Deep Learning for Computer Vision

Program Magister Terapan PENS

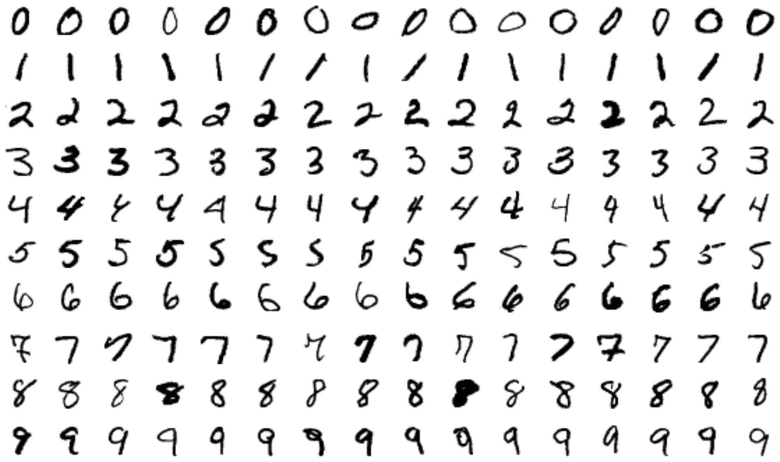
Applications of Deep Learning for Computer Vision

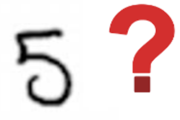
Jason Brownlee, 9 Applications of Deep Learning for Computer Vision, https://machinelearningmastery.com/applications-of-deep-learning-for-computer-vision/

1. Image Classification

- Assigning a label to an entire image or photograph.
  - **binary classification:**
    - Labeling an x-ray as cancer or not.
    - Labelling a photograph as cat or not
  - **multiclass classification**:
    - Classifying a handwritten digit.
    - Assigning a name to a photograph of a face.

Cancer or not ?





Classification

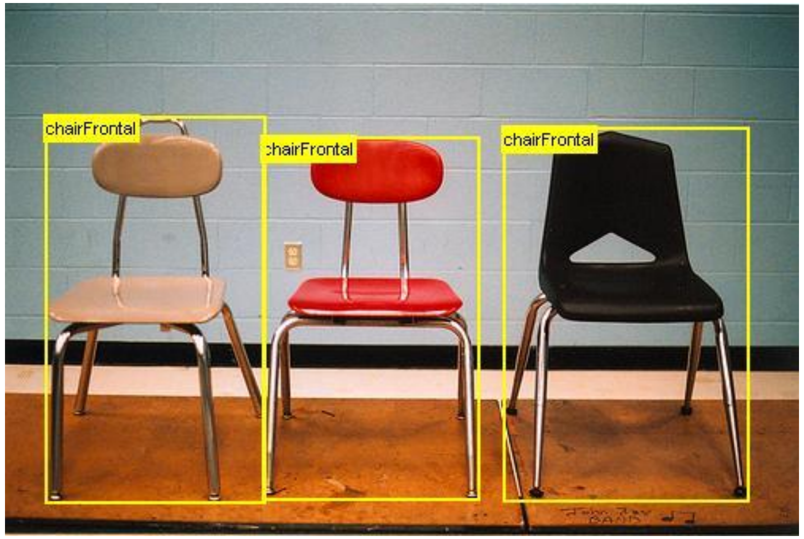
CAT

Example of Handwritten Digits From the MNIST Dataset

Qin et al., Computer-aided detection in chest radiography based on artificial intelligence: a survey, BioMedical Engineering, Springer, 2018

2. Image Classification with Localization

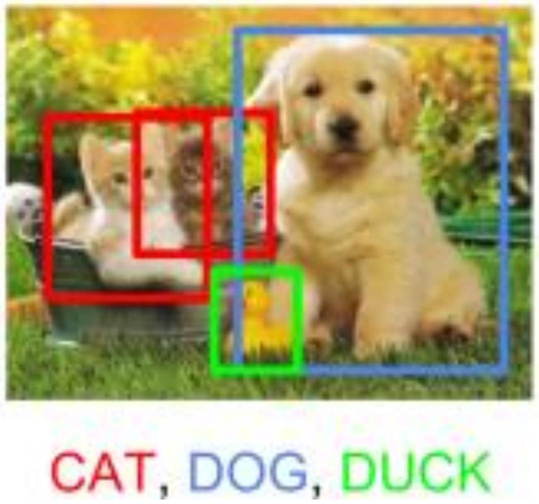
- Assigning a class label to an image and showing the location of the object in the image by a bounding box (drawing a box around the object).
  - **Classifying photographs of animals** and drawing a box around the animal in each scene.
  - **Labeling an x-ray as cancer or not** and drawing a box around the cancerous region.
- Datasets : PASCAL VOC (VOC 2012) and ILSVRC2016 (comprised of 150,000 photographs with 1,000 categories of objects).



