



Inteligencia Artificial & Machine Learning

Aplicaciones en movilidad

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Engineering The logo for Engineering, consisting of the word in a bold, dark blue sans-serif font, followed by a stylized "X" composed of several parallel diagonal lines.

Founded by the Royal Academy of Engineering
and Lloyd's Register Foundation

Inteligencia Artificial & Machine Learning para movilidad

- Objetivo
 - Introducir al estudiante a las técnicas básicas de IA como regresión lineal y logística, neuronales artificiales e identificación de patrones
- Evaluación
 - Completar el curso
 - Formulación de problema de movilidad y propuesta de solución enfocado a su región
 - Reporte técnico (mini proyecto)

Inteligencia Artificial & Machine Learning para movilidad

Perfil de salida

- Conocer las bases para la programación de aplicaciones de IA y Machine learning aplicados a proyectos de movilidad y transporte
- Conocer los distintos modelos de IA y machine learning
- Conocer las oportunidades y límites actuales de la IA y sus potenciales aplicaciones para impulsar la movilidad sustentable
- Identificar los riesgos y limitaciones de las herramientas de la IA
- Identificar potenciales fuentes de bases de datos para la programación de IA y machine learning

Inteligencia Artificial & Machine Learning para movilidad

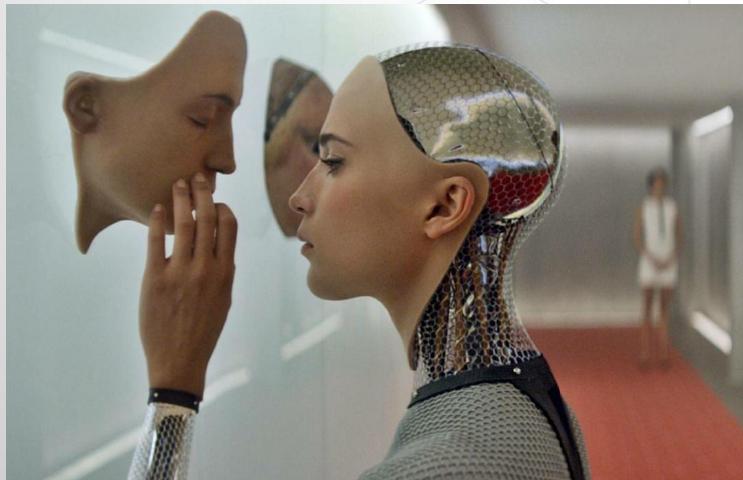
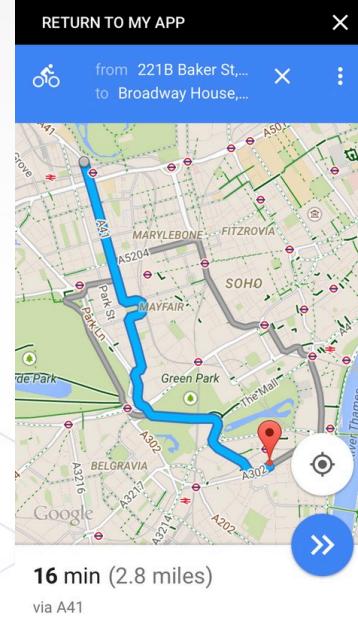
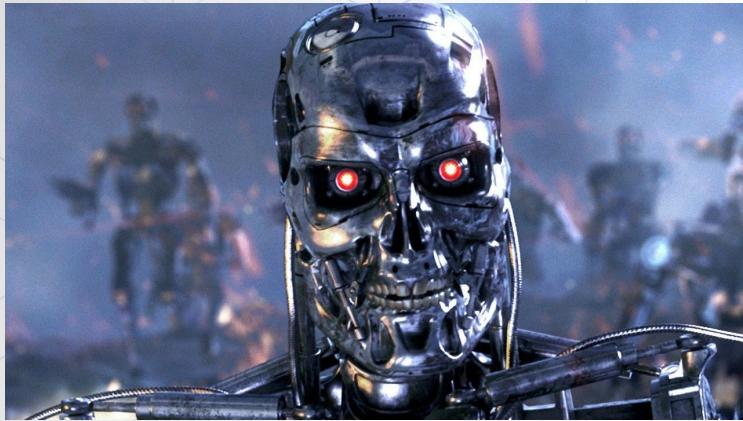
1. Conceptos básicos
2. Aprendizaje supervisado
3. Aprendizaje no supervisado
4. Retos en movilidad



Conceptos básicos



Inteligencia artificial (IA)



ChatGPT

Examples

"Explain quantum computing in simple terms" →

"Got any creative ideas for a 10 year old's birthday?" →

"How do I make an HTTP request in Javascript?" →

Capabilities

Remembers what user said earlier in the conversation
Allows user to provide follow-up corrections
Trained to decline inappropriate requests

Limitations

May occasionally generate incorrect information
May occasionally produce harmful instructions or biased content
Limited knowledge of world and events after 2021

Send a message...

ChatGPT Mar 23 Version. Free Research Preview. ChatGPT may produce inaccurate information about people, places, or facts.

¿Qué es IA?

Sistemas que PIENSAN como HUMANOS

Ciencias cognitivas

Psicología

Sistemas que ACTUAN como HUMANOS

Prueba de Turing



Requiere un sistema con:

- Procesamiento de lenguaje natural
- Representación del conocimiento
- Razonamiento automático
- Aprendizaje de Máquina
- Visión computacional
- Robotica

Sistemas que PIENSAN RACIONALMENTE

Lógica

Aristoteles. Silogismos.

Todos los metales son maleables (premisa)

El oro es un metal (premisa)

Por lo tanto, el oro es maleable (inferencia)

Sistemas que ACTUAN RACIONALMENTE

Teoría de decisiones

Bajo este enfoque, la IA es vista como el estudio y construcción de agentes/sistemas racionales (i.e. toman decisiones racionales)

¿Qué es IA?

AI has focused on the **study and construction** of **agents** that do the **right thing**

... What counts as the right thing is defined by the **objective** that we provide to the agent

¿Qué es IA?



“... una rama de la informática que se ocupa de crear sistemas que puedan realizar tareas que normalmente requieren inteligencia humana, como el *aprendizaje*, el *razonamiento*, la *percepción*, la *comprensión del lenguaje natural* y la *toma de decisiones*”

Disciplinas que han contribuido a la IA

- Filosofía
 - Aristoteles
 - Positivismo lógico
 - Ética
- Matemáticas
 - Lógica simbólica
 - Probabilidad y Estadística
- Economía
 - Teoría de juegos
 - Sistemas multiagente
- Neurociencia
 - Neuronas artificiales
 - Redes Neuronales Artificiales
- Psicología
 - Conductismo
 - Interacción persona-computadora (HCI)
- Teoría de Control y Cibernética
 - Homeostasis, retroalimentación
 - Función de costo
- Lingüística
 - Procesamiento de Lenguaje Natural (NLP)
 - Representación del conocimiento

(Breve) Historia de la IA

- Gestación (1943-1956)
 - Neurona de McCulloch-Pitts
- Entusiasmo y grandes expectativas (1952-1969)
 - Solucionador General de Problemas (Newell & Simon)
- Dosis de realidad (1966-1973)
 - Intratabilidad de los problemas
- Sistemas expertos (1969-1986)
 - Conocimientos y reglas específicos del dominio/problema

(Breve) Historia de la IA

- Regreso de redes neuronales (1986 -)
 - Re-invención / re-descubrimiento del algoritmo de retropropagación (backpropagation)
- Razonamiento probabilístico y aprendizaje de máquina (1987 -)
 - Modelos ocultos de Márkov → Aprendizaje por refuerzo
 - Redes Bayesianas
- Big data (2001 -)
 - World Wide Web
- Aprendizaje profundo (2011 -)
 - Redes neuronales convolucionales
 - GPU, TPU, FPGA

Inteligencia Artificial - Desarrollo histórico

- IBM Deep Blue
- 1996
- Ajedrez
- Análisis de posibles movimientos



Inteligencia Artificial - Desarrollo histórico

- IBM Watson
- 2013



IBM's Watson competes on US TV show Jeopardy, January 11, 2013 (Photo credit: Courtesy IBM)

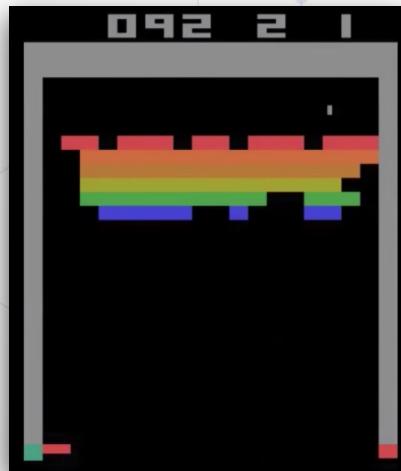
Inteligencia Artificial - Desarrollo histórico

- Nuevo regreso de redes neuronales - “deep learning”(2011- presente)
- DeepMind



DQN: Human-level control of Atari games

One of the great challenges in AI is building flexible systems that can take on a wide range of tasks. Our Deep Q-Network (DQN) surpassed the overall performance of professional players in 49 different Atari games using only raw pixels and the score as inputs.



AlphaGo defeats Lee Sedol in the game of Go

While becoming the first computer program to defeat a professional human Go player, AlphaGo taught the world new knowledge about perhaps the most studied and contemplated game in history.



Inteligencia Artificial - Desarrollo histórico

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Article | Published: 15 July 2021

This is an unedited manuscript that has been accepted for publication. Nature Research are providing this early version of the manuscript as a service to our authors and readers. The manuscript will undergo copyediting, typesetting and a proof review before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers apply.

