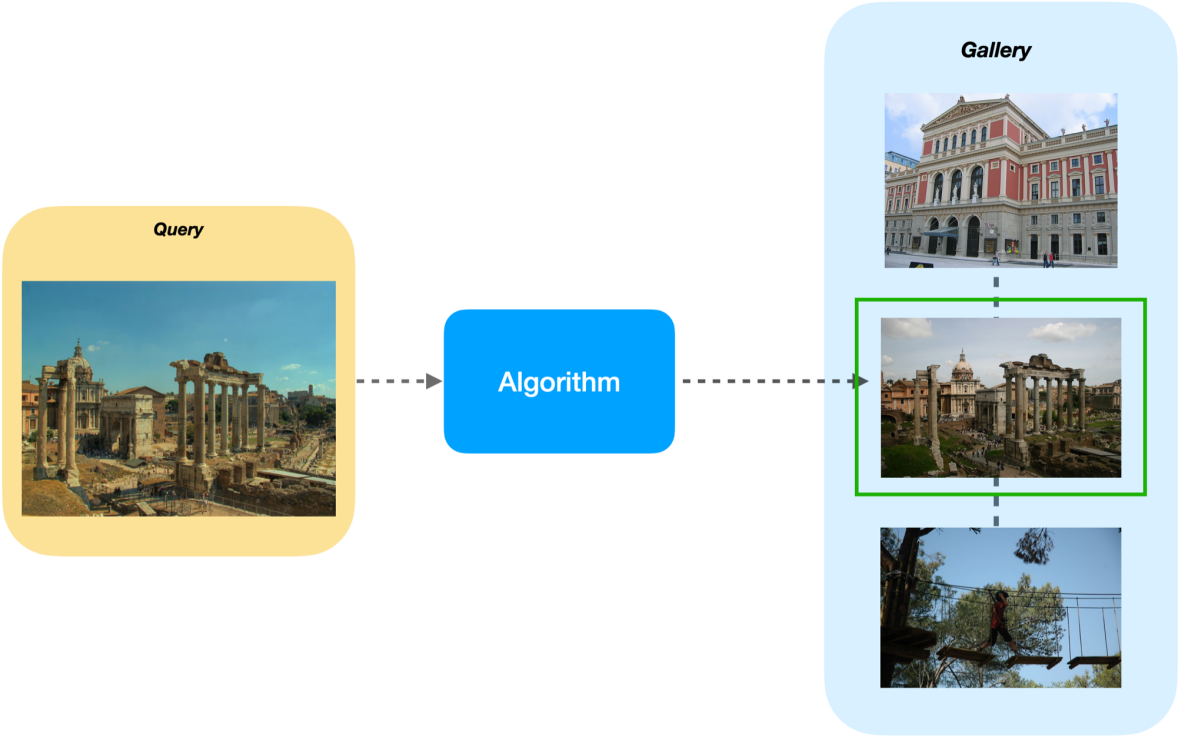
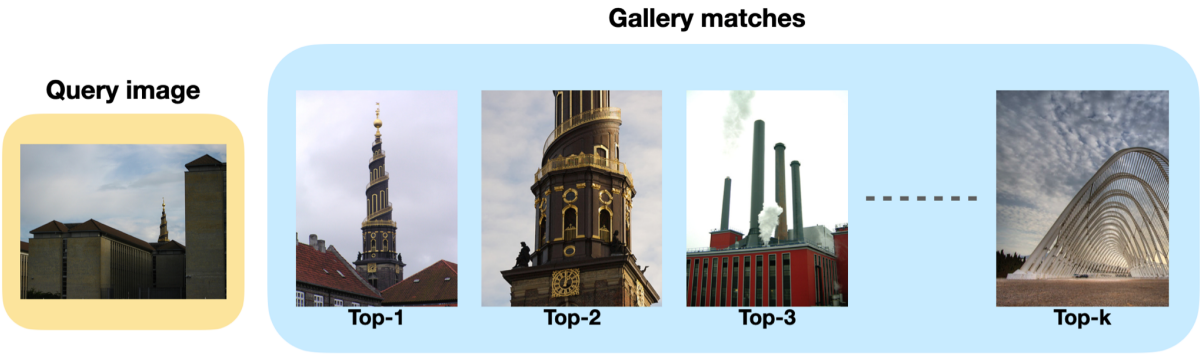
Applied Machine Learning Competition

