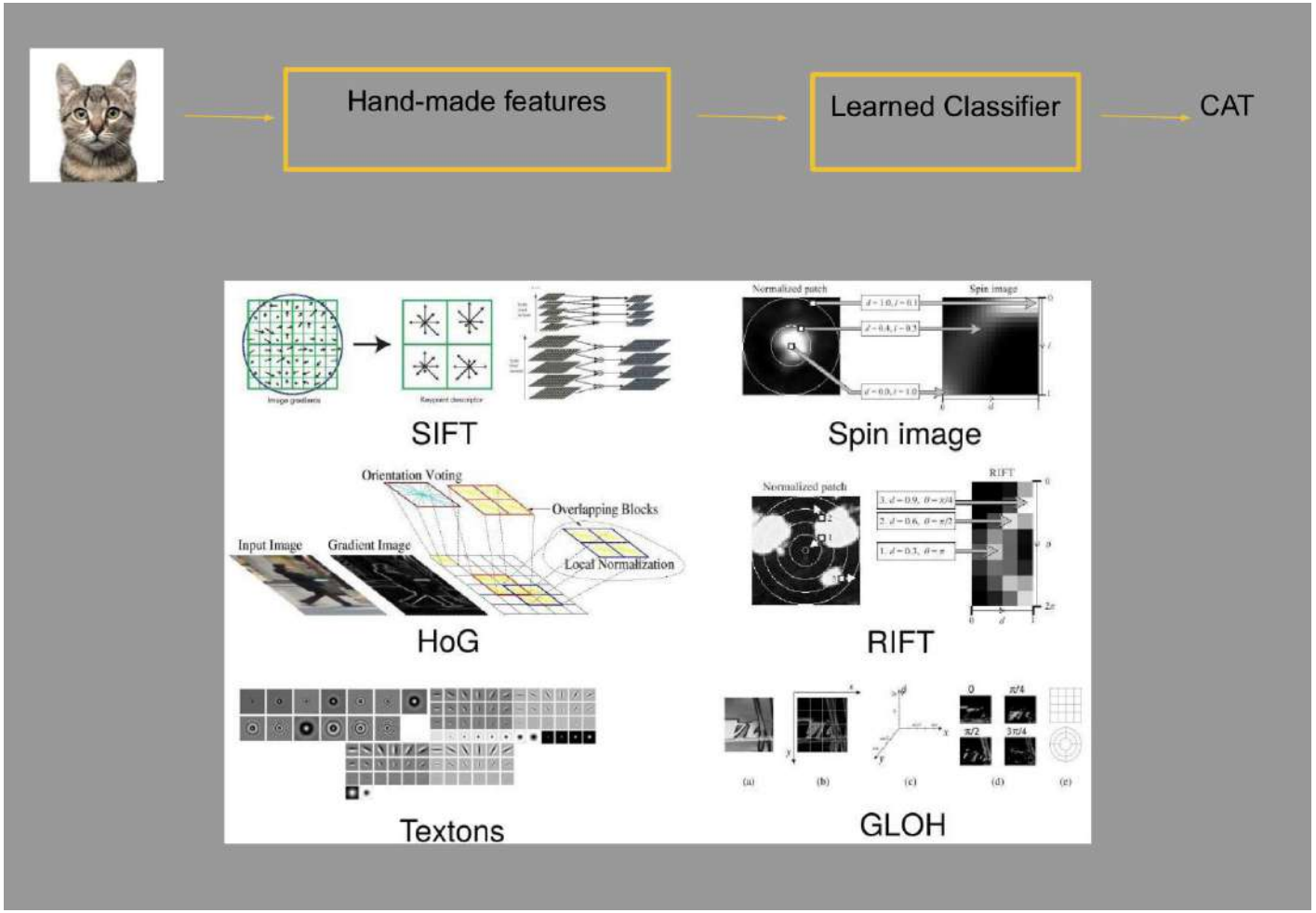
Good old computer vision