Highly accurate protein structure prediction with AlphaFold

John Jumper , Richard Evans, [...] Demis Hassabis [Nature \(2021\)](#) | Cite this article

255k Accesses | 1 Citations | 2660 Altmetric | Metrics

<https://www.nature.com/articles/s41586-021-03819-2>

The recipes for those proteins - called genes - are encoded in our DNA

Proteins are comprised of chains of amino acids (also referred to as amino acid residues). But DNA only contains information about the *sequence* of amino acids - not how they fold into shape

Predicting how these chains will fold into the intricate 3D structure of a protein is what's known as the "protein folding problem" - a challenge that scientists have worked on for decades

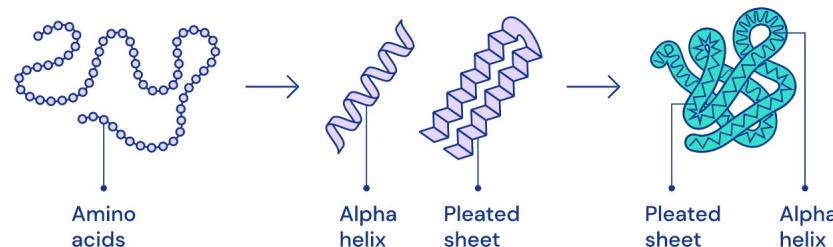


Figure 1: Complex 3D shapes emerge from a string of amino acids.

Inteligencia Artificial - Desarrollo histórico

The screenshot shows a Science magazine page. At the top, there is a navigation bar with 'Science' on the left and 'Contents', 'News', 'Careers', and 'Journals' dropdown menus on the right. Below the navigation bar is a red banner with the text 'Read our COVID-19 research and news.' In the center, there is an 'Advertisement' section featuring several small images of laptops and smartwatches with various stickers or designs on their screens.

SHARE **RESEARCH ARTICLE**

Accurate prediction of protein structures and interactions using a three-track neural network

BY Minkyung Baek^{1,2}, Frank DiMaio^{1,2}, Ivan Anishchenko^{1,2}, Justas Dauparas^{1,2}, Sergey Ovchinnikov^{3,4}, Gyu Rie Lee^{1,2}, Jue Wang^{1,2}, Qian Cong^{5,6}, Lisa N. Kinch⁷, R. Dustin Schaeffer⁶, Claudia Millán⁸, Hahnbeom Park^{1,2}, Carson Adams^{1,2}, Caleb R. Glassman^{9,10}, Andy DeGiovanni¹², Jose H. Pereira¹², Andria V. Rodrigues¹², Alberdina A. van Dijk¹³, Ana C. Ebrecht¹³, Diederik J. Opperman¹⁴, Theo Sagmeister¹⁵, Christoph Buhleller^{15,16}, Tea Pavkov-Keller^{15,17}, Manoj K. Rathinawamy¹⁸, Udit Dalwadi¹⁹, Calvin K. Yip¹⁹, John E. Burke¹⁸, K. Christopher Garcia^{9,10,11,20}, Nick V. Grishin^{6,21,7}, Paul D. Adams^{12,22}, Randy J. Read⁸, David Baker^{1,2,23,*}

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²Institute for Protein Design, University of Washington, Seattle, WA 98195, USA.
³Faculty of Arts and Sciences, Division of Science, Harvard University, Cambridge, MA 02138, USA.
⁴John Harvard Distinguished Science Fellowship Program, Harvard University, Cambridge, MA 02138, USA.
⁵Eugene McDermott Center for Human Growth and Development, University of Texas Southwestern Medical Center, Dallas, TX, USA.

<https://science.sciencemag.org/content/early/2021/07/19/science.abj8754>

Inteligencia Artificial - Desarrollo histórico

DALL-E 2

DALL-E 2 is an AI system that can create realistic images and art from a description in natural language.

Input

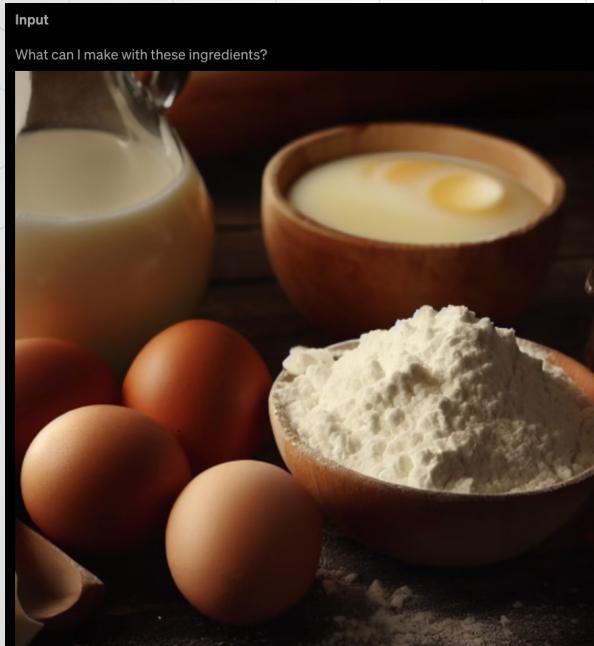
An astronaut riding a horse in photorealistic style.

Output



Inteligencia Artificial - Desarrollo histórico

GPT-4 can solve difficult problems with greater accuracy, thanks to its broader general knowledge and problem solving abilities.

**Output**

There are many options for what you can make with these ingredients! Some possibilities include:

- Pancakes or waffles
- Crepes
- French toast
- Omelette or frittata
- Quiche
- Custard or pudding
- Cake or cupcakes
- Muffins or bread- Cookies or biscuits

User What is funny about this image? Describe it panel by panel.



GPT-4 The image shows a package for a "Lightning Cable" adapter with three panels.

Panel 1: A smartphone with a VGA connector (a large, blue, 15-pin connector typically used for computer monitors) plugged into its charging port.

Panel 2: The package for the "Lightning Cable" adapter with a picture of a VGA connector on it.

Panel 3: A close-up of the VGA connector with a small Lightning connector (used for charging iPhones and other Apple devices) at the end.

The humor in this image comes from the absurdity of plugging a large, outdated VGA connector into a small, modern smartphone charging port.

Inteligencia Artificial - Desarrollo histórico



GPT-4 Developer Livestream

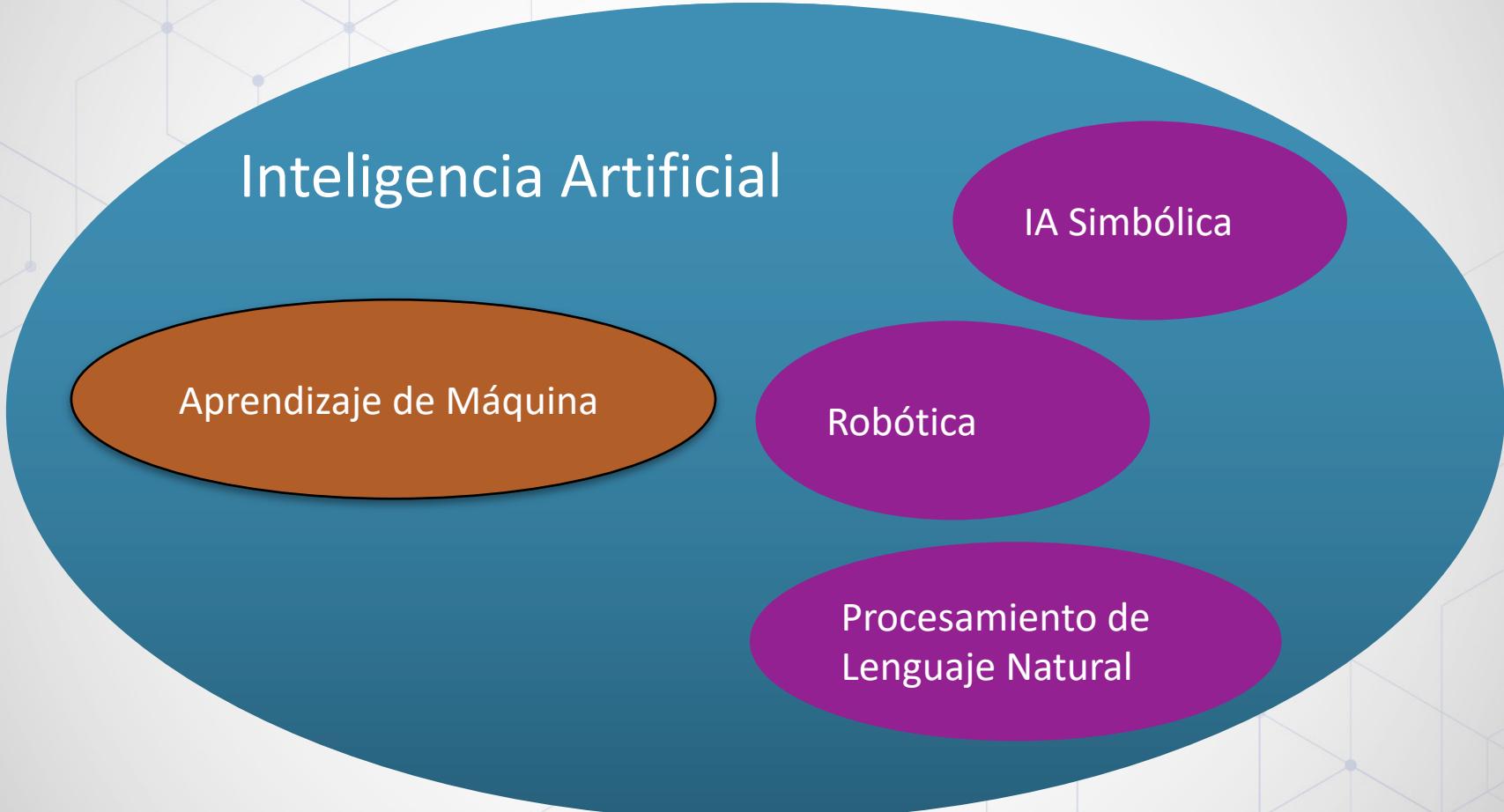
The stream will begin in:

00:00:03

<https://www.youtube.com/watch?v=outcGtbnMuQ>

Aprendizaje de Máquina

Aprendizaje de Máquina



Aprendizaje de Máquina

- Aprendizaje Automático / Machine learning
- “machine learning is concerned with the question of how to construct computer programs that automatically improve with experience”¹
- “we define machine learning as a set of methods that can automatically detect patterns in data, and then use the uncovered patterns to predict future data, or to perform other kinds of decision making under uncertainty (such as planning how to collect more data!)”²

¹Mitchell, T. M. (1997). Machine Learning. McGraw-Hill, New York.