1. **Rules:** the competition is not mandatory. Students who choose to participate the competition will present their solution during the competition day after the challenge and will discuss it during the oral exam. You can work in teams of at most 4 people, and each team is required to develop an original solution which should be properly justified and sustained. Each team is required to produce a report in IEEE format which will include an explanation of the design choices, the issues and performances encountered during the development and a table reporting the contribution of each team member to the project. In addition, the student is required to provide the source code. Report and code could be sent in a zip file. In alternative, students can produce a Colab notebook with runnable code, akin to what you have seen during the laboratory session. In case you opt for the latter solution, the submission consists in sharing the link to your colab notebook besides the report (sent by email). The submission of the report and code is mandatory to be done within 2 weeks from the expected oral exam date.

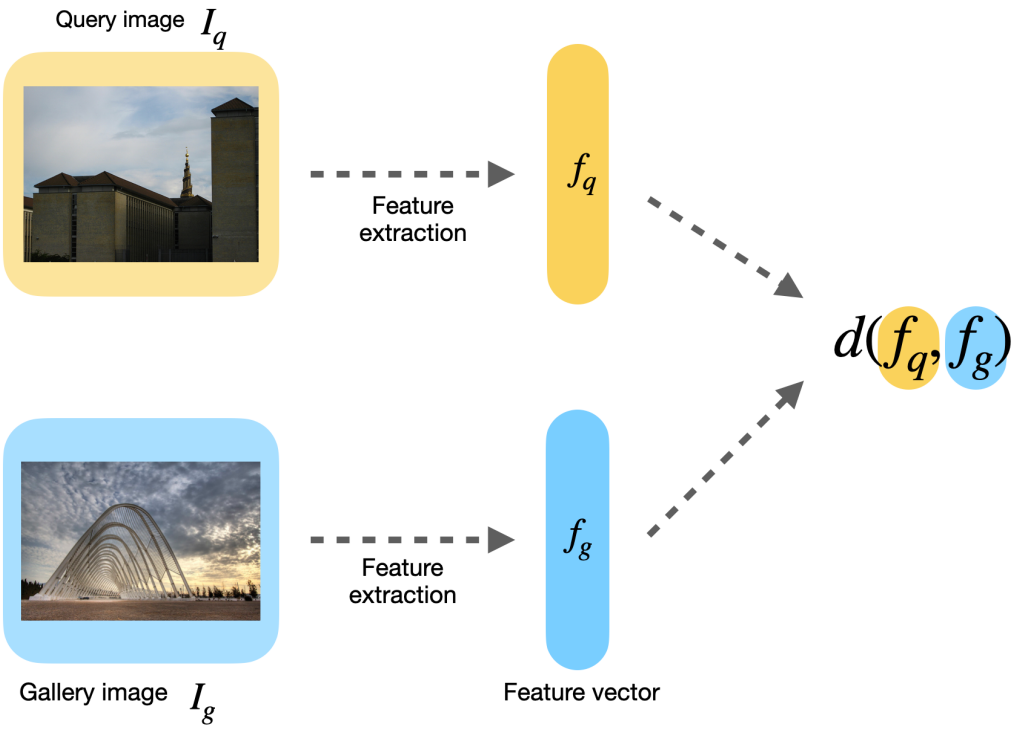
2. **Objectives:** the main objective of this project is to create an algorithm able to match the images in a *query* set with the images in a much larger set called *gallery*.
   The problem can be viewed as an extension of the identity verification task to places/buildings and can be thought of as a kind of image search engine. For clarity, let's have a look at the below example. Given the input query image, the algorithm has to be capable of matching the input query image with another gallery image



