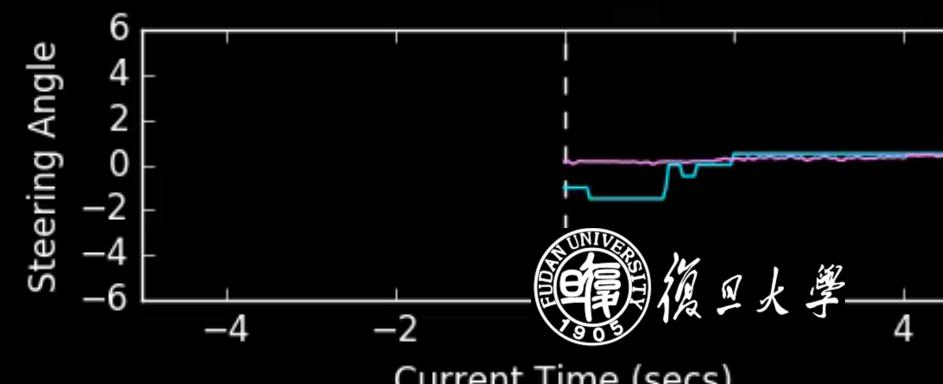
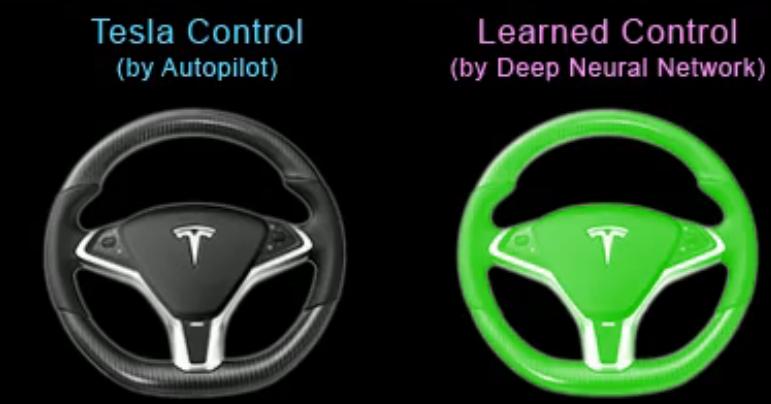


# 数据驱动的人工智能（1b）概述

## Data Driven Artificial Intelligence

邬学宁 SAP 硅谷创新中心

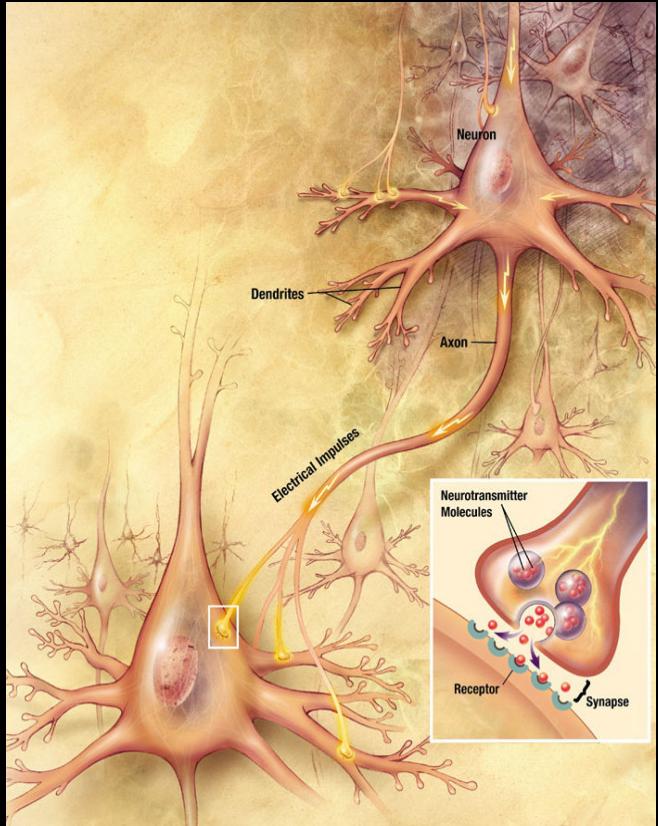
2017 / 02



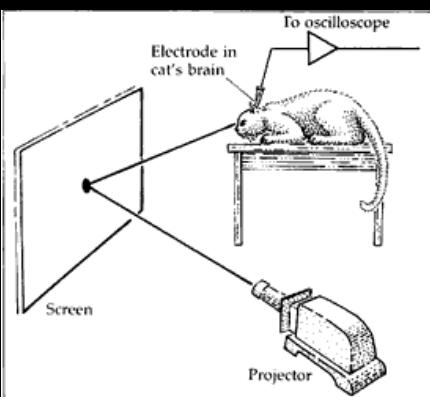
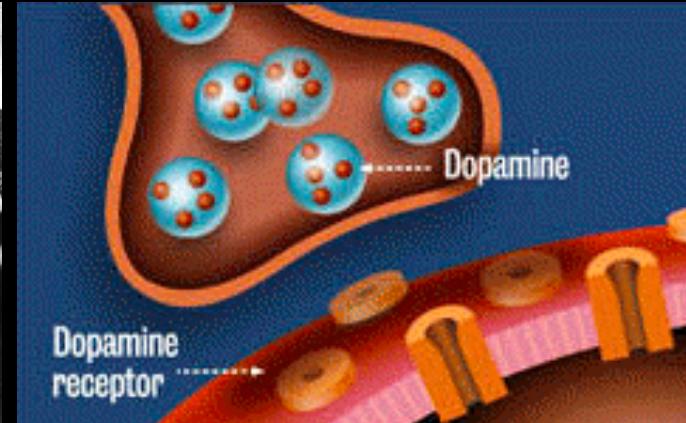
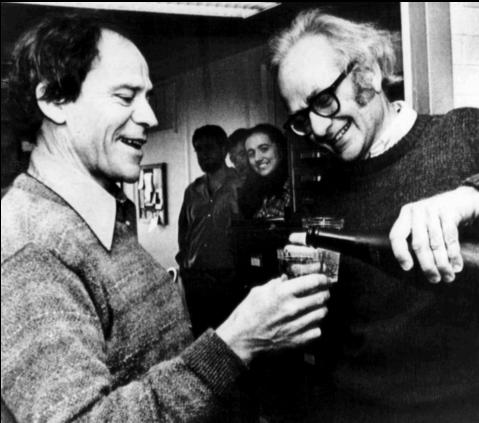
復旦大學  
1905

# “认知科学发展对AI的影响”

Neuron Dendrites and Axon



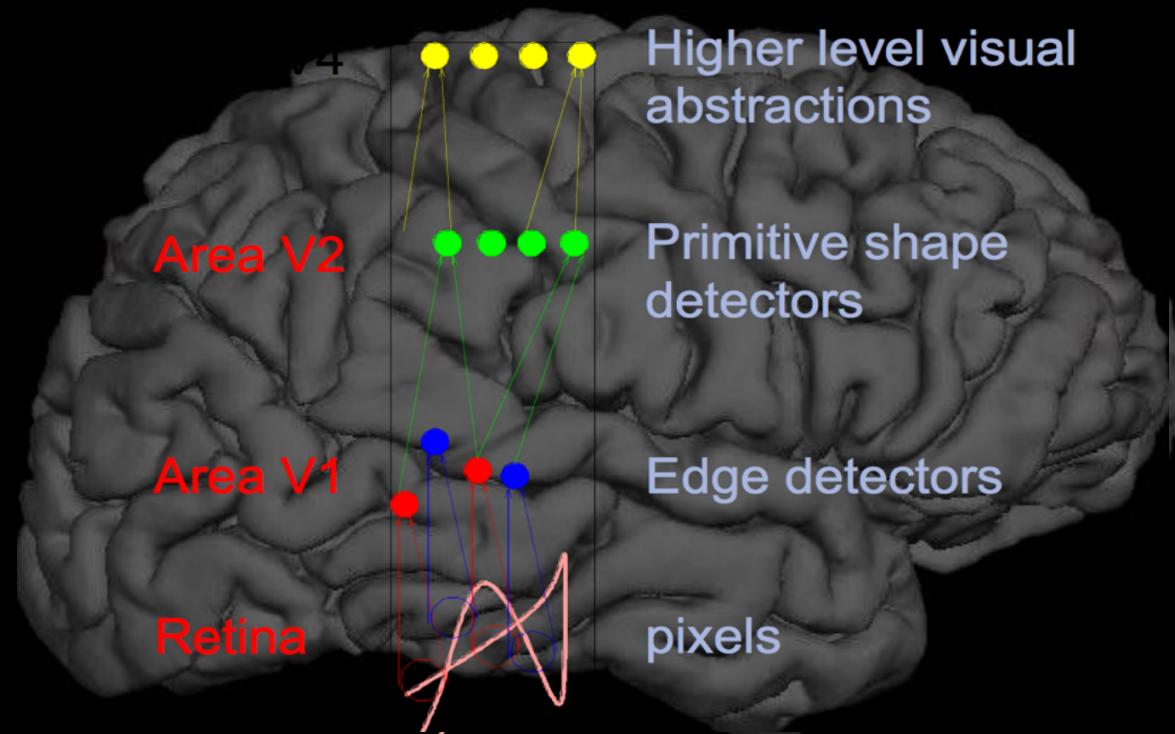
Hubel & Wiesel



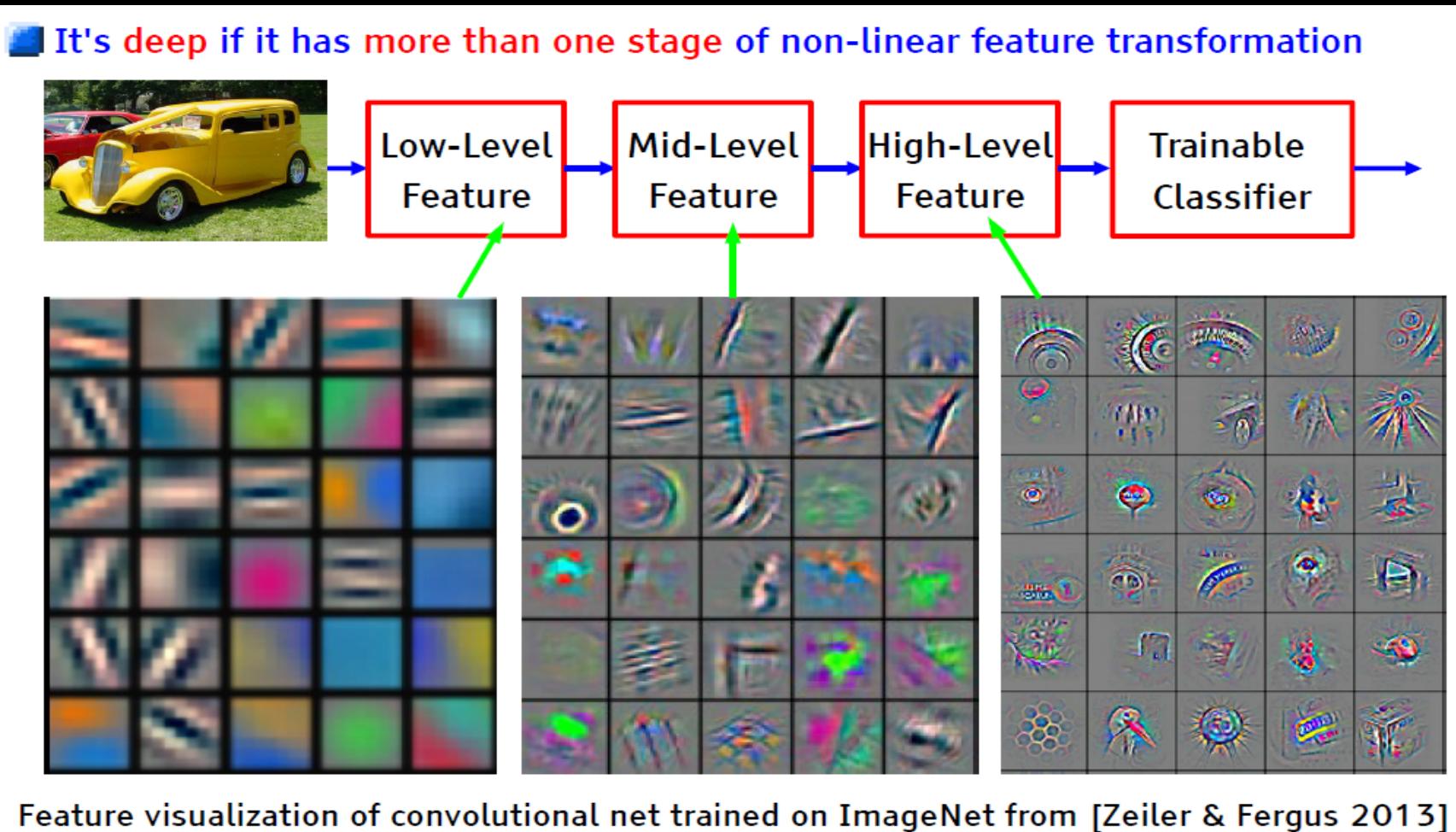
STIMULATION OF RETINA with patterns of light. The eyes of an anesthetized, light-adapted cat (or monkey) focus on a screen onto which various patterns of light are projected. Alternatively, a TV screen is used, with patterns generated by a computer. An electrode records the responses from a single cell in the visual pathway. Light (or shadow) falling onto a restricted area of the screen may accelerate (excite) or slow (inhibit) the signals given by a neuron. By determining the areas on the screen from which a neuron's firing is influenced, one can delineate the receptive field of the cell. The positions of cells in the brain and the tracks of electrode penetrations can be reconstructed histologically after the experiment.



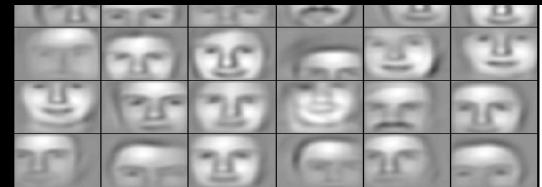
# “视觉的形成是分层的



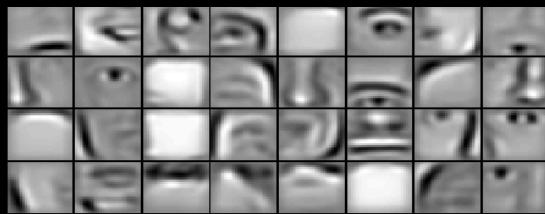
# “深度学习 = 学习层次表达



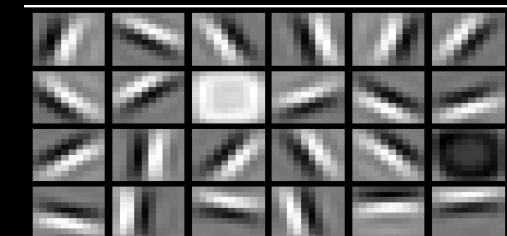
# “ 特征层级



object models



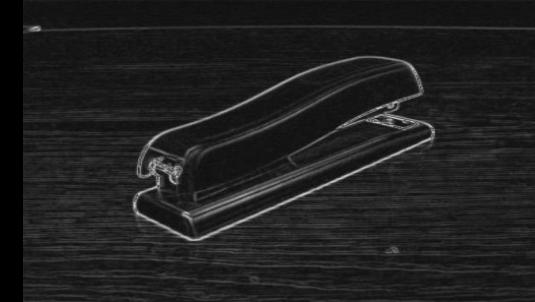
object parts  
(combination  
of edges)



