“Learning approaches” – Discussion group

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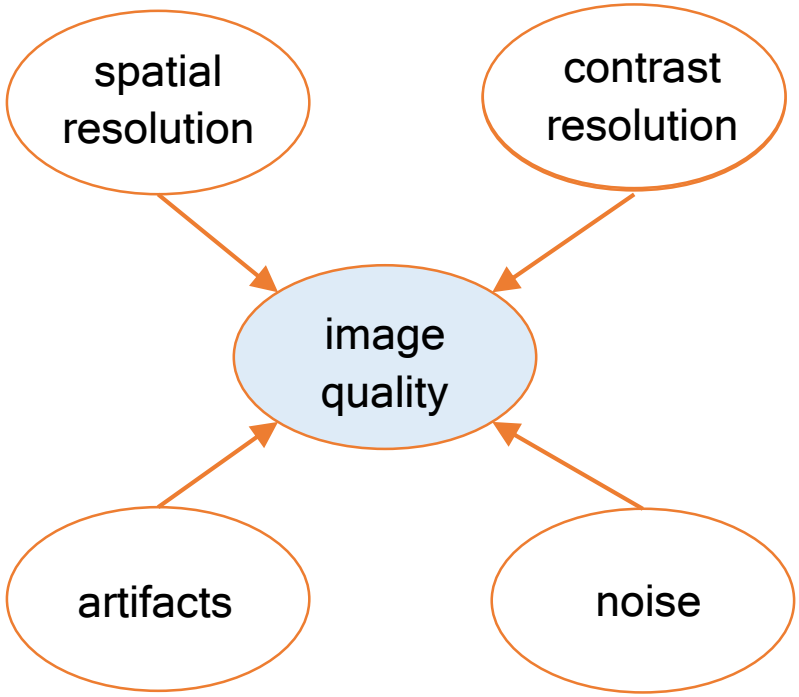
- The original idea:
  - ✓ To discuss about learning – based reconstruction methods

- The evolution (we actually discussed about…):
  - ✓ Objective evaluation of the **quality** of reconstructed images

- Motivations:
  - ✓ Sooner or later we need to have a good answer for:
    “Is this new method *better* than the other one?”

  - ✓ “Ok… what does *better* mean (for us)?”

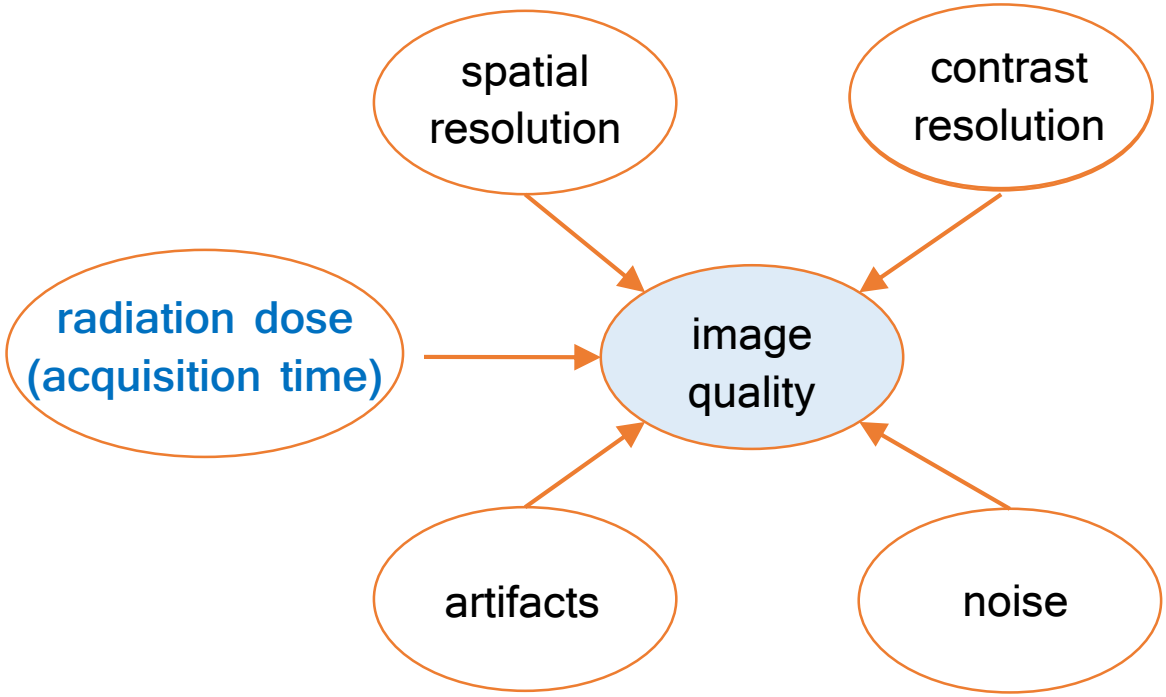
Image quality: the classical perspective



