Une introduction à l'Intelligence artificielle, à l'apprentissage statistique et au deep learning

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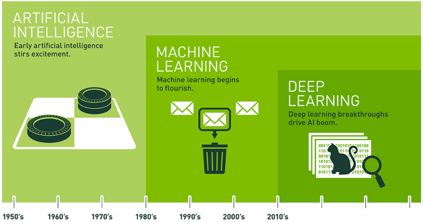


Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

JOURNEÉ TECHNIQUE

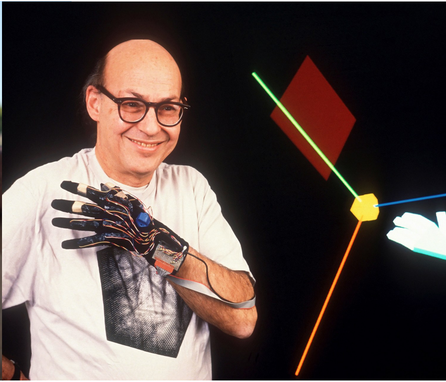
Le Machine Learning au CEREMA

En lançant le premier robotoaxi payant, Waymo (Google) coupe l'herbe sous le pied de la concurrence. *- Shutterstock*

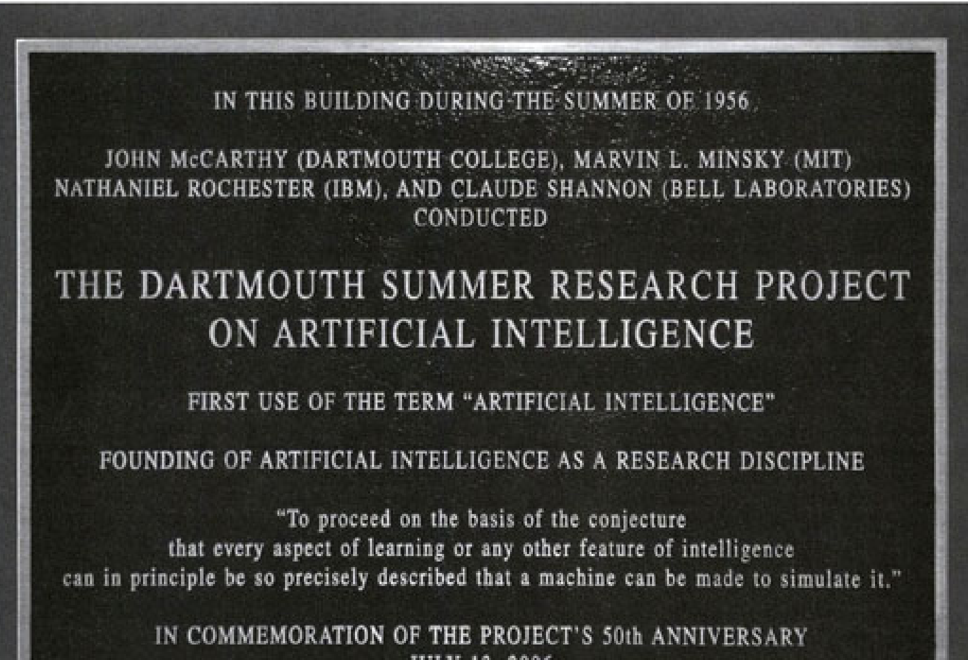
La division Véhicule autonome de Google inaugure le marché des taxis sans chauffeur à Phoenix.


HAPPY
NEW YEAR
1927

1927 : Année de naissance de John McCarthy et Marvin Minsky, LES (grand) pères de l'IA



1956: the Dartmouth Summer Research Project



To do's list # 1 : définir l'IA

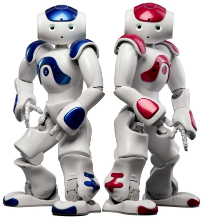
Cette recherche se basera sur le fait que chaque aspect de l'apprentissage ou caractéristique de l'intelligence peut, en principe, être décrit avec une telle précision que vous pouvez créer une machine qui les simule.

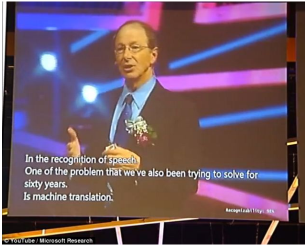
Apprendre !

Apprentissage : humain vs. machine

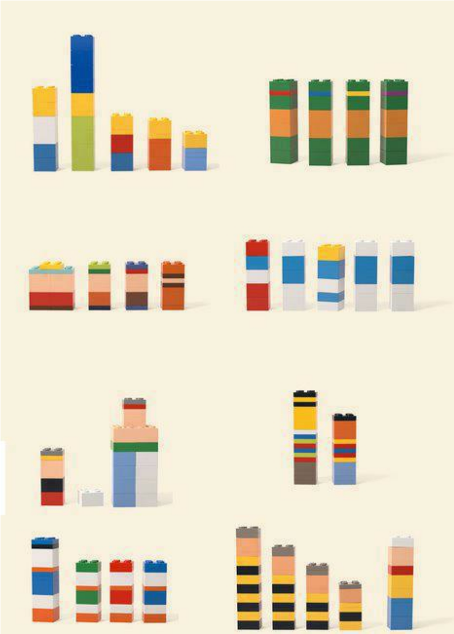
Les apprentissages d'un enfant

- marcher : un an
- parler : deux ans
- raisonner : le reste





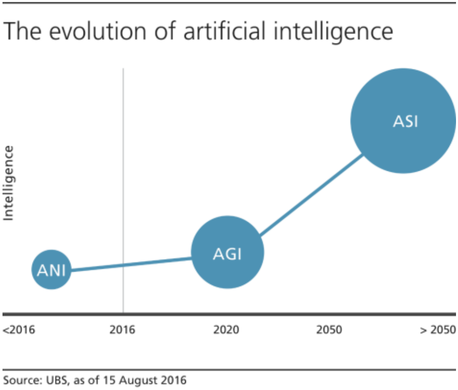
Apprendre à raisonner



Les 3 niveaux de l'IA

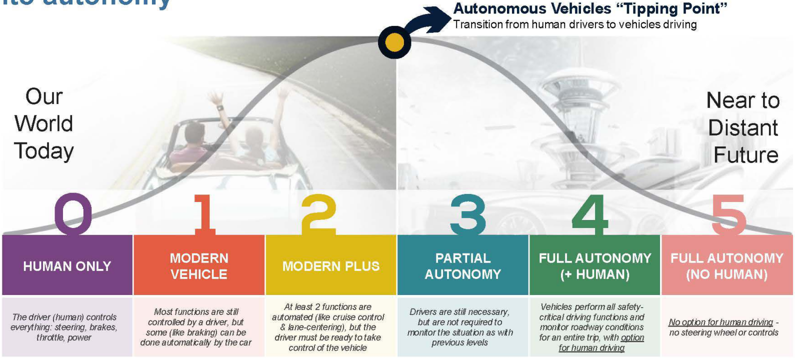
Qu'y a-t-il sur cette image ? (Est-ce un chat ?)	l'intelligence spécifique
Pourquoi est-ce un chat ?	l'intelligence générale
Est-ce qu'il monte ou il descend ?	la super intelligence