edges



pixels

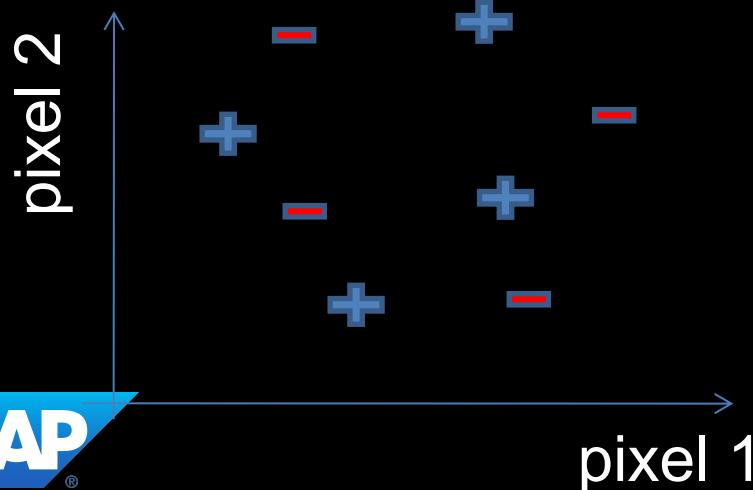


# “ 机器学习 & 特征表达

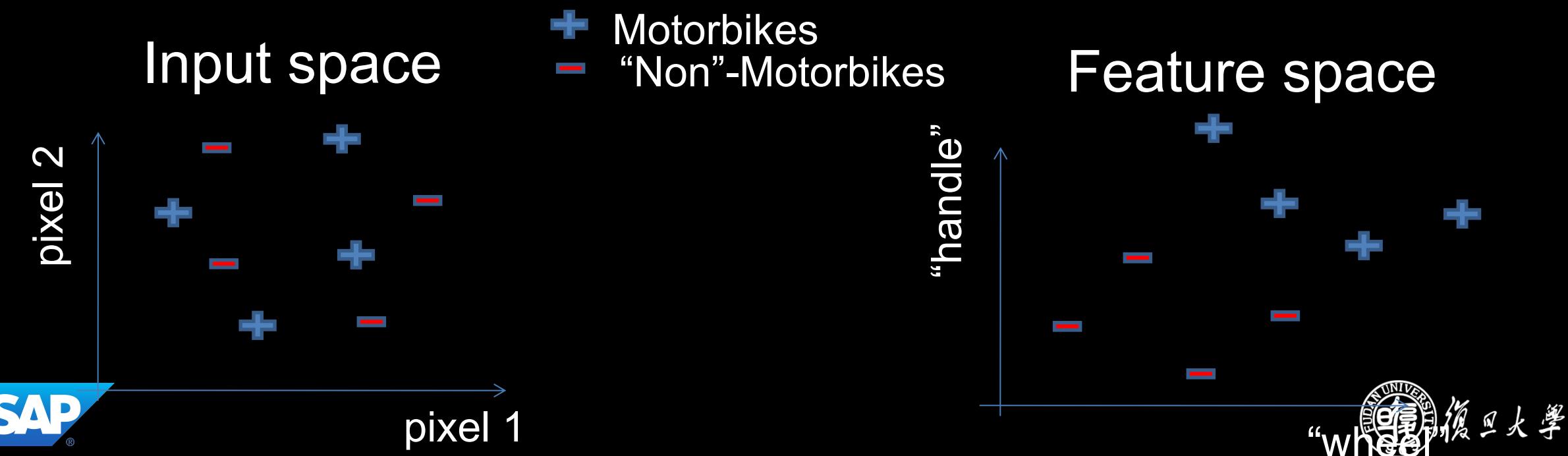
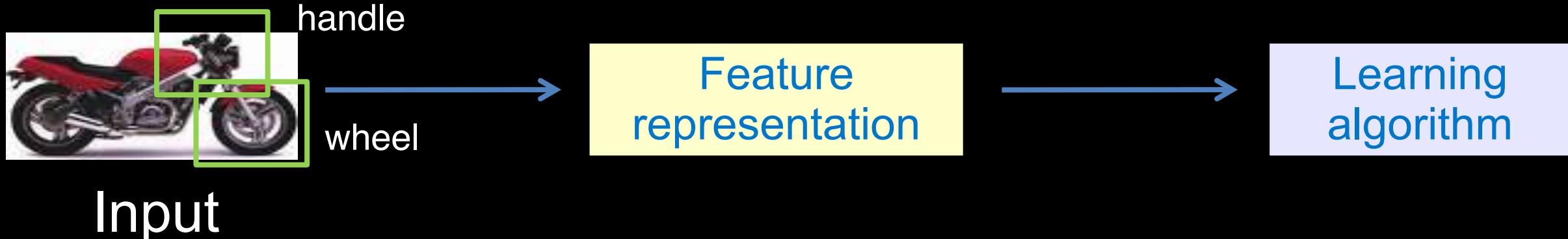


Input space

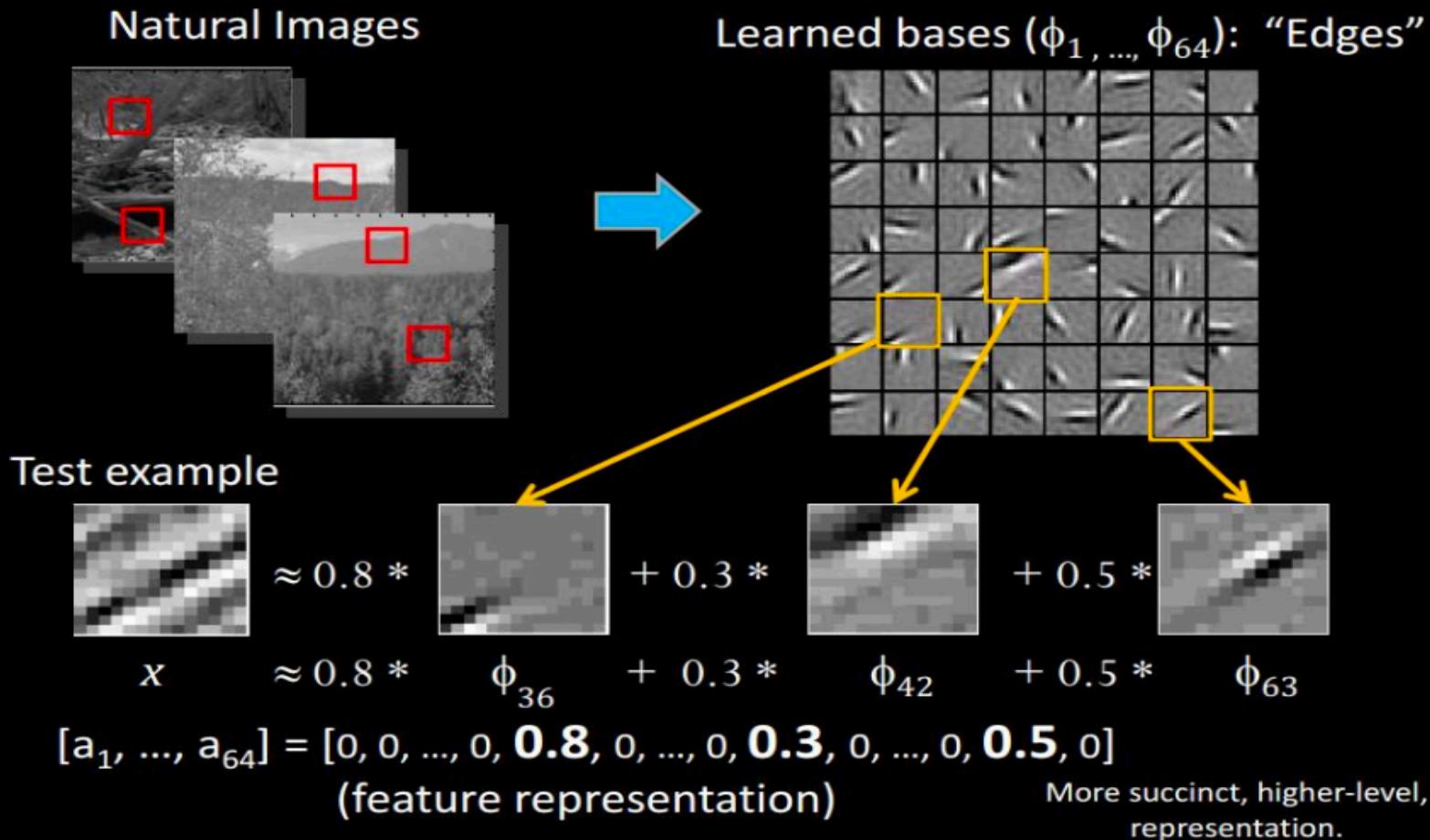
- + Motorbikes
- “Non”-Motorbikes



# “ 机器学习 & 特征表达



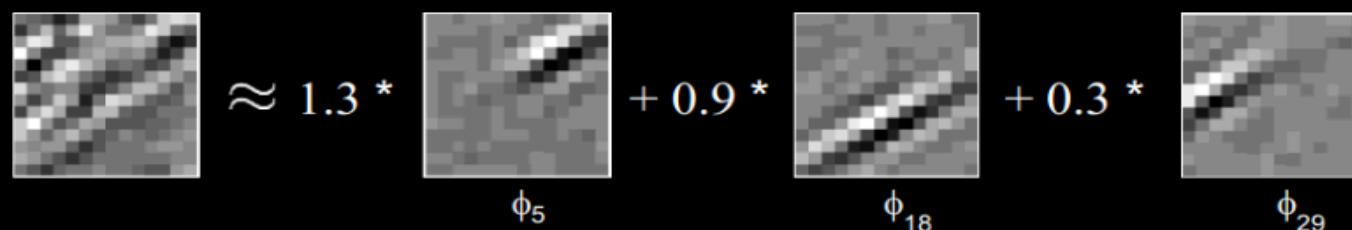
# “ 使用稀疏编码学习特征



# “ 使用稀疏编码学习特征


$$\text{Image} \approx 0.6 * \phi_{15} + 0.8 * \phi_{28} + 0.4 * \phi_{37}$$

Represent as:  $[a_{15}=0.6, a_{28}=0.8, a_{37} = 0.4]$ .


$$\text{Image} \approx 1.3 * \phi_5 + 0.9 * \phi_{18} + 0.3 * \phi_{29}$$

Represent as:  $[a_5=1.3, a_{18}=0.9, a_{29} = 0.3]$ .

- Method “invents” edge detection.
- Automatically learns to represent an image in terms of the edges that appear in it. Gives a more succinct, higher-level representation than the raw pixels.
- Quantitatively similar to primary visual cortex (area V1) in brain.

# “ 使用稀疏编码学习特征 (细节)

输入: 图像  $x^{(1)}, x^{(2)}, \dots, x^{(m)}$  (each in  $R^{n \times n}$ )

$$\min_{a, \phi} \sum_{i=1}^m \left( \left\| x^{(i)} - \sum_{j=1}^k a_j^{(i)} \phi_j \right\|^2 + \lambda \sum_{j=1}^k |a_j^{(i)}| \right)$$



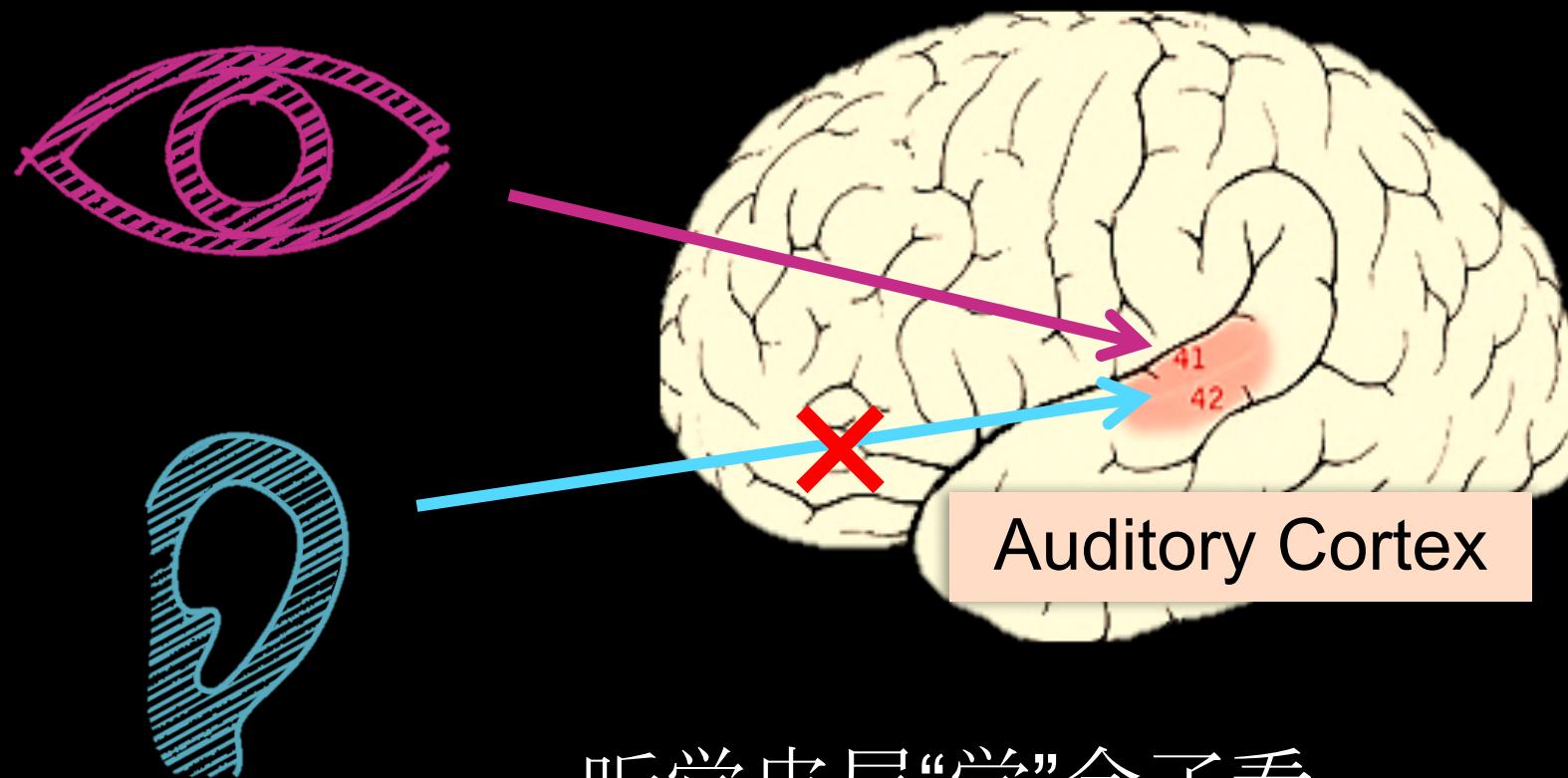
$L_1$  sparsity term



Andrew Ng



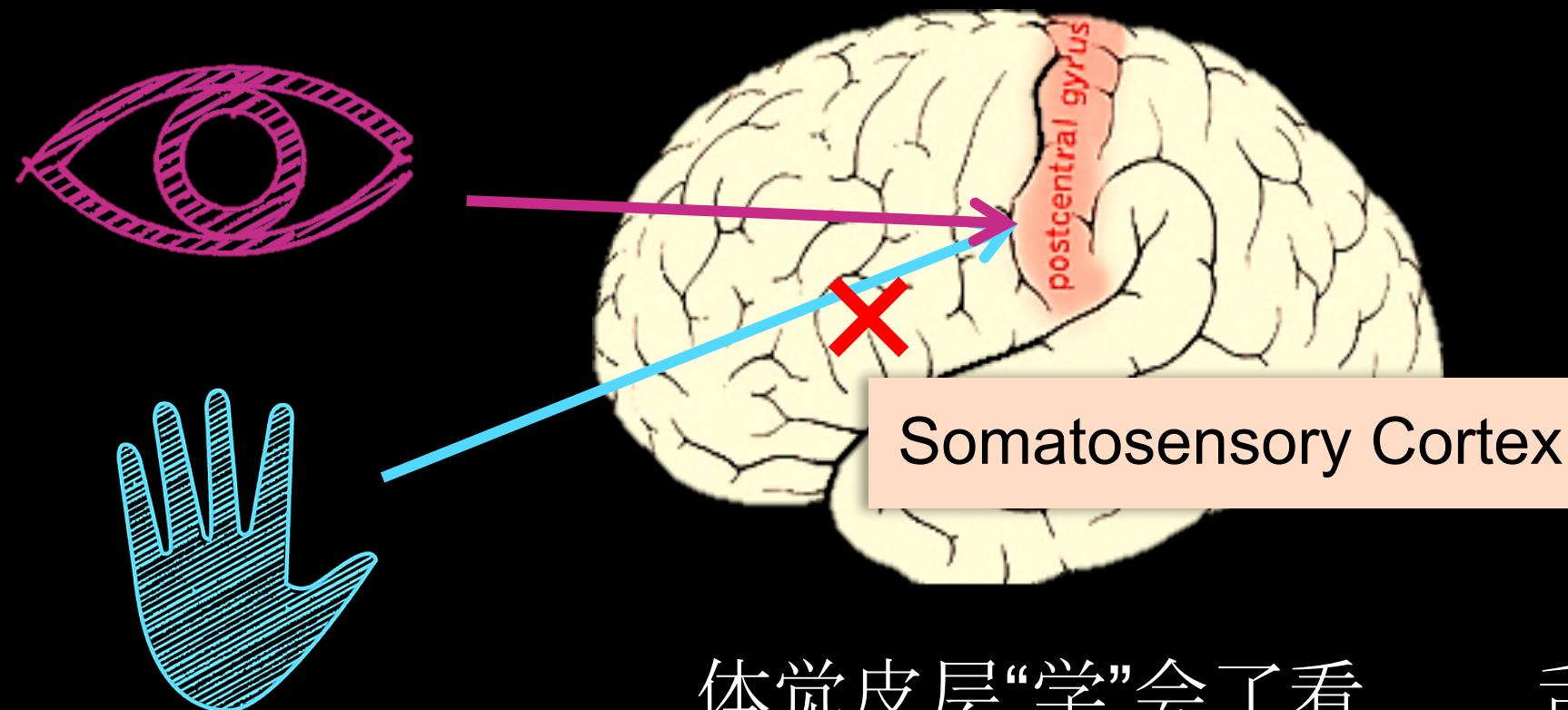
# “单一“学习”算法假设



听觉皮层“学”会了看

[Roe et al., 1992]

