Sesión 1

En esta primera sesión nos familiarizaremos con el entorno de trabajo y algunos conjuntos de datos. Comenzaremos con el conjunto "iris" y, a continuación, podrás proseguir con los conjuntos "digits" y "olivetti". Finalmente, se introducirá la plataforma "openml" cuyos conjuntos de datos se usarán en el ejercicio del examen.

El corpus iris

El corpus iris ha sido ampliamente utilizado para introducir conceptos y métodos básicos de aprendizaje automático. Consta de $N = 150$ muestras, 50 por cada una de $C = 3$ clases, representadas mediante vectores de $D = 4$ características reales homogéneas. Una de las clases es linealmente separable del resto, pero las otras dos no son linealmente separables. Aunque hoy en día se considera un corpus de "juguete", sigue siendo muy útil para introducir conceptos y métodos básicos.

Primero importamos algunas librerías estándar i sklearn:

In [ ]:
```
import pandas as pd
import seaborn as sns
from sklearn.datasets import load_iris
```

Lectura del corpus iris:

In [2]:
```
iris = load_iris()
print(dir(iris))
X = iris.data
y = iris.target
fn = iris.feature_names
cn = iris.target_names
print(iris.DESCR)
```

```
['DESCR', 'data', 'data_module', 'feature_names', 'filename', 'frame', 'target', 'target_names']
.. _iris_dataset:

Iris plants dataset
--------------------

**Data Set Characteristics:**

:Number of Instances: 150 (50 in each of three classes)
:Number of Attributes: 4 numeric, predictive attributes and the class
:Attribute Information:
    - sepal length in cm
    - sepal width in cm
    - petal length in cm
    - petal width in cm
    - class:
            - Iris-Setosa
            - Iris-Versicolour
            - Iris-Virginica

:Summary Statistics:

============== ==== ==== ======= ===== ====================
                Min  Max   Mean    SD   Class Correlation
============== ==== ==== ======= ===== ====================
sepal length:   4.3  7.9   5.84   0.83    0.7826
sepal width:    2.0  4.4   3.05   0.43   -0.4194
petal length:   1.0  6.9   3.76   1.76    0.9490  (high!)
petal width:    0.1  2.5   1.20   0.76    0.9565  (high!)
============== ==== ==== ======= ===== ====================

:Missing Attribute Values: None
:Class Distribution: 33.3% for each of 3 classes.
:Creator: R.A. Fisher
:Donor: Michael Marshall (MARSHALL%PLU@io.arc.nasa.gov)
:Date: July, 1988

The famous Iris database, first used by Sir R.A. Fisher. The dataset is taken
from Fisher's paper. Note that it's the same as in R, but not as in the UCI
Machine Learning Repository, which has two wrong data points.

This is perhaps the best known database to be found in the
pattern recognition literature.  Fisher's paper is a classic in the field and
is referenced frequently to this day.  (See Duda & Hart, for example.)  The
data set contains 3 classes of 50 instances each, where each class refers to a
```

```
type of iris plant.  One class is linearly separable from the other 2; the
latter are NOT linearly separable from each other.

|details-start|
**References**
|details-split|

- Fisher, R.A. "The use of multiple measurements in taxonomic problems"
  Annual Eugenics, 7, Part II, 179-188 (1936); also in "Contributions to
  Mathematical Statistics" (John Wiley, NY, 1950).
- Duda, R.O., & Hart, P.E. (1973) Pattern Classification and Scene Analysis.
  (Q327.D83) John Wiley & Sons.  ISBN 0-471-22361-1.  See page 218.
- Dasarathy, B.V. (1980) "Nosing Around the Neighborhood: A New System
  Structure and Classification Rule for Recognition in Partially Exposed
  Environments".  IEEE Transactions on Pattern Analysis and Machine
  Intelligence, Vol. PAMI-2, No. 1, 67-71.
- Gates, G.W. (1972) "The Reduced Nearest Neighbor Rule".  IEEE Transactions
  on Information Theory, May 1972, 431-433.
- See also: 1988 MLC Proceedings, 54-64.  Cheeseman et al"s AUTOCLASS II
  conceptual clustering system finds 3 classes in the data.
- Many, many more ...

|details-end|
```

