



# DECSAI

Departamento de Ciencias de la Computación e I.A.

Universidad de Granada



## Inteligencia Computacional

© Fernando Berzal, [berzal@acm.org](mailto:berzal@acm.org)

## Cuestiones administrativas



### Inteligencia Computacional

Máster Universitario en Ingeniería Informática

<https://masteres.ugr.es/ingenieria-informatica/>

### Horario de clases

#### Curso 2024/2025

##### ■ Teoría

Lunes, de 18:00 a 20:00, aula 1.6, ETSIIT

##### ■ Prácticas

Martes, de 16:00 a 18:00, laboratorio 3.9, ETSIIT

Viernes, de 18:00 a 20:00, laboratorio 3.2, ETSIIT



# Cuestiones administrativas



Máster Universitario en Ingeniería Informática 1er cuatrimestre								
	Lunes	Martes	Miércoles		Jueves	Viernes		
9:30-10:30								
10:30-11:30								
11:30-12:30								
12:30-13:30								
13:30-14:30								
15:30-16:00								
16:00-16:30	CC 1.6	PGPI 1 3.8	IC 2 3.9	DSS 1 2.9	TID 2 3.3	TID 1.6	CC 1 2.9	PGPI 2 3.2
16:30-17:00								
17:00-17:30	CC 1.6	PGPI 1 3.8	IC 2 3.9	DES 1 3.3	TID 1 2.9	DSS 1.6	CC 1 2.9	PGPI 2 3.2
17:30-18:00								
18:00-18:30	IC 1.6	PGPI 1.6					IC1 3.2	CC 2 2.9
18:30-19:00								
19:00-19:30	IC 1.6	PGPI 1.6		DES 2 3.3	DSS 2 2.9	DES 1.6	IC1 3.2	CC 2 2.9
19:30-20:00								
20:00-20:30								
20:30-21:00								
21:00-21:30								



# Cuestiones administrativas



## Profesor de teoría

**Fernando Berzal Galiano**

Departamento de Ciencias de la Computación e I.A.

Despacho 17, 4ª planta, ETSIIT

- E-mail: [fberzal@decsai.ugr.es](mailto:fberzal@decsai.ugr.es)
- Web: <https://elvex.ugr.es/>
- Teléfono: 958 24 83 18
- Tutorías: **Confirmar por correo electrónico.**



# Cuestiones administrativas



## Profesor de prácticas

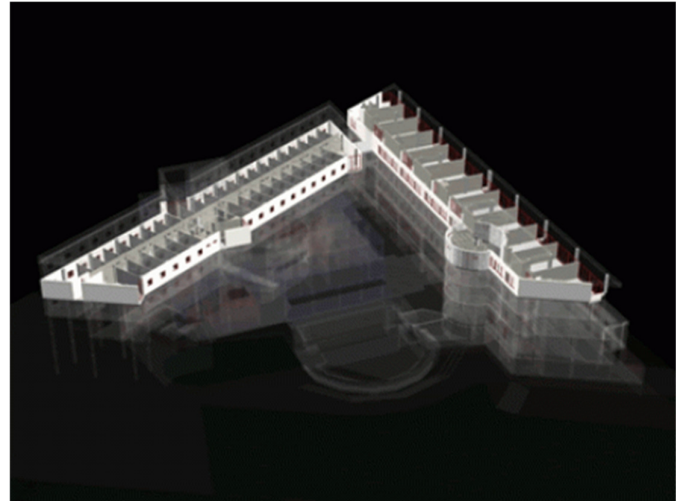
**GRUPO 1**  
(viernes, 18:00-20:00)

&

**GRUPO 2**  
(martes, 16:00-18:00)

**Pavel Novoa**

[pavelnova@ugr.es](mailto:pavelnova@ugr.es)