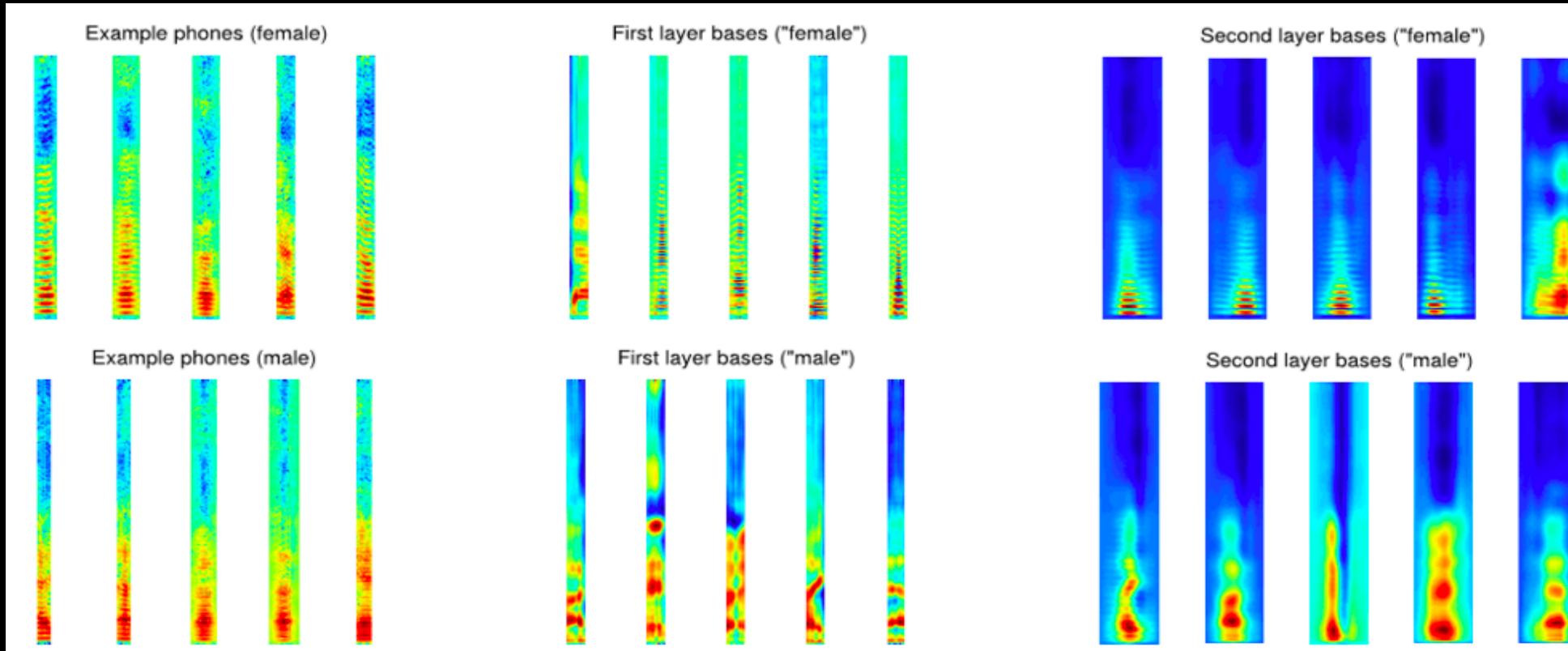
# “单一“学习”算法假设



体觉皮层“学”会了看

舌头“学”会了看

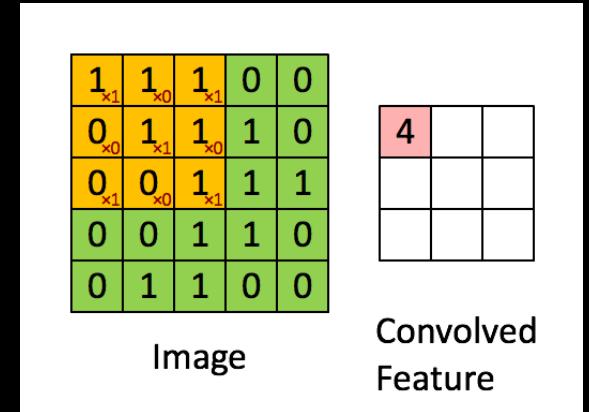
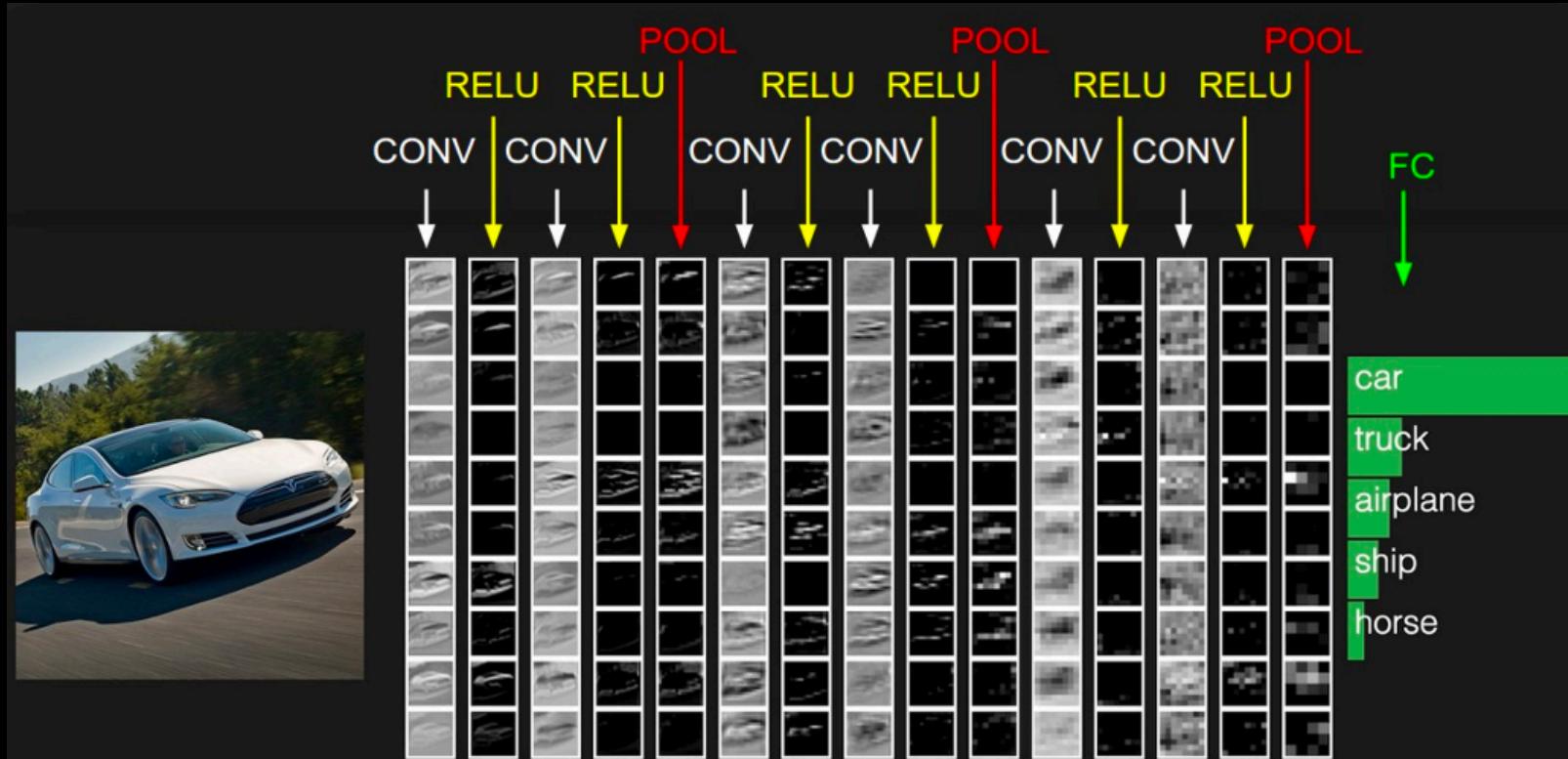
# “稀疏编码也可以用于音频识别



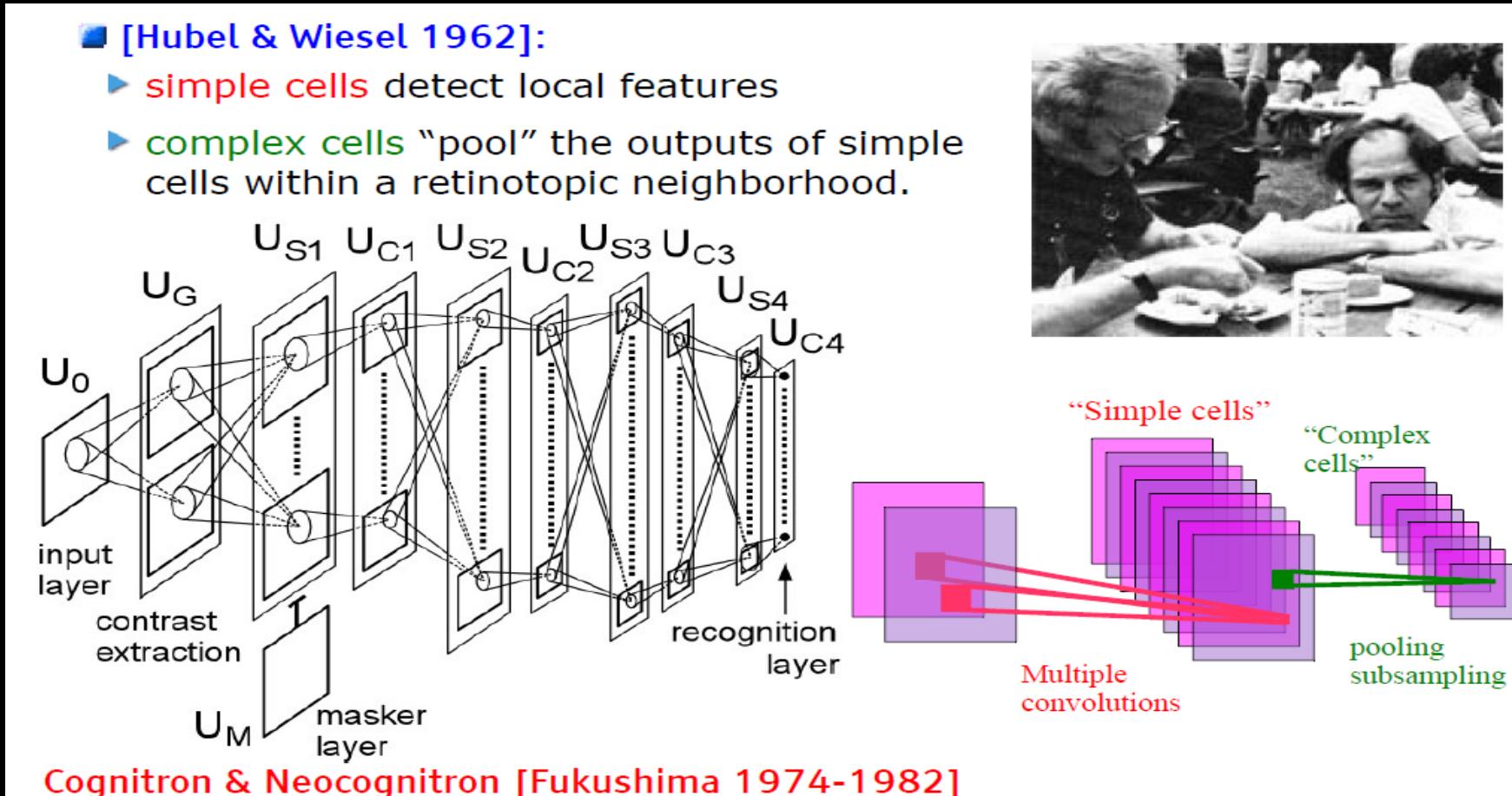
Honglak Lee, Peter T. Pham, Yan Largman, Andrew Y. Ng NIPS 2009



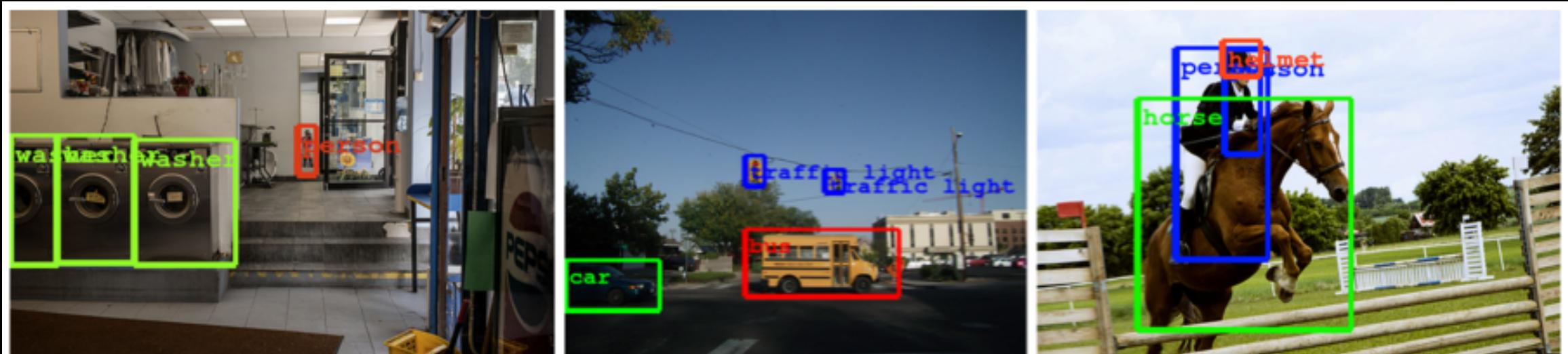
# “卷积神经网络 (CNN) ”



# “早期针对视觉的层次特征建模



# “卷积神经网络：对象识别



# 数据科学

小测验.

These numbers were found in two tax declarations. One is entirely made up. Which one?