²Murphy, K. P. (2012). Machine Learning: a Probabilistic Perspective. MIT Press, Cambridge, MA, USA.

Principales paradigmas

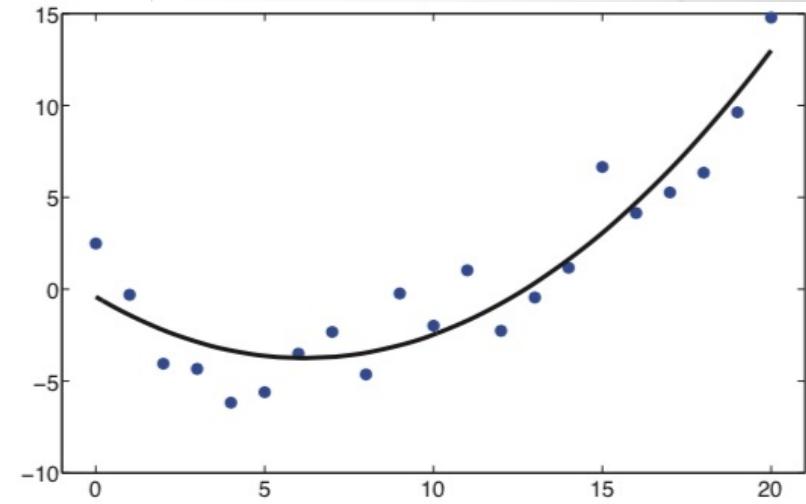
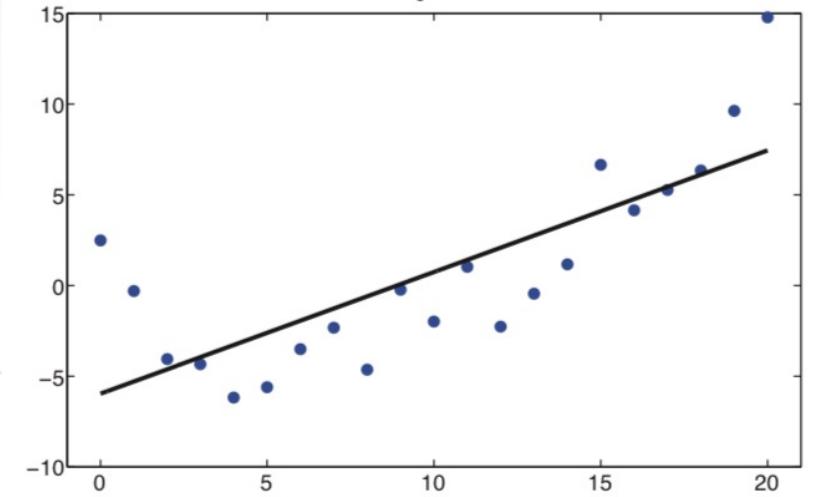
- Aprendizaje Supervisado
- Aprendizaje No Supervisado
- Aprendizaje por Refuerzo (Reforzado)
- Aprendizaje Profundo

Aprendizaje Supervisado

- Predicción
 - Regresión
 - Clasificación
 - Regresión
 - Crear un modelo para poder predecir un valor futuro dados los datos del pasado (datos de entrenamiento)
 - Se usan por ejemplo, árboles de regresión, regresión lineal, redes neuronales, etc.

Regresión

- Predecir el precio del mercado de valores de mañana dadas las condiciones actuales del mercado
- Predecir la edad de un espectador que ve un video determinado en YouTube



Regresión

	0	1	2	3	4	5	6	7	8	9		0
0	0.0380759	0.0506801	0.0616962	0.0218724	-0.0442235	-0.0348208	-0.0434008	-0.002592...	0.0199075	-0.0176461	0	151
1	-0.001882...	-0.0446416	-0.0514741	-0.0263275	-0.008448...	-0.0191633	0.0744116	-0.0394934	-0.0683315	-0.092204	1	75
2	0.0852989	0.0506801	0.0444512	-0.005670...	-0.0455995	-0.0341945	-0.0323559	-0.002592...	0.00286131	-0.0259303	2	141
3	-0.0890629	-0.0446416	-0.011595	-0.0366561	0.0121906	0.0249906	-0.0360376	0.0343089	0.0226877	-0.009361...	3	206
4	0.00538306	-0.0446416	-0.0363847	0.0218724	0.00393485	0.0155961	0.00814208	-0.002592...	-0.0319876	-0.0466409	4	135
5	-0.0926955	-0.0446416	-0.0406959	-0.0194418	-0.0689906	-0.0792878	0.0412768	-0.0763945	-0.0411762	-0.0963462	5	97
6	-0.0454725	0.0506801	-0.0471628	-0.015999	-0.0400956	-0.0248	0.0007788...	-0.0394934	-0.0629169	-0.0383567	6	138
7	0.0635037	0.0506801	-0.001894...	0.0666294	0.0906199	0.108914	0.0228686	0.0177034	-0.0358162	0.00306441	7	63
8	0.0417084	0.0506801	0.0616962	-0.0400989	-0.0139525	0.00620169	-0.0286743	-0.002592...	-0.0149597	0.0113486	8	110
9	-0.0709002	-0.0446416	0.0390622	-0.0332132	-0.0125766	-0.0345076	-0.0249927	-0.002592...	0.0677371	-0.013504	9	310
10	-0.096328	-0.0446416	-0.0838084	0.00810098	-0.103389	-0.0905612	-0.0139477	-0.0763945	-0.0629169	-0.0342146	10	101
11	0.0271783	0.0506801	0.0175059	-0.0332132	-0.007072...	0.0459715	-0.0654907	0.07121	-0.0964349	-0.0590672	11	69
12	0.0162807	-0.0446416	-0.02884	-0.009113...	-0.004320...	-0.009768...	0.0449585	-0.0394934	-0.0307479	-0.0424988	12	179
13	0.00538306	0.0506801	-0.001894...	0.00810098	-0.004320...	-0.0157187	-0.002902...	-0.002592...	0.0383939	-0.013504	13	185
14	0.045341	-0.0446416	-0.0256066	-0.0125561	0.0176944	-6.12836e...	0.0817748	-0.0394934	-0.0319876	-0.0756356	14	118
15	-0.0527376	0.0506801	-0.0180619	0.0804009	0.0892439	0.107662	-0.0397192	0.108111	0.0360603	-0.0424988	15	171
16	-0.005514...	-0.0446416	0.0422956	0.0494152	0.0245741	-0.0238606	0.0744116	-0.0394934	0.052277	0.0279171	16	166
17	0.0707688	0.0506801	0.0121169	0.0563009	0.0342058	0.0494162	-0.0397192	0.0343089	0.027364	-0.0010777	17	144
18	-0.0382074	-0.0446416	-0.0105172	-0.0366561	-0.0373437	-0.0194765	-0.0286743	-0.002592...	-0.0181137	-0.0176461	18	97
19	-0.0273098	-0.0446416	-0.0180619	-0.0400989	-0.002944...	-0.0113346	0.0375952	-0.0394934	-0.0089434	-0.0549251	19	168
20	-0.049105	-0.0446416	-0.0568631	-0.0435418	-0.0455995	-0.0432758	0.0007788...	-0.0394934	-0.0118969	0.0154907	20	68
21	-0.0854304	0.0506801	-0.0223731	0.00121528	-0.0373437	-0.0263658	0.0155054	-0.0394934	-0.0721328	-0.0176461	21	49

Clasificación



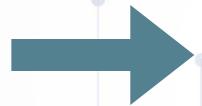
Imágenes de entrenamiento

Agente/sistema inteligente

Perro

Clasificación

Nueva imagen

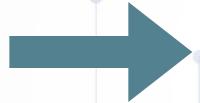


Agente/sistema inteligente



Clasificación

Nueva imagen

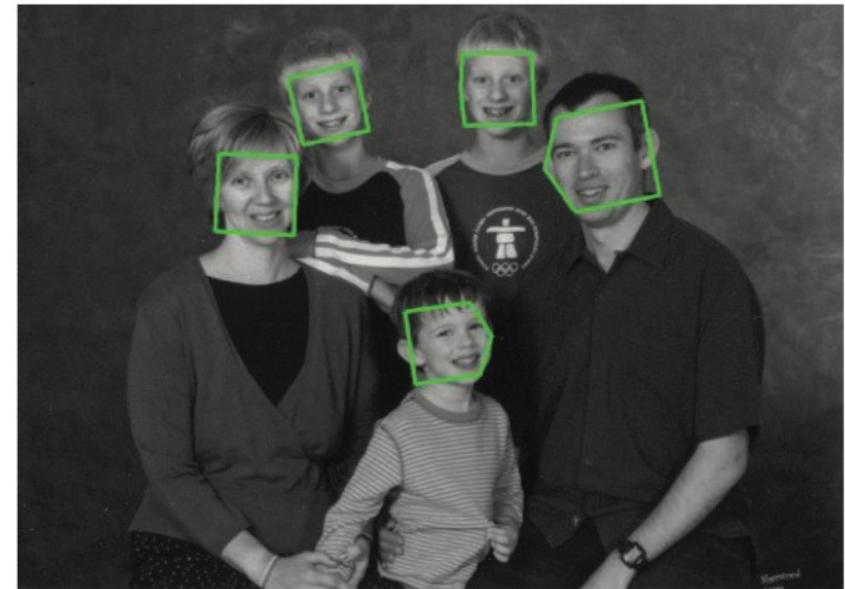


Agente/sistema inteligente



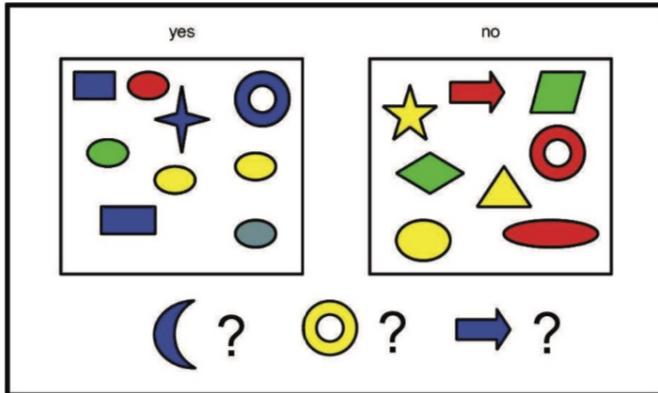
Perro

Clasificación



<https://github.com/probml/pml-book>

Clasificación



(a)