Convertimos el corpus en un dataframe pandas para facilitar su descripción:

In [3]:
```
data = pd.DataFrame(data=X, columns=fn)
data['species'] = pd.Series(iris.target_names[y], dtype='category')
data
```

Out[3]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	species
0	5.1	3.5	1.4	0.2	setosa
1	4.9	3.0	1.4	0.2	setosa
2	4.7	3.2	1.3	0.2	setosa
3	4.6	3.1	1.5	0.2	setosa
4	5.0	3.6	1.4	0.2	setosa
...	...	...	...	...	...
145	6.7	3.0	5.2	2.3	virginica
146	6.3	2.5	5.0	1.9	virginica
147	6.5	3.0	5.2	2.0	virginica
148	6.2	3.4	5.4	2.3	virginica
149	5.9	3.0	5.1	1.8	virginica

150 rows × 5 columns

Veamos algunas estadísticas básicas:

```
In [4]: data.describe()
```

Out[4]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)
count	150.000000	150.000000	150.000000	150.000000
mean	5.843333	3.057333	3.758000	1.199333
std	0.828066	0.435866	1.765298	0.762238
min	4.300000	2.000000	1.000000	0.100000
25%	5.100000	2.800000	1.600000	0.300000
50%	5.800000	3.000000	4.350000	1.300000
75%	6.400000	3.300000	5.100000	1.800000
max	7.900000	4.400000	6.900000	2.500000

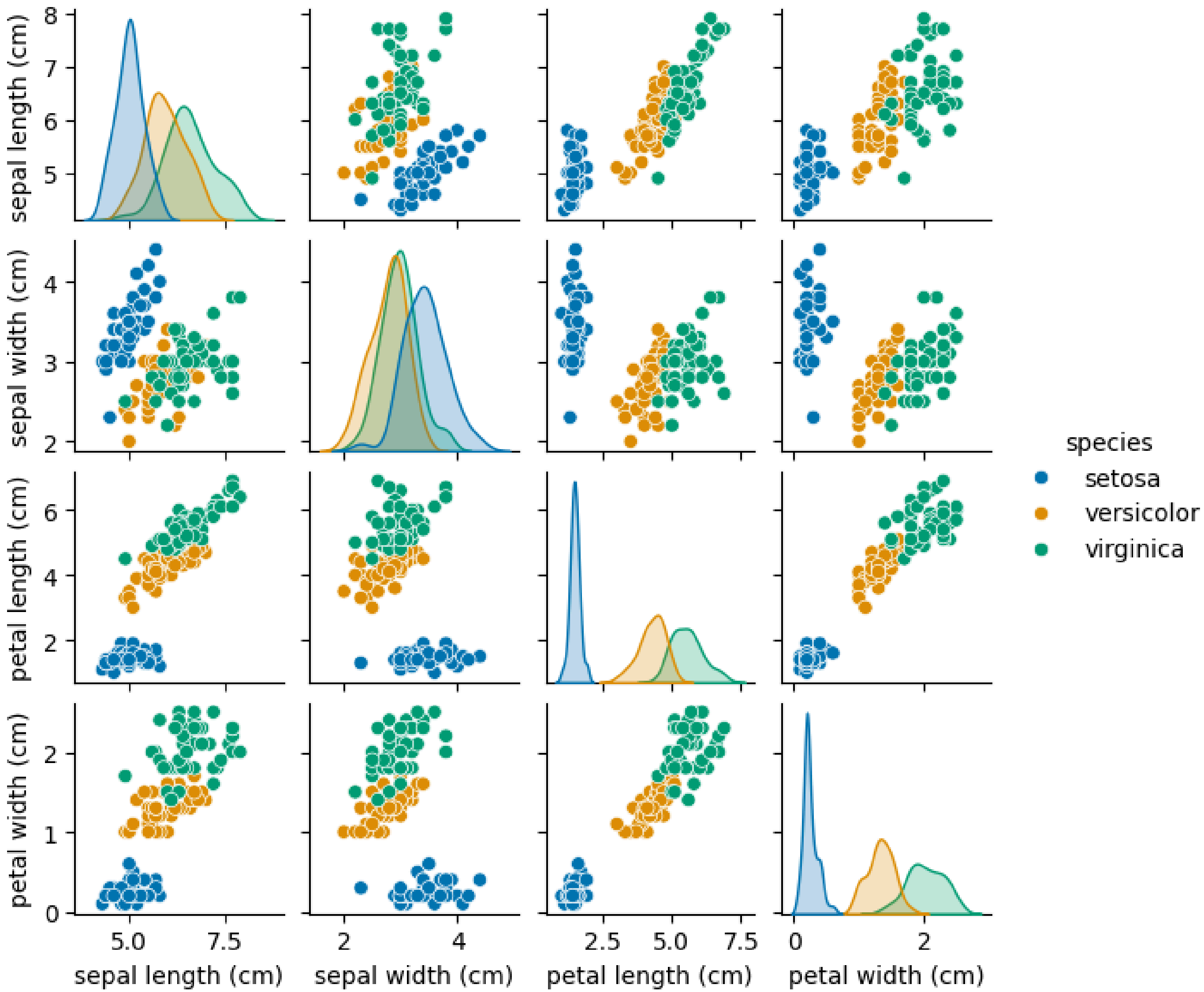
Comprobamos que tenemos 50 muestras de cada clase:

```
In [5]: data.groupby('species',observed=True).size()
```

```
Out[5]: species
setosa        50
versicolor    50
virginica     50
dtype: int64
```

