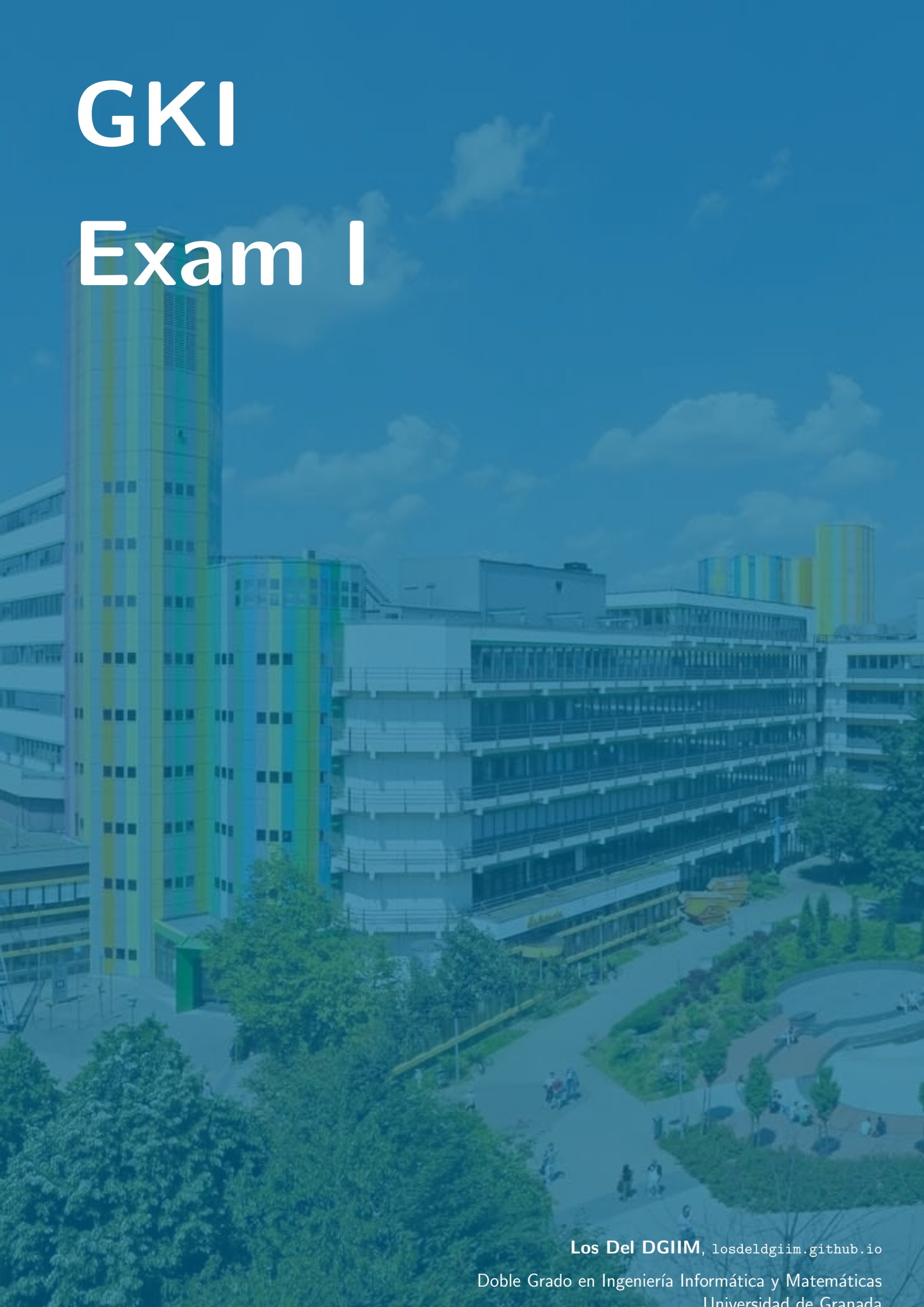
# GKI

# Exam I



**Los Del DGIIM**, losdeldgiim.github.io

Doble Grado en Ingeniería Informática y Matemáticas

Universidad de Granada

# GKI
# Exam I

Los Del DGIIM, `losdeldgiim.github.io`

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**Subject** Fundamentals of Artificial Intelligence.