Intelligence spécifique, générale et supérieure



Qu'y a-t-il sur cette image ? (Est-ce un chat ?)	l'intelligence spécifique
Pourquoi est-ce un chat ?	l'intelligence générale
Est-ce qu'il monte ou il descend ?	la super intelligence

Level 3 Partial Autonomy adoption is when the market "tips" into autonomy



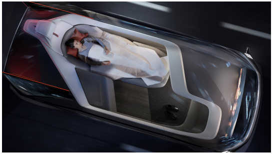
http://roboticsandautomationnews.com/2017/06/05/saes-full-list-of-levels-for-autonomous-vehicles/12669/

Niveaux d'autonomie et Intelligence artificielle

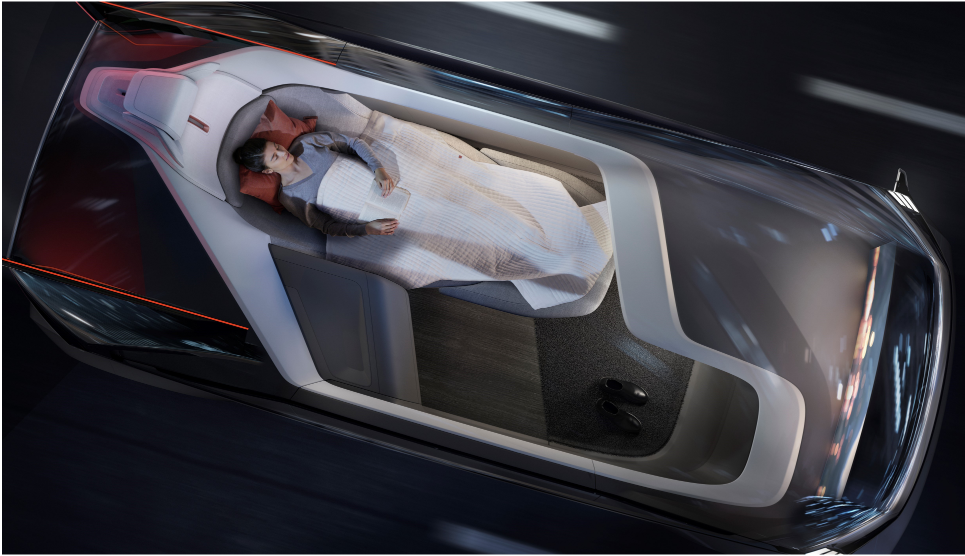
Level 3 autonomy — specific intelligence

Level 4 autonomy — general intelligence

Level 5 autonomy — super intelligence

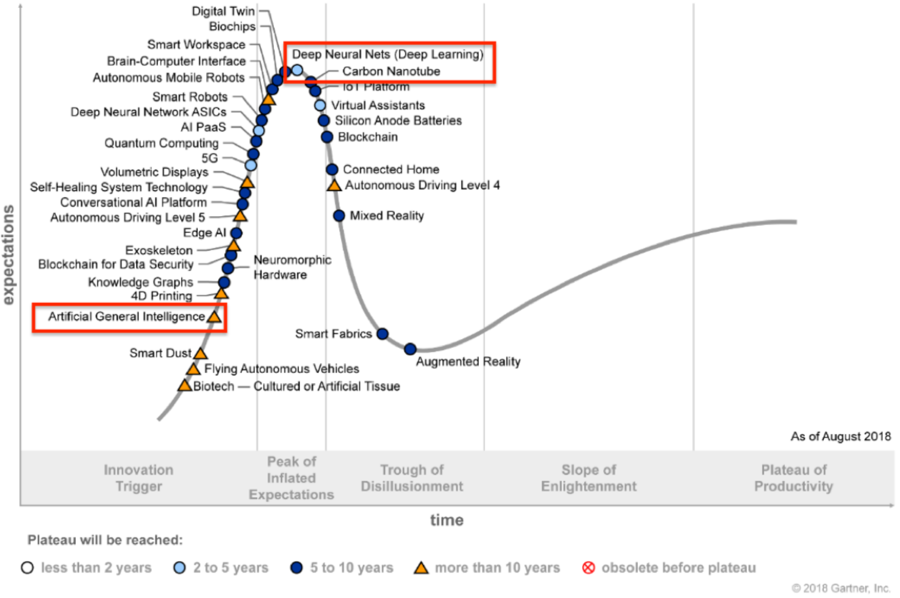


La voiture autonome, c'est pour quand ?



La super intelligence, c'est pour quand ?

C'est pas pour demain...



AI et machine learning (deep learning)

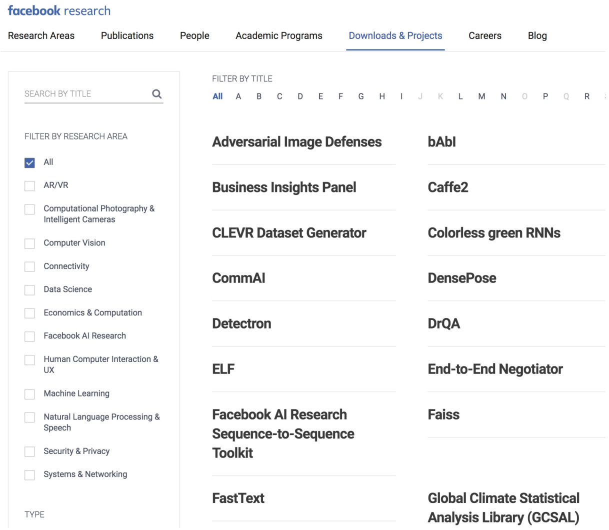
Yann LeCun

9 décembre 2013 ·

Big news today!

Facebook has created a new research laboratory with the ambitious, long-term goal of bringing about major advances in Artificial Intelligence.

Facebook AI Research is machine learning



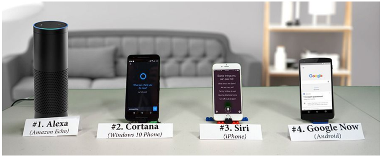
Google research: AI Fundamentals & Applications

Research areas

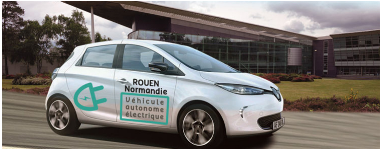
- Graph-based learning
- Supervised machine learning
- Large-scale machine learning
- Online clustering
- Coauthor
- Modeling and data science
- Structured data
- Scalable matching
- Speech and language algorithms
- Sensitive content detection
- ML for personalization and assistance
- Semi-supervised and unsupervised machine learning
- ML model compression for mobile devices
- Media understanding in conversations
- Combinatorial machine learning
- Glassbox

Les enjeux de l'IA pour eux

- les agents conversationnels

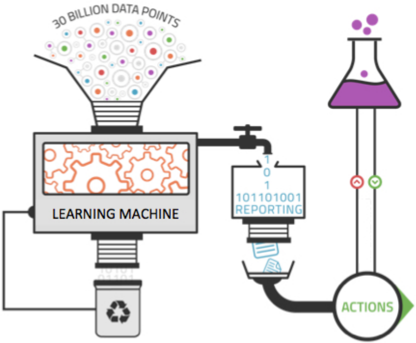


- les véhicules autonomes



- la santé
- la sécurité
- ...