The diagram illustrates the representation of training data as a matrix. It shows a table with N rows (cases) and D columns (features). The last column represents the label. A double-headed arrow indicates the width of the matrix represents D features (attributes), and another double-headed arrow indicates the height represents N cases.

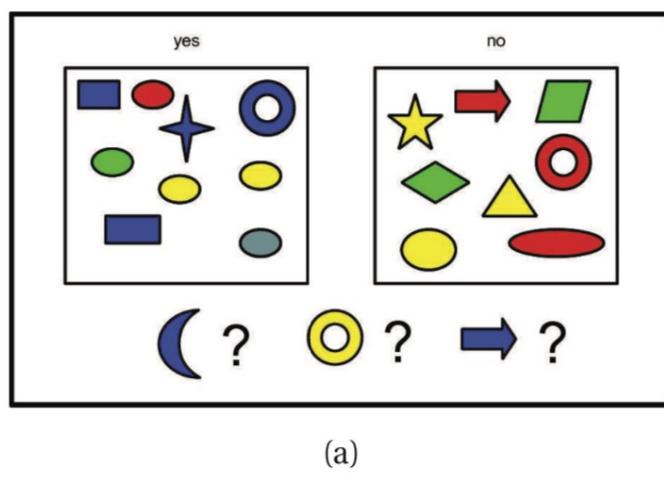
Color	Shape	Size (cm)	Label
Blue	Square	10	1
Red	Ellipse	2.4	1
Red	Ellipse	20.7	0

(b)

Figure 1.1 Left: Some labeled training examples of colored shapes, along with 3 unlabeled test cases. Right: Representing the training data as an $N \times D$ design matrix. Row i represents the feature vector \mathbf{x}_i . The last column is the label, $y_i \in \{0, 1\}$. Based on a figure by Leslie Kaelbling.

Aprendizaje No Supervisado

- Datos "crudos"
- No hay clases predefinidas



D features (attributes)

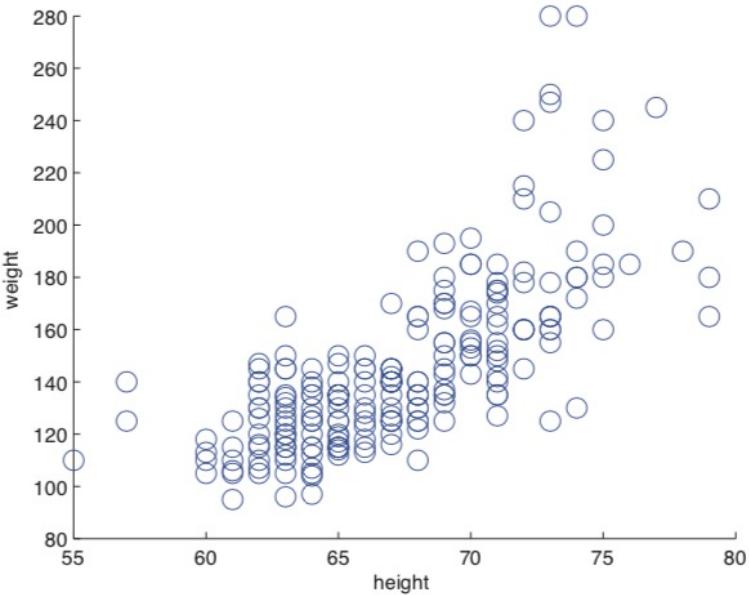
Color	Shape	Size (cm)
Blue	Square	10
Red	Ellipse	2.4
Red	Ellipse	20.7

N cases

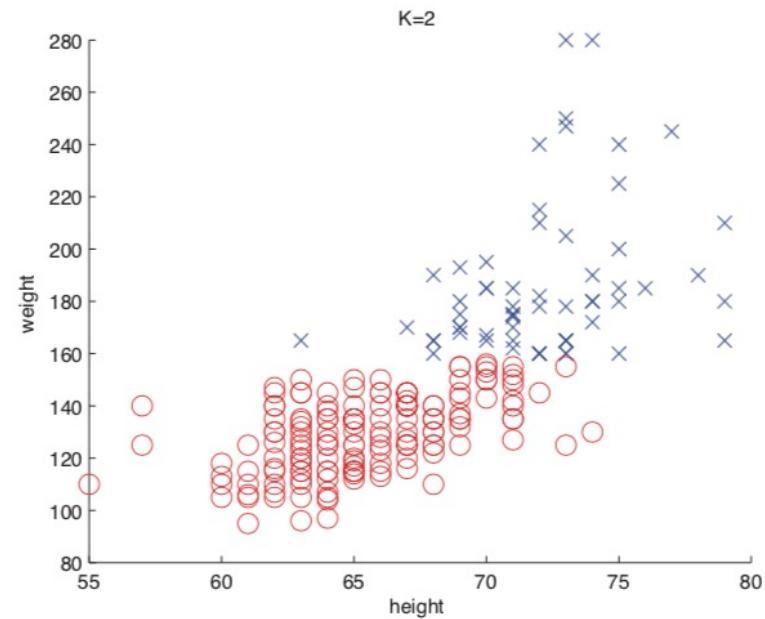
(b)

- Descubrir una "estructura interesante" en los datos; esto a veces se llama descubrimiento de conocimiento

Aprendizaje No Supervisado



(a)



(b)

Aprendizaje No Supervisado



inferring hierarchies from sequences

Simple C++

Full C++

Java

JavaScript

Object Pascal

Description

Publication

Sequitur is a method for inferring compositional hierarchies from strings. It detects repetition and factors it out of the string by forming rules in a grammar. The rules can be composed of non-terminals, giving rise to a hierarchy. It is useful for recognizing lexical structure in strings, and excels at very long sequences.

Please Porridge | Genesis | Green Eggs & Ham

Sequitur is a method for inferring compositional hierarchies from strings. It detects repetition and factors it out of the string by forming rules in a grammar. The rules can be composed of non-terminals, giving rise to a hierarchy. It is useful for recognizing lexical structure in strings, and excels at very long sequences.

Craig Nevill-Manning, Google
Ian Witten, University of Waikato, New Zealand

```
0 → S 1 2 u 3 4 _ m 5 h o 6 o 3 n f 7 8 9 10 11 12 13 14 f r 15 16 s 17 d 5 e 18 19 20 p 5 10 21 6 a 18 22 19 2 23 u 24 o 25 t 26 16  
27 y 28 m 29 30 31 32 33 r a m m 34 35 T 26 30 36 n 27 e 9 e d 23 25 n 37 - t 7 m 31 11 38 33 i v 29 39 40 e _ t o 32 12 h y 17 40 -  
u s e f 41 28 39 e c o g n i z 29 42 43 i 36 l 44 u 18 u 20 45 n 44 29 38 21 d _ 43 46 l 4 24 v 7 y 42 37 g 47 1 e n 46 s .  
1 → e q u equ  
2 → i t it  
3 → r 45 r.i  
4 → 19 a s.a  
5 → e t et  
6 → d 48 d.f  
7 → e r er  
8 → r 29 ring  
9 → _ c 15 p o s _compos  
10 → 2 i 37 ition  
11 → a l al  
12 → _ 13 7 34 c _hierarc  
13 → h i hi  
14 → e 19 es._  
15 → o m om  
16 → 49 8 _string  
17 → 35 I 24 ..It._  
18 → c t ct  
19 → s _ s._  
20 → r e re  
21 → 32 n _an  
22 → o r or  
23 → _ o _o  
24 → t _ t._  
25 → f _ f._  
26 → h e he  
27 → _ h h
```

<http://www.sequitur.info/>

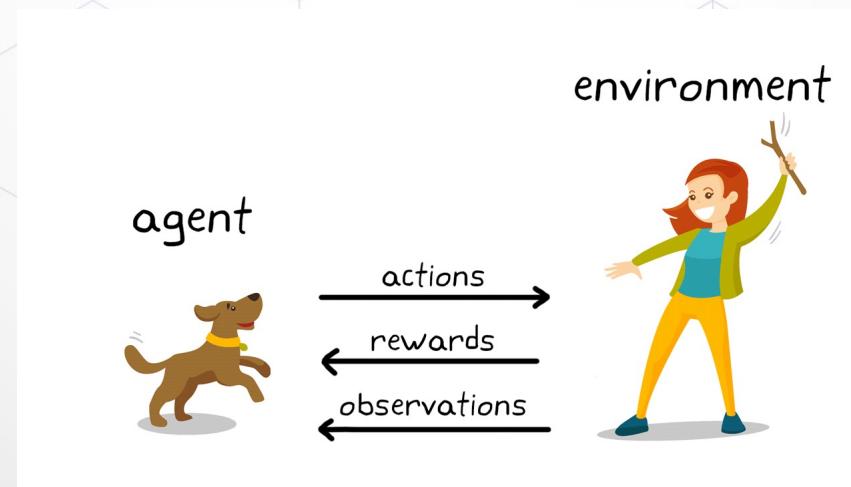
Aprendizaje No Supervisado

- Aplicaciones:

- En astronomía, el sistema de autoclases (Cheeseman et al. 1988) descubrió un nuevo tipo de estrella, basado en mediciones astrofísicas agrupadas.
- En el comercio electrónico, es común agrupar a los usuarios en grupos, según su comportamiento de compra o navegación web, y luego enviar publicidad dirigida personalizada a cada grupo

Aprendizaje por Refuerzo

- El agente o sistema inteligente aprende a través de la interacción con el ambiente en el que se desempeña
- En aprendizaje por refuerzo (RL) el objetivo es aprender cómo mapear situaciones (estados) a acciones para maximizar una cierta señal de recompensa (positiva o negativa)
- Por ejemplo, cuando las personas aprenden a andar en bicicleta



Aprendizaje por Refuerzo

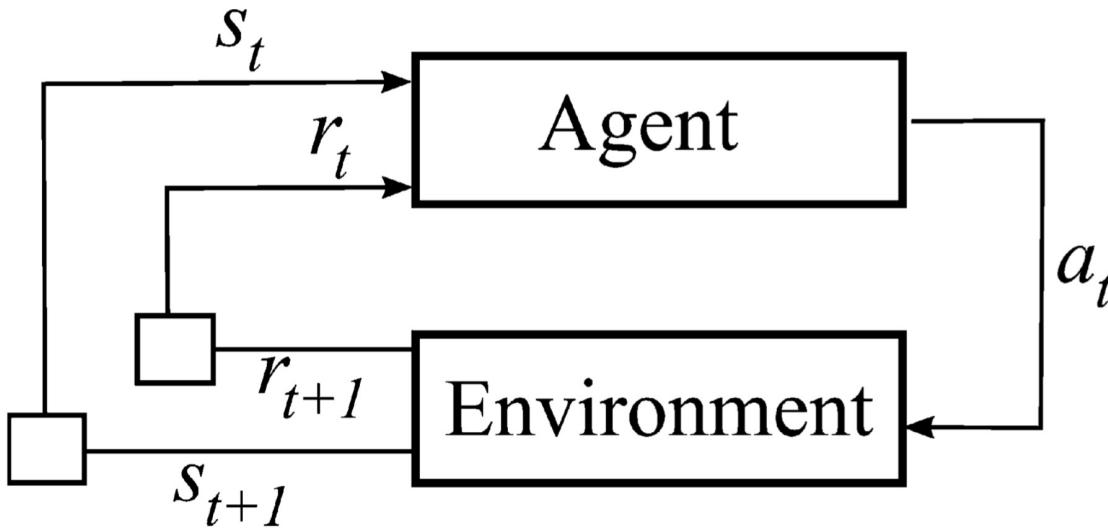
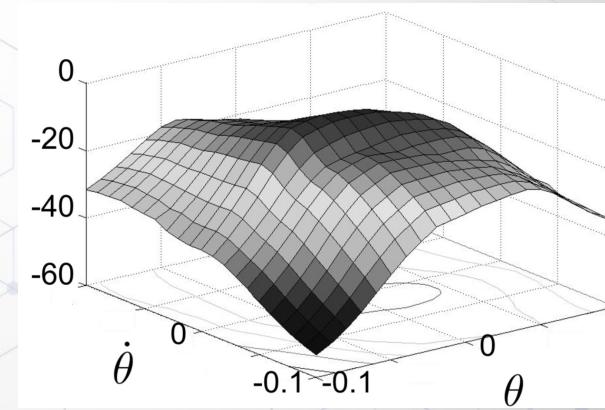


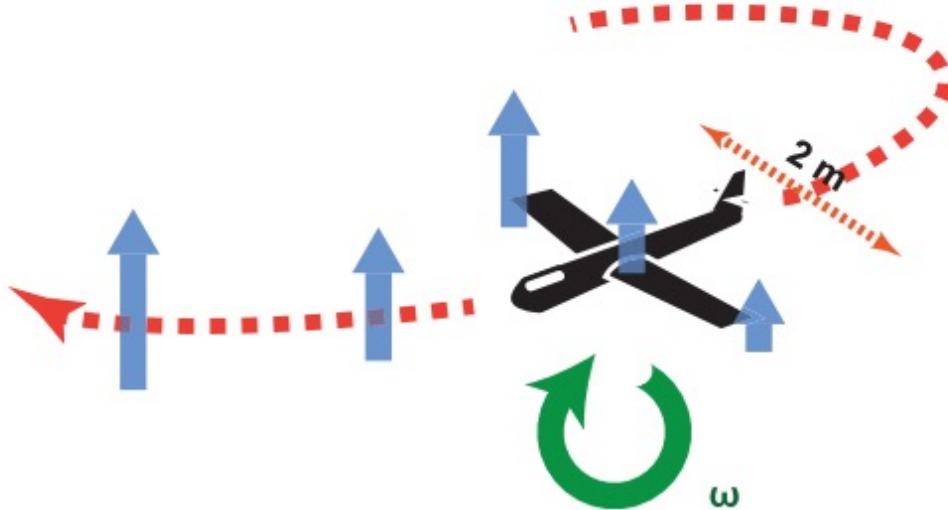
Fig. 7. Agent–environment interaction.



Razo-Zapata, I. S., Castañón, G., & Mex-Perera, C. (2014). Self-healing in transparent optical packet switching mesh networks: A reinforcement learning perspective. *Computer Networks*, 60, 129-146.

Aprendizaje por Refuerzo

- Aplicaciones
 - Sistemas de recomendación, energía, finanzas, salud, robótica y transporte (vehículos voladores autónomos)



Letter | Published: 19 September 2018

Glider soaring via reinforcement learning in the field

Gautam Reddy, Jerome Wong-Ng, Antonio Celani, Terrence J. Sejnowski & Massimo Vergassola [Cite this article](#)

Nature 562, 236–239 (2018) | [Cite this article](#)

14k Accesses | 76 Citations | 411 Altmetric | [Metrics](#)