Como que tenemos pocas características, es buena idea hacer un gráfico matricial de dispersión:

In [6]:
```
sns.pairplot(data, hue="species", height = 1.5, palette = 'colorblind');
```



Cuestión: qué clase se separa linealmente de las otras dos?

El corpus digits

Al igual que iris, digits puede considerarse un corpus de "juguete". Ahora bien, en comparación con iris, digits supone un salto de complejidad por el mayor número de clases, $C = 10$, muestras, $N = 1797$, y dimensión de los vectores de características, $D = 64$. Además, digits aborda una de las principales tareas perceptivas del aprendizaje automático: el reconocimiento de caracteres óptico (OCR) y, más concretamente, el reconocimiento de dígitos manuscritos. Aunque el reconocimiento de dígitos manuscritos se considera una tarea "resuelta" desde los años 90, la clasificación de imágenes en general sigue siendo una tarea compleja, de gran interés académico y comercial. Así pues, la relativa sencillez de digits resulta muy conveniente como tarea introductoria a la clasificación de imágenes.

In [ ]:
```
import matplotlib.pyplot as plt
from sklearn.datasets import load_digits
```

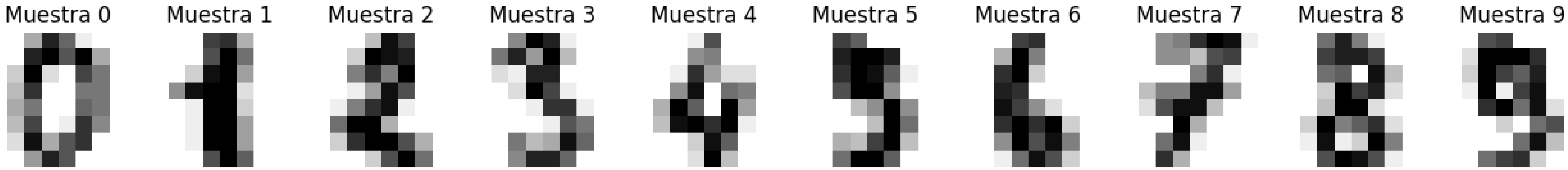
In [2]:
```
digits = load_digits()
print(digits.DESCR)
```

```
.. _digits_dataset:

Optical recognition of handwritten digits dataset
--------------------------------------------------

**Data Set Characteristics:**

:Number of Instances: 1797
:Number of Attributes: 64
:Attribute Information: 8x8 image of integer pixels in the range 0..16.
:Missing Attribute Values: None
:Creator: E. Alpaydin (alpaydin '@' boun.edu.tr)
:Date: July; 1998

This is a copy of the test set of the UCI ML hand-written digits datasets
https://archive.ics.uci.edu/ml/datasets/Optical+Recognition+of+Handwritten+Digits

The data set contains images of hand-written digits: 10 classes where
each class refers to a digit.

Preprocessing programs made available by NIST were used to extract
normalized bitmaps of handwritten digits from a preprinted form. From a
total of 43 people, 30 contributed to the training set and different 13
to the test set. 32x32 bitmaps are divided into nonoverlapping blocks of
4x4 and the number of on pixels are counted in each block. This generates
an input matrix of 8x8 where each element is an integer in the range
0..16. This reduces dimensionality and gives invariance to small
distortions.

For info on NIST preprocessing routines, see M. D. Garris, J. L. Blue, G.
T. Candela, D. L. Dimmick, J. Geist, P. J. Grother, S. A. Janet, and C.
L. Wilson, NIST Form-Based Handprint Recognition System, NISTIR 5469,
1994.

|details-start|
**References**
|details-split|

- C. Kaynak (1995) Methods of Combining Multiple Classifiers and Their
  Applications to Handwritten Digit Recognition, MSc Thesis, Institute of
  Graduate Studies in Science and Engineering, Bogazici University.
- E. Alpaydin, C. Kaynak (1998) Cascading Classifiers, Kybernetika.
- Ken Tang and Ponnuthurai N. Suganthan and Xi Yao and A. Kai Qin.
  Linear dimensionalityreduction using relevance weighted LDA. School of
  Electrical and Electronic Engineering Nanyang Technological University.
```

```
  2005.
- Claudio Gentile. A New Approximate Maximal Margin Classification
  Algorithm. NIPS. 2000.

|details-end|
```