Qu’est-ce l’IA aujourd’hui pour eux ?



La programmation basée sur les exemples

Apprentissage statistique (Machine learning)

- model

$$decision = f(image) + noise$$

$$\mathbb{P}(decision, image) \text{ unknown}$$

.

- goal = cost

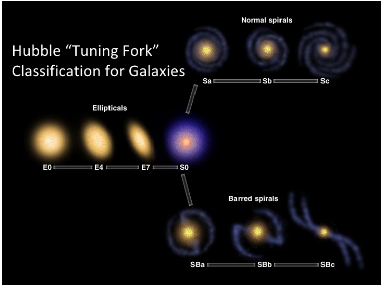
$\widehat{f}$ estimate f from data .

minimize the cost of $\widehat{f}$.

- issues: induction

  statistics + unknown distribution + cost + computational issues .

Exemples de machines capables d'apprendre



tâche	données	performance
prédire le type d'une galaxie	images	taux d'erreur
estimer une fréquence	images	écart quadratique
(découvrir) des types de galaxies	images	entropie de la partition
recommander une ligne de code	programmes	renforcement

d'après `https://www.kaggle.com/c/galaxy-zoo-the-galaxy-challenge`

Les trois (principales) familles d'apprentissage automatique

Apprendre à prédire : apprentissage supervisé

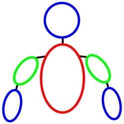
Entrée x sorties y

- $y \in \{0, 1\}$ classification binaire ou multiple



- $y \in \mathbf{R}$ régression

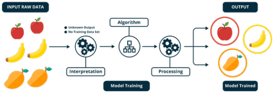

- $y \in \{faible, moyen, fort\}$ ordonnancement
- y structuré

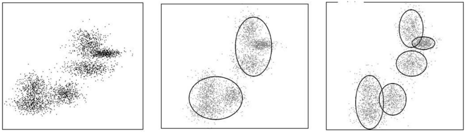



Apprendre à résumer : apprentissage non supervisé

Entrée x seul (pas de y)

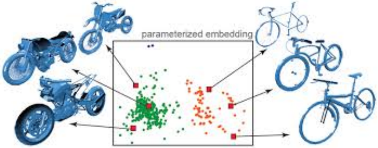
- Catégoriser (clustering) : qui se ressemble s'assemble k-means, CHA



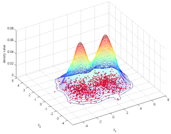


(a) Input data (b) GMM (K=2) (c) GMM (K=5)

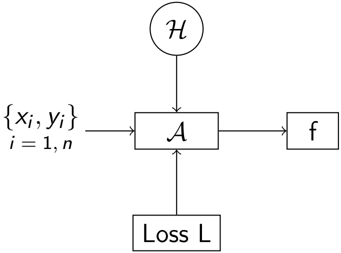
- Représenter: $x \in \mathbb{R}^p \longrightarrow z \in \mathbb{R}^d, d \ll p$ ACP, t-SNE, UMAP



- Estimer une densitée $\mathbb{P}(x)$ Parzen,



Apprentissage et ensemble d'hypothèses



apprendre c'est :

sélectionner, parmi des hypothèses, la plus cohérente avec les données

Universalité de l'apprentissage

Résultat d'existence

Théorème d'approximation universel

- soit $\varepsilon > 0$ un réel
- quelle que soit la tâche à apprendre $\forall f^\star$
- il existe $\hat{f} \in \mathcal{H}$, telle que

$$\|f^\star - \hat{f}\| \leq \varepsilon$$

Choisir un ensemble d'hypothèses $\mathcal{H}$ universel

- plus on a d'exemples, plus le modèle doit pouvoir être complexe
- danger : surapprentissage
- question centrale : adapter la complexité du modèle au prolème

Les différents types de modèles universels

- modèles basées sur les variables
  - la notion de dictionnaire (base, polynômes, ondelettes...)

$$\hat{f}(x) = \sum_{k=1}^{k} \alpha_k \phi_k(x)$$

- modèles basées sur les exemples
  - plus proches voisins
  - noyaux (SVM)
- combinaison d'éléments simples (partitions)
  - les forêts aléatoires
  - le boosting
- modèles profonds (deep learning)

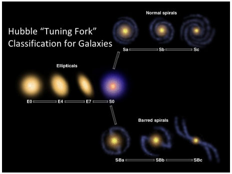
linéaires vs non linéaires

$\rightarrow$ C'est un problème de représentation (extraction de caractéristiques)

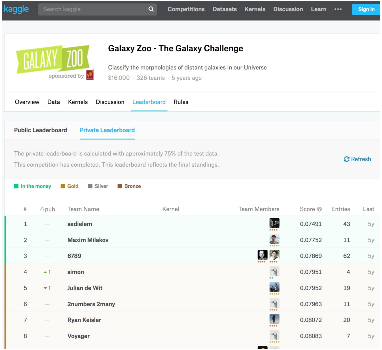
Machine learning for galaxy morphology prediction

Galaxy Zoo - The Galaxy Challenge at Kaggle

- Data
  - training set with 61,578 images
  - test set of 79,975 images
  - Data augmentation



- model
  - inputs: images
  - outut: proba galaxy morphology
  - SVM, GBM,
  - convolutional deep network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GALAXY ZOO sponsored by

Galaxy Zoo - The Galaxy Challenge

Classify the morphologies of distant galaxies in our Universe

$16,000 · 326 teams · 5 years ago

Overview Data Kernels Discussion Leaderboard Rules

Public Leaderboard Private Leaderboard

The private leaderboard is calculated with approximately 75% of the test data.
This competition has completed. This leaderboard reflects the final standings.