Aprendizaje Profundo

- Siguiente paso en Redes Neuronales

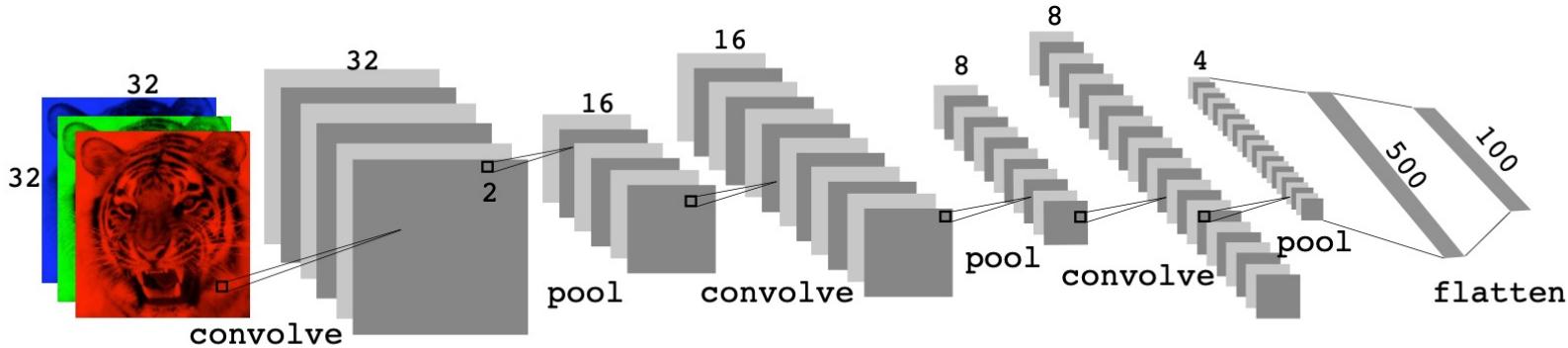


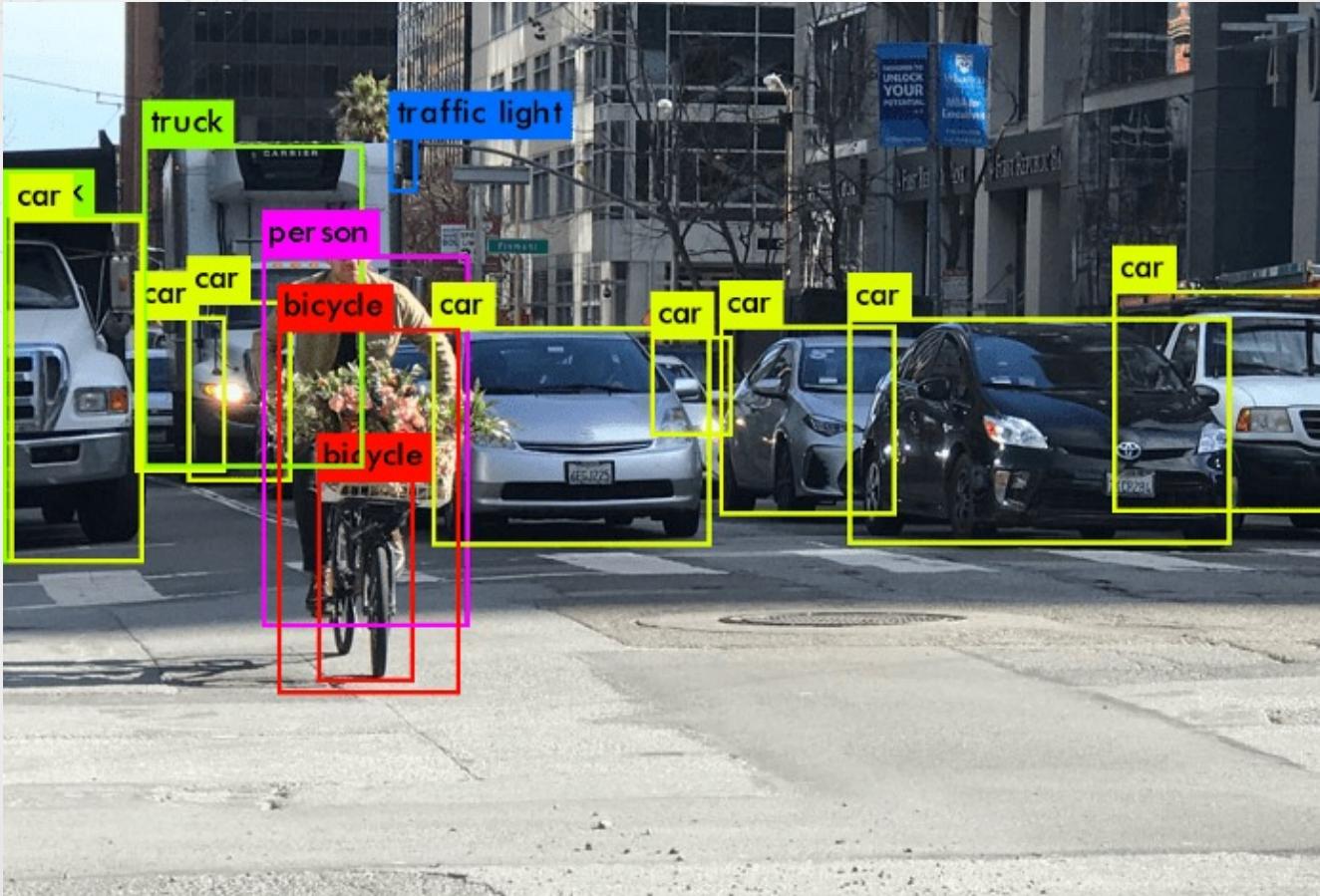
FIGURE 10.8. Architecture of a deep CNN for the CIFAR100 classification task. Convolution layers are interspersed with 2×2 max-pool layers, which reduce the size by a factor of 2 in both dimensions.



Aplicaciones en Movilidad



Visión Computacional / Computer Vision



Procesamiento de Lenguaje Natural / Natural Language Processing

- Human-vehicle interaction



<https://www.volksvagen-newsroom.com/en/press-releases/enhanced-power-and-speed-volkswagen-takes-voice-control-in-the-golf-to-a-new-level-7698>

Mantenimiento Predictivo / Predictive Maintenance

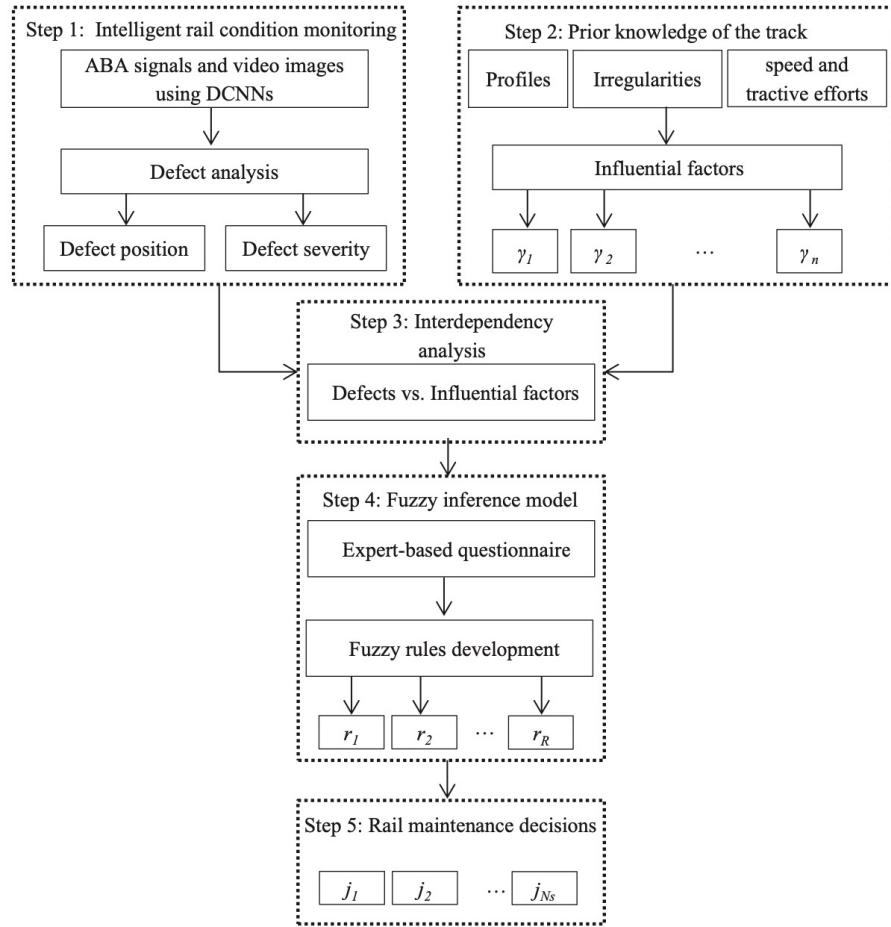


Fig. 1. Flowchart of the proposed methodology.



Fig. 9. Schematic track map between two stations, Amersfoort and Weert.

Modelado de Tráfico

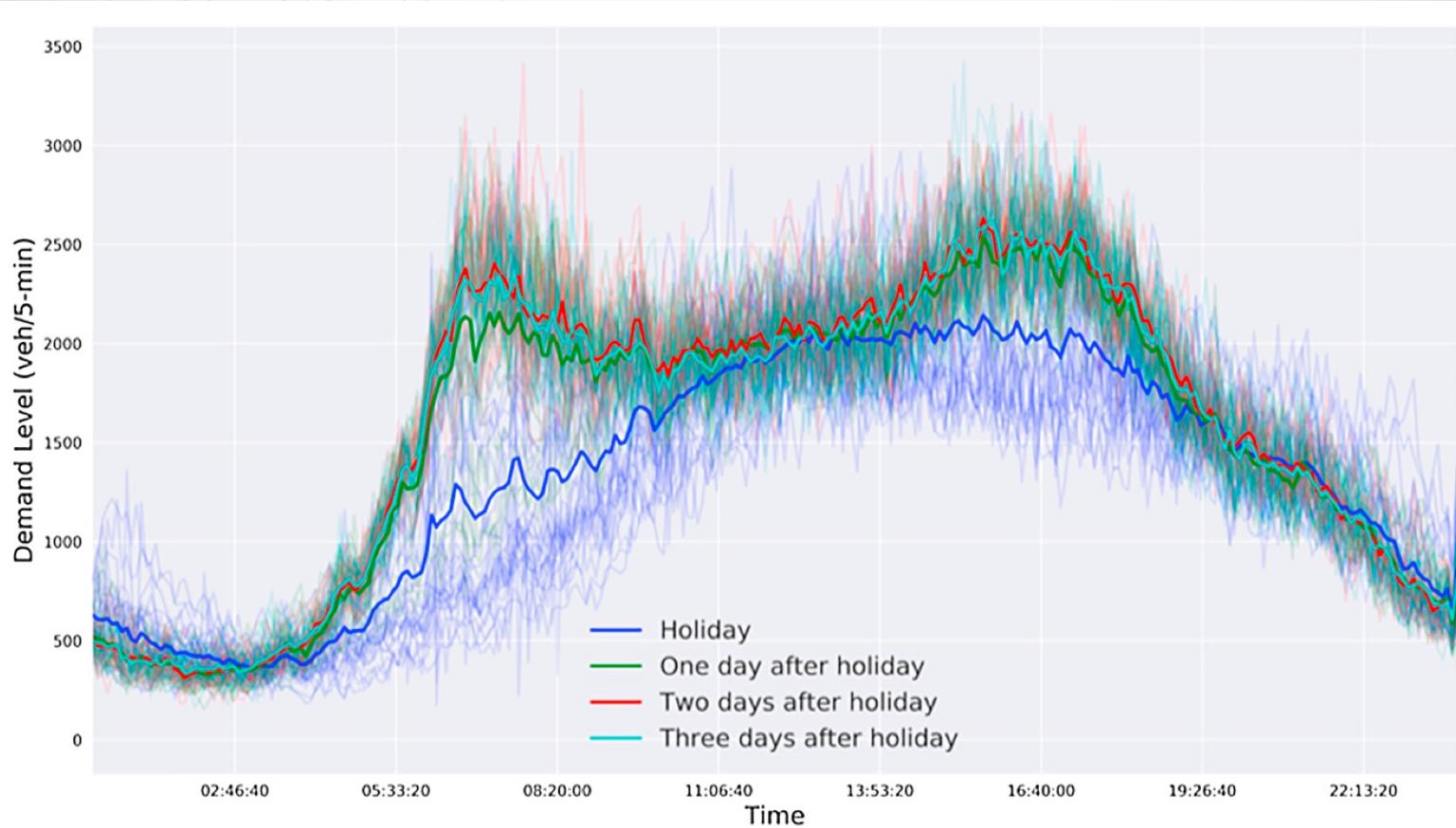


Fig. 18. Aggregated OD demand, on holidays and on weekdays immediately after holidays.