Veamos las primeras 10 imágenes:

In [3]:
```
_, axes = plt.subplots(nrows=1, ncols=10, figsize=(16, 16))
for ax, image, label in zip(axes, digits.images, digits.target):
    ax.set_axis_off()
    ax.imshow(image, cmap=plt.cm.gray_r, interpolation="none")
    ax.set_title("Muestra {!s}".format(label))
```



El corpus Olivetti

Olivetti contiene $N = 400$ imágenes de caras de $C = 40$ personas, con 10 imágenes por persona. Las imágenes se adquirieron en momentos diferentes, variando la iluminación, expresión facial (cerrando o no los ojos; sonriente o no) y detalles faciales (con o sin gafas). Todas ellas se encuentran normalizadas en 64×64 píxeles en escala de gris entre 0 y 1; esto es, cada imagen se puede ver como un vector de $D = 4096$ dimensiones de características reales en $[0, 1]$. Las personas se identifican con una etiqueta entera de 0 a 39.

In [ ]:
```
import numpy as np
import matplotlib.pyplot as plt
from sklearn.datasets import fetch_olivetti_faces
```

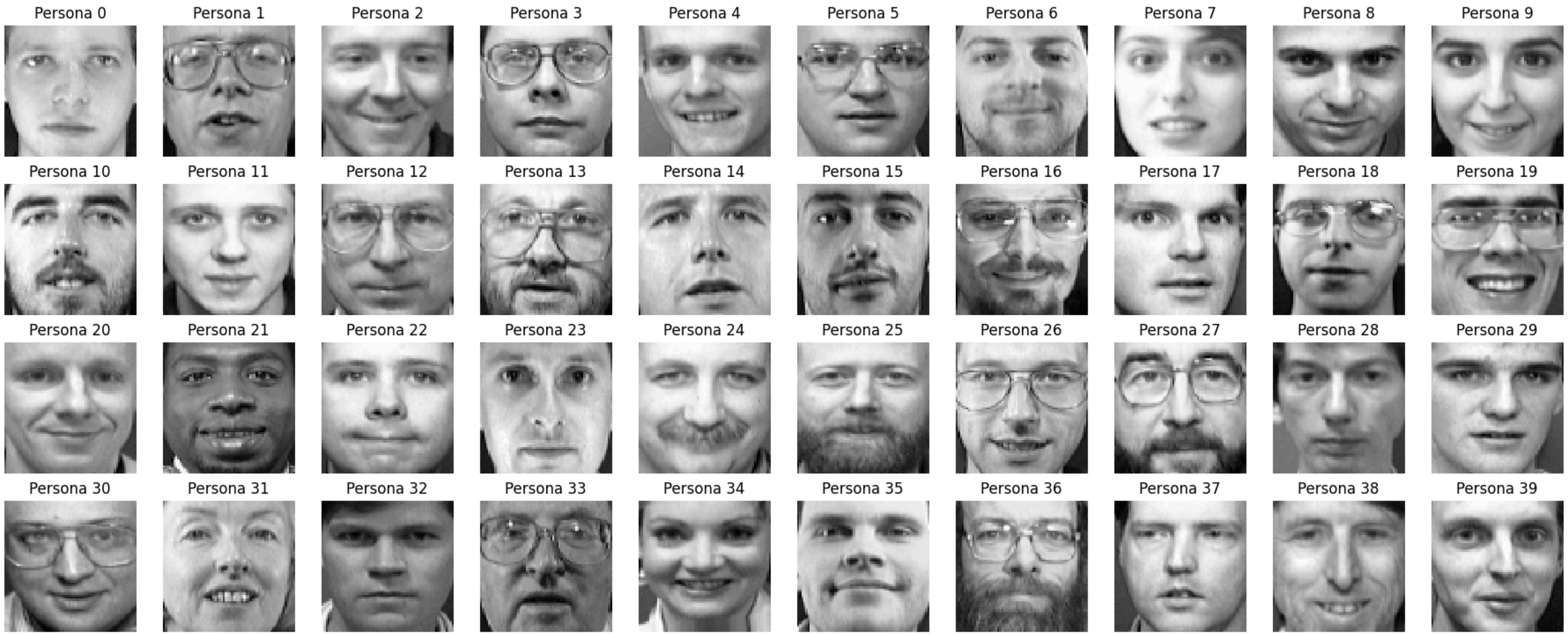
In [2]:
```
orl = fetch_olivetti_faces()
print(orl.DESCR)
```

```
downloading Olivetti faces from https://ndownloader.figshare.com/files/5976027 to /home/josanna/scikit_learn_data
.. _olivetti_faces_dataset:

The Olivetti faces dataset
--------------------------

`This dataset contains a set of face images`_ taken between April 1992 and
April 1994 at AT&T Laboratories Cambridge. The
:func:`sklearn.datasets.fetch_olivetti_faces` function is the data
fetching / caching function that downloads the data
archive from AT&T.

.. _This dataset contains a set of face images: https://cam-orl.co.uk/facedatabase.html

As described on the original website:

    There are ten different images of each of 40 distinct subjects. For some
    subjects, the images were taken at different times, varying the lighting,
    facial expressions (open / closed eyes, smiling / not smiling) and facial
    details (glasses / no glasses). All the images were taken against a dark
    homogeneous background with the subjects in an upright, frontal position
    (with tolerance for some side movement).

**Data Set Characteristics:**

=================   =====================
Classes                                40
Samples total                         400
Dimensionality                       4096
Features            real, between 0 and 1
=================   =====================

The image is quantized to 256 grey levels and stored as unsigned 8-bit
integers; the loader will convert these to floating point values on the
interval [0, 1], which are easier to work with for many algorithms.

The "target" for this database is an integer from 0 to 39 indicating the
identity of the person pictured; however, with only 10 examples per class, this
relatively small dataset is more interesting from an unsupervised or
semi-supervised perspective.

The original dataset consisted of 92 x 112, while the version available here
consists of 64x64 images.
```

```
When using these images, please give credit to AT&T Laboratories Cambridge.
```