Example of Image Classification With Localization PASCAL VOC 2012

3. Object Detection

- Label an image that may contain multiple objects that require localization and classification.
- It is more complex than simple image classification or image classification with localization, as often there are **multiple objects** in the image of different types.
- Common datasets: PASCAL VOC (VOC 2012) and MS COCO.



Example of Object Detection with Faster R-CNN on the MS COCO Dataset

4. Object Segmentation

- Or semantic segmentation, is the task of object detection where a line is drawn around each object detected in the image.
- Identifies the specific pixels in the image that belong to the object.
- Common datasets: KITTI, PASCAL VOC (VOC 2012) and MS COCO.

Example of Object Segmentation on the COCO Dataset Taken from “Mask R-CNN”.

5. Style Transfer

- Style transfer is the task of learning style from one or more images and applying that style to a new image.
- Example: applying the style of specific famous artworks (e.g. by Pablo Picasso or Vincent van Gogh) to new photographs.
- Dataset: using famous artworks and photographs from standard computer vision datasets.
- May not have an objective evaluation

Example of Neural Style Transfer From Famous Artworks to a Photograph. Taken from “A Neural Algorithm of Artistic Style”

6. Image Colorization

- Image colorization involves converting a grayscale image to a full color image.
- Examples: colorizing old black and white photographs and movies.
- May not have an objective evaluation.
- Datasets: using existing photo datasets and creating grayscale versions of photos that models must learn to colorize.

Examples of Photo Colorization Taken from “Colorful Image Colorization”

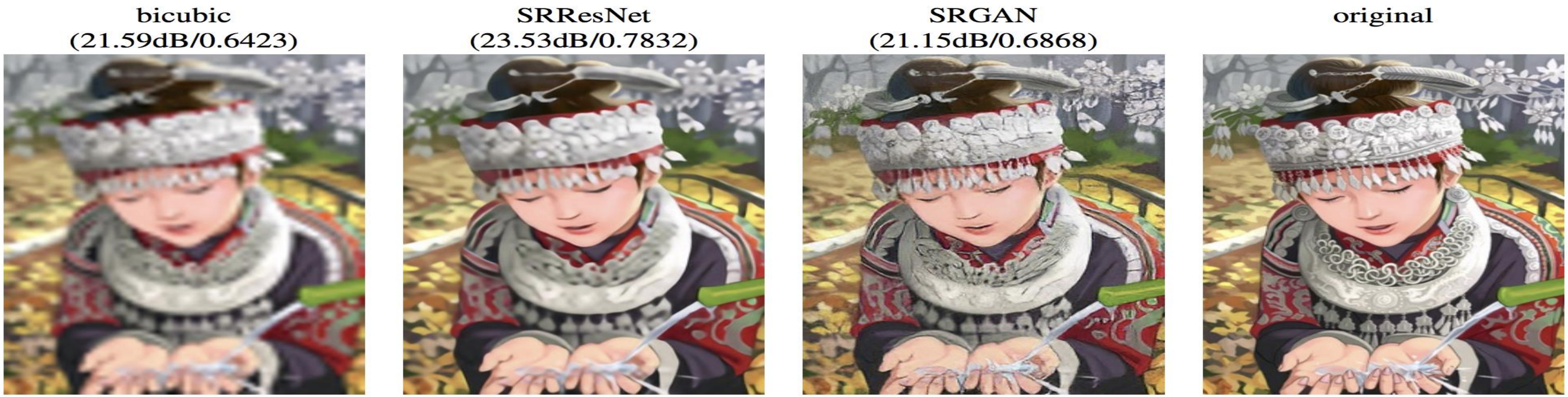
7. Image Reconstruction/Restoration

- It is the task of filling in missing or corrupt parts of an image.
- Example: reconstructing old, damaged black and white photographs and movies.
- May not have an objective evaluation
- Datasets: using existing photo datasets and creating corrupted versions of photos that models must learn to repair.