Refresh

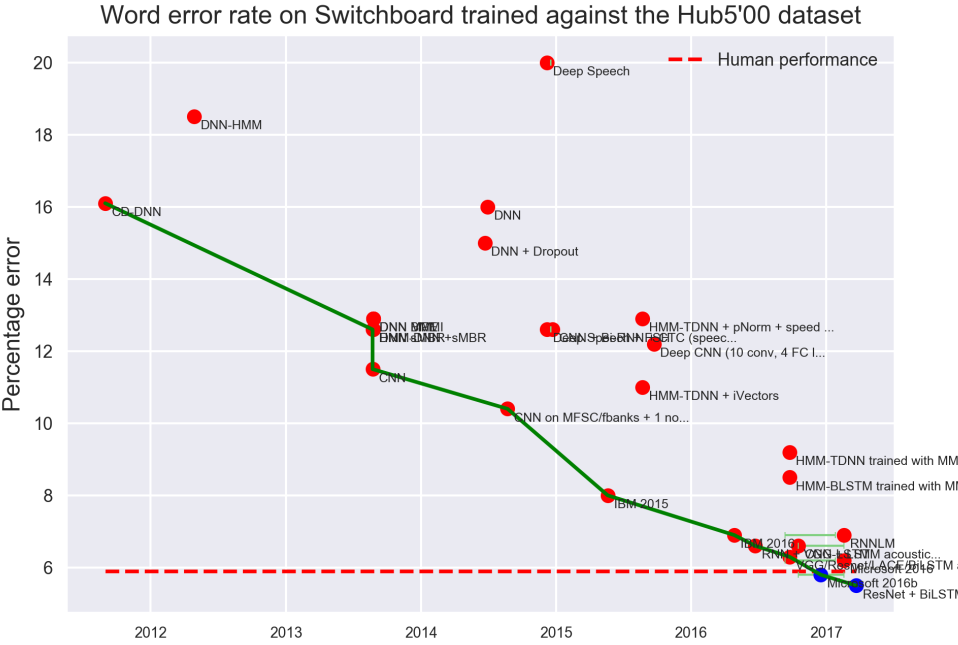
In the money Gold Silver Bronze

#	△pub	Team Name	Kernel	Team Members	Score	Entries	Last
1	—	sedielem			0.07491	43	5y
2	—	Maxim Milakov			0.07752	11	5y
3	—	6789			0.07869	62	5y
4	▲1	simon			0.07951	4	5y
5	▼1	Julian de Wit			0.07952	19	5y
6	—	2numbers 2many			0.07963	11	5y
7	—	Ryan Keisler			0.08072	20	5y
8	—	Voyager			0.08083	7	5y

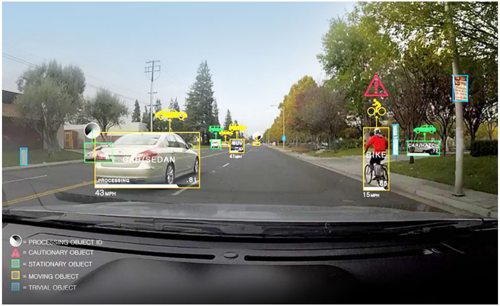
- training accuracy
  - SVM 88%
  - Gradient Boosting 90 %
  - deep learning (CNN) 93%

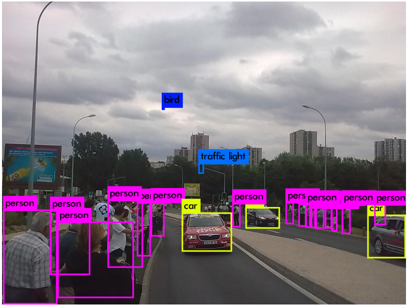
https://www.kaggle.com/c/galaxy-zoo-the-galaxy-challenge/discussion/7599

L'IA pour la parole (entrainée sur 2000 heures)



L'IA pour l'image : reconnaissance d'objets



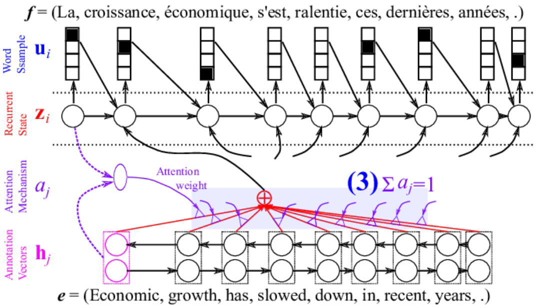


https://www.nvidia.com/en-au/self-driving-cars/drive-px/
https://pjreddie.com/darknet/yolo/

Deux composantes

- détection
- reconnaissance (caractérisation)

L'IA pour le texte

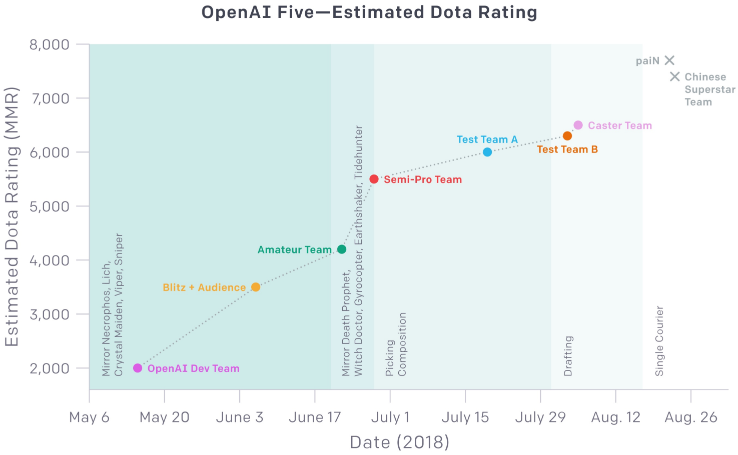


Apprendre à traduire avec 36 million de phrases

- Performances à notre niveau Correction d'erreurs grammaticales
- Performances à notre niveau Traduction de news

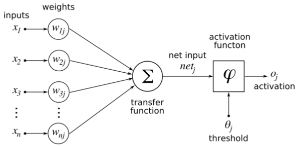
https://devblogs.nvidia.com/author/kcho/

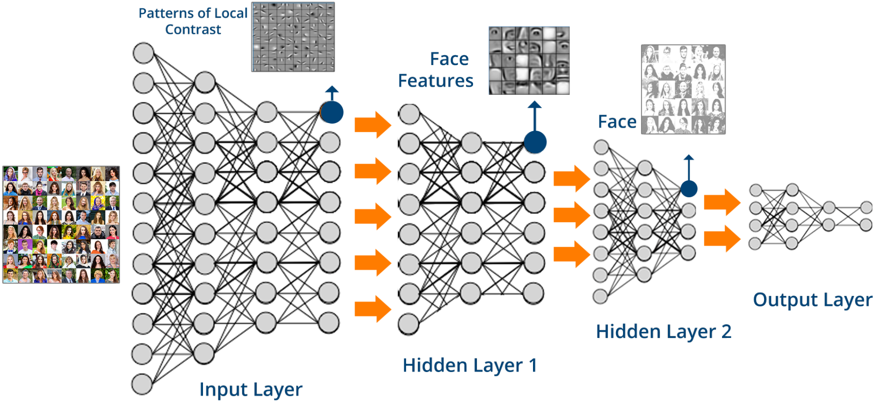
L'IA pour le jeu : E. Musk OpenAI



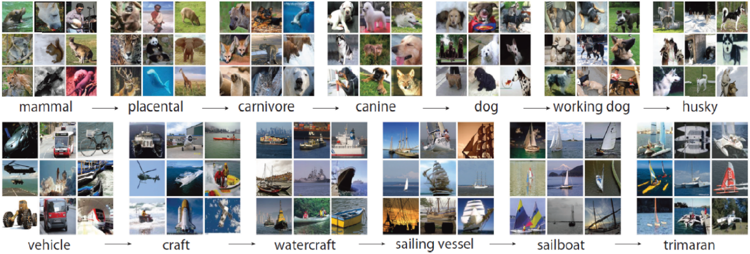
- separate LSTM for each hero
- 180 years/days of games against itself
- Proximal Policy Optimization running
- 256 GPUs and 128,000 CPU cores

Entrainer quoi : un réseau de neurones profond





The image net database (Deng et al., 2012)



ImageNet = 15 million high-resolution images of 22,000 categories.
Large-Scale Visual Recognition Challenge (a subset of ImageNet)

- 1000 categories.
- 1.2 million training images,
- 50,000 validation images,
- 150,000 testing images.

