

Anomalous image detection

E. Decencière

MINES ParisTech
PSL Research University
Center for Mathematical Morphology



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Definition in layman terms

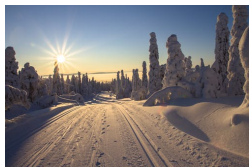
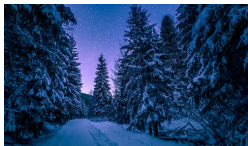
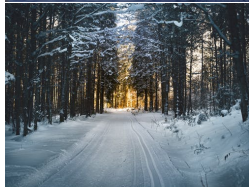
Anomaly detection

Let us consider a given kind of objects (for example, images). Among these objects, some are defined as being **normal**. The aim of the detection task is to decide, for a given object, if it is normal, or not.

The definition of normal objects is given through a set of examples.

We will focus on images, but the problem is very general.

Example - set of normal images



Example - which images are normal?

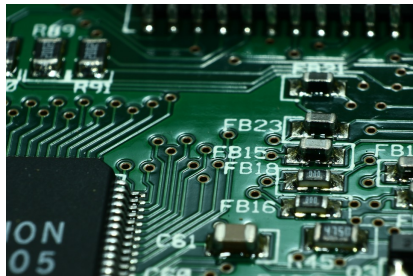


Application: security

- Intrusion detection in private network
- Suspicious object or unusual behaviour in a scene

Application: industrial control

- Non destructive testing (NDT)



Medicine

- Detection of suspicious conditions
- Non specific screening

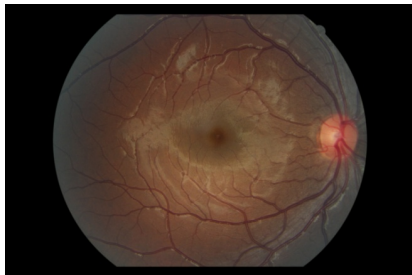


Figure: Retinal image used for pathology screening

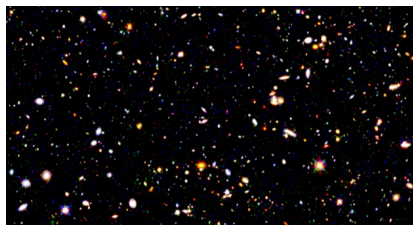
Science

- In some fields so many images are generated that it is becoming impossible to look at all of them
- Example: Euclid telescope (European Space Agency and Euclid consortium)



Euclid project

- A new space telescope, to be launched in 2022
- Its objective is improving our understanding of the acceleration of the universe expansion
- To do so, the shapes of galaxies at different distances from the earth will be measured
- An estimated 10^{10} extra galactic objects will be acquired by the telescope
- Data will be automatically analyzed, without visual inspection



Vocabulary

- Anomaly
- Novelty
- Outlier

In machine learning: one-class classification.

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Basic principles

- Let E be a set (the whole set of objects), \mathcal{N} the subset of E (constituted by all normal objects) and X a subset of N (the set of examples that are considered to be *normal*).
- The question we would like to answer is:

Is a given x in E normal?

- What should we add to our definition of E and X for this question to be meaningful?

Some possibilities:

- Metric space
- Probability space

Metric space

E is equipped with a distance d . We then can answer the question if there is a distance value d_0 such that:

$$x \in \mathcal{N} \iff d(x, X) \leq d_0$$

Of course, the essential point will be then how to choose the distance function d .

References I