Example of Photo Inpainting. Taken from “Image Inpainting for Irregular Holes Using Partial Convolutions”

8. Image Super-Resolution

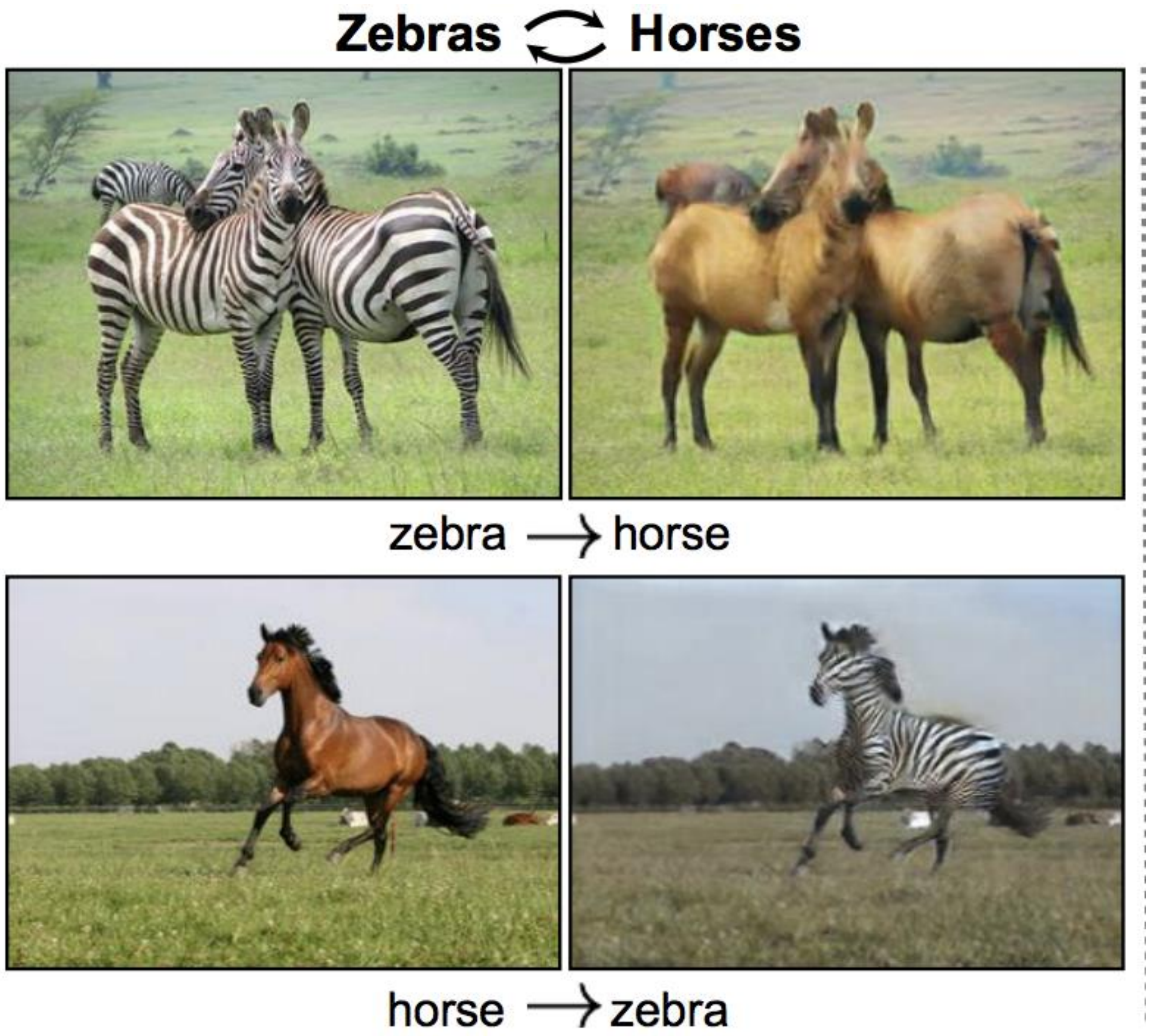
- It is the task of generating a new version of an image with a higher resolution and detail than the original image.
- Datasets: using existing photo datasets and creating down-scaled versions of photos or which models must learn to create super-resolution versions.



Example of the Results From Different Super-Resolution Techniques.
Taken from "Photo-Realistic Single Image Super-Resolution Using a Generative Adversarial Network"