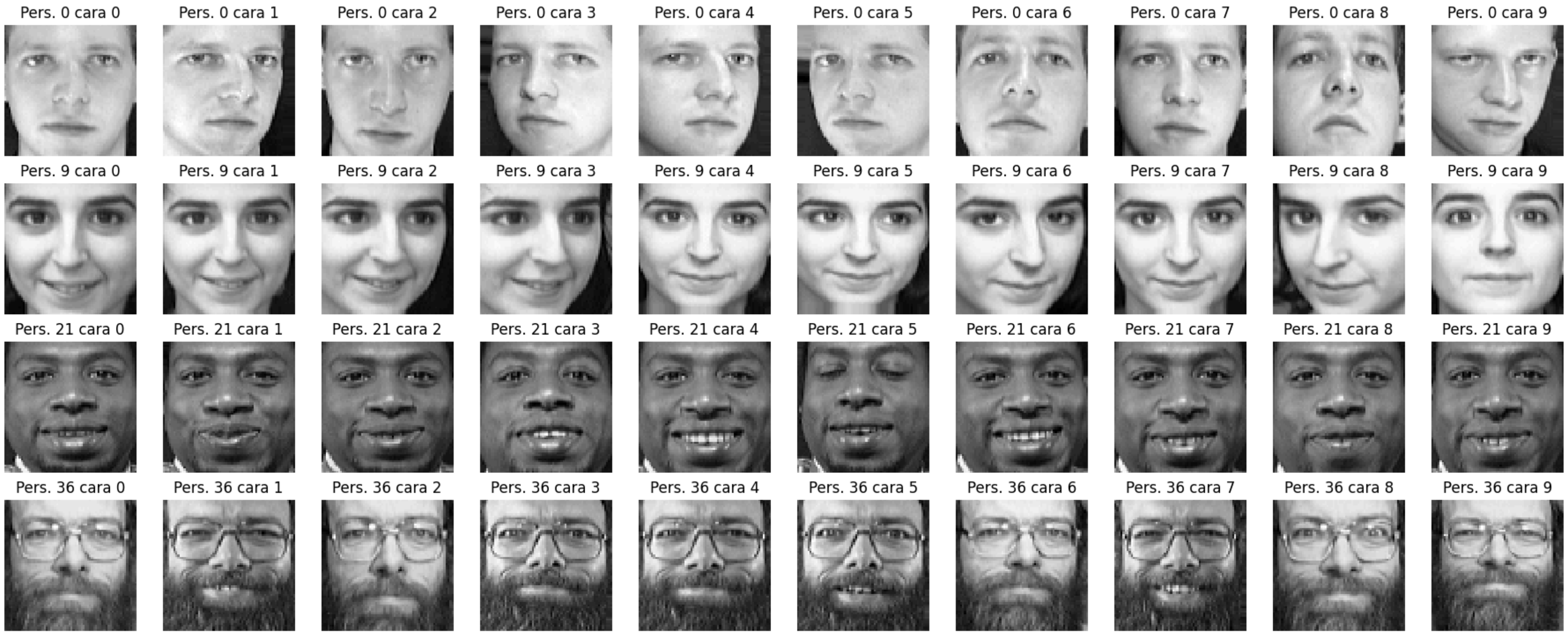
Veamos la primera imagen de cada persona:

In [3]:
```python
nrows, ncols = 4, 10
fig, axes = plt.subplots(nrows=nrows, ncols=ncols, figsize=(18, 18*nrows/ncols), constrained_layout=True)
for c in np.arange(0, 40):
    ax = axes.flat[c]; ax.set_axis_off(); ax.set_title(f"Persona {c}")
    ax.imshow(orl.images[10*c], cmap=plt.cm.gray, interpolation="none")
```



Veamos las 10 imágenes de algunas personas:

In [4]:
```
cc = [0, 9, 21, 36]
nrows, ncols = len(cc), 10
fig, axes = plt.subplots(nrows=nrows, ncols=ncols, figsize=(18, 18*nrows/ncols), constrained_layout=True)
for i, c in enumerate(cc):
    for j in np.arange(0, 10):
        ax = axes.flat[10*i+j]; ax.set_axis_off(); ax.set_title(f"Pers. {c} cara {j}")
        ax.imshow(orl.images[10*c+j], cmap=plt.cm.gray, interpolation="none")
```



openml

openml.org es una plataforma abierta para compartir conjuntos de datos, algoritmos y experimentos de aprendizaje automático con datos tabulados. Los principales conceptos sobre los cuales se basa son:

- **Dataset:** conjunto de datos tabulados
- **Task:** conjunto de datos, tarea de aprendizaje a realizar y método de evaluación
- **Flow:** pipeline de aprendizaje automático con detalles sobre software a emplear e hiperparámetros a ajustar
- **Run:** experimento de evaluación de un flow en una tarea