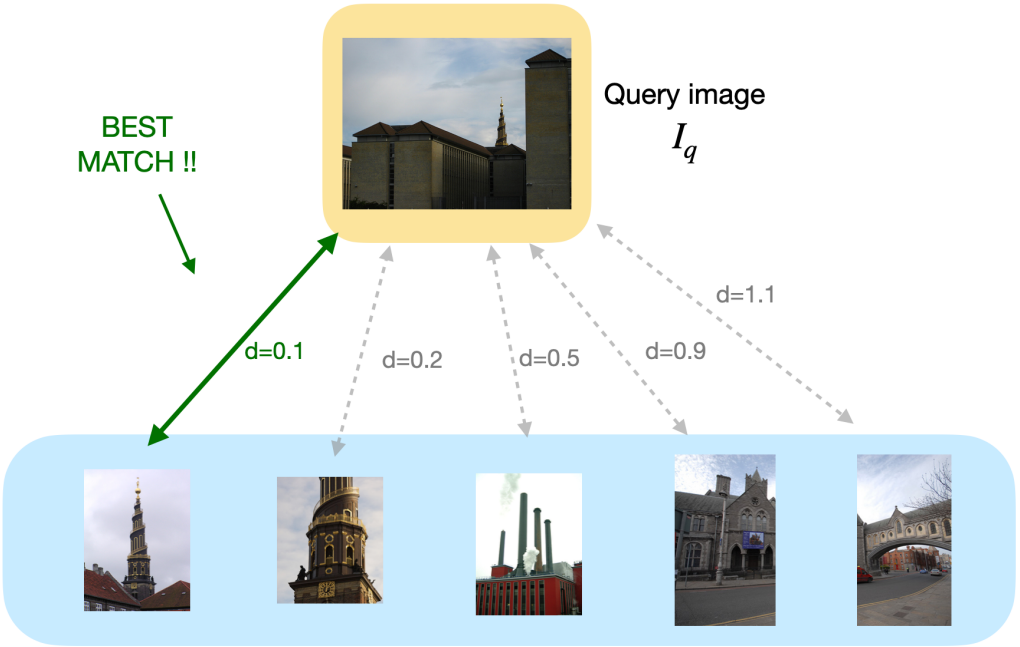
depicting the same scene/place or building. The expected algorithm's output is therefore a list of ranked matches between the query image and the gallery images. An example output is depicted below where the top-*k* matches are reported. In this case, the algorithm correctly matched top-1 and top-2 images while the others (the ones reported) are false matches.



At this point it is important to define how a match can be defined. Among all the possibilities, one of the most used method is the definition of a similarity/distance $d([], [])$ metric on top of extracted image features. As we saw during the colab example, once we extracted the query image features f_q, we can compute a similarity/distance measure between our query f_q and each gallery f_g.



Once the feature distance between each gallery image I_g and our query image I_q has been computed, we can sort each match based on $d(f_q, f_g)$ and define the top-*k* matches as the top-*k* gallery images with the lowest feature distance from our query.