`www.image-net.org/challenges/LSVRC/2012/`

A new fashion in image processing

2012 Teams	%error
Supervision (Toronto)	15.3
ISI (Tokyo)	26.1
VGG (Oxford)	26.9
XRCE/INRIA	27.0
UvA (Amsterdam)	29.6
INRIA/LEAR	33.4

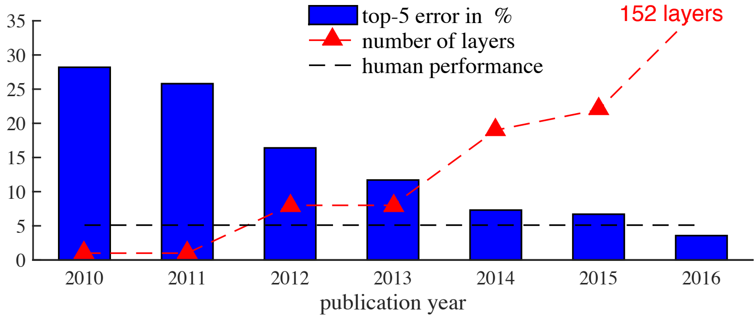
2013 Teams	%error
Clarifai (NYU spinoff)	11.7
NUS (singapore)	12.9
Zeiler-Fergus (NYU)	13.5
A. Howard	13.5
OverFeat (NYU)	14.1
UvA (Amsterdam)	14.2
Adobe	15.2
VGG (Oxford)	15.2
VGG (Oxford)	23.0

2014 Teams	%error
GoogLeNet	6.6
VGG (Oxford)	7.3
MSRA	8.0
A. Howard	8.1
DeeperVision	9.5
NUS-BST	9.7
TTIC-ECP	10.2
XYZ	11.2
UvA	12.1

shallow approaches

deep learning

ImageNet results



2012 Alex Net

2013 ZFNet

2014 VGG

2015 GoogLeNet / Inception

2016 Residual Network

karpathy's blog: `karpathy.github.io/2014/09/02/what-i-learned-from-competing-against-a-convnet-on-imagenet/`

Neural Network for Identifying Exoplanets

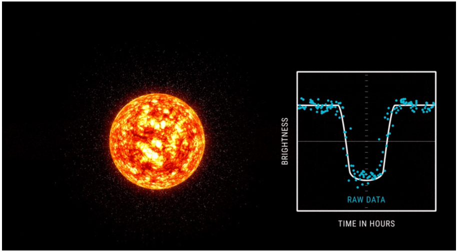
THE ASTRONOMICAL JOURNAL, 155:94 (21pp), 2018 February
https://doi.org/10.3847/1538-3881/aa9e09

Identifying Exoplanets with Deep Learning: A Five-planet Resonant Chain around Kepler-80 and an Eighth Planet around Kepler-90

Christopher J. Shallue[1] and Andrew Vanderburg[2,3,4]
[1] Google Brain, 1600 Amphitheatre Parkway, Mountain View, CA 94043, USA; shallue@google.com
[2] Department of Astronomy, The University of Texas at Austin, 2515 Speedway, Stop C1400, Austin, TX 78712, USA
[3] Harvard–Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA
Received 2017 September 19; revised 2017 November 13; accepted 2017 November 20; published 2018 January 30

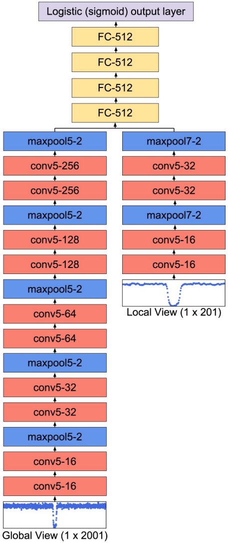
Abstract

NASA's *Kepler Space Telescope* was designed to determine the frequency of Earth-sized planets orbiting Sun-like stars, but these planets are on the very edge of the mission's detection sensitivity. Accurately determining the occurrence rate of these planets will require automatically and accurately assessing the likelihood that individual candidates are indeed planets, even at low signal-to-noise ratios. We present a method for classifying potential planet signals using deep learning, a class of machine learning algorithms that have recently become state-of-the-



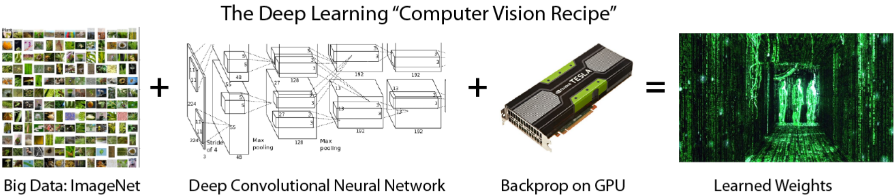
Astronet: brute force CNN

- Data
  - 3600 planet candidates
  - 9596 astrophysical false positive
  - 2541 nontransiting phenomenon
- model
  - inputs: both global and local input
  - convolutional deep network
- training
  - Google vizier for hyper parameters tuning
  - 100 CPUs in parallel
- prediction: 10 copies model averaging



Golovin, Daniel, et al. "Google vizier: A service for black-box optimization." Proceedings of the 23rd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining. ACM, 2017 `github.com/tobegit3hub/advisor`

L’équation de l’IA d’aujourd’hui



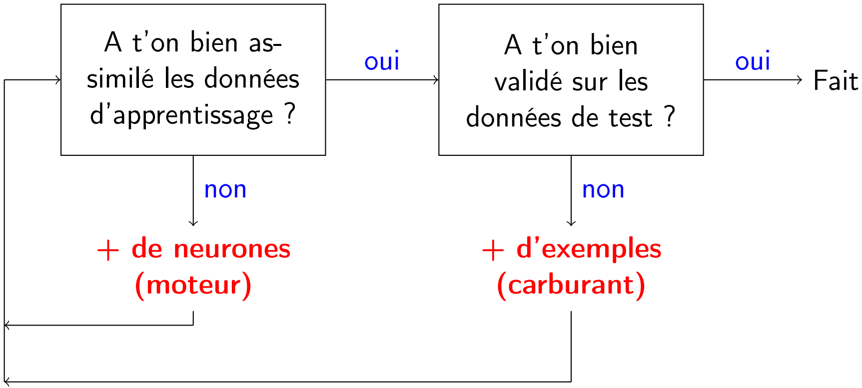
Entrainer plutôt qu'apprendre

Apprentissage statistique selon Andrew Ng

moteur le réseaux de neurones profond

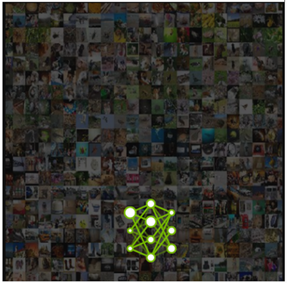
carburant les données

Pour apprendre : la recette d'Andrew Ng



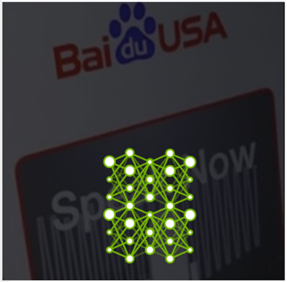
Quelle est la taille des réseaux ?