9. Image Synthesis

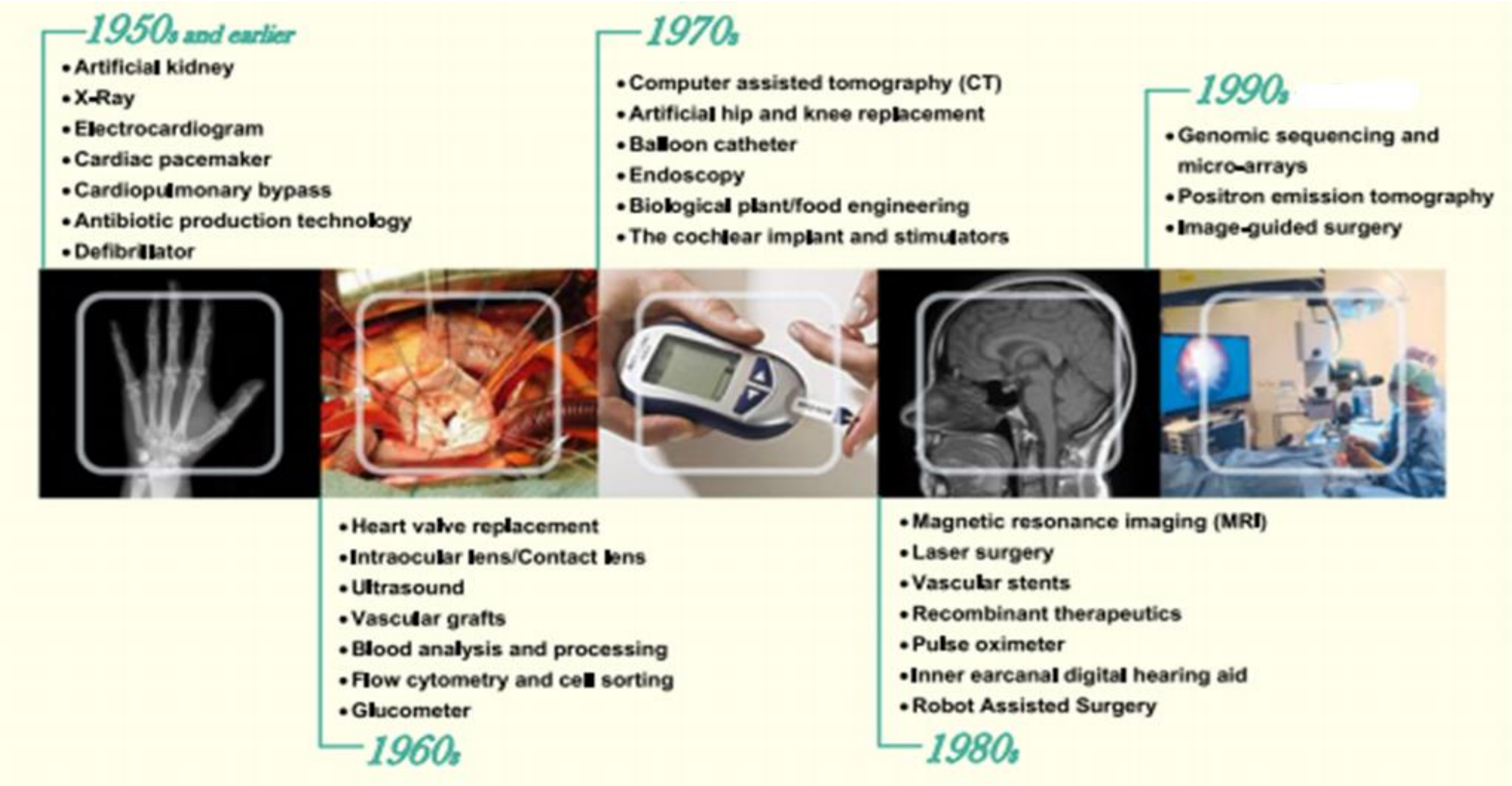
- It is the task of generating targeted modifications of existing images or entirely new images.



Example of Styling Zebras and Horses.
Taken from “Unpaired Image-to-Image Translation using Cycle-Consistent Adversarial Networks”