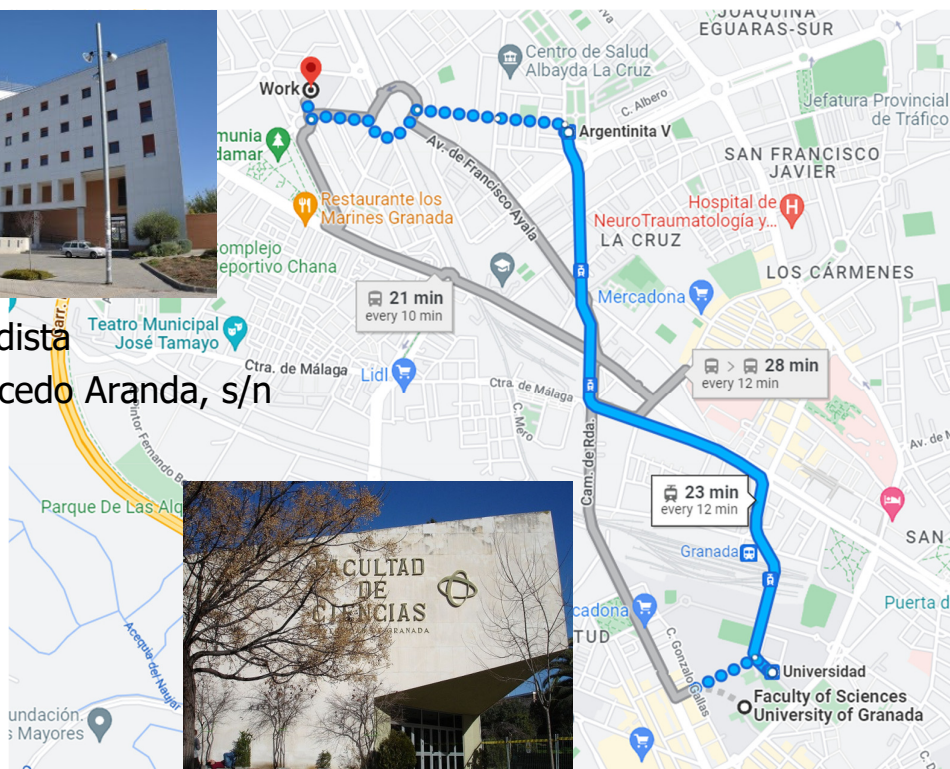
# Cuestiones administrativas



## ETSIIT



Calle Periodista  
Daniel Saucedo Aranda, s/n



Transporte  
público

**Metro**  
**Bus 9**



# Temario de la asignatura



- Inteligencia Computacional: Orígenes & Paradigmas
- Lógica Difusa
- Redes Neuronales Artificiales & Deep Learning
- Computación Evolutiva

Apuntes de teoría, guiones de prácticas, ejercicios...

<https://elvex.ugr.es/decsai/computational-intelligence/>



# Prácticas de la asignatura



## Prácticas asociadas a cada bloque de teoría

- Caso práctico  
(aplicación de la lógica difusa).
- Problema de clasificación  
(solución basada en redes neuronales artificiales).
- Problema de optimización  
(solución basada en algoritmos genéticos)



# Prácticas de la asignatura



Entrega a través de... ¿<https://decsai.ugr.es/>?



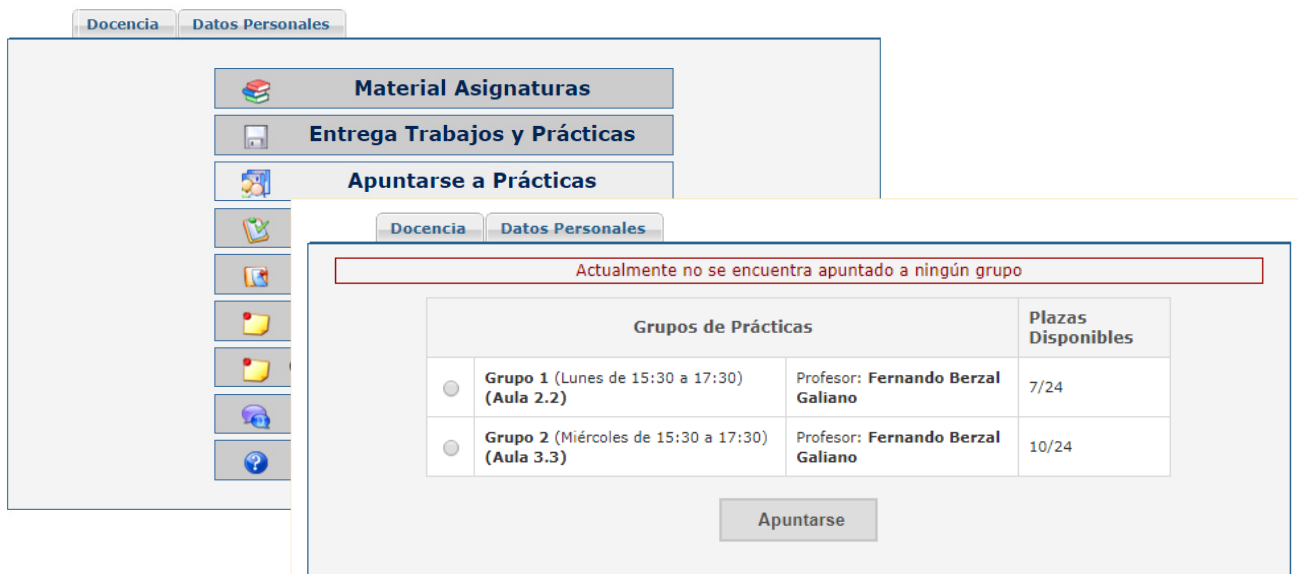
Usuario y contraseña por defecto: DNI/Pasaporte (sin la letra final)