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**Lecturer** Gérald Kämmerer.

**Description** Final Exam.

**Date** 05.03.2026.

**Duration** 90 minutes.

# Part 1: Short Questions (47 pts.)

**Ejercicio 1** (Supervised Learning (3 pts.))**.** What is supervised learning? Mark whether each of the following methods belongs to supervised learning or not.

| Method | Right | Wrong |
|---|---|---|
| kNN | ☐ | ☐ |
| ID3 | ☐ | ☐ |
| Hill Climbing | ☐ | ☐ |
| OPTICS | ☐ | ☐ |
| CNN | ☐ | ☐ |
| LSTM | ☐ | ☐ |

Tabla 1: Classification of Supervised Learning Methods

**Ejercicio 2** (PPDAC Cycle (5 pts.))**.** List the steps of the PPDAC cycle and give an application example.

**Ejercicio 3** (Data Aggregation Errors (2 pts.))**.** Name two possible errors that can occur when data is aggregated.

**Ejercicio 4** (Basic Statistics (5 pts.))**.** Given the numbers $A = \{10, 0, 6, 0, 9\}$, compute the median, mean, mode, and variance.

**Ejercicio 5** (Data Encoding Issues (2 pts.))**.** Name two problems that can occur when we encode data.

**Ejercicio 6** (Neural Network Optimization (2 pts.))**.** Name two methods used for optimizing neural networks.

**Ejercicio 7** (Search Algorithms (1 pt.))**.** For which search method is Depth-Limited Search a modification?

**Ejercicio 8** (Genetic Algorithms - Evaluation (2 pts.))**.** Given three chromosomes of length 8 with the bases $\{a, b, c\}$:

- Chromosome 1: *cabbacba*
- Chromosome 2: *aabaabca*
- Chromosome 3: *babbaaba*

Evaluate the chromosomes based on the frequency of $a$ (the more $a$'s, the better). What would the best chromosome from the given set look like, and what does the theoretically best chromosome look like?

**Ejercicio 9** (Genetic Algorithms - Recombination & Mutation (3 pts.))**.** Given two chromosomes: Chromosome 1 (*acbcaaba*) and Chromosome 2 (*cabaabca*). Apply order-based recombination (OX2) using the sequence $1, 2, 4, 6$. Afterwards, apply a mutation.

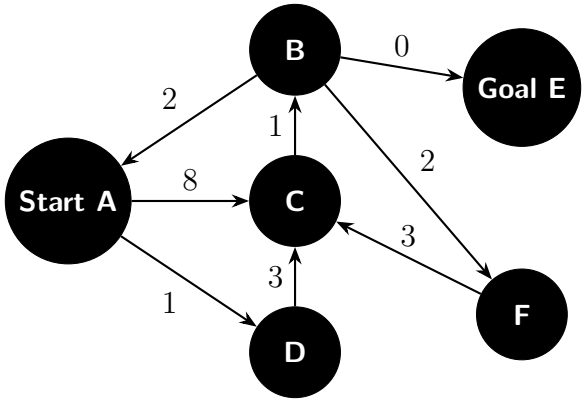


Figura 1: Uniform Cost Graph

**Ejercicio 10** (Uniform Cost Search (6 pts.))**.** Explain Uniform Cost Search using the graph in Figure 1. Go through the different steps. Note down the path/steps, the respective costs, and the total cost.

**Ejercicio 11** (Regularization Models (5 pts.))**.** List the definitions and differences between Ridge, Lasso, and ElasticNet regularization.

**Ejercicio 12** (Specificity (1 pt.))**.** How is the specificity (TNR) defined, and in which value range does it lie?

**Ejercicio 13** (Confusion Matrix (2 pts.))**.** Write down the general confusion matrix and name its elements.

**Ejercicio 14** (Hierarchical Clustering (2 pts.))**.** Define Single Linkage and Average Linkage in hierarchical clustering, and state the mutual advantages and disadvantages of each.