EUR

127,-

2.863,-

10.983,-

694,-

29.309,-

32,-

843,-

119.846,-

18.744,-

1.946,-

275,-

EUR

937,-

82.654,-

18.465,-

725,-

98.832,-

7.363,-

4.538,-

38,-

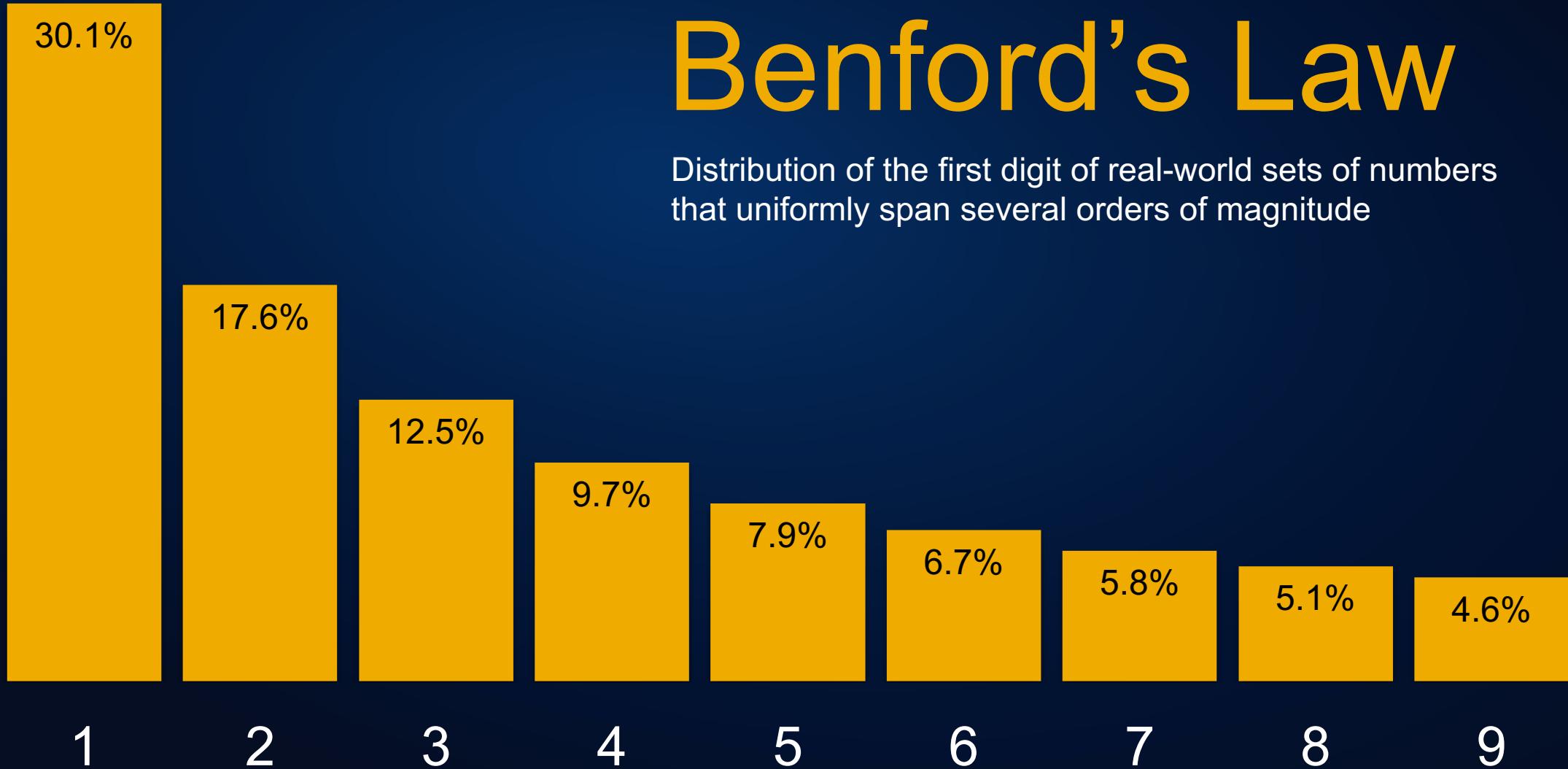
8.327,-

482,-

2.945,-

# Benford's Law

Distribution of the first digit of real-world sets of numbers  
that uniformly span several orders of magnitude



# 数据科学

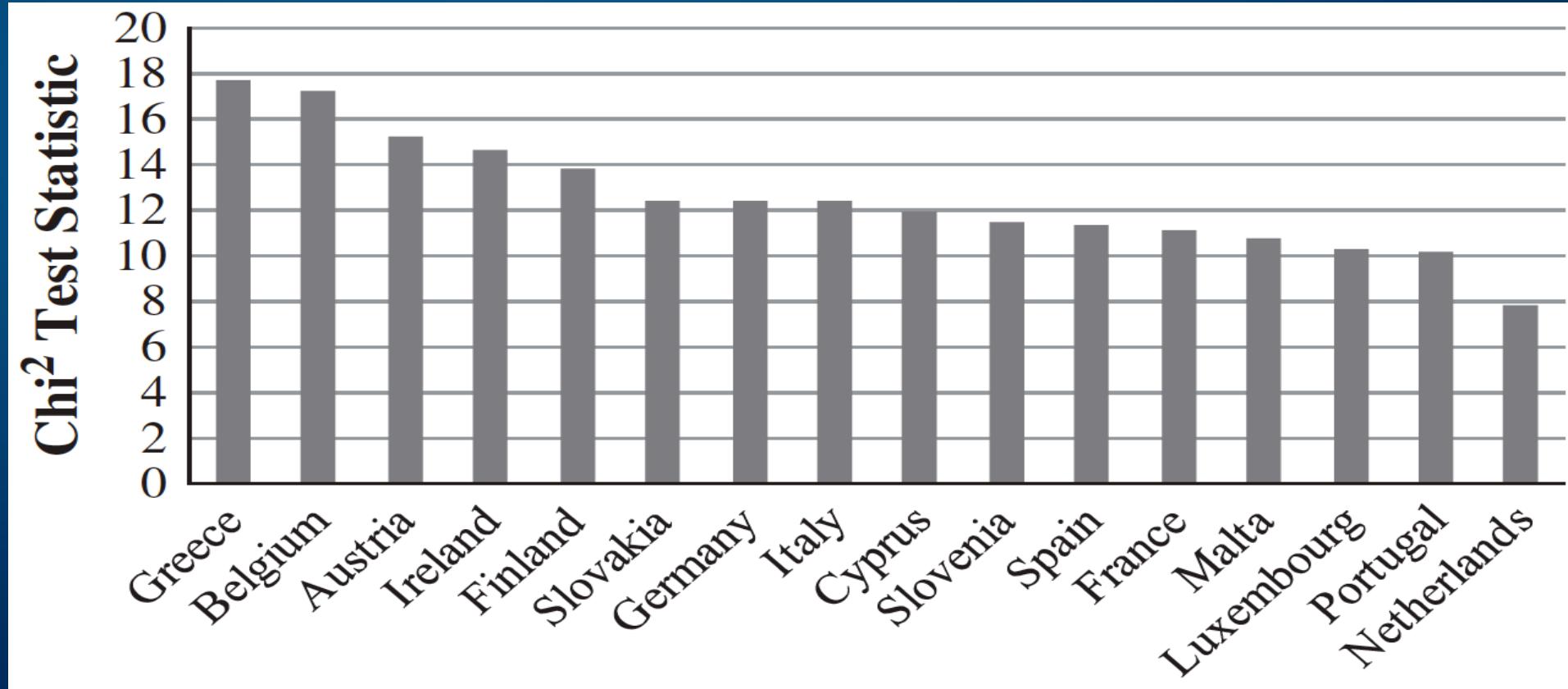
小测验.

These numbers were found in two tax declarations. One is entirely made up. Which one?

Benford's Law, also called the First-Digit Law

EUR	EUR
127,-	937,-
2.863,-	82.654,-
10.983,-	18.465,-
694,-	725,-
29.309,-	98.832,-
32,-	7.363,-
843,-	4.538,-
119.846,-	38,-
18.744,-	8.327,-
1.946,-	482,-
275,-	2.945,-

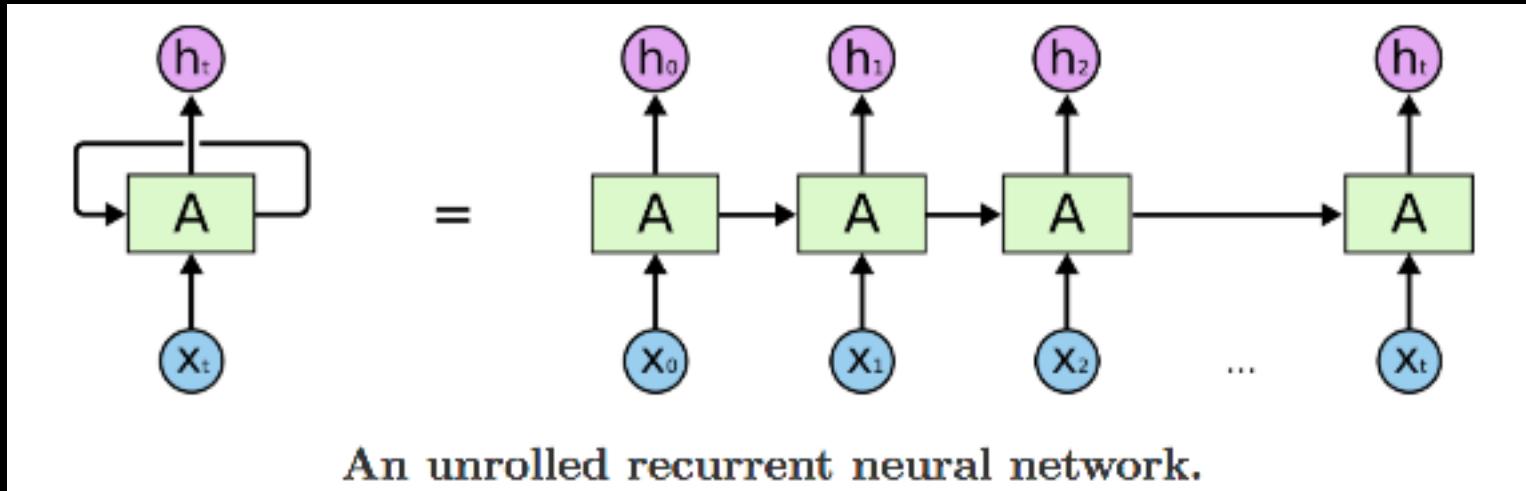
1999 to 2009



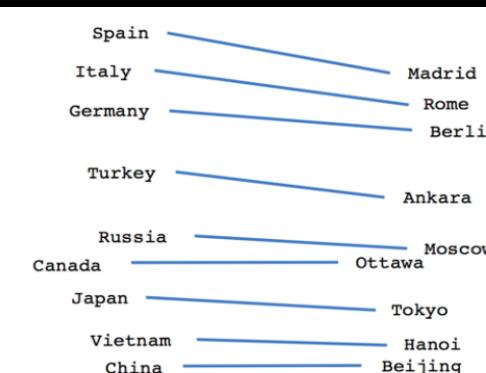
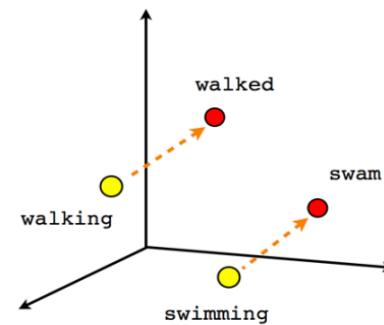
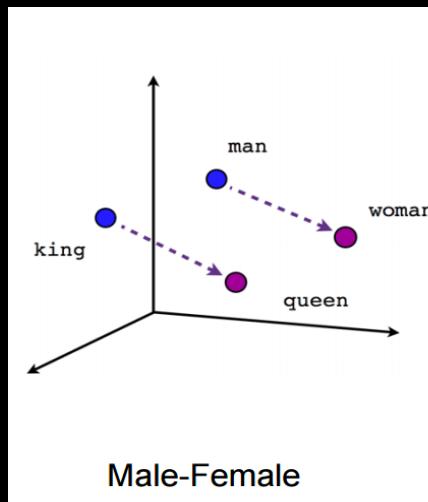
*“Greece shows the largest deviation from Benford’s law with respect to all measures. [And] the suspicion of manipulating data has officially been confirmed by the European Commission.”*

*Fact and Fiction in EU-Governmental Economic Data, 2011*

# “循环神经网络（RNN） & Word2Vec

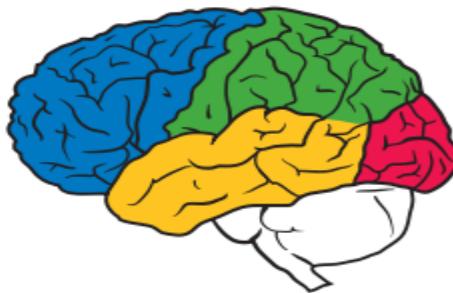


Colah



Tensorflow

# Generating Image Captions from Pixels



*Human:* A young girl asleep on the sofa cuddling a stuffed bear.

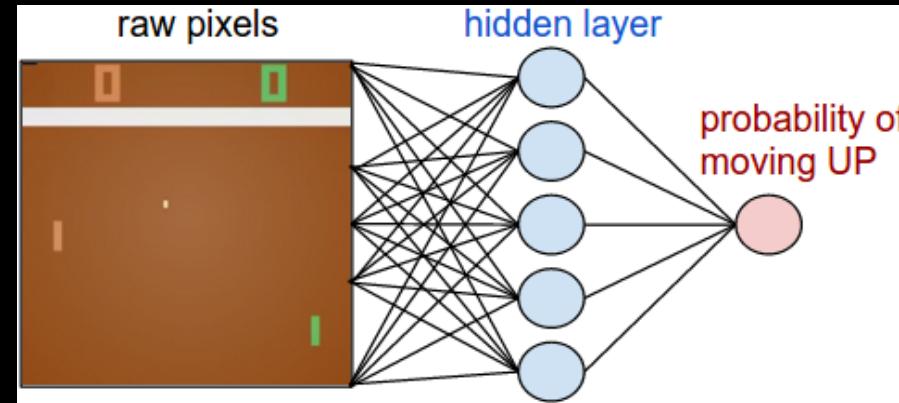
*Model sample 1:* A close up of a child holding a stuffed animal.

*Model sample 2:* A baby is asleep next to a teddy bear.

# “ 强化学习：通用智能



Policy Network:



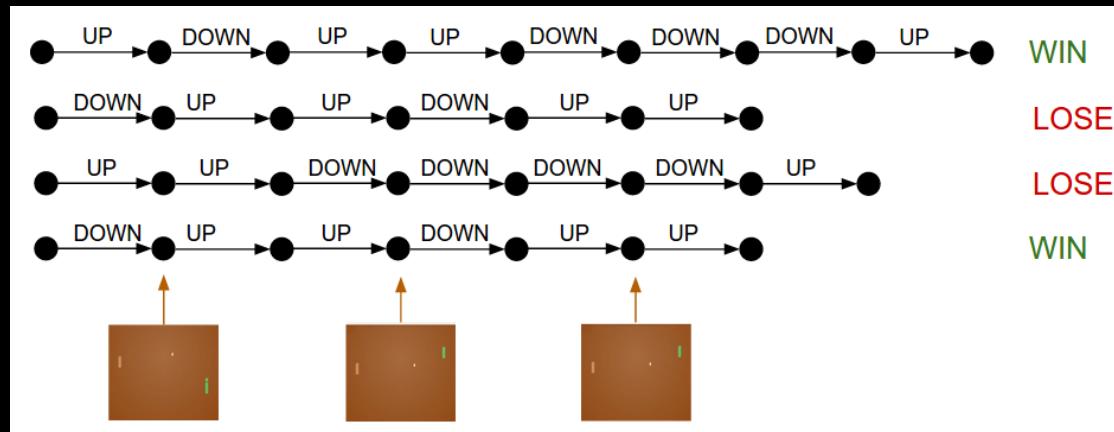
- 80x80 image (difference image)
- 2 actions: up or down
- 200,000 Pong games

这是迈向通用智能的关键一步!

Andrej Karpathy. "Deep Reinforcement Learning: Pong from Pixels." 2016.