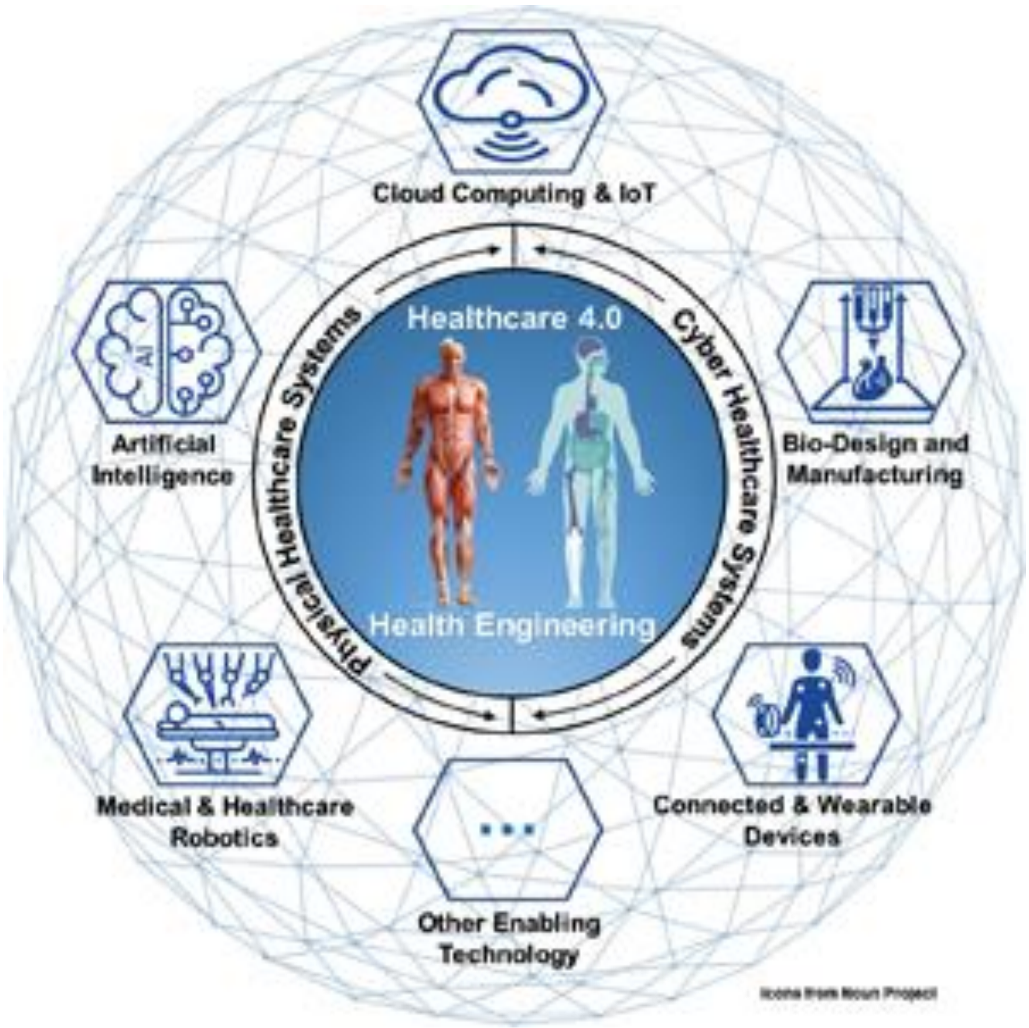
Medical image (Radiology) and Healthcare 4.0

Medical and Biomedical Engineering Innovations Across the Decades



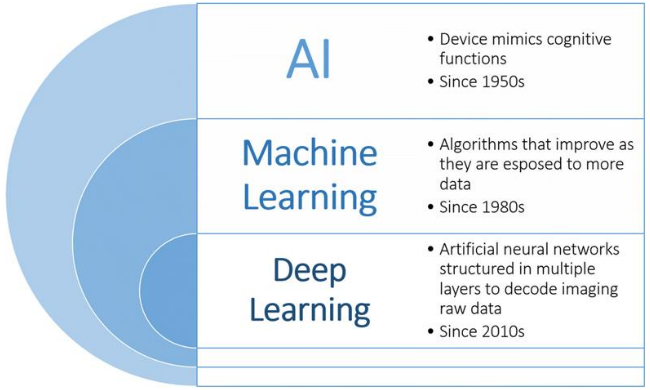
American institute for medical and biological engineering's hall of fame . M. R. Neuman et al., "Advances in medical devices and medical electronics,"Proc. IEEE, vol. 100, no. Special Centennial Issue, pp. 1537–1550, May 2012 and Sumber Geng Yang, Introduction to the Special Section: Convergence of Automation Technology,Biomedical Engineering, and Health Informatics Toward the Healthcare 4.0, IEEE Reviews in Biomedical Engineering, January 2018. DOI: 10.1109/RBME.2018.2848518

The fourth revolution in healthcare technologies (Healthcare 4.0)



As a result, the industry is **facing a second wave of digitalization**, sometimes also referred to as "**Healthcare 4.0**".

Big Data
Artificial Intelligent
Internet of Things
mobile patient platforms
⇩
change every day healthcare practice



https://jbhi.embs.org., Filippo Pesapane, Marina Codari, Francesco Sardanelli, Artificial intelligence in medical imaging: threat or opportunity? Radiologists again at the forefront of innovation in medicine, European Radiology Experimental, page 2-35, 2018. doi:10.1186/s41747-018-0061-6

Common medical Imaging

https://www.radiologyinfo.org

http://medicalpicturesinfo.com

http://medicalpicturesinfo.com

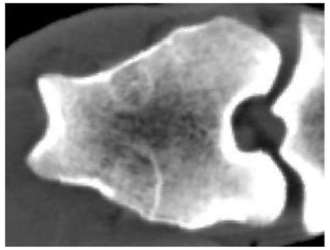
Computed Tomography
- Radiation exposure
- Expensive

• Limited frequency of use
• Allowed only for patient and cadaver
• Not for healthy human