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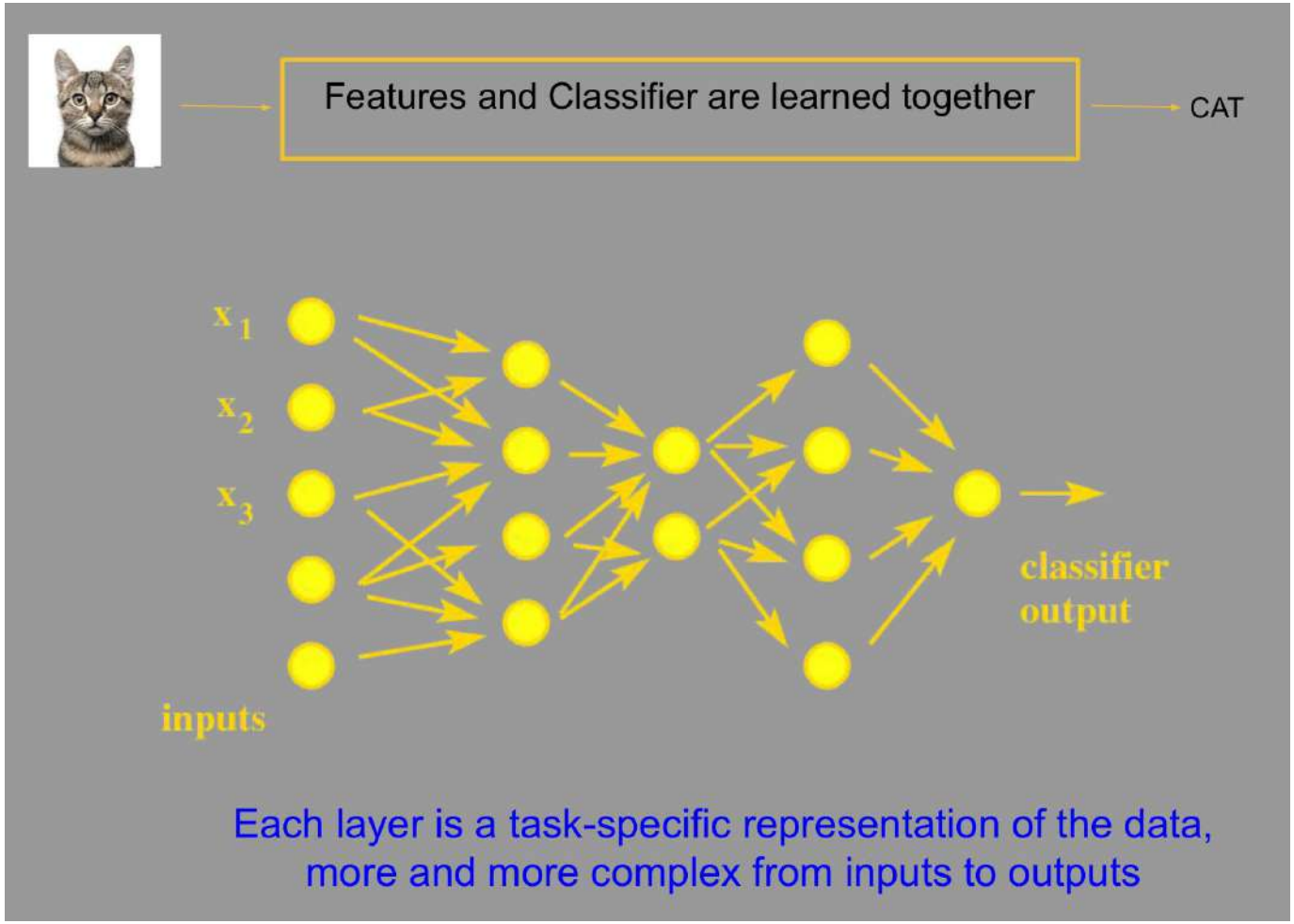
End-to-end learning