Ma, Wei, and Zhen Sean Qian. "Estimating multi-year 24/7 origin-destination demand using high-granular multi-source traffic data." *Transportation Research Part C: Emerging Technologies* 96 (2018): 96-121.

Cambio climático

- Enabling low-carbon options

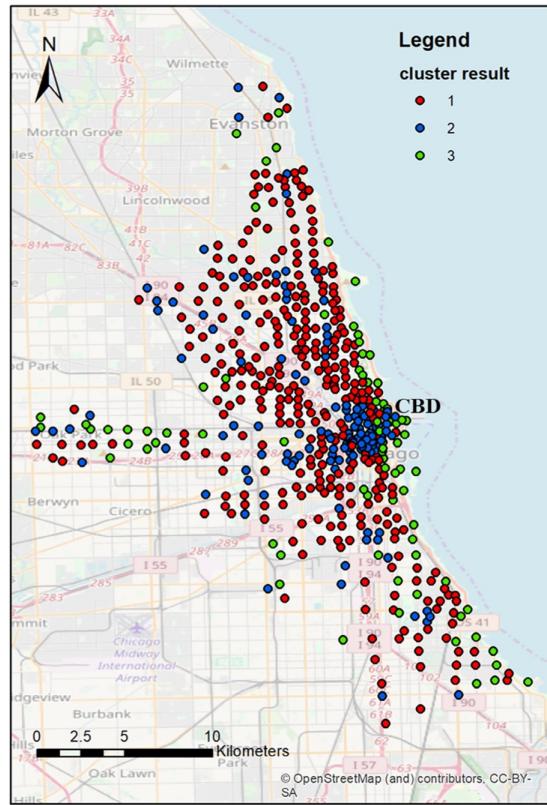


Fig. 2. Divvy PBS stations, by station-cluster, overlaid on a map of Chicago.

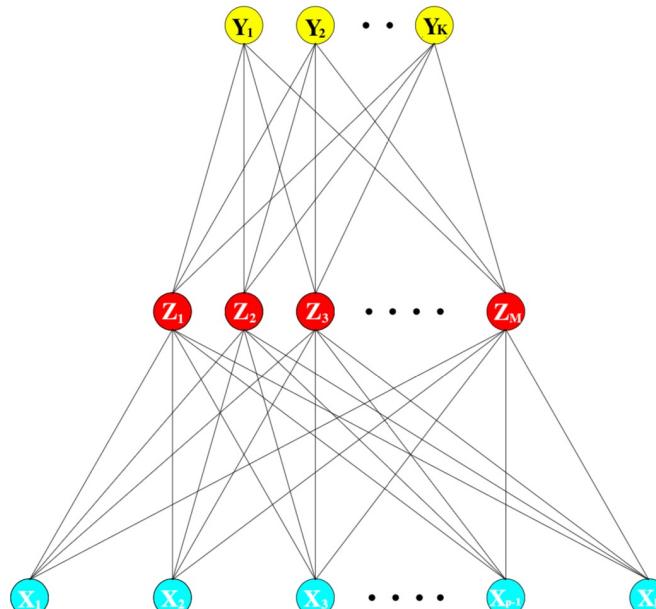
Table 3
Summary Statistics for Station Clusters.

Variable	Cluster 1 Stations			Cluster 2 Stations			Cluster 3 Stations		
	Mean	Median	Std. Dev	Mean	Median	Std. Dev	Mean	Median	Std. Dev
Log (Trip Count)	5.4	5.6	1.4	6.1	6.4	1.4	5.7	6.0	2.1
Age 25–44	0.59	0.60	0.11	0.60	0.59	0.13	0.53	0.54	0.10
Bachelor's Degree	0.52	0.59	0.25	0.60	0.62	0.23	0.58	0.69	0.25
Labor Force Participation	0.73	0.75	0.12	0.73	0.73	0.14	0.71	0.71	0.09
Family	0.44	0.40	0.16	0.40	0.39	0.16	0.39	0.33	0.17
Mean Income	84.7	76.4	41.1	102.3	107.6	36.8	92.0	100.8	47.1
Population Density	8.1	7.9	4.8	6.5	5.0	5.1	7.9	6.4	5.0
Drive	0.42	0.52	0.11	0.35	0.34	0.13	0.39	0.33	0.13
Transit	0.32	0.31	0.12	0.25	0.21	0.12	0.29	0.29	0.13
Employees	22.7	24.3	13.8	42.0	35.0	33.5	33.2	25.1	28.8
Businesses	1413	1334	586	1621	1671	728	1463	1215	926
Homicides	16	12	16.3	14.7	12	13.2	16.2	6	21.4
Bike Route Length	6.8	6.2	4.3	7.9	8.1	4.1	11.1	13.3	6.3
Nearest Rail Station	0.67	0.65	0.39	0.54	0.42	0.45	0.81	0.77	0.52
Transit Stops	208	201	48	292	263	86	197	187	80
Train Stations	5.2	5	2.9	7.3	8	3.7	4.4	3	3.1
Restaurants	10.1	9	6.7	12.2	14	7.9	10.1	8	8.3
Museums	1.05	0	1.81	2.02	1	2.51	1.95	1	2.43
Parks	2.04	1	2.5	2.67	2	2.7	2.7	2	2.3
Nearby PBS Stations 4.8 km	140	144	59	164	182	56	127	147	59
Nearby PBS Stations 0.8 km	6.4	6	3.9	12.0	9	7.8	6.6	5	5.4
Capacity Nearby PBS Stations 4.8 km	2496	2448	1196	3052	3326	1202	2377	2677	1270
Capacity Nearby PBS Stations 0.8 km	110	94	89	266	166	213	138	92	133
Station Capacity	15.9	15	3.3	20.3	19	6.4	20.2	19	7.7
Current Station Age	20.9	20	10.7	21.8	21	11.0	20.2	19	11.2
CBD Distance	6.6	6.1	3.6	4.1	2.4	3.9	5.7	4.7	4.2

Hyland, Michael, et al. "Hybrid cluster-regression approach to model bikeshare station usage." *Transportation Research Part A: Policy and Practice* 115 (2018): 71-89.

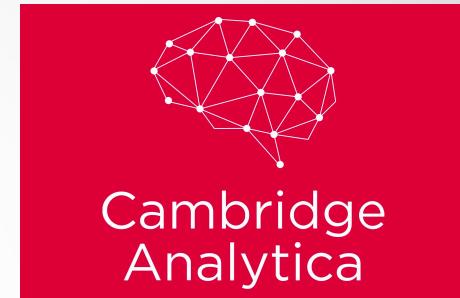
Retos actuales

- Explainable AI (XAI)
- Métodos y técnicas en la aplicación de la tecnología de inteligencia artificial (IA) de tal manera que los humanos puedan entender los resultados de la solución

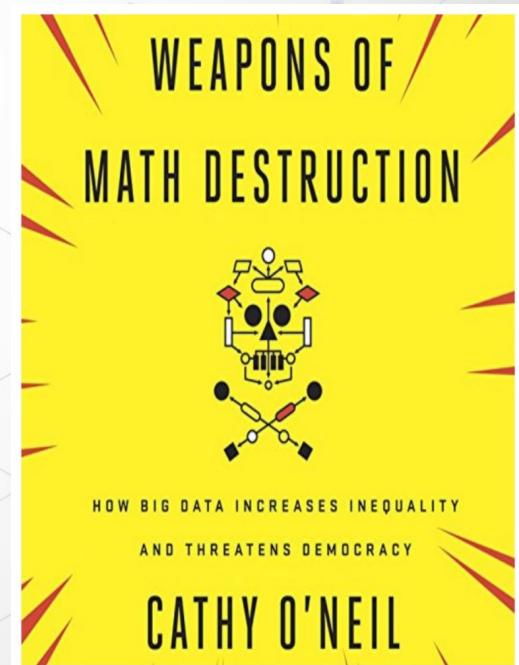


Retos actuales

- Uso ético
- Privacidad
- Veracidad
- Responsabilidad (Accountability)