**Ejercicio 15** (Autoencoders (1 pt.))**.** Name the main components of an autoencoder.

**Ejercicio 16** (NLP Lemmatization (2 pts.))**.** Lemmatize the words in the sentence: *"I am well prepared"*.

**Ejercicio 17** (Neural Network Architecture (3 pts.))**.** Draw a feed-forward neural network with:

- 1 input layer (1 neuron)
- 2 hidden layers (2 neurons each)
- 1 output layer (1 neuron)

The first hidden layer must be fully connected to the second hidden layer. You can choose the other connections freely. Additionally, draw and label exactly one direct feedback connection and one indirect feedback connection.

# Part 2: k-Means (13 pts.)

**Ejercicio 18** (k-Means Algorithm Steps (3 pts.))**.** Explain the steps involved in performing the k-Means algorithm.

**Ejercicio 19** (Execution of k-Means (10 pts.))**.** The following dataset (Table 2) is provided. We want to cluster these points and find centroids.

| **Point** | **x** | **y** |
|---|---|---|
| P1 | 1 | 2 |
| P2 | 1 | 4 |
| P3 | 2 | 1 |
| P4 | 5 | 4 |
| P5 | 6 | 5 |
| P6 | 6 | 7 |

Tabla 2: Data for k-Means Clustering

Execute the k-Means algorithm step-by-step. Start with $k = 2$ and initial centroids at points P3 and P5. Fully execute the first two iterations. Distances are calculated using Manhattan distance:

$$d(P1, P2) = |x_1 - x_2| + |y_1 - y_2|$$

**Example calculation for distance between points:**

$$d(P1, P2) = |1 - 1| + |2 - 4| = 0 + 2 = 2$$

# Part 3: Kahn's Algorithm, Entropy & Random Forest (22 pts.)

**Ejercicio 20** (Kahn's Algorithm (6 pts.))**.** Name and explain the steps of Kahn's Algorithm.

**Ejercicio 21** (Feature Types (2 pts.))**.** Consider Table 3 below. Which features are categorical and which are nominal?

| **Client** | **Age** | **Ad** | **Buy** |
|---|---|---|---|
| 1 | young | yes | yes |
| 2 | young | no | no |
| 3 | medium | yes | yes |
| 4 | old | yes | yes |
| 5 | old | yes | no |
| 6 | medium | yes | yes |

Tabla 3: Customer Dataset

**Ejercicio 22** (Entropy Calculation (9 pts.))**.** Which feature should you split on first in Table 3 if the column *Buy* is the target? Calculate the entropy for each feature using the formula:

$$S(x) = -\sum_{i=1}^{N} p(x_i) \cdot \log_2(p(x_i))$$

**Ejercicio 23** (Information Gain Range (2 pts.))**.** What is the range of values for Information Gain? Specify its minimum and maximum values.

**Ejercicio 24** (Random Forest Classification (3 pts.))**.** Classify the point ($F_1 = 1, F_2 = 4, F_3 = 7$) using the Random Forest in Figure 2. Provide the explicit result for each tree as well as the final aggregated result. Draw the explicit decision path. Note: the left branch of a node represents **true**, and the right branch represents **false**.