7 ExaFLOPS
60 Million Parameters



2015 - Microsoft ResNet
Superhuman Image Recognition

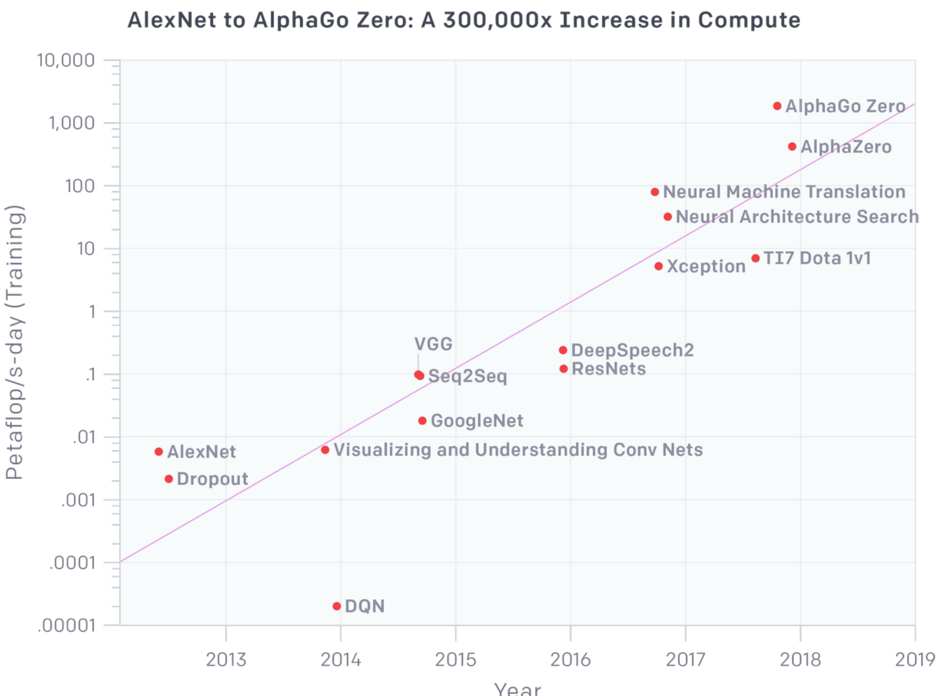
20 ExaFLOPS
300 Million Parameters



2016 - Baidu Deep Speech 2
Superhuman Voice Recognition

100 ExaFLOPS
8700 Million Parameters

2017 - Google Neural Machine Translation
Near Human Language Translation


AlexNet to AlphaGo Zero: A 300,000x Increase in Compute
10,000
1,000
100
10
1
.1
.01
.001
.0001
.00001
Petaflop/s-day (Training)
2013
2014
2015
2016
2017
2018
2019
Year
AlphaGo Zero
AlphaZero
Neural Machine Translation
Neural Architecture Search
TI7 Dota 1v1
Xception
VGG
Seq2Seq
DeepSpeech2
ResNets
GoogleNet
AlexNet
Visualizing and Understanding Conv Nets
Dropout
DQN


WINTER
IS COMING

Deep learning : une évaluation critique

arXiv.org > cs > arXiv:1801.00631

Search or Art

(Help | Advanced

Computer Science > Artificial Intelligence

Deep Learning: A Critical Appraisal

Gary Marcus

(Submitted on 2 Jan 2018)

Although deep learning has historical roots going back decades, neither the term "deep learning" nor the approach was popular just over five years ago, when the field was reignited by papers such as Krizhevsky, Sutskever and Hinton's now classic (2012) deep network model of Imagenet. What has the field discovered in the five subsequent years? Against a background of considerable progress in areas such as speech recognition, image recognition, and game playing, and considerable enthusiasm in the popular press, I present ten concerns for deep learning, and suggest that deep learning must be supplemented by other techniques if we are to reach artificial general intelligence.

Comments:	1 figure
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For most problems where deep learning has enabled transformationally better solutions (vision, speech), we've entered diminishing returns territory in 2016-2017.

Francois Chollet, Google, author of Keras neural network library Dec. 2017

10 limites de l'apprentissage profond

- nécessite trop de données
- trop spécialisés
- ne gère pas les structures complexes (NLP)
- pas facile d'intégrer des connaissances a priori
- on n'y comprend rien : pas de théorie explicative
- n'intègre que des corrélations
- ne permet pas de distinguer la causalité
- gère mal les évolutions
- ne garanti pas la qualité des décisions
- l'ingénierie est compliquée

10 limites de l'apprentissage en profondeur

- nécessite trop de données
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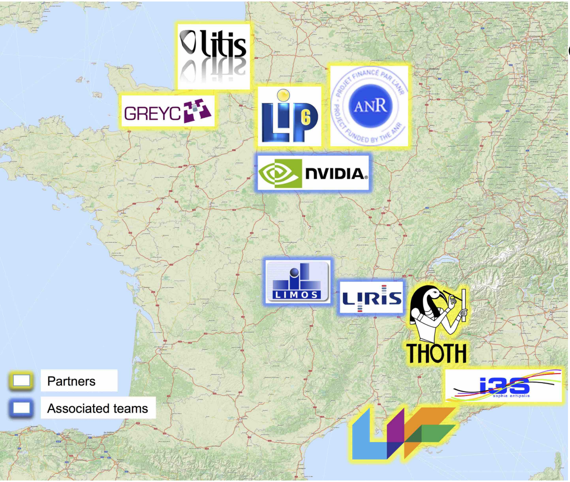
Deep in France basic research projet



Expanding the frontier of green deep learning

- ANR labelized
- Network: 6 partners
- 42 months
- 4 Tasks
  1. green deep architectures
  2. optimization algorithms
  3. scalable embedded deep learning
  4. pilot applications

LITIS Audio scene recog.
I3S Vision for robotics
LIF Video forecasting

Deep in France

- Publications

Predicting Deeper into the Future of Semantic Segmentation

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[1] Facebook AI Research
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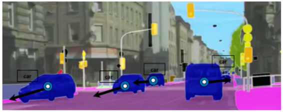
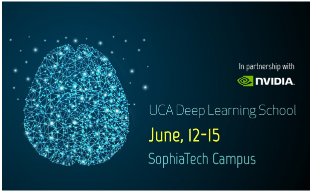
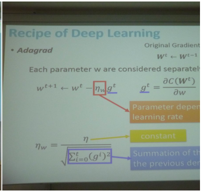
Abstract