# Prácticas de la asignatura



Selección de grupo de prácticas en DECSAI: <https://decsai.ugr.es/>



Usuario y contraseña por defecto: DNI/Pasaporte (sin la letra final)



# Prácticas de la asignatura



## Entrega a través de Google Classroom

Classroom > IC2425  
Inteligencia Computacional

Tablón Trabajo de clase Personas Calificaciones

IC2425  
Inteligencia Computacional

Meet  
Unirme  
Visible para los alumnos

Código de clase  
diqiqjo

Próximas entregas  
No tienes ninguna tarea para esta semana  
Ver todo

Anuncia algo a tu clase

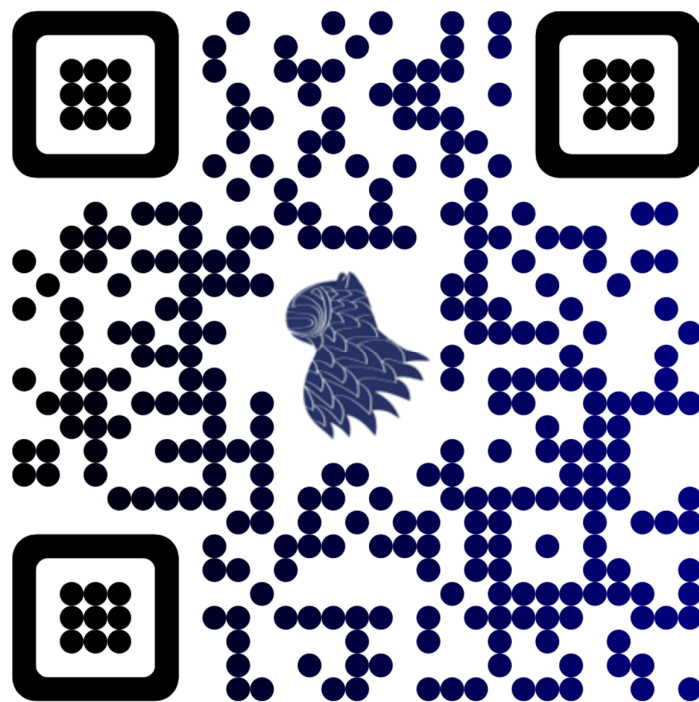
FERNANDO BERZAL GALIANO ha publicado nuevo material: Página web de la asignatura  
10:05

Alta usando una cuenta @go.ugr.es:

<https://classroom.google.com/c/NzEzNDcxMDcxMzQx?cjc=diqiqjo>



# Prácticas de la asignatura



Alta en Google Classroom



# Método de evaluación



- Parte teórica (45%)  
**Calificación mínima: 4 sobre 10.**
- Parte práctica (45%)  
**Calificación mínima: 4 sobre 10.**
- Asistencia y participación (10%)

NOTA: En la convocatoria extraordinaria se mantendrá el mismo método de evaluación para la parte teórica (50%) y la parte práctica (50%).



# Método de evaluación



Se realizarán trabajos y actividades en cada uno de los tres grandes bloques de la asignatura:

- Lógica Difusa
- Redes Neuronales Artificiales & Deep Learning
- Computación Evolutiva

Cada bloque se evaluará de forma independiente.

La calificación final será la media aritmética de las calificaciones obtenidas en cada bloque.