- The problem:

  The psychophysical visual perception of the quality of an image is a not yet well defined combination of these aspects

Image quality: a more CT-specific perspective



"While I cover my neck, I expose my feet, and if I cover my feet, I expose my neck."

Global quality indexes

- Quantitative descriptors such as:
  - ✓ CNR (Contrast-to-Noise Ratio)
  - ✓ A measure of spatial resolution
  - ✓ …

  are interesting quantitative values

- There's the need to have "global" and reliable quality indexes **for CT**

- Work has been done by the image (lossy) compression community
- We think that our community needs **CT-specific metrics**

Quality indexes: a review

- Full reference (FR) evaluation:

  The quality is defined with respect to a **reference image.** "Famous" indexes are:

  - ✓ MSE: Mean Squared Error
  - ✓ UQI: Universal Quality Index
  - ✓ SSIM: Structural Similarity
  - ✓ …

- Reduced reference (RR):

  Representative features about texture or other suitable characteristics are defined

  Then quality is defined with respect to these features

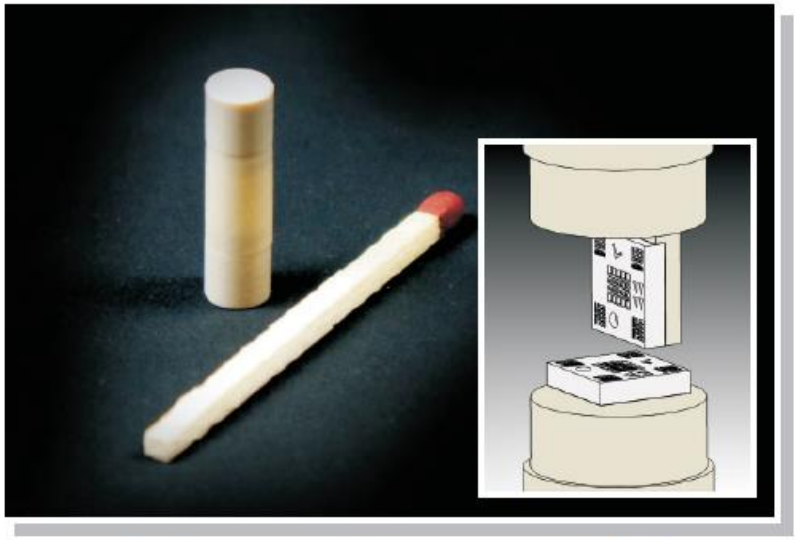
- No-reference (NR) evaluation:

  Metrics are defined based on **intrinsic properties** of the image itself

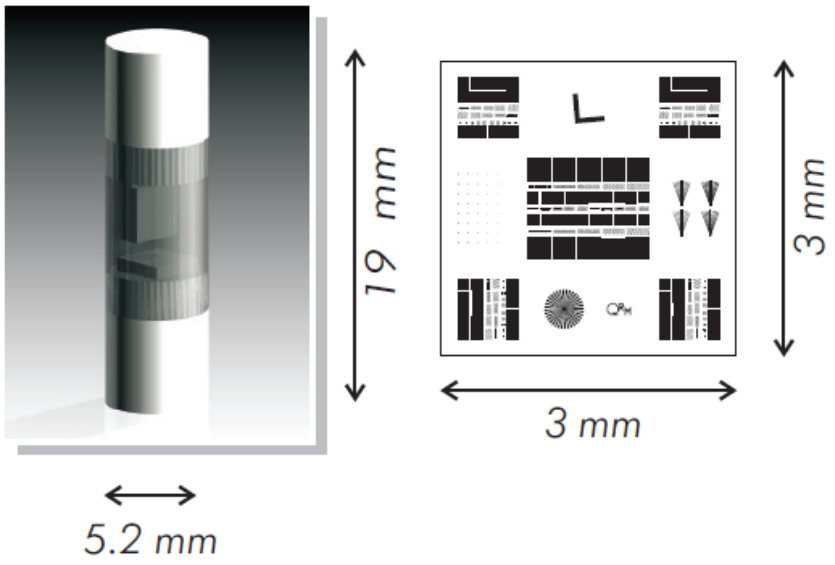
Example: full reference evaluation

- Probably the most “easy-to-understand” evaluation method

- The “mathematical” approach:
  - ✓ Work with simulated data (a phantom or the ground truth)
- The “experimental” approach:
  - ✓ Scan a phantom with known properties (e.g. bar patterns)