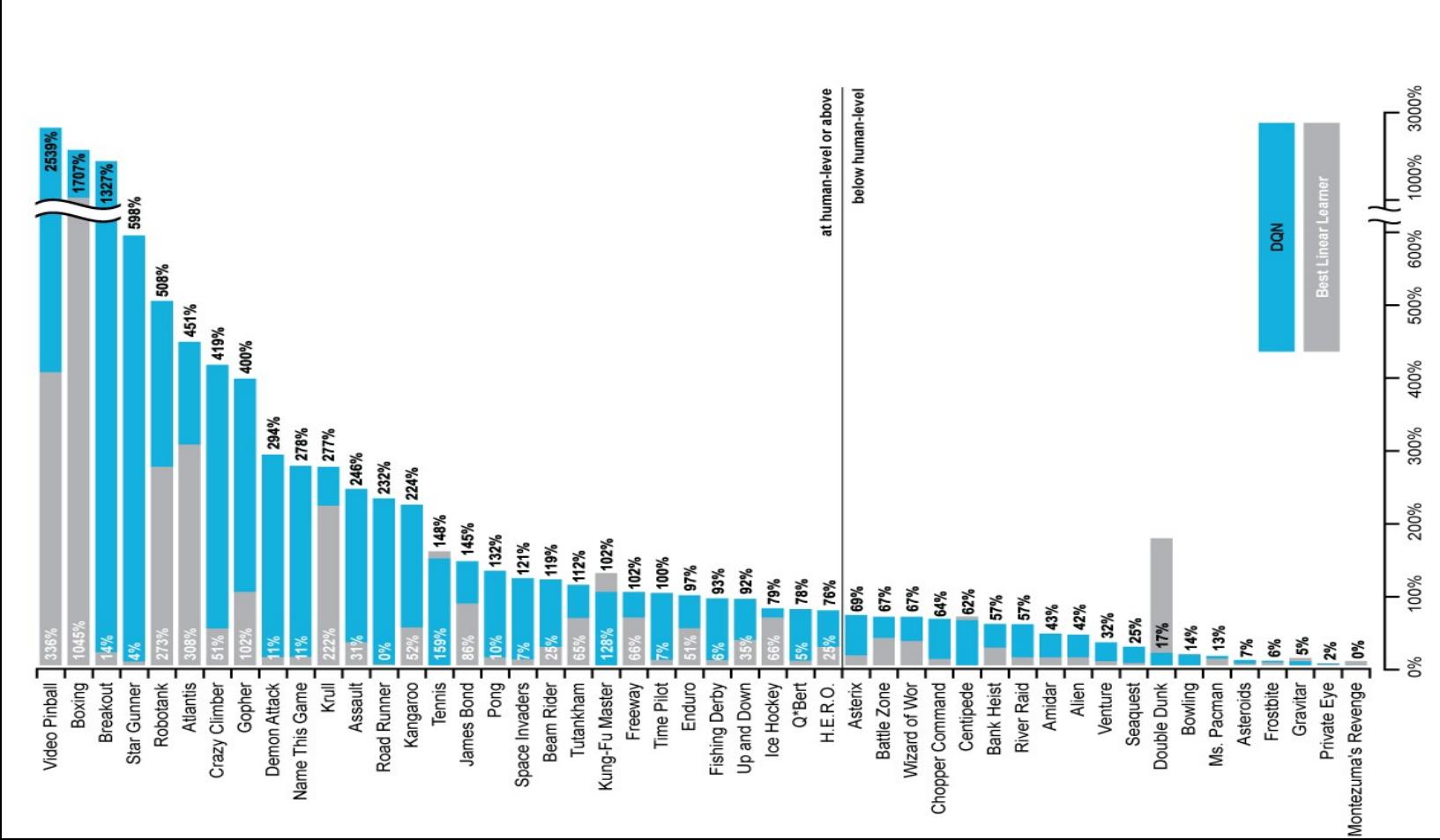


# “ 强化学习：通用智能



- Every (state, action) pair is **rewarded** when the final result is a **win**.
- Every (state, action) pair is **punished** when the final result is a **loss**.

# “ 强化学习：通用智能



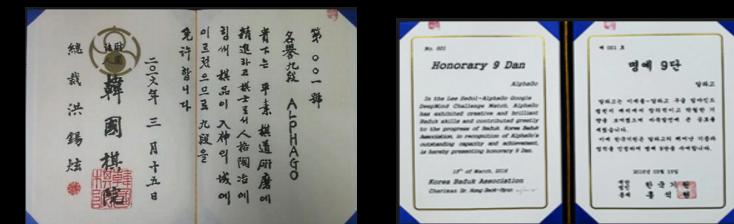
# “ Google Deepmind AlphaGo vs. 李世石九段



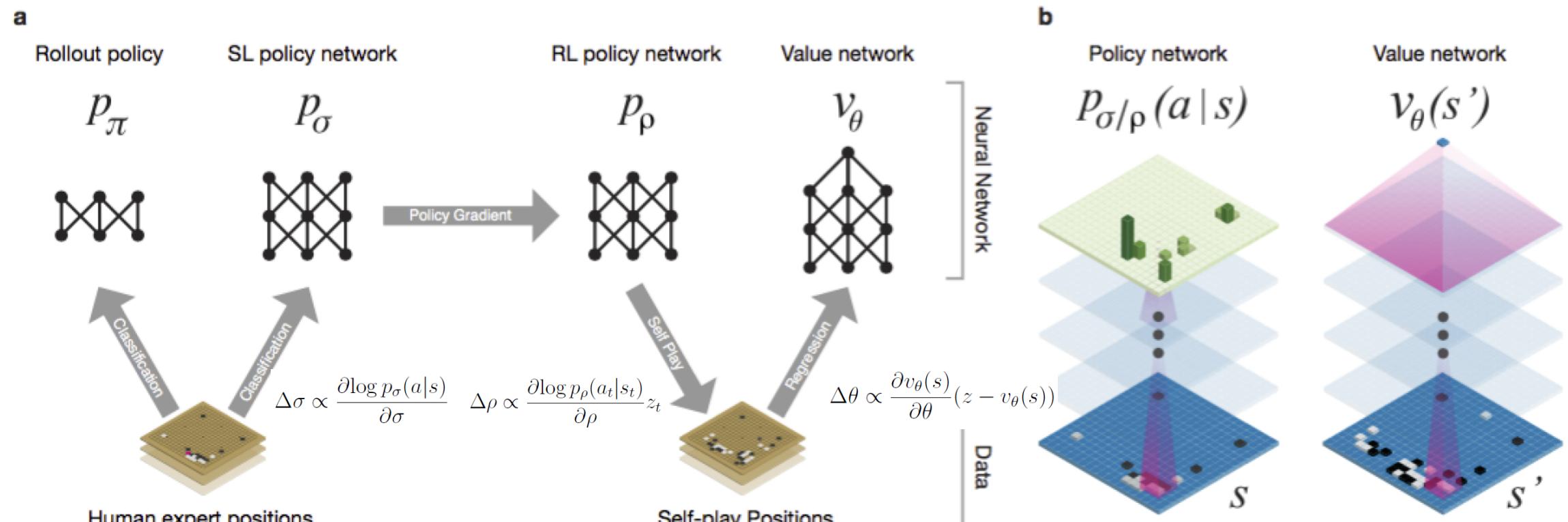
Image Source: Josun Times Jan 28<sup>th</sup> 2015

日期: March 9-15, 2016  
地点: Four Seasons Hotel, Seoul  
奖金: 1M USD  
时限: 2 hours  
战果: 4-1

- 99.8% Winning rate against other Go Program
- Defeat Europe Champion Fan Hui by 5:0 in 2015



# AlphaGo 训练流程

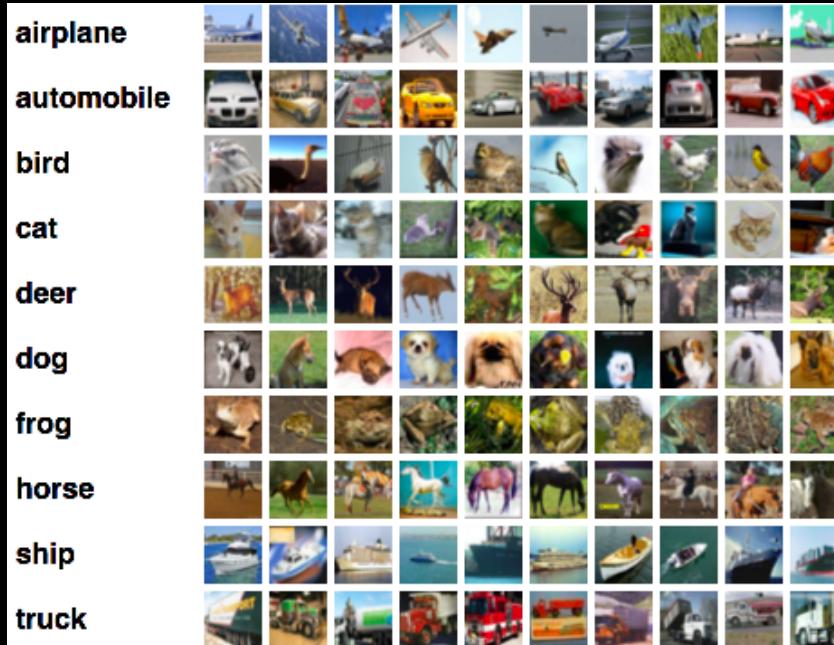


Maximizing predictive accuracy

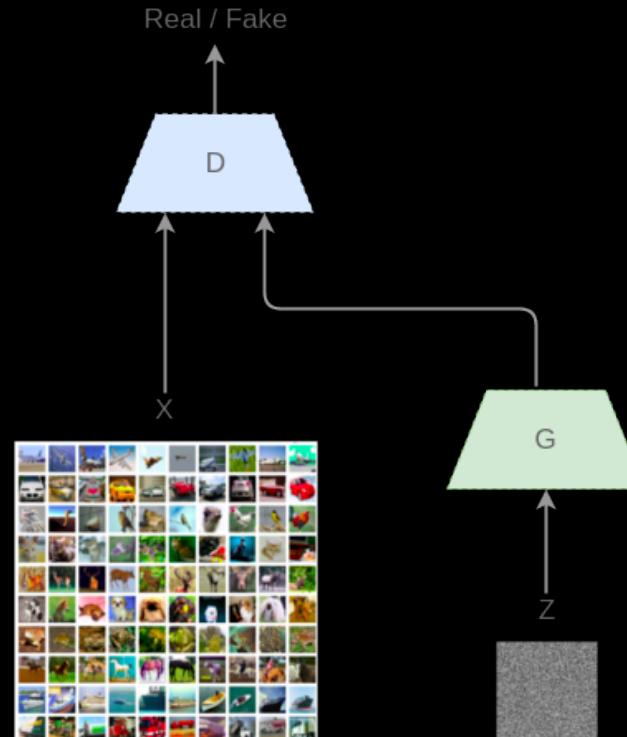
Source : Nature

Goal of winning games  
10,000\*128 games

# “生成对抗网络 (GANs) ”



CIFAR-10



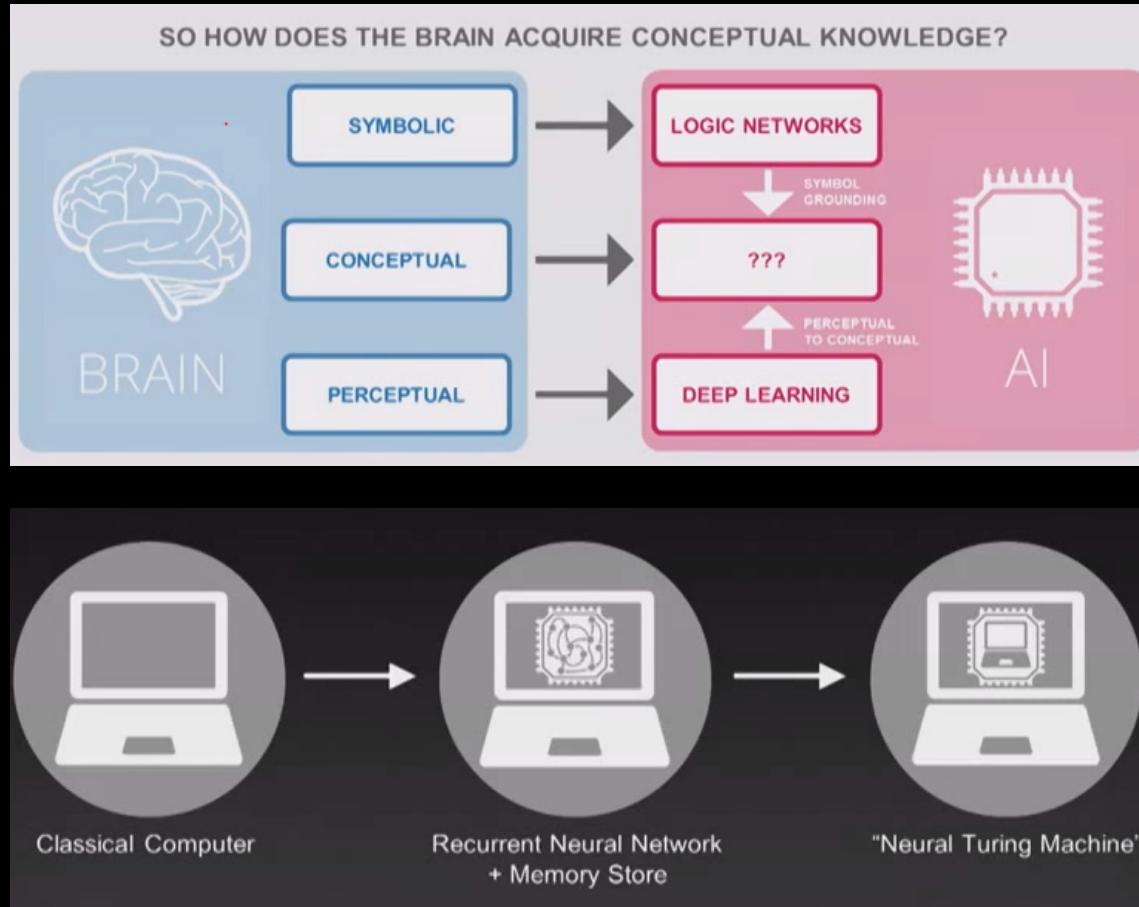
GAN生成的非真实对象

# “ GANs矢量空间计算



Alec Radford, Luke Metz, Soumith Chintala , 2015

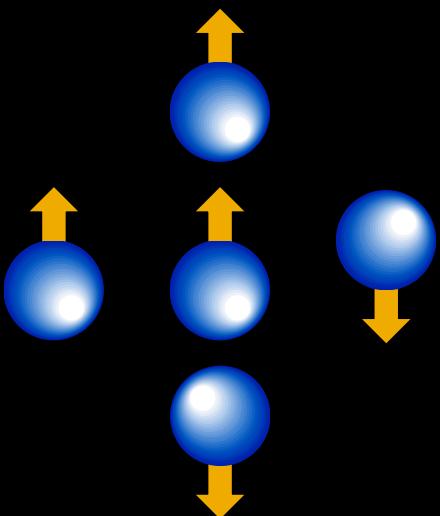
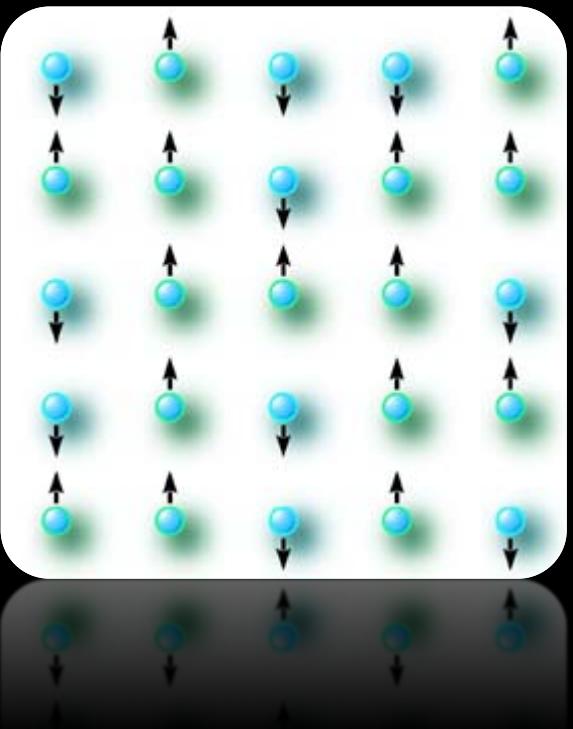
# “概念形成与自动编程



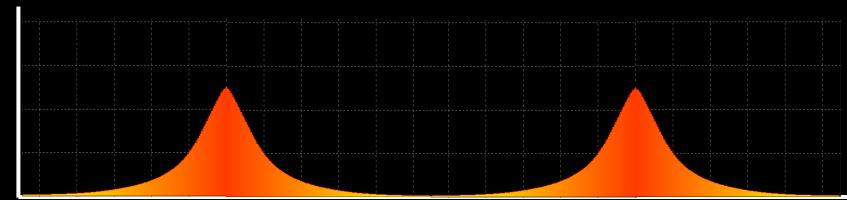
“



# Ising Model



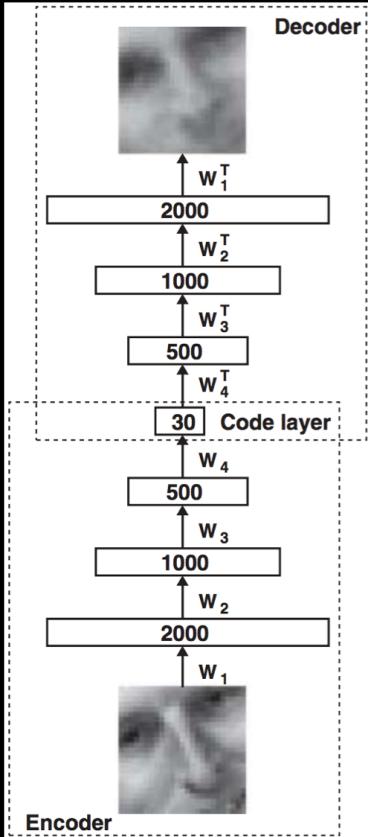
$$p(x_i | w) = \frac{e^{-E(x_i, w)}}{\sum_{k=1}^n e^{-E(x_k, w)}}$$