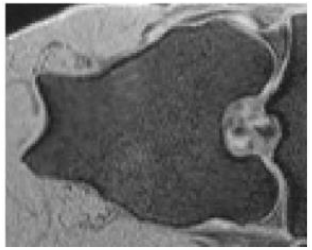
Magnetic Resonance Imaging
- Radiation free
- Expensive
- For soft tissues

Ultrasound
- Radiation free
- Cost effective
- widely available

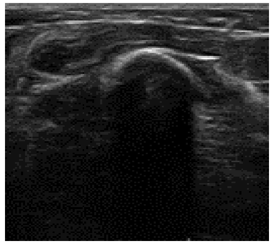
CT-scan



MRI



Ultrasound

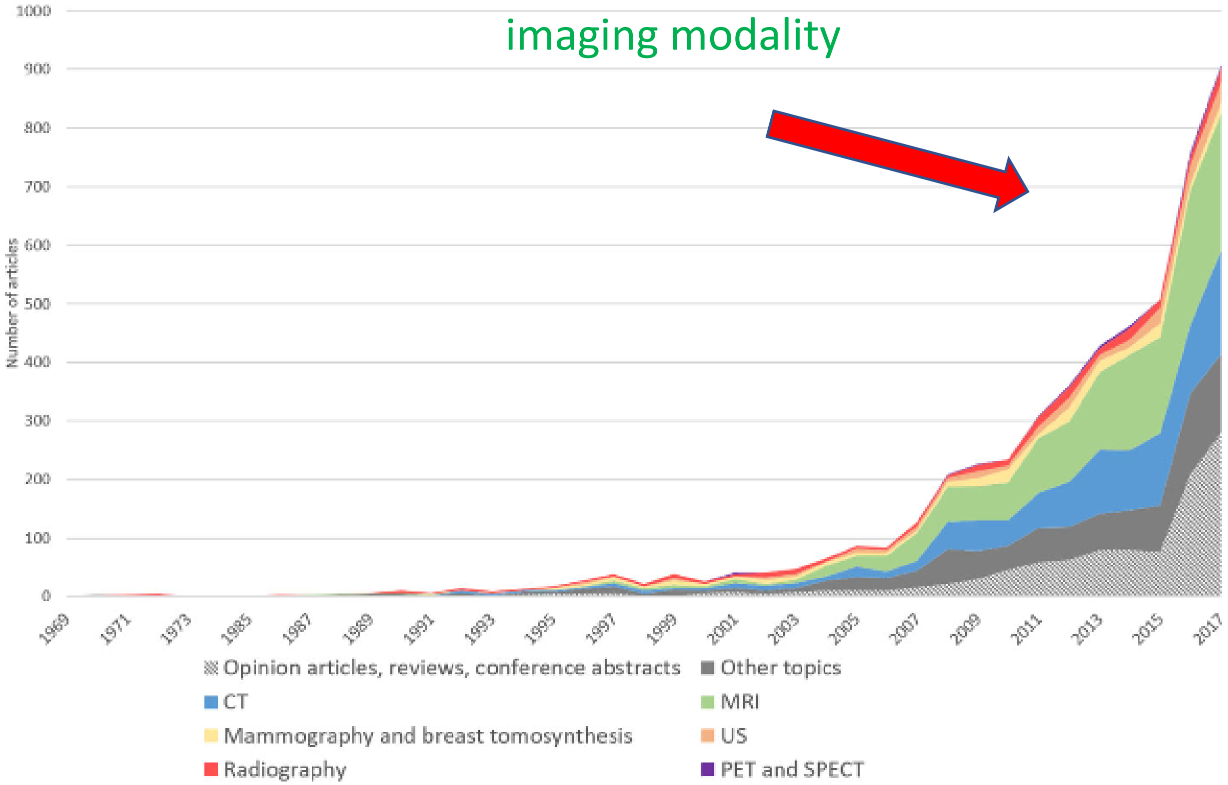


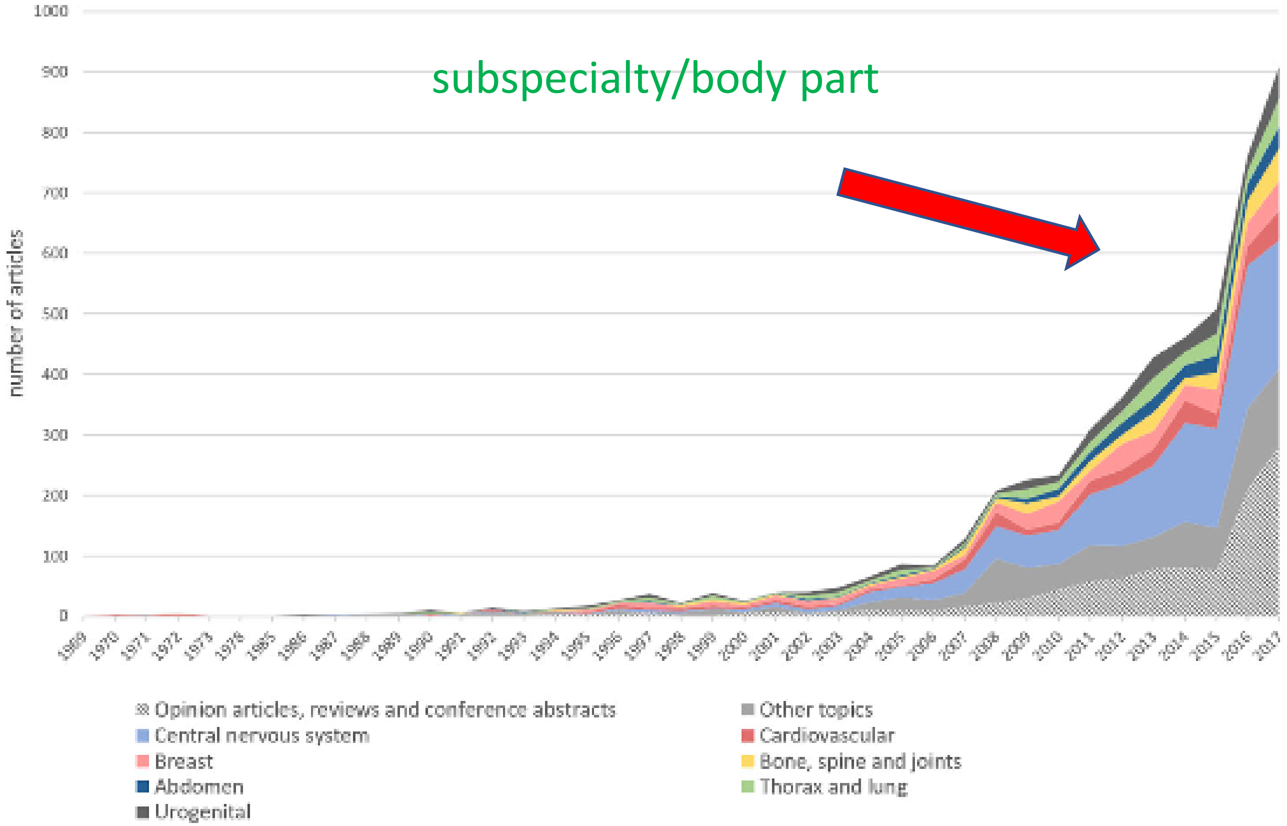
(Rathnayaka et al., 2012)

Information and Data Center, Ministry of Health, Republic of Indonesia
(Chalid and Ajeng, 2014)