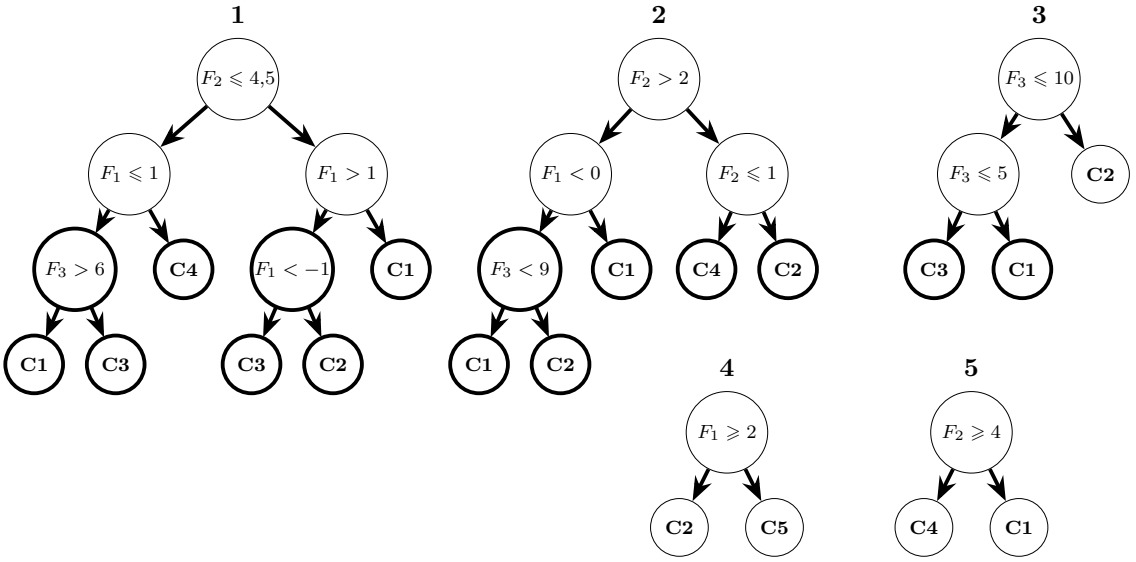


Figura 2: Random Forest Classifier

# Part 4: NLP & Forward Propagation (8 pts.)

**Ejercicio 25** (Bag of Words Encoding (4 pts.))**.** Given the sentence: *"Nobody makes it better than me, nobody."* and the vocabulary

$$\{A, be, better, easy, is, it, make, makes, me, nobody, than, then\}$$

, encode the sentence using frequency-based Bag of Words.

**Ejercicio 26** (Forward Propagation Computation (4 pts.))**.** Given the small neural network below, write the calculated output values (after applying the activation functions) into the corresponding boxes. The weights $w$ are provided for all connections.

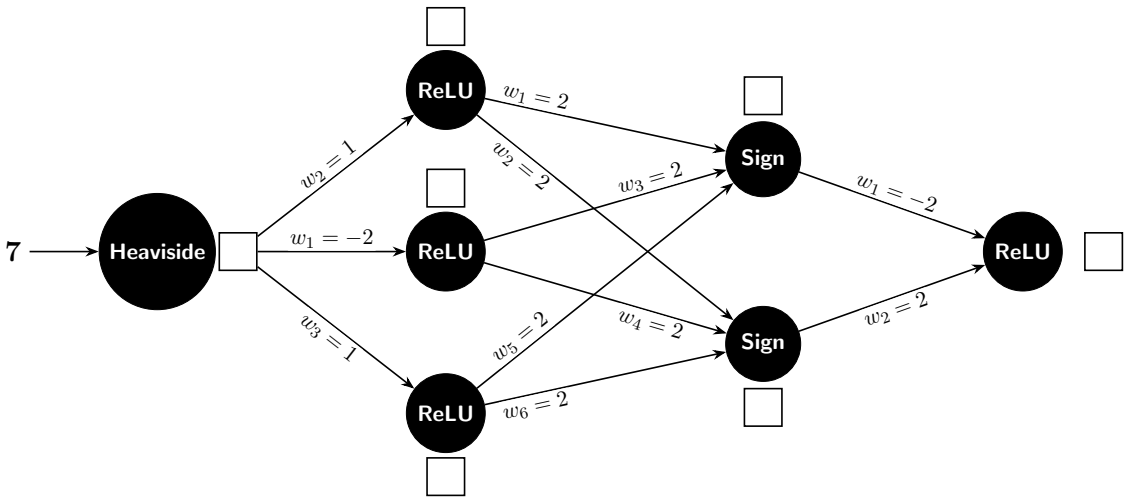


Figura 3: Forward Propagation Network Schema