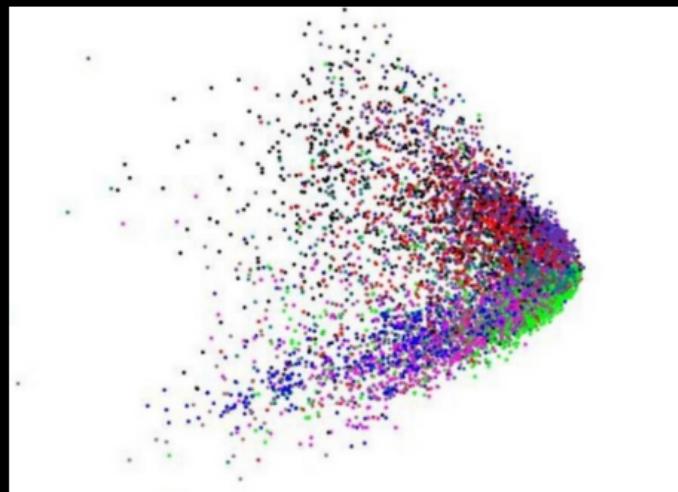
Carey Nachenberg



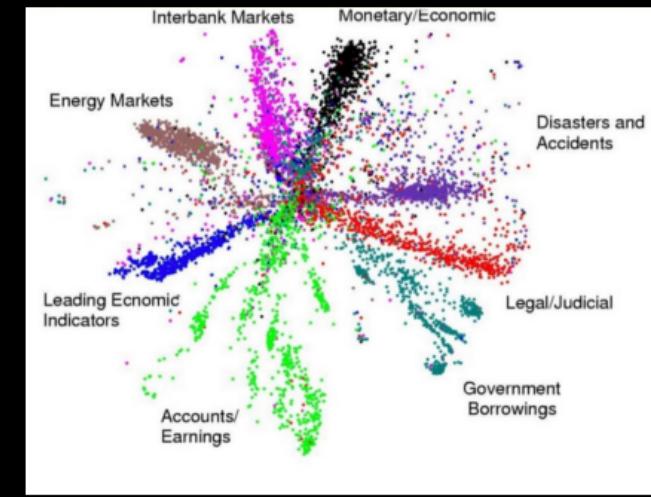
# “ AutoEncoder v.s. PCA



Hinton

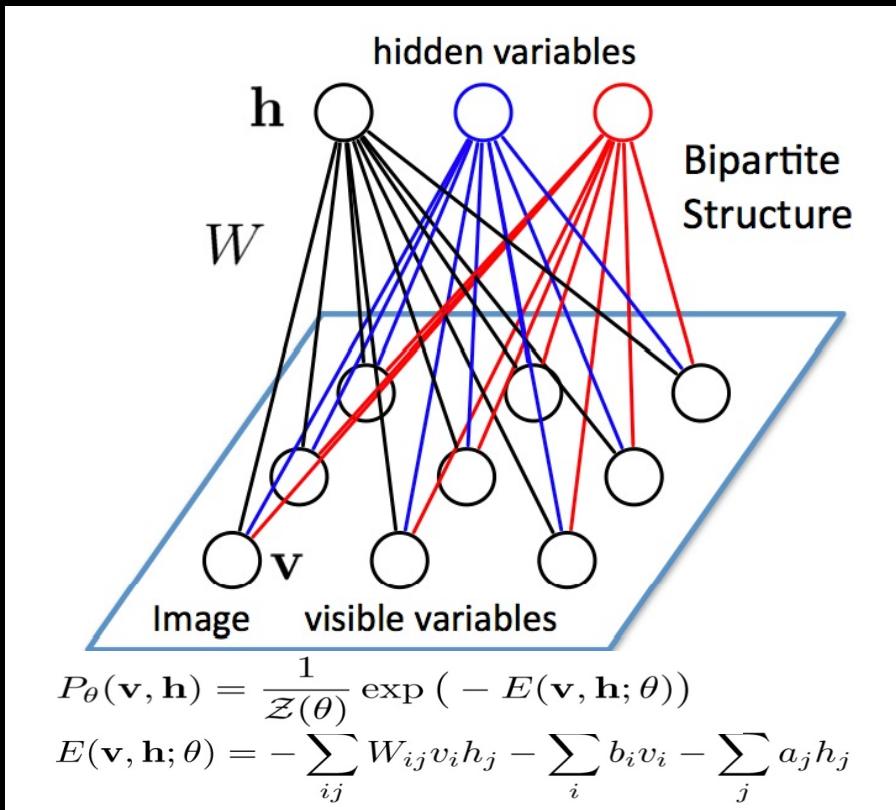


PCA

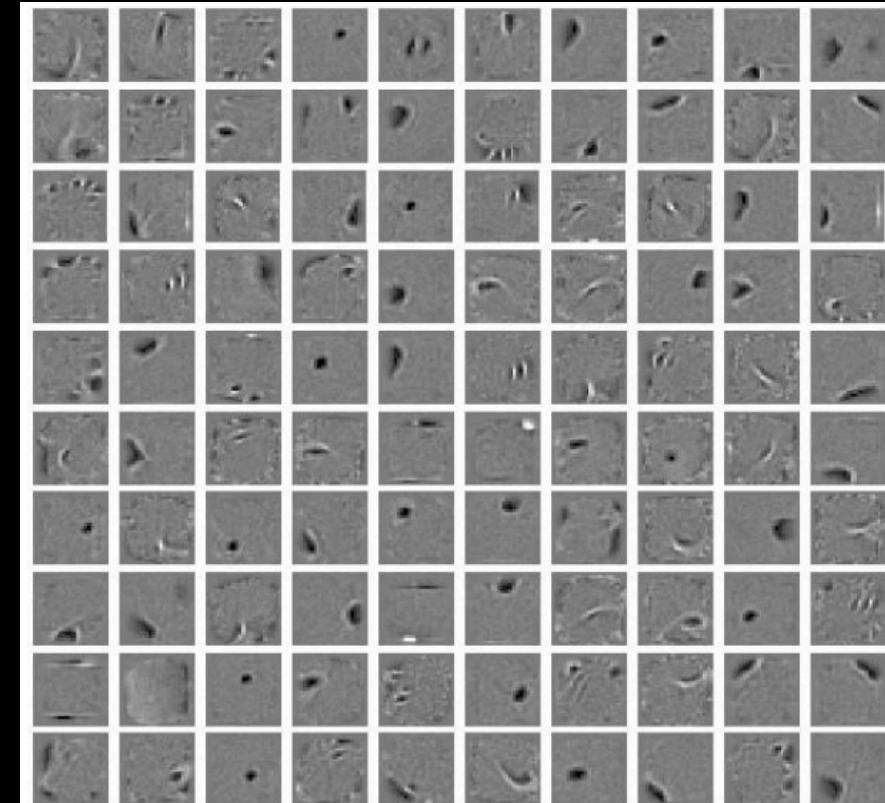


AutoEncoder

# “ 受限的玻尔兹曼机 (RBM) ”



Hinton, Sejnowski 1986



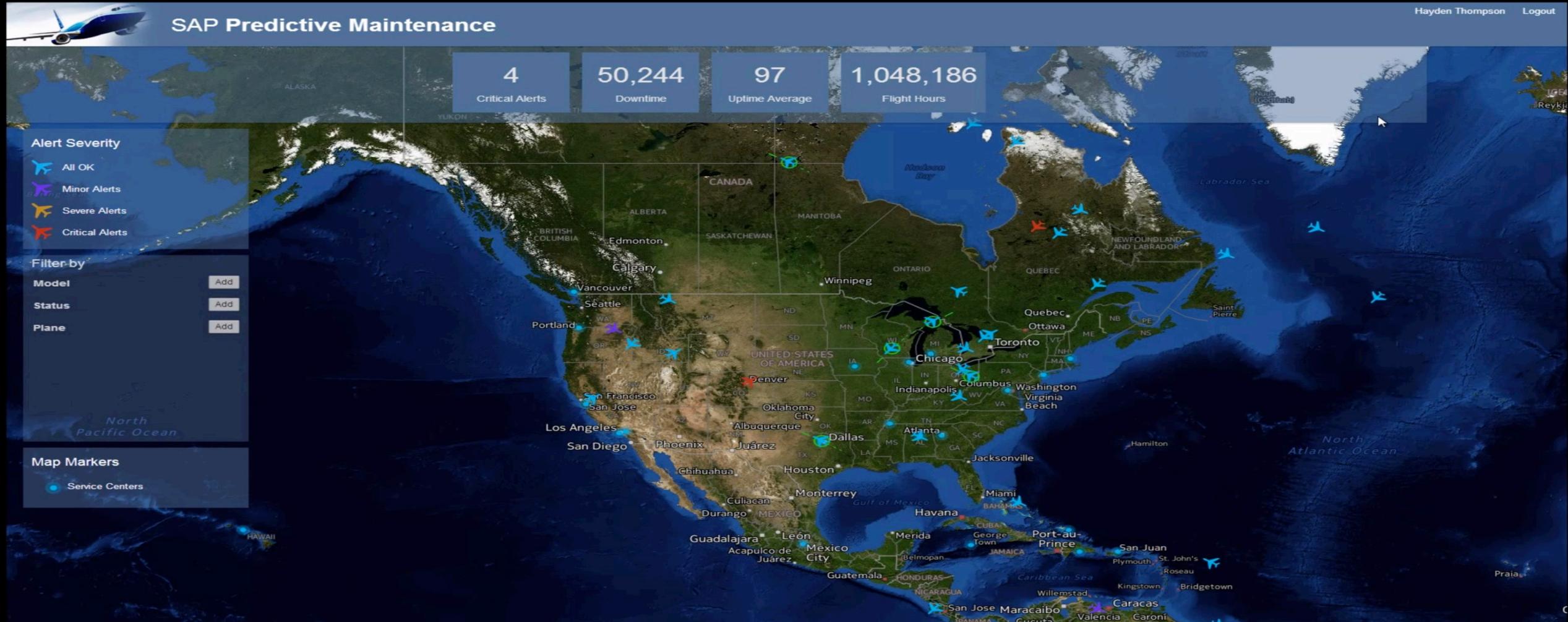
Features learned in the 1<sup>st</sup> hidden layer of 500 hidden units  
for 10 handwriting digits classes

# “Keaser Compressors: 商业模式转型



**“Our predictive maintenance solution has enabled us to proactively attend to maintenance needs and increase service levels for customers”**

# “ 预测性维修 (1) ”



復旦大學

# “ 预测性维修 (2) ”

SAP Predictive Maintenance

Hayden Thompson Logout

ALASKA

Critical Alerts: 4

Downtime: 50,244

Uptime Average: 97

Flight Hours: 1,048,186

Alert Severity:

- All OK
- Minor Alerts
- Severe Alerts
- Critical Alerts

YEAR: 2013

TAIL NUMBER: 12345

TIME HORIZON: 8 HOURS

DESTINATION: LONDON, ENGLAND

99.89 Up Time

50,000 Engine Hours

FLT Current Location

MAINTENANCE VIEW

AUGUST 20, 2013 / 4500 HOURS

UNSCHEDULED

Alert	Service By	Downtime (Hrs)	Has Part
EEC Alternator	08/15/13	4.0	■
5000 hr maint.	10/15/13	1.0	■
Total Downtime		4.0	

SCHEDULED OCTOBER 15, 2013 - LONDON/BQH

Alert	Service By	Downtime (Hrs)	Has Part
Turbojet Compressor	09/15/13	6.0	■
ECC	09/15/13	2.0	■
Total Downtime		8.0	

DECEMBER 15, 2013 - LONDON/BQH

Alert	Service By	Downtime (Hrs)	Has Part
REV	01/15/14	6.0	■
HCS	01/15/14	2.0	■
Total Downtime		8.0	

North Pacific Ocean

Map Markers: Service Centers

Acapulco de Juárez, Mexico City, Belmopan, Guatemala, Honduras, Nicaragua, San Jose, Maracaibo, Panama, Cúcuta, Colombia, San Juan, St. John's, Plymouth, Roseau, Kingstown, Bridgetown, Willemstad, Caracas, Valencia, Caroni, Venezuela, Praia, Brazil

# “ 预测性维修 (3) ”

SAP Predictive Maintenance

Hayden Thompson Logout

ALERT VIEW

Critical Alert: EEC Alternator

Error Code: GA4C-5833-12

Timestamp: 2013-07-28T05:14:00.000Z

Description: Aberrant voltage spike pattern matching prior failure signature has been detected. There is a significant possibility that the EEC Alternator would experience a failure in the next 300 engine hours.

A full inspection and/or replacement of the EEC Alternator is recommended at the next scheduled service.

Explanation of the predictive model: the decision tree shows how the telematics data pattern were correlated with the failure.

```
graph TD; A[5938 PIN Days  
0.25% Failure] --> B[25 PIN Days  
20% Failure]; A --> C[5913 PIN Days  
0.14% Failure]; B --> D[DTC_CODE855_EH_10 = NO  
Engine Speed Low]; C --> E[DTC_CODE855_EH_10 = YES  
Engine Speed Low]; D --> F[18 PIN Days  
11% Failure]; D --> G[5212 PIN Days  
0.0% Failure]; E --> H[MEASURE234_ENG_HR_10_MAX  
<5680 455]; E --> I[MEASU[RE234_ENG_HR_10_MAX  
<5680 455];  
ECC Alternator, state=working]
```

Powered by SAP HANA®

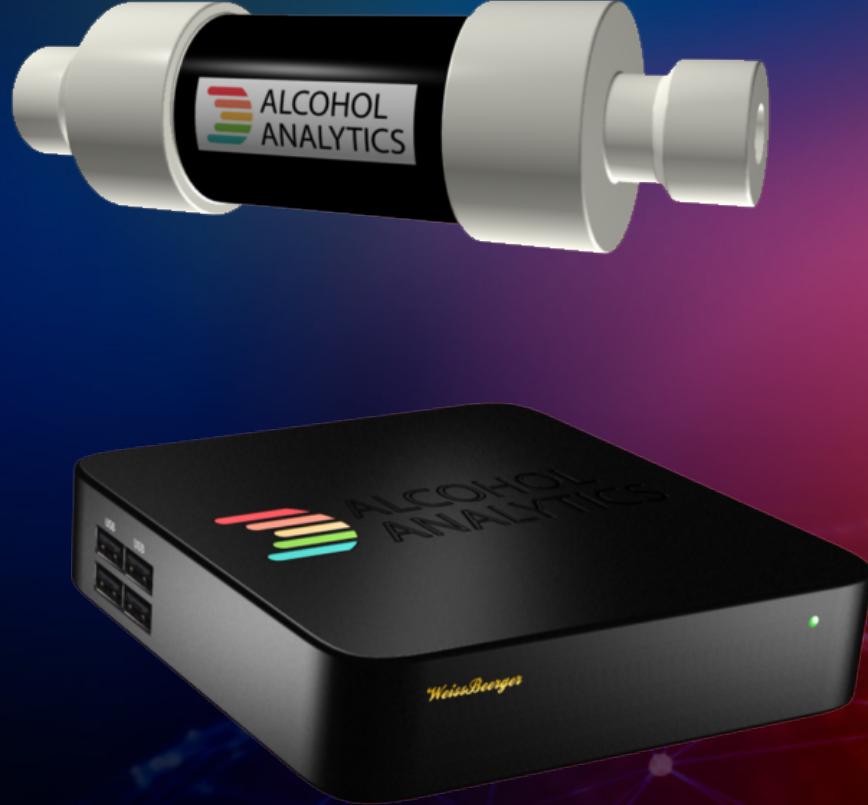
The screenshot displays the SAP Predictive Maintenance dashboard. At the top, there's a world map with flight paths and four key metrics: 4 Critical Alerts, 50,244 Downtime, 97 Uptime Average, and 1,048,186 Flight Hours. Below this is an 'ALERT VIEW' window for a critical EEC Alternator alert. The alert details include the error code (GA4C-5833-12), timestamp (2013-07-28T05:14:00.000Z), and a description about a potential failure in the next 300 engine hours. A decision tree diagram explains the predictive model, showing correlations between PIN days, DTC codes, and specific engine measurements like MEASURE234\_ENG\_HR\_10\_MAX. The bottom right corner features the SAP HANA logo. The overall theme is dark blue with light blue highlights.