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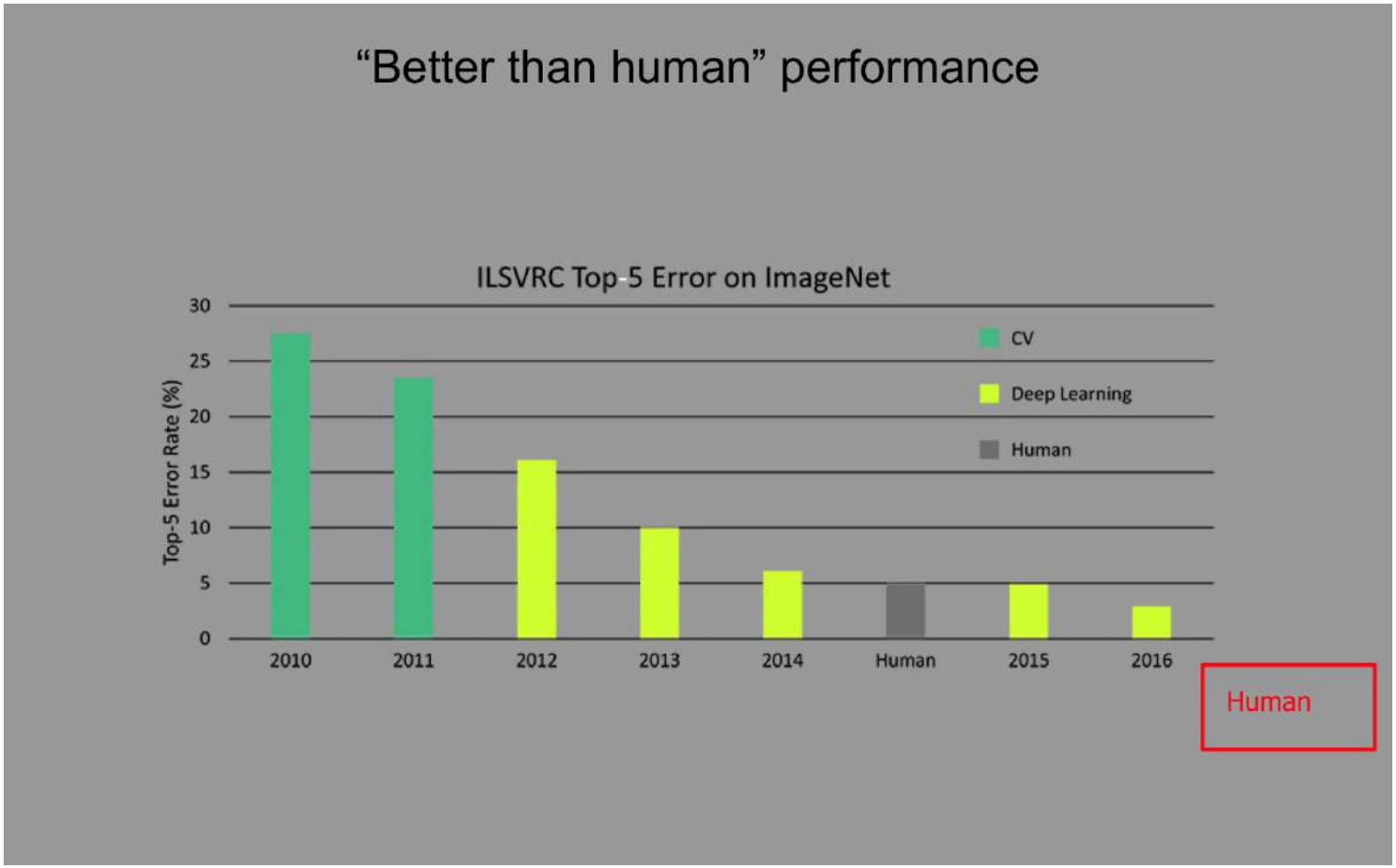
Deep supervised learning



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Some issues with deep learning

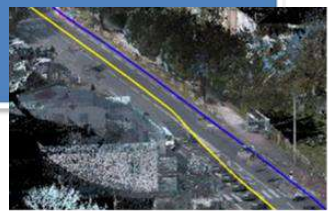
- No formal certification (only emperimental)
- Black boxes (interpretability, explainability)
- Reproduce the past, poor innovation
- Reproduce bias convayed by data (fairness)
- Huge computational cost (ecological disaster, irreproductible science)

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

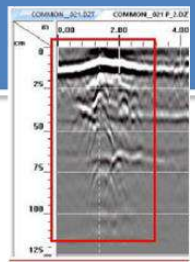
- Relevé altimétrique fin de la surface de la chaussée
- Relevé de l'état de déformation de la chaussée ainsi que de son état de dégradation
- Etat « au repos »
- Image de l'état de la chaussée
- Nuages de points acquis en continu

Déflectographe

- 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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