La elección de conjuntos de datos se puede hacer en la sección datasets. Los conjuntos elegidos se pueden descargar directamente o en uso de la función fetch_openml de sklearn. Ahora bien, en general es preferible escoger conjuntos de datos previamente elegidos por otros usuarios (con algún criterio específico) y publicados en la sección benchmarks. En particular, podemos destacar tres "benchmark suites" recientes para comparar y evaluar técnicas de clasificación:

- **OpenML-CC18 Curated Classification benchmark:** 72 conjuntos de Bahri et al, 2022
- **Tabular benchmark categorical classification:** 7 conjuntos de Grinsztajn et al, 2022
- **AutoML Benchmark All Classification:** 71 conjuntos de Gijsbers et al, 2019

```
In [ ]: !pip install openml
```

```
In [1]: import openml
        # OpenML-CC18 99; Tabular 334; AutoML 271
        benchmark_suite = openml.study.get_suite(suite_id=334)
        benchmark_suite
```

```
Out[1]: OpenML Benchmark Suite
        ======================
        ID..............: 334
        Name............: Tabular benchmark categorical classification
        Status..........: in_preparation
        Main Entity Type: task
        Study URL.......: https://www.openml.org/s/334
        # of Data.......: 7
        # of Tasks......: 7
        Creator.........: https://www.openml.org/u/26324
        Upload Time.....: 2023-01-16 03:22:41
```

```
In [2]: openml.datasets.list_datasets(data_id=benchmark_suite.data, output_format='dataframe')
```

Out[2]:

	did	name	version	uploader	status	format	MajorityClassSize	MinorityClassSize	NumberOfClasses	NumberOfFeatures	Numbe
44156	44156	electricity	13	26324	active	arff	19237.0	19237.0	2.0	9.0	
44157	44157	eye_movements	8	26324	active	arff	3804.0	3804.0	2.0	24.0	
44159	44159	covertype	13	26324	active	arff	211840.0	211840.0	2.0	55.0	
45035	45035	albert	2	26324	active	arff	29126.0	29126.0	2.0	32.0	
45036	45036	default-of-credit-card-clients	4	26324	active	arff	6636.0	6636.0	2.0	22.0	
45038	45038	road-safety	7	26324	active	arff	55881.0	55881.0	2.0	33.0	
45039	45039	compas-two-years	5	26324	active	arff	2483.0	2483.0	2.0	12.0	

In [3]:
```
openml.tasks.list_tasks(task_id=benchmark_suite.tasks, output_format="dataframe")
```

Out[3]:

	tid	ttid	did	name	task_type	status	estimation_procedure	evaluation_measures	so
361110	361110	TaskType.SUPERVISED_CLASSIFICATION	44156	electricity	Supervised Classification	active	10-fold Crossvalidation	predictive_accuracy	
361111	361111	TaskType.SUPERVISED_CLASSIFICATION	44157	eye_movements	Supervised Classification	active	10-fold Crossvalidation	predictive_accuracy	
361113	361113	TaskType.SUPERVISED_CLASSIFICATION	44159	covertype	Supervised Classification	active	10-fold Crossvalidation	predictive_accuracy	
361282	361282	TaskType.SUPERVISED_CLASSIFICATION	45035	albert	Supervised Classification	active	10-fold Crossvalidation	predictive_accuracy	
361283	361283	TaskType.SUPERVISED_CLASSIFICATION	45036	default-of-credit-card-clients	Supervised Classification	active	10-fold Crossvalidation	predictive_accuracy	
361285	361285	TaskType.SUPERVISED_CLASSIFICATION	45038	road-safety	Supervised Classification	active	10-fold Crossvalidation	predictive_accuracy	
361286	361286	TaskType.SUPERVISED_CLASSIFICATION	45039	compas-two-years	Supervised Classification	active	10-fold Crossvalidation	predictive_accuracy	

Accediendo a un conjunto ("electricity") mediante su identificador proporcionado en la lista de conjuntos de datos

In [4]:
```
from sklearn.datasets import fetch_openml
# Identificador correspondiente al conjunto de datos "electricity" con 9 características y 2 clases
data_id = 44156
X, y = fetch_openml(data_id=data_id, return_X_y=True, as_frame=False, parser="liac-arff")
```