# “ Burberry 大规模个性化用户体验



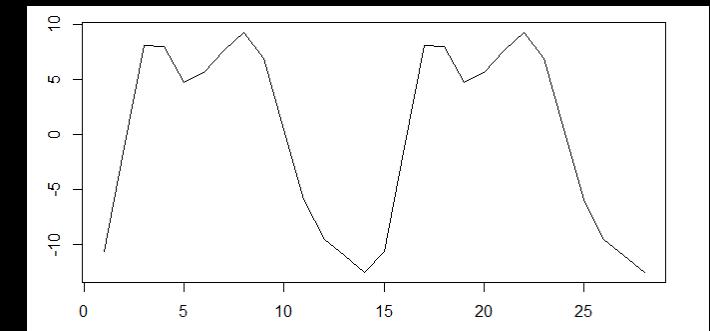
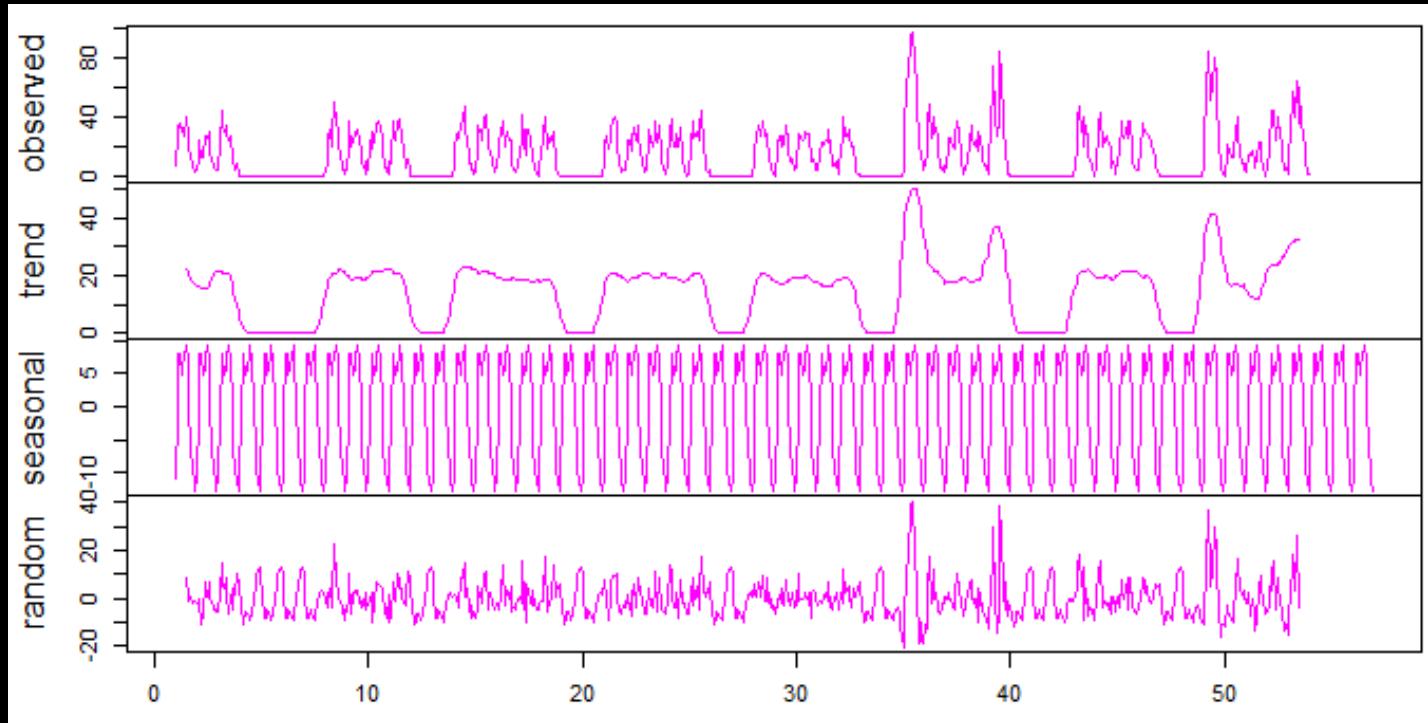
# 传感器催生新流程与应用



Weissbecker 饮料分析

# “ 巴西某银行呼叫中心负载时间序列结构

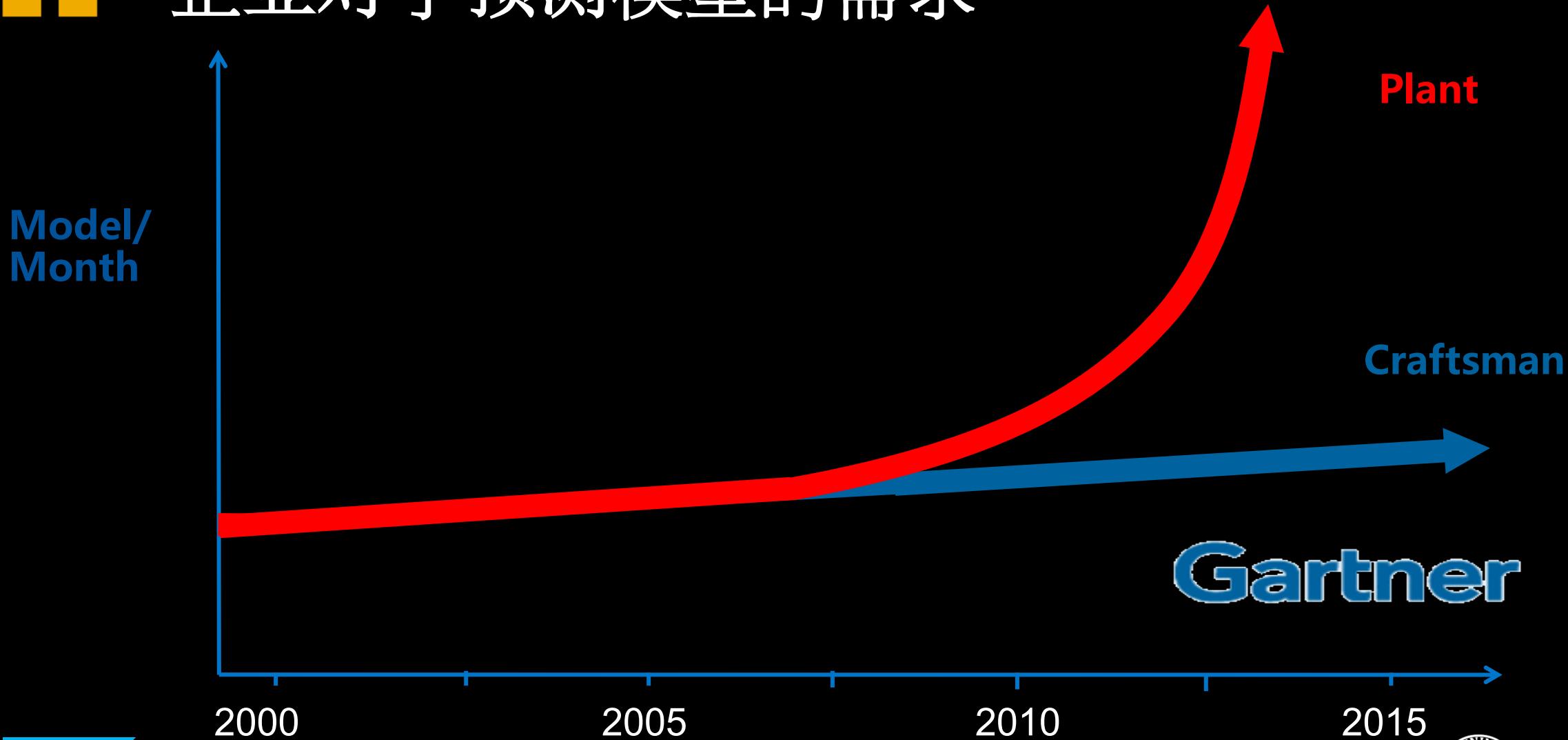
每周  
每天



$$\text{Observed} = \text{Trend} + \text{Seasonal} + \text{Random}$$

“

# 企业对于预测模型的需求



来源: Adopted from Factory Analysis vs. Craftsman Analysis, Gartner, 2010

# 企业利用机器学习进行创新的主要机遇领域



超个性化  
客户体验



交互 & 授权  
未来的工作人员



计划 & 优化  
资源



驾驭网络经济的智能

# Predictive reaches maturity

**Descriptive:**  
What happened?

**Diagnostic:**  
Why did it happen?

**Predictive:**  
What will happen?

**Prescriptive:**  
How can we make it  
happen?

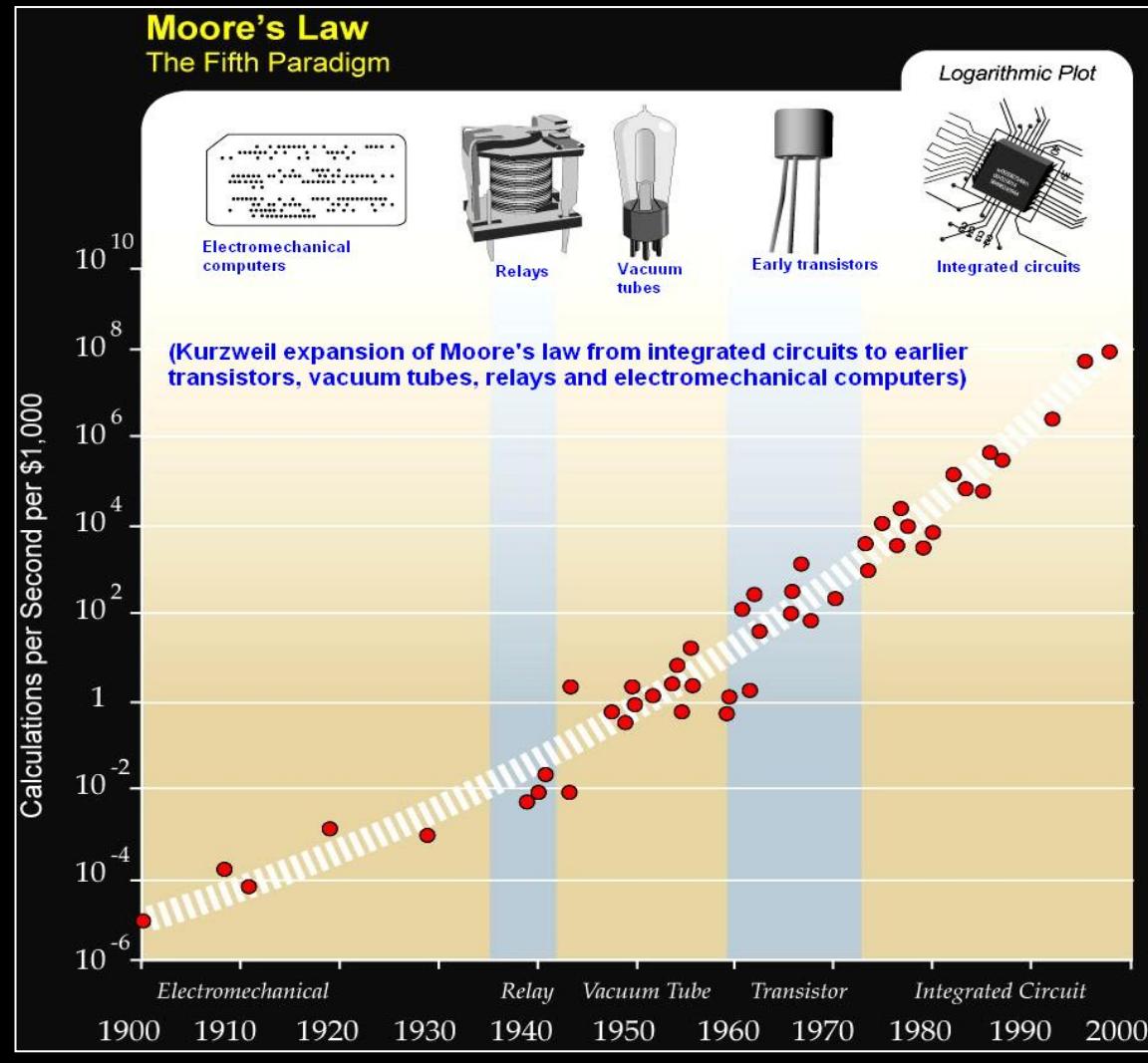
Hindsight

Insight

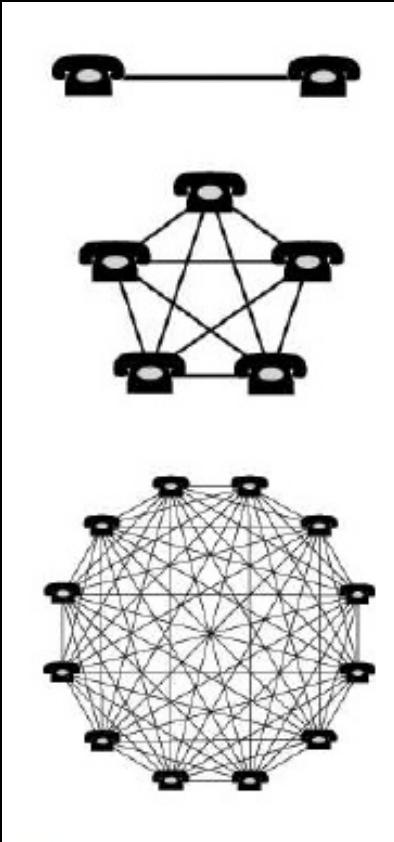
Foresight



# “(扩展的) Moore's Law



# “ Metcalfe's Law



The value of a telecommunications network is proportional to the square of the number of connected users of the system ( $O(n^2)$ ).

# “ 网络经济成功案例

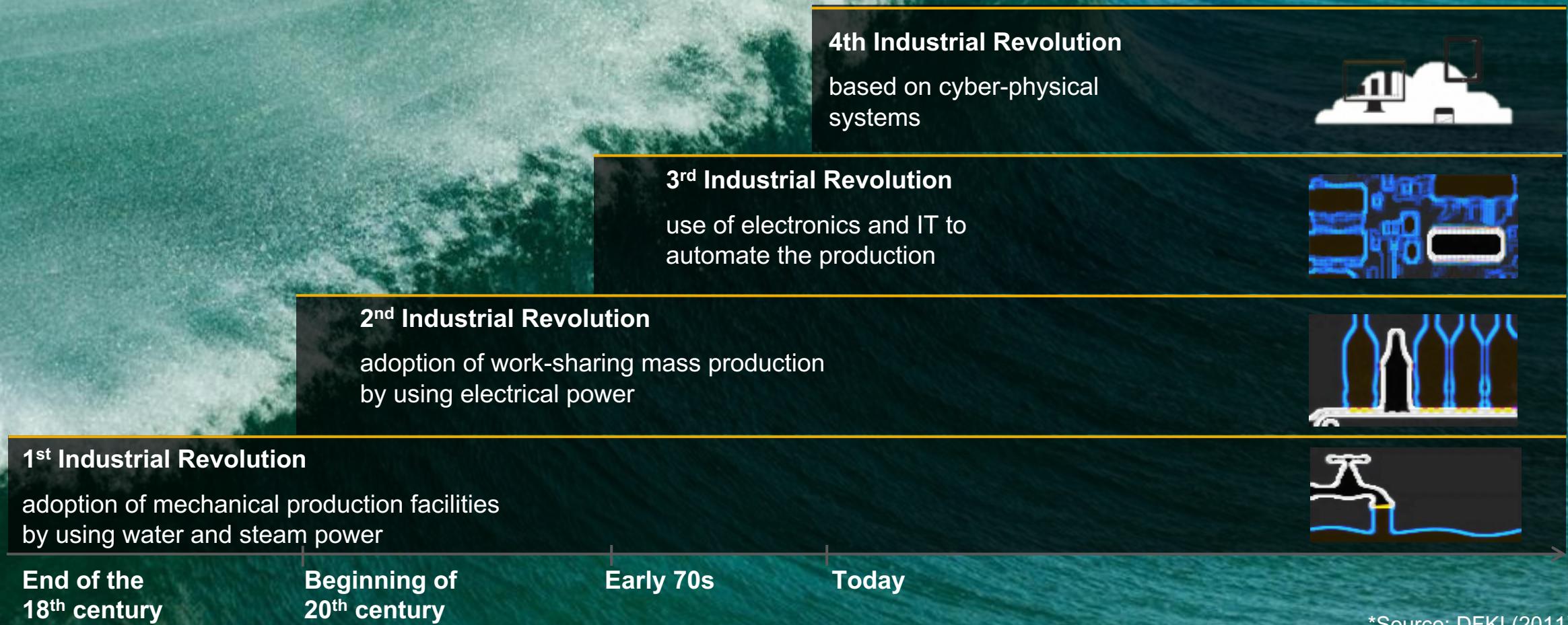


Market Value	19B \$	13B \$	>40B \$
User #	450 M	20M	50000 Drivers
Employee #	55	600	1000
Found at	2009	2008	2009