The ability to predict and therefore to anticipate the future is an important attribute of intelligence. It is also of utmost importance in real-time systems, e.g. in robotics or autonomous driving, which depend on visual scene understanding for decision making. While prediction of the raw RGB pixel values in future video frames has been studied



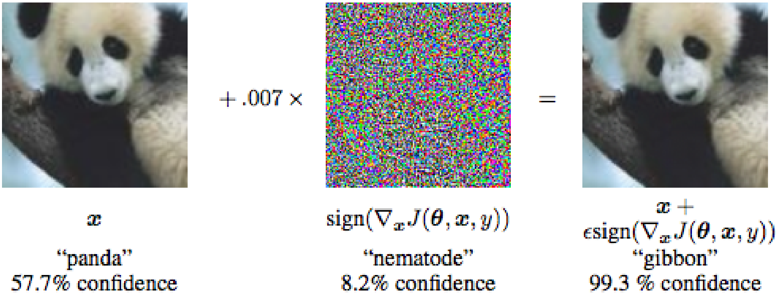
- Deep learning schools





- Conferences
  - CAP 2018 (Rouen 20, 21 et 22 juin 2018) `cap2018.litislab.fr`
  - RFIAP 2018 (Marne-la-Vallée les 26, 27 et 28 juin 2018)

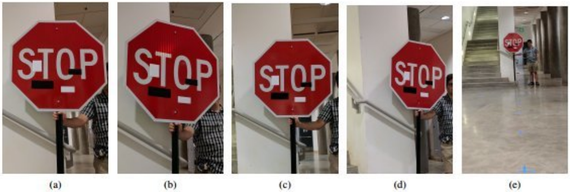
Deep neural networks are easily fooled (1/2)



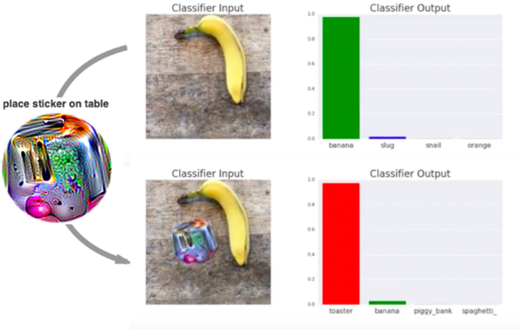
Explaining and Harnessing Adversarial Examples, Ian J. Goodfellow, Jonathon Shlens, Christian Szegedy, 2015

https://arxiv.org/abs/1412.6572

Adversarial examples (2/2)

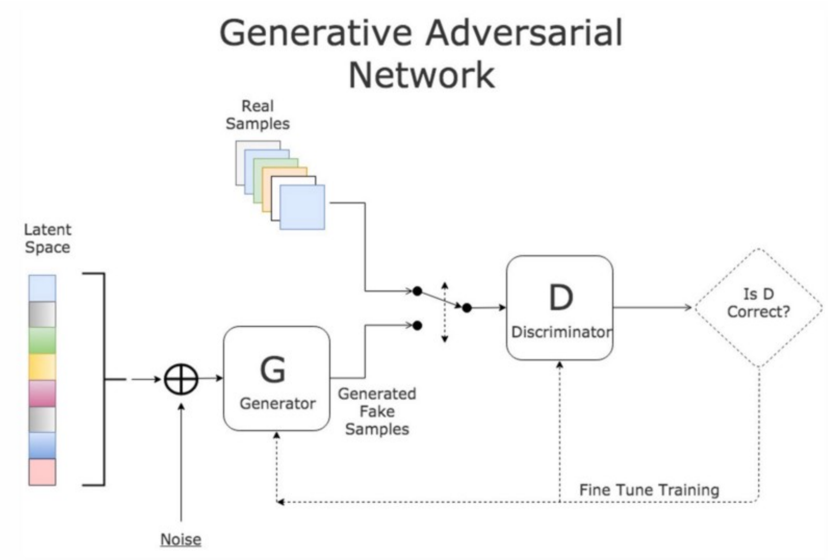


Adversarial Examples for Evaluating Reading Comprehension Systems, Robin Jia, Percy Liang, 2017



Adversarial Patch Tom B. Brown, Dandelion Mané, Aurko Roy, Martin Abadi, Justin Gilmer, 2017

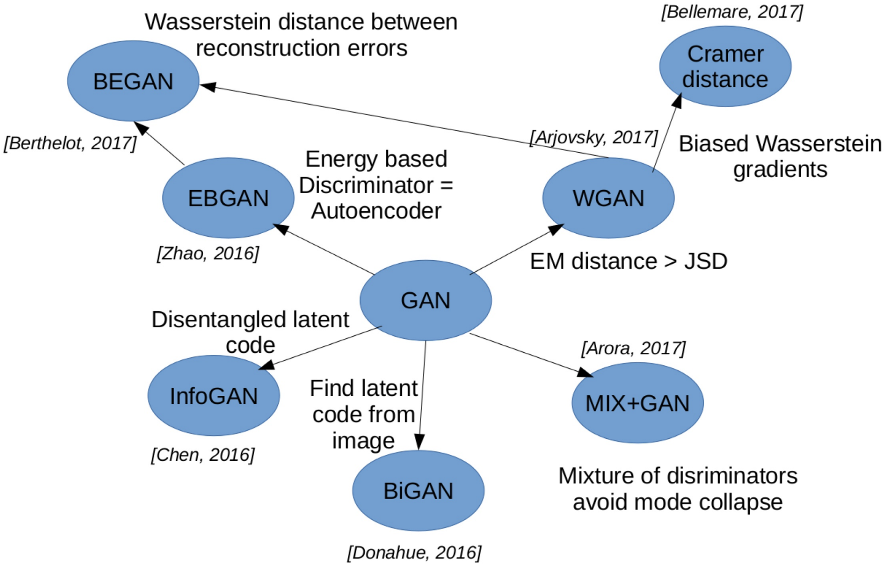
Generative models



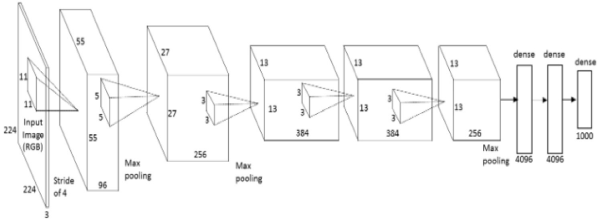
https://www.datasciencecentral.com/profiles/blogs/generative-adversarial-networks-gans-engine-and-applications