# Bibliografía recomendada

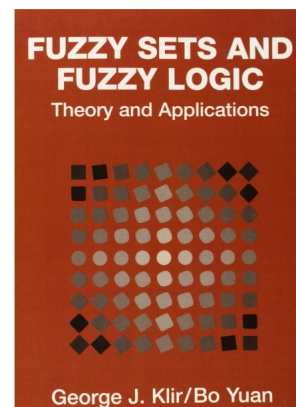


## Lógica Difusa

- Hans-Jürgen Zimmermann:  
**Fuzzy Set Theory**,  
WIREs Computational Statistics,  
John Wiley & Sons, 2:3, May/June 2010.  
DOI 10.1002/wics.82



- George J. Klir & Bo Yuan:  
**Fuzzy Sets and Fuzzy Logic:  
Theory and Applications**,  
1<sup>st</sup> edition, Prentice Hall, 1995.  
ISBN 0131011715



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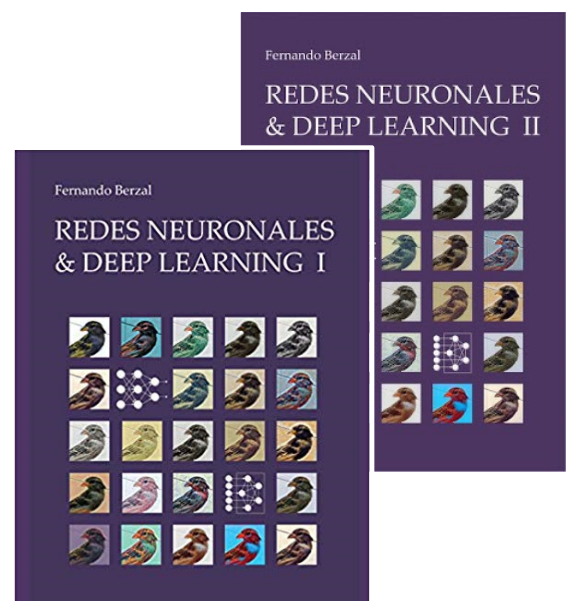


## Redes Neuronales Artificiales

Fernando Berzal:  
**Redes Neuronales  
& Deep Learning**  
Edición en dos volúmenes, 2019  
Volumen I: Entrenamiento  
de redes neuronales artificiales  
ISBN 1-0903-2030-2

Volumen II: Regularización,  
optimización y arquitecturas especializadas  
ISBN 1-0903-3688-8

<https://deep-learning.ikor.org>





# Bibliografía recomendada

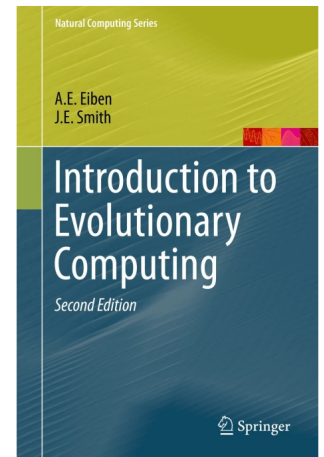
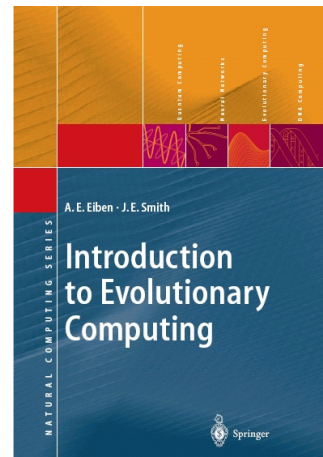


## Computación Evolutiva

A.E. Eiben & J.E. Smith:  
**Introduction to  
Evolutionary Computing**

Springer, 2<sup>nd</sup> printing, 2007  
ISBN 3540401849

<https://www.cs.vu.nl/~gusz/ecbook/ecbook.html>



Springer, 2<sup>nd</sup> edition, 2015  
ISBN3662448734

<http://www.evolutionarycomputation.org/>

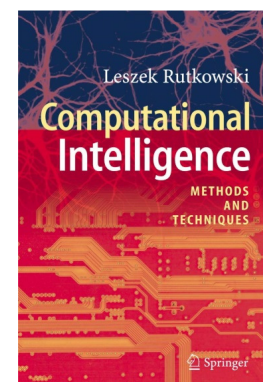
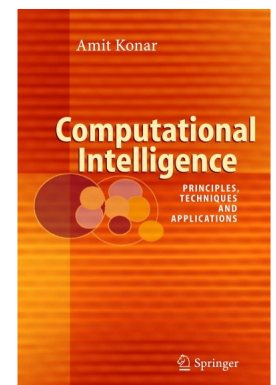
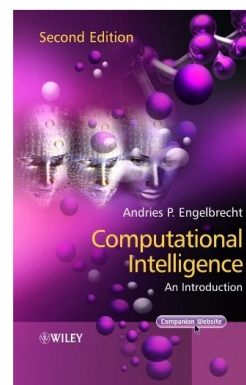