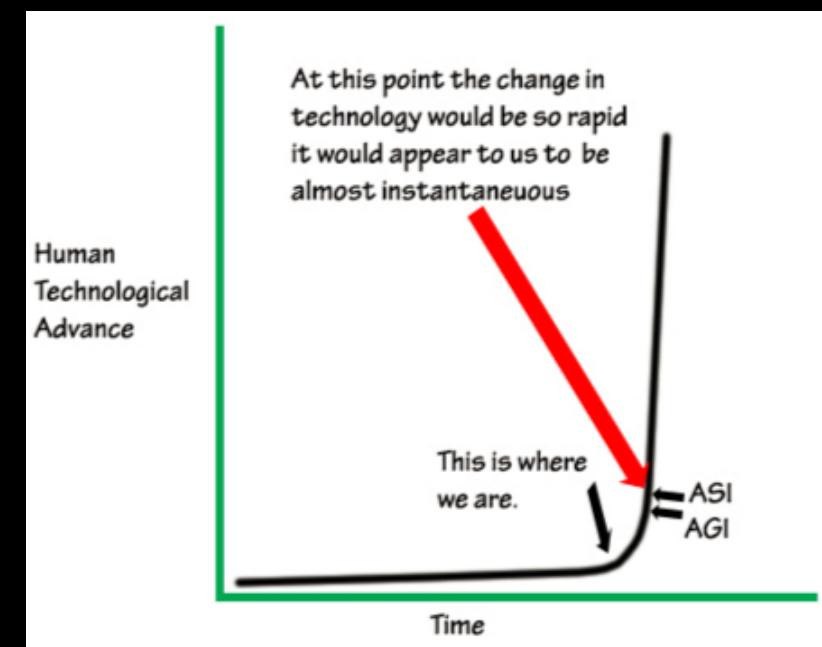
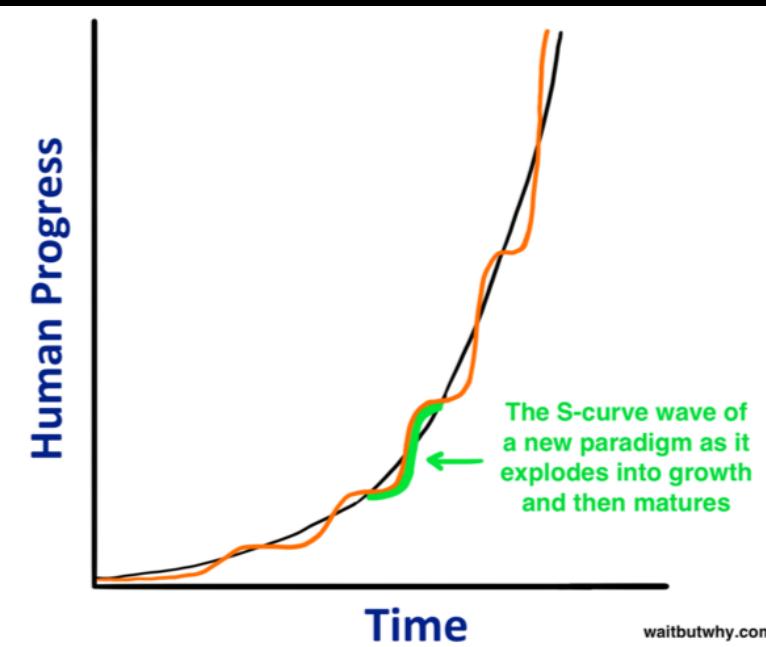
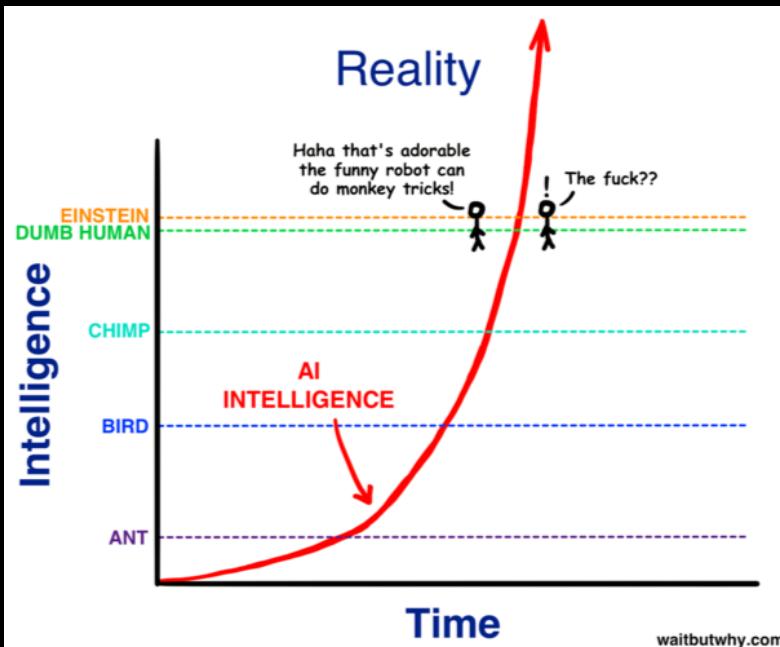
# “Technologies Drive Networked Economy



# The 4<sup>th</sup> Industrial Revolution is Changing Manufacturing

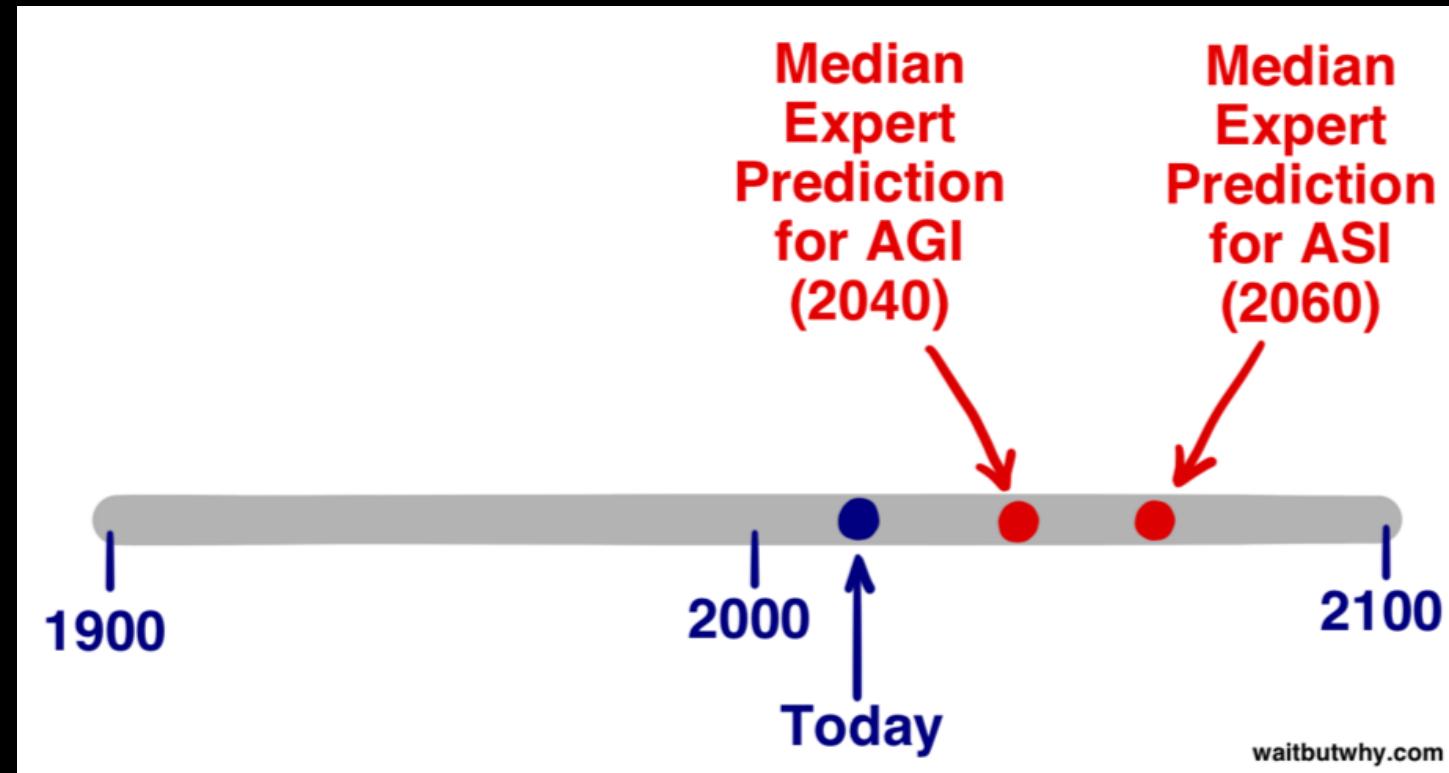


# “幂律增长”

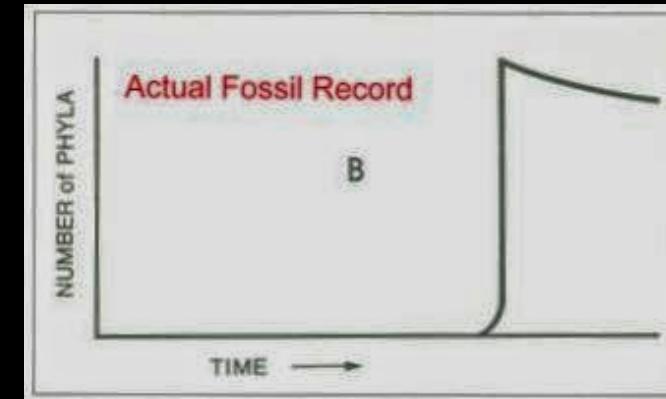
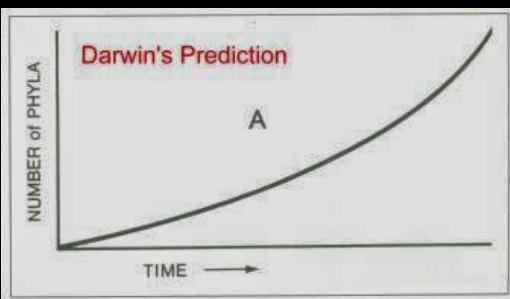
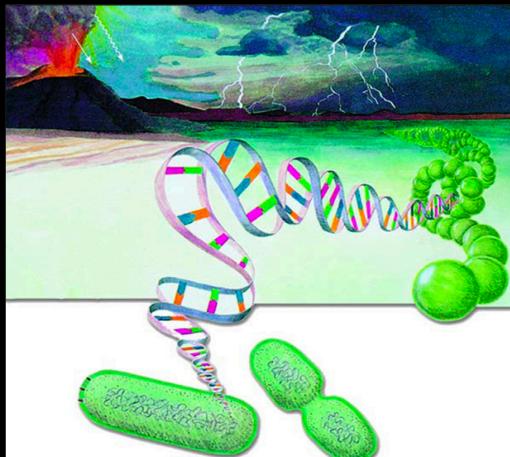


# “弱/强/超人工智能

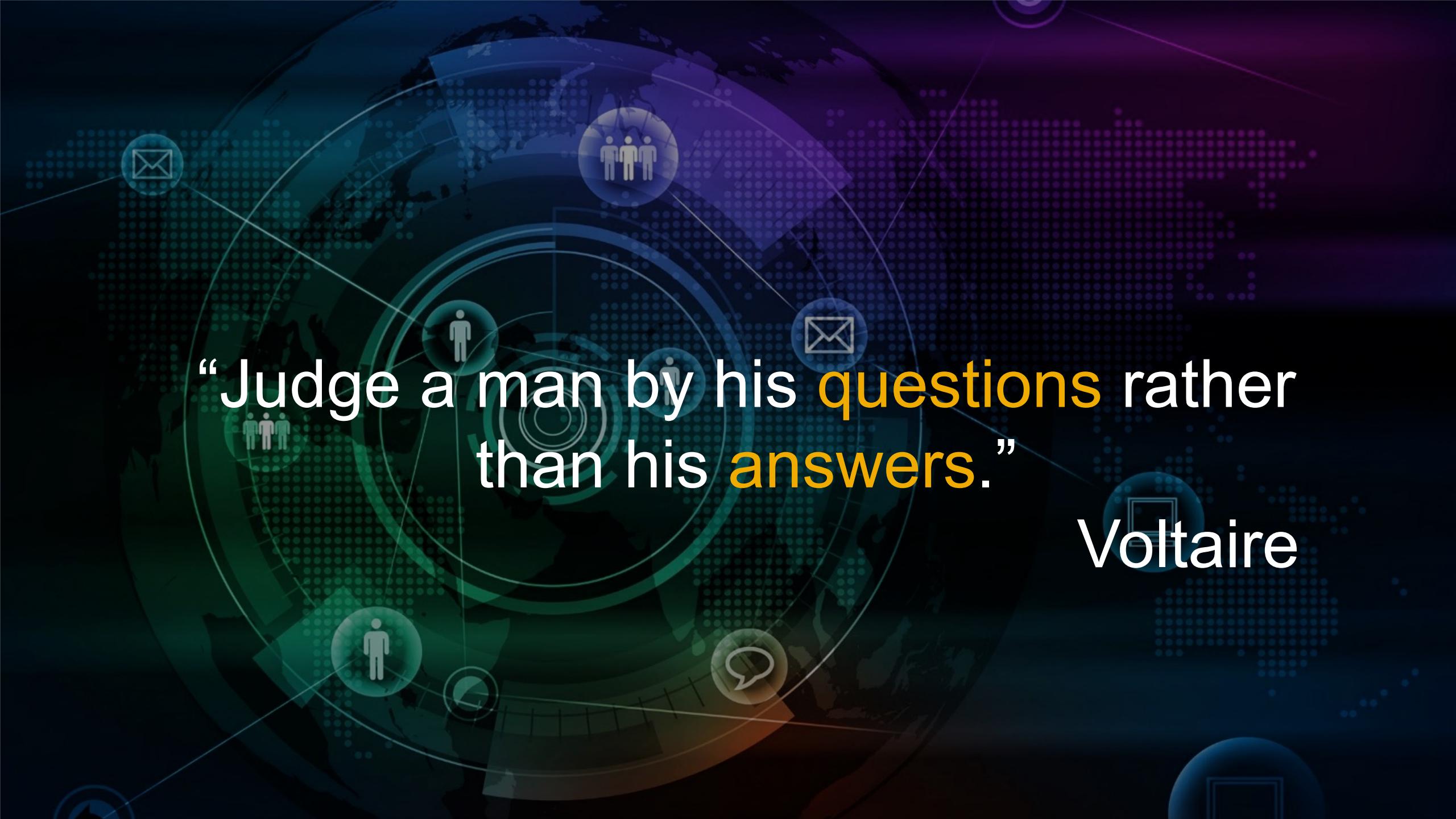
- ANI : 现在
- AGI : Human-level AI
- ASI : Super AI



# “人工智能演进



AGI : 寒武纪大爆发



“Judge a man by his **questions** rather than his **answers**.”

Voltaire

# “ Exercises Preparation

1. Python 3.6 / Anaconda
2. Numpy, pandas, Matplotlib, Scikit-learn, Tensor flow, Jupyter
3. <http://pandas.pydata.org/pandas-docs/stable/10min.html#min>
4. <http://scikit-learn.org/stable/tutorial/basic/tutorial.html>
5. [http://matplotlib.org/users/pyplot\\_tutorial.html](http://matplotlib.org/users/pyplot_tutorial.html)

# “ Exercises Preparation: conda command

1. conda create -n <env\_name> python = <ver> <list of packages>
2. source activate <env\_name>
3. conda install <package\_name>
4. conda list
5. Jupyter notebook





# Thank you!

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**对未来的最好的预测是创造未来！**

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## 未济：物不可穷也



预测未来，优化决策，采取行动，影响未来，模型迭代，周而复始，未济，物不可穷也