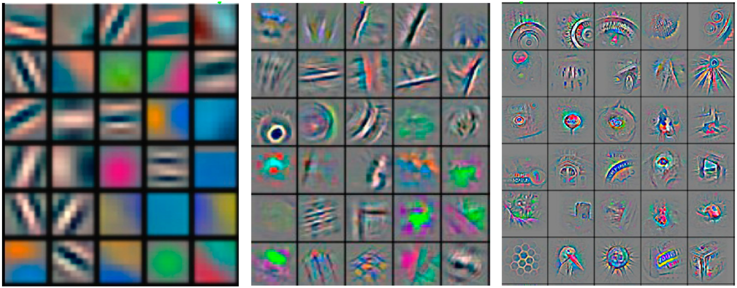
Defense-GAN: Protecting classifiers against adversarial attacks using generative models, 2018

Other Generative architectures



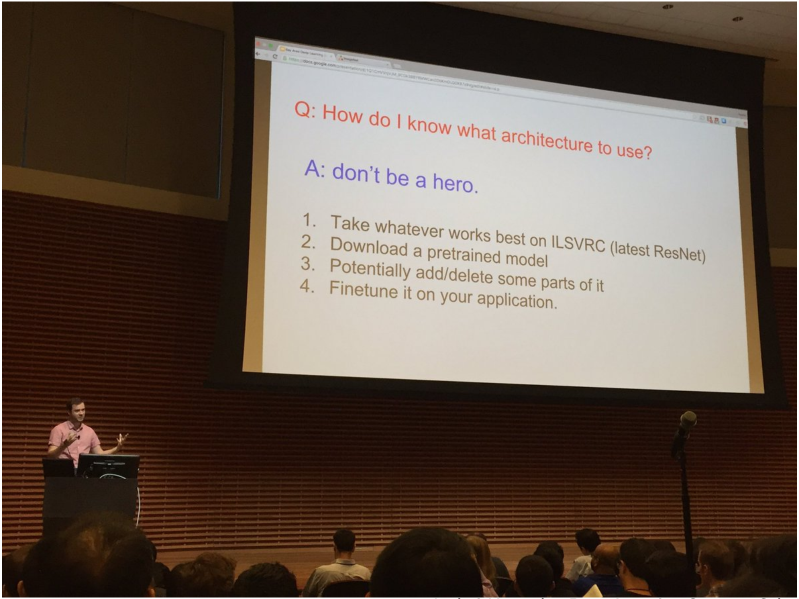
AlexNet works because of learning internal representation





Feature visualization of convolutional net trained on ImageNet from [Zeiler & Fergus 2013]

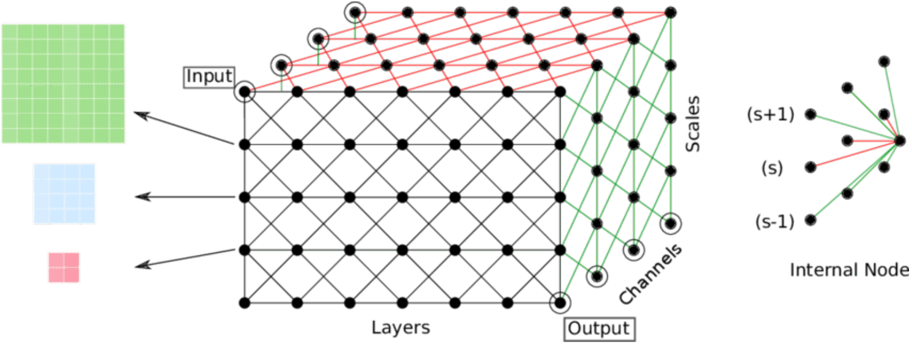
How to start with deep learning?



Andrej Karpathy, Deep Learning Summer School 2016

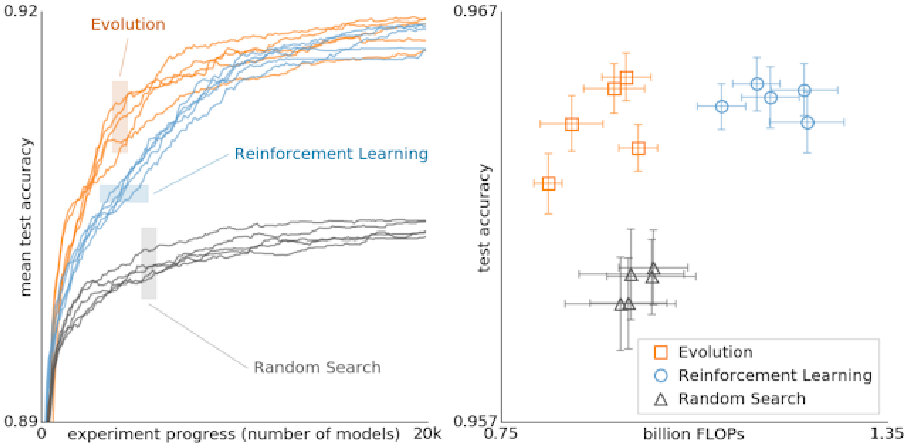
Convolutional Neural Fabrics

- problem: how to find the most relevant architecture
- todays solution: try and test
- A new solution: learn the architecture



Convolutional Neural Fabrics, Saxena and Verbeek, NIPS 2016

Neural Architecture Search

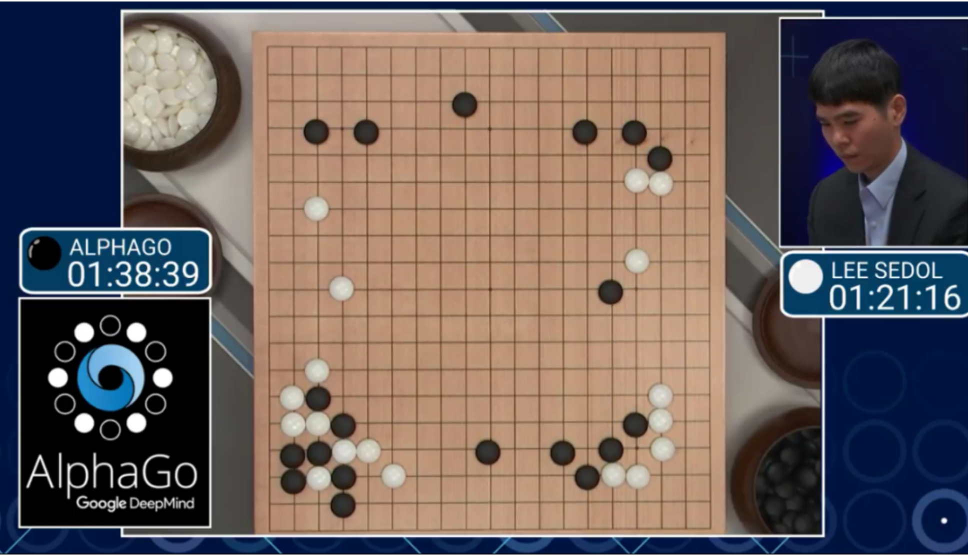


Regularized Evolution for Image Classifier Architecture Search, E. Real et al, 2018
https://chinagdg.org/2018/03/using-evolutionary-automl-to-discover-neural-network-architectures/

Je sais entrainer des machines,

mais je cherche toujours à comprendre ce qu'est l'apprentissage

le Deep learning joue et gagne



Les amateurs en profitent