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- Andries P. Engelbrecht:  
**Computational Intelligence.  
An Introduction,**  
2<sup>nd</sup> edition, John Wiley, 2007.  
ISBN 0470035617.
- Amit Konar:  
**Computational Intelligence.  
Principles, Techniques and Applications,**  
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ISBN 3540208984.
- Leszek Rutkowski:  
**Computational Intelligence.  
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ISBN 3540762876.

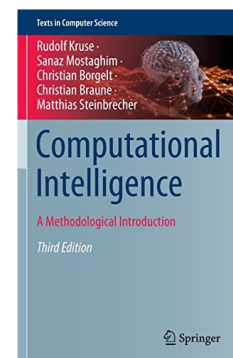
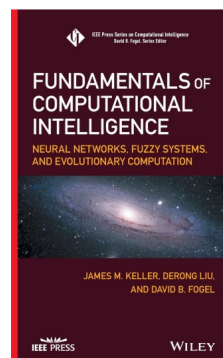


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**Fundamentals of Computational Intelligence: Neural Networks, Fuzzy Systems, and Evolutionary Computation**, Wiley - IEEE Press, 2016. ISBN 1119214343
- Rudolf Kruse, Sanaz Mostaghim, Christian Borgelt, Christian Braune, Matthias Steinbrecher, Frank Klawonn & Christian Moewes: **Computational Intelligence: A Methodological Introduction**. Springer, 3<sup>rd</sup> edition, 2022. ISBN 3030422267

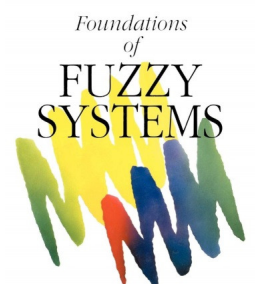


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## Lógica y Sistemas Difusos

- Rudolf Kruse, Joan E. Gebhardt & Frank Klawonn:  
**Foundations of Fuzzy Systems**.  
John Wiley & Sons, 1994. ISBN 047194243X.
- Witold Pedrycz & Fernando Gomide:  
**An introduction to Fuzzy Sets: Analysis and Design**.  
MIT Press, 1998. ISBN 0262161710.
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**Fuzzy Set Theory and Its Applications**,  
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Springer, 4<sup>th</sup> edition, 2001. ISBN 9401038708.
- F. Martin McNeill & Ellen Thro:  
**Fuzzy Logic: A Practical Approach**.  
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R. Kruse • J. Gebhardt • F. Klawonn

**FUZZY LOGIC**  
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F. MARTIN McNEILL • ELLEN THRO  
Foreword by Ronald R. Yager

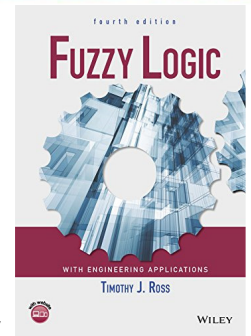


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- Lofti A. Zadeh: **Fuzzy Sets**.  
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- James C. Bezdek: **Pattern Recognition with Fuzzy Objective  
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- Bart Kosko: **Neural Networks and Fuzzy Systems: A  
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Prentice Hall, 1992. ISBN 0136114350
- Mohammad Jamshidi, Nader Vadiee & Timothy Ross (editors):  
**Fuzzy Logic and Control. Software and Hardware  
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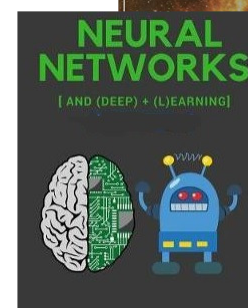
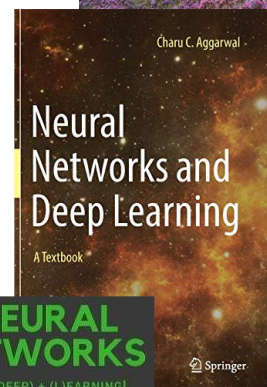
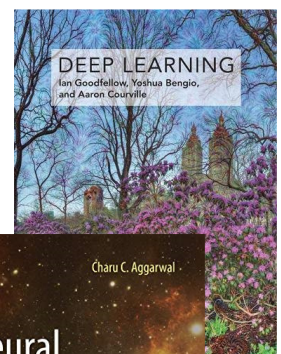
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### Fundamentos