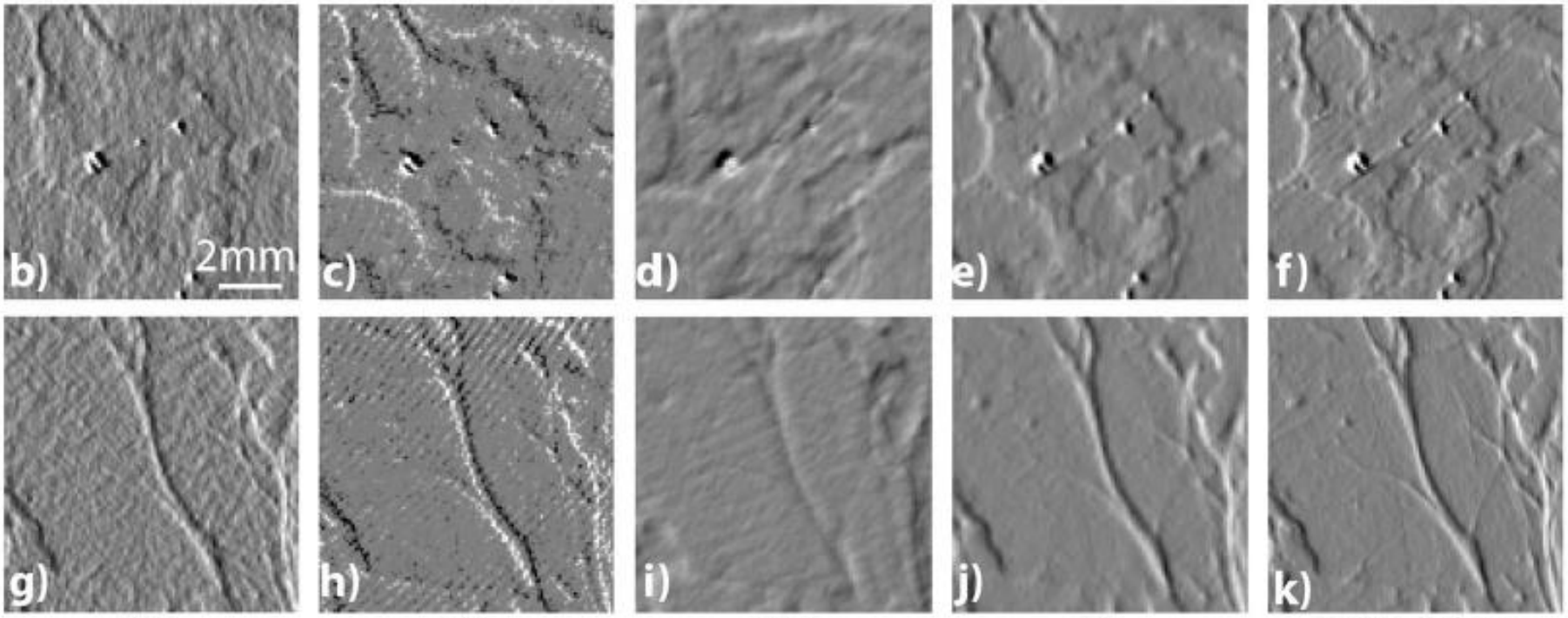


QRM-MicroCT-Barpattern-NANO



Example from the literature

- Often phantoms are hard to define (e.g. *in vivo* applications)
- Here an example [1] with mastectomy data



[1] DOI: 10.1371/journal.pone.0114325

The conclusion

- A message to/from the CT community:

  - ✓ We need to propose **CT-specific metrics** for image quality
  - ✓ Move from full-reference to no-reference methods

- Additional discussion:
  - ✓ Often segmentation (or image analysis) follows reconstruction
  - ✓ The quality issue can be postponed after the segmentation step