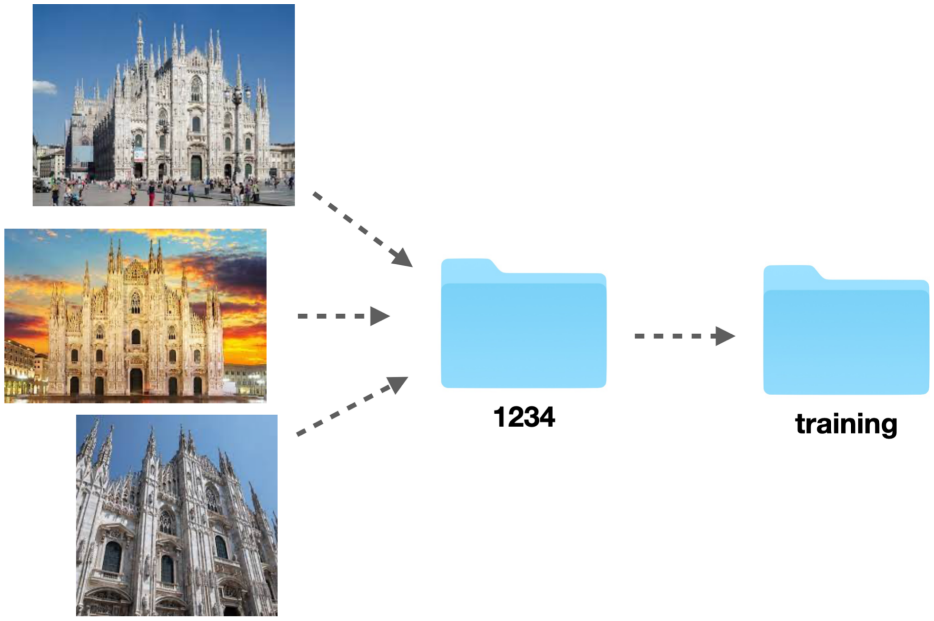


The given algorithm can be either pretrained on an external source of data (eg. *a*

dataset of landmarks) or run simply at test time without any learned parameter. Please, note that the algorithm is not trained on the gallery data, otherwise this would be a simple classification ;)
The secondary objective of the project is to practice in the acquisition of the data. As we saw during the course, collecting a large amount of data is crucial for ML applications. Therefore, you are required to largely expand the provided training data in order to improve your algorithm performance on the test sert. Let's see more details in the next section.

3. **Data:** we provide only an initial small amount of data but you are free to collect as much data you like to train your model to improve your algorithm performance. The provided initial dataset is composed of a training set and a validation set. The training set is composed of 697 images belonging to 21 different buildings/places and 1 distractor class. The validation set is divided into a gallery of 534 images among 15 classes and a query of 70 images (5 for each of the 14 classes). Finally, during the challenge day we will release the test set to measure the performance of your algorithm and to fill the leaderboard.

5. **How to add data:** let's say you want to add a new class for the Duomo di Milano in the training set. First, collect multiple instances of the Duomo di Milano. Second, place your instances in the same folder and name it with an ID not already used in the set you want to expand. Finally, move your new folder inside the training set folder. Note that in case you want to add a class to the query set, you have also to add it to the gallery set in order to be able to retrieve it.



4. **Where to find initial data and example code**: the data and the code shown during the challenge presentation can be found in this folder. In the ”dataset” folder you will find 2 sub-folders, one for each split. In the *training* folder, you will find a small amount of data that you are required to expand by adding data you will mine from external sources. In the validation folder you will find a *gallery* and a *query*. If you use Colab, you may need to have a look here.

5. **Methods to use:** you can use any of the methods which have been taught during this course. We encourage you not to limit the solution to just one method, but instead to try out different ones in order to better understand their strengths and limitations and report results obtained by each method.

6. **How to measure the performances:** the objective of the challenge is to obtain the best performance on the *test split*, namely, to match correctly the highest number of *test query* images in the *test gallery* images. To measure the performance of your algorithm we will use the **top-1**, **top-3** and **top-10** accuracy metric. The top-*k* accuracy metric allows to measure how often the correct match/label falls in the top-*k* matches/predictions and it's defined as:

$$Acc_{top-k} = \frac{C_k}{|Q_{val}|}$$

where

$$C_k = \sum_{q \in Q_{val}} 1_k(x_q, y_{top-k})$$

is the sum of correct matches among the top-*k* matches, Q_{val} is the test query set and $1_k()$ is the correct match function between the top-*k* gallery matches y_{top-k} and a query sample x_q.

7. **How to measure the performances on the test set:** we will release the test set during the challenge day. Regarding the submission format, we will provide additional details in the next few weeks!

8. **Contacts:** if you have any question or you want to submit your test results, send an email to cristiano.saltori@unitn.it