- Ian Goodfellow, Yoshua Bengio & Aaron Courville:  
**Deep Learning**  
MIT Press, 2016. ISBN 0262035618  
<http://www.deeplearningbook.org>
- Charu C. Aggarwal:  
**Neural Networks and Deep Learning:  
A Textbook**.  
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<http://link.springer.com/978-3-319-94463-0>
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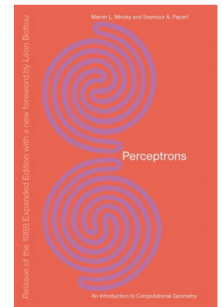
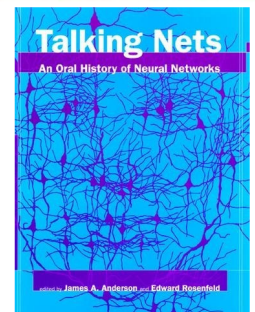
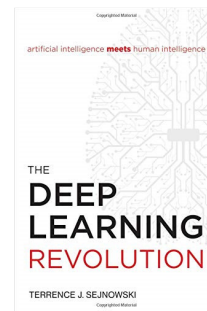
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## Redes Neuronales Artificiales

### Perspectiva histórica

- Terrence J. Sejnowski:  
**The Deep Learning Revolution**  
MIT Press, 2018. ISBN 026203803X  
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- James A. Anderson & Edward Rosenfeld (editores):  
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<https://mitpress.mit.edu/books/talking-nets>
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MIT Press, 1969 ... 2017. ISBN 0262534770



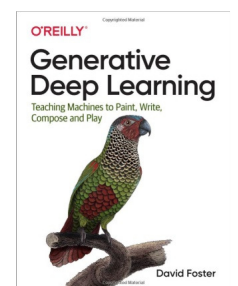
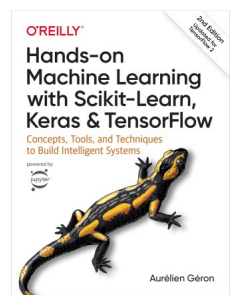
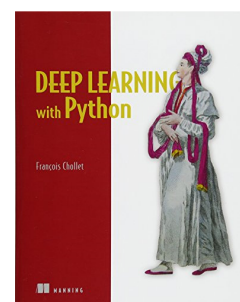
# Bibliografía complementaria



## Redes Neuronales Artificiales

### Con una orientación práctica

- François Chollet:  
**Deep Learning with Python**  
Manning Publications, 2018  
ISBN 1617294438  
<https://github.com/fchollet/deep-learning-with-python-notebooks>
- Aurélien Géron: **Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems**  
O'Reilly, 2<sup>nd</sup> edition, 2019, ISBN 1627052984  
<https://github.com/ageron/handson-ml2>
- David Foster: **Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play**  
O'Reilly, 2019, ISBN 1492041947  
[https://github.com/davidADSP/GDL\\_code](https://github.com/davidADSP/GDL_code)

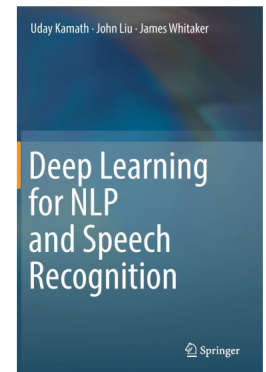
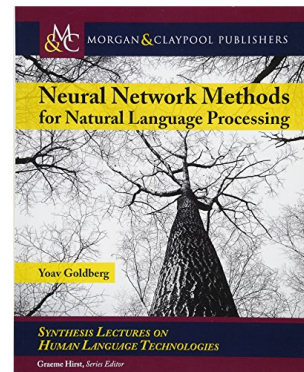


# Bibliografía complementaria



## Redes Neuronales Artificiales Áreas de aplicación, p.ej. NLP

- Yoav Goldberg:  
**Neural Network Methods  
in Natural Language Processing**  
Morgan & Claypool Publishers, 2017  
ISBN 1627052984



<https://doi.org/10.2200/S00762ED1V01Y201703HLT037>

- Uday Kamath, John Liu & James Whitaker:  
**Deep Learning for NLP and Speech Recognition**  
Springer, 2019  
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<http://link.springer.com/978-3-030-14595-8>