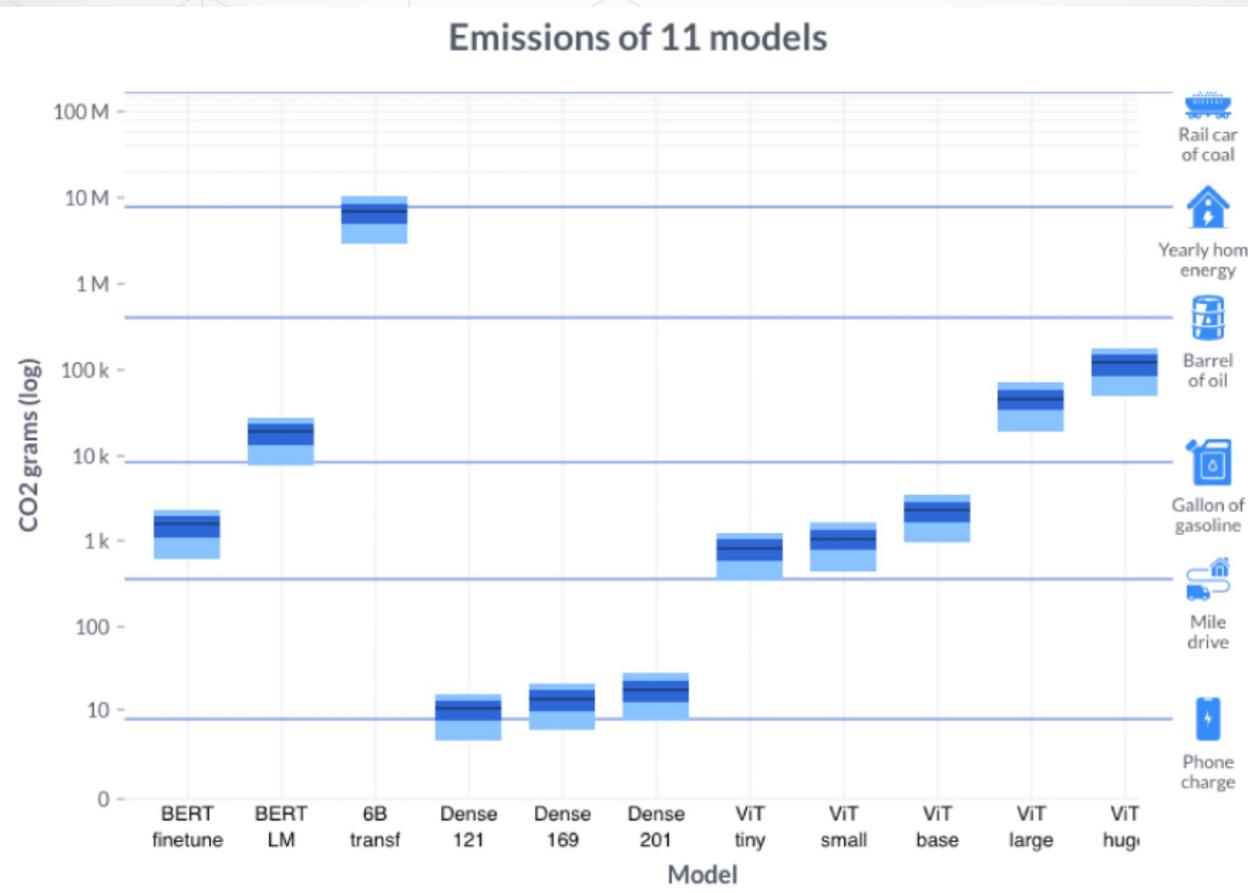


Cambridge
Analytica



Retos actuales

- Consumo de electricidad





Herramientas



Software

- Python
- Numpy
- Pandas
- Scikit-learn

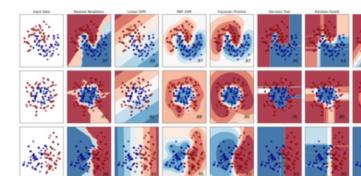


Classification

Identifying which category an object belongs to.

Applications: Spam detection, image recognition.

Algorithms: SVM, nearest neighbors, random forest, and more...



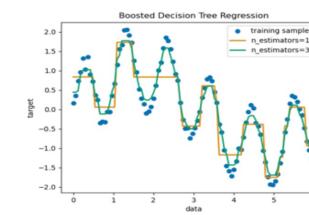
Examples

Regression

Predicting a continuous-valued attribute associated with an object.

Applications: Drug response, Stock prices.

Algorithms: SVR, nearest neighbors, random forest, and more...



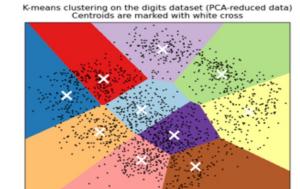
Examples

Clustering

Automatic grouping of similar objects into sets.

Applications: Customer segmentation, Grouping experiment outcomes

Algorithms: k-Means, spectral clustering, mean-shift, and more...



Examples



Referencias



Material gratuito

- James, G., Witten, D., Hastie, T., & Tibshirani, R. (2021). An introduction to statistical learning. Springer.
- <https://www.statlearning.com/>
- Hagan, Martin T., Howard B. Demuth, Mark Beale, and Orlando De Jesús. Neural network design (2nd edition). 2014 .
<https://hagan.okstate.edu/nnd.html>

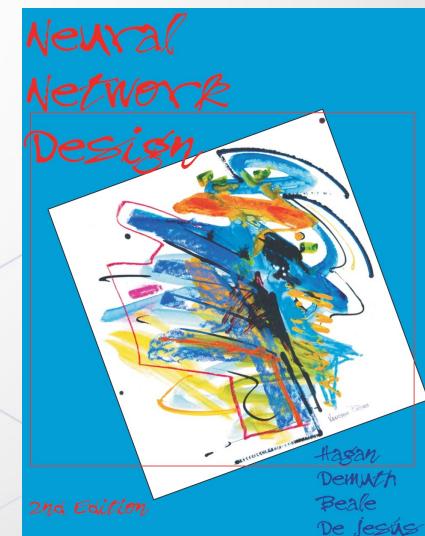
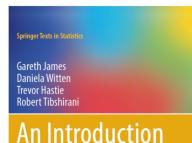
An Introduction to Statistical Learning

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Winner of the 2014 Eric Ziegel award from Technometrics.

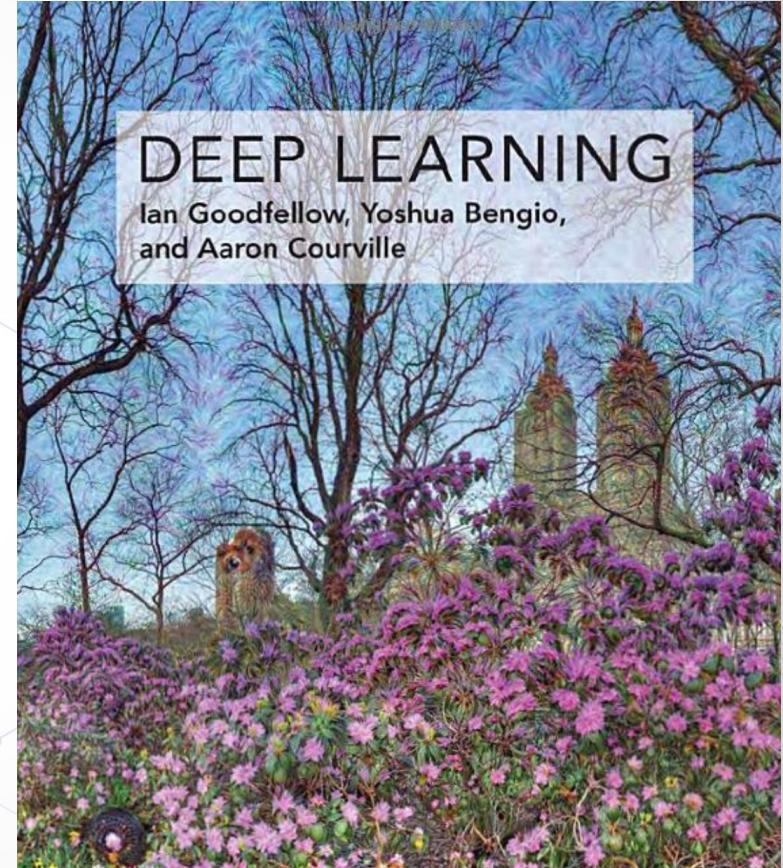
As the scale and scope of data collection continue to increase across virtually all fields, statistical learning has become a critical toolkit for anyone who wishes to understand data. *An Introduction to Statistical Learning* provides a broad and less technical treatment of key topics in statistical learning. Each chapter includes an R lab. This book is appropriate for anyone who wishes to use contemporary tools for data analysis.

The book has been translated into Chinese, Italian, Japanese, Korean, Mongolian, Russian and Vietnamese.



Material gratuito

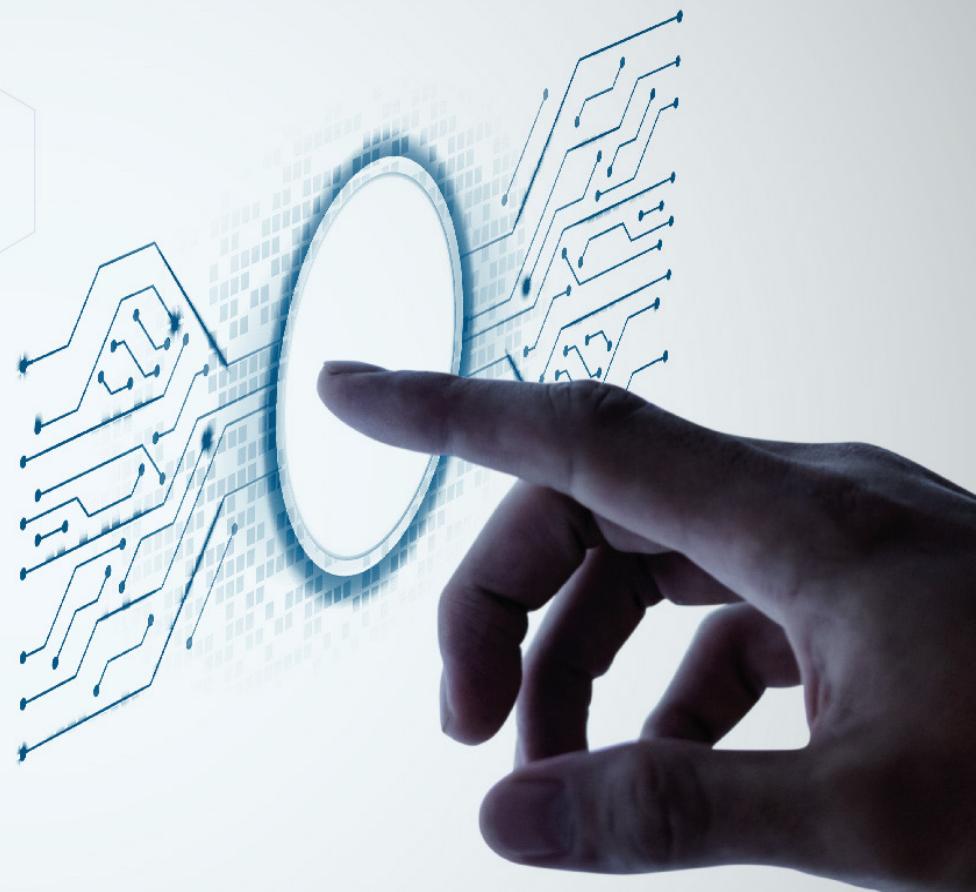
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- <https://www.deeplearningbook.org/>



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