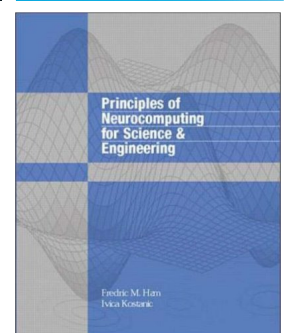
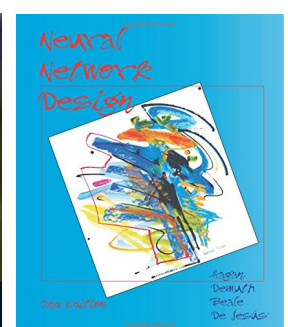
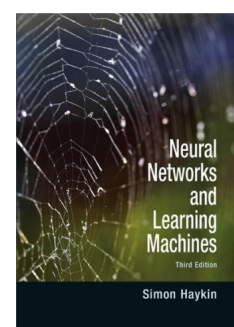


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**Neural Networks  
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- Martin T. Hagan, Howard B. Demuth,  
Mark H. Beale & Orlando de Jesús:  
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ISBN 0971732116  
<http://hagan.okstate.edu/NNDesign.pdf>
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**Principles of Neurocomputing  
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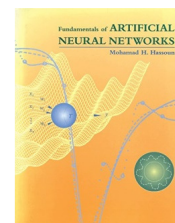
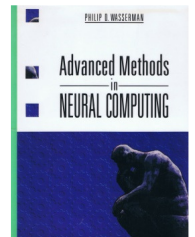
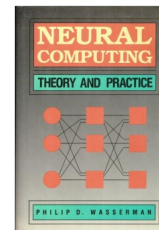
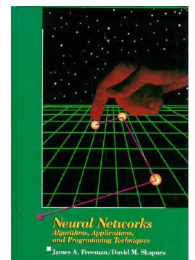
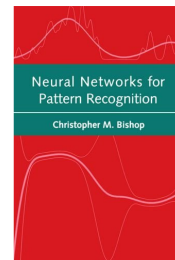


# Bibliografía complementaria



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**Neural Networks: Algorithms, Applications, and Programming Techniques**  
Addison-Wesley, 1991. ISBN 0201513765
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**Advanced Methods in Neural Computing**  
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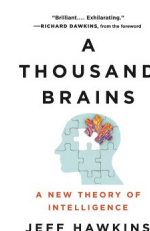
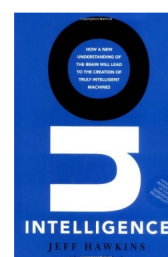
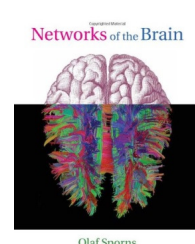
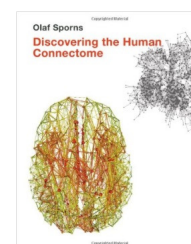
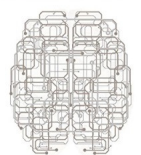


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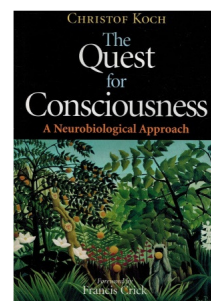
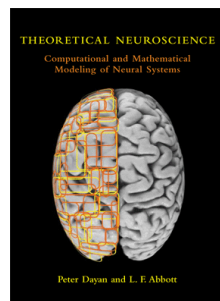
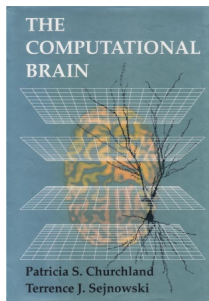


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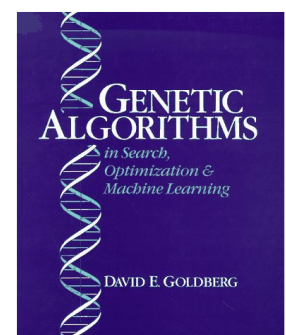
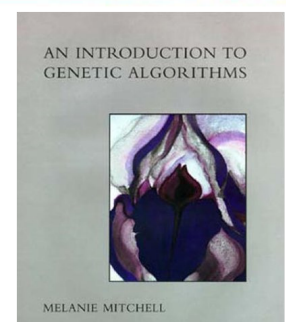


# Bibliografía complementaria



## Computación Evolutiva

- Melanie Mitchell:  
**An Introduction to Genetic Algorithms**  
MIT Press, 1996. ISBN 0262133164
- David E. Goldberg:  
**Genetic Algorithms in Search, Optimization & Machine Learning.**  
Addison-Wesley, 1989. ISBN 0201157675
- Carlos Artemio Coello Coello:  
**Introducción a la Computación Evolutiva.**  
CINVESTAV-IPN, 2014-2022.  
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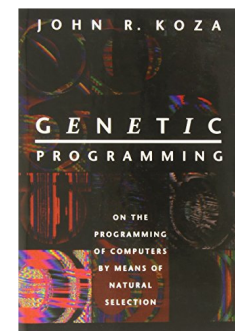
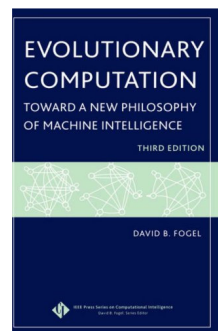
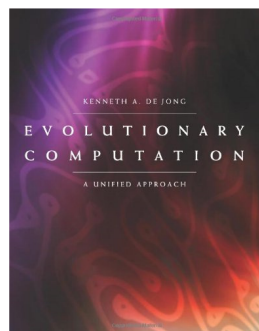


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## Computación Evolutiva

- Kenneth A. De Jong: **Evolutionary Computation: A Unified Approach**, MIT Press, 1<sup>st</sup> edition, 2006. ISBN 0262041944
- David B. Fogel: **Evolutionary Computation: Toward a New Philosophy of Machine Intelligence**, Wiley - IEEE Press, 3<sup>rd</sup> edition, 2006. ISBN 0471669512.
- John R. Koza: **Genetic Programming: On the Programming of Computers by Means of Natural Selection**, MIT Press, 1992. ISBN 0262111705

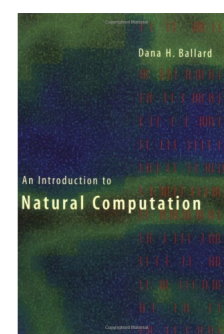
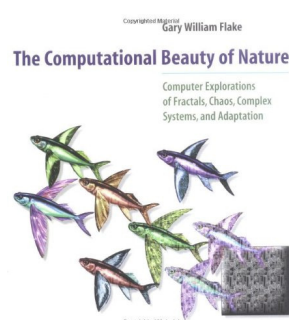
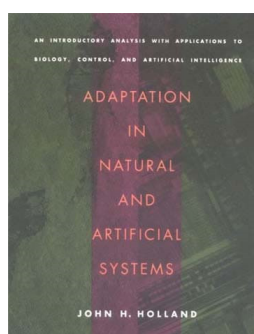


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## Computación Evolutiva

- John H. Holland: **Adaptation in Natural and Artificial Systems: An Introductory Analysis with Applications to Biology, Control, and Artificial Intelligence**, MIT Press, 1992. ISBN 0262581116
- Dana H. Ballard: **An Introduction to Natural Computation**, MIT Press, 1997. ISBN 0262024209
- Gary W. Flake: **The Computational Beauty of Nature**, MIT Press, 2000. ISBN 0262561271





# Material de la asignatura



<https://elvex.ugr.es/decsai/computational-intelligence/>

## Inteligencia Computacional Computational Intelligence

I.C. | [Sistemas Difusos](#) | [Redes Neuronales](#) | [Computación Evolutiva](#) | [Bibliografía](#)

- I.C.
- Sistemas Difusos
- Redes Neuronales
- Computación Evolutiva
- Bibliografía

### Inteligencia Computacional

- Presentación de la asignatura
- Introducción a la Inteligencia Computacional
- Bioinspiración

#### Material complementario

- Sistemas expertos

#### Lecturas recomendadas

- AI's Hall of Fame, IEEE Intelligent Systems, July / August 2011, DOI 10.1109/MIS.2011.64
- History of Artificial Intelligence, Wikipedia, [http://en.wikipedia.org/wiki/History\\_of\\_artificial\\_intelligence](http://en.wikipedia.org/wiki/History_of_artificial_intelligence)



Acceso identificado

### Sistemas Difusos

- Lógica y sistemas difusos
- Conjuntos difusos
- Funciones de pertenencia a conjuntos difusos
- Operaciones sobre conjuntos difusos
- Variables lingüísticas
- Relaciones difusas
- Razonamiento aproximado
- Control difuso