Medical	Total
MRI	113
Ultrasound	1.441
CT-Scan	410
X-Ray	1.258
Mammography	368

The great enthusiasm for the development of AI systems in radiology

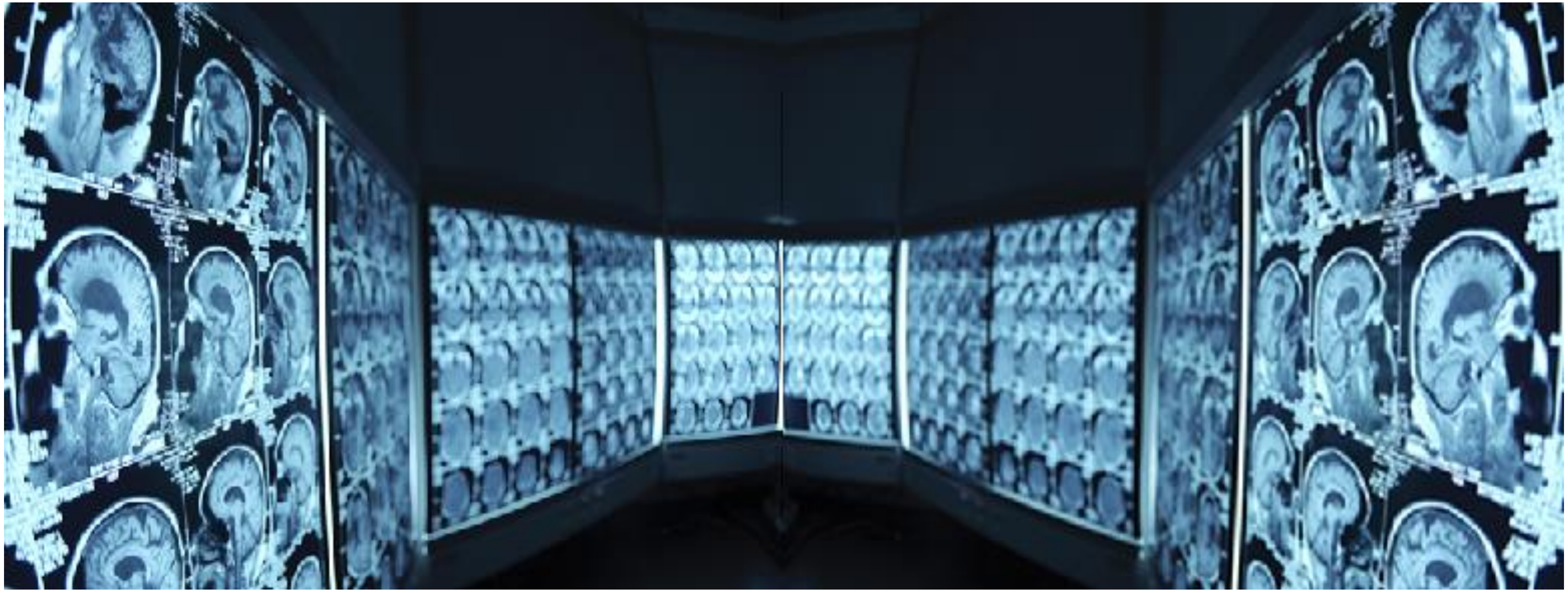




Over 10 years, publications on AI in radiology have increased from 100–150 per year to 700–800 per year.

https://eurradiolexp.springeropen.com/track/pdf/10.1186/s41747-018-0061-6

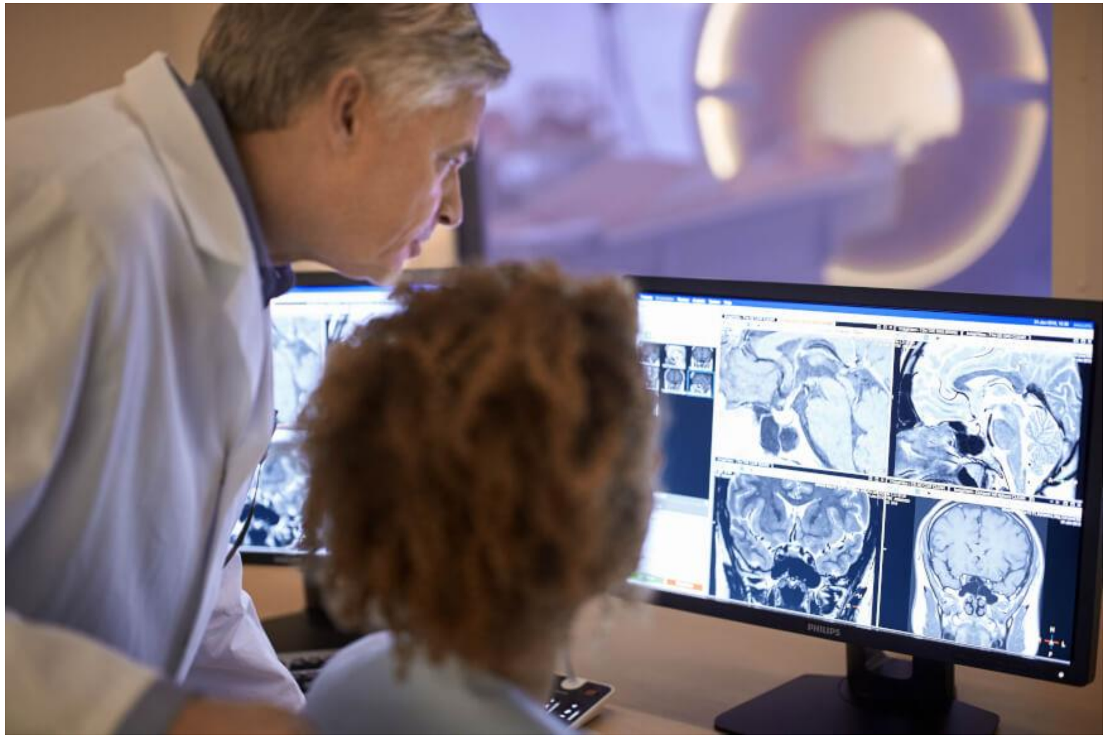
Artificial intelligence in medical imaging: threat or opportunity?



https://researcher.watson.ibm.com/researcher/view_group.php?id=4384 and www.cartoonstrock.com

Challenges in introducing AI to the radiology department

- *acquiring access and ingesting the data*
- *sufficiently annotating the data*
- the creation of high-quality training datasets
- *storage strategy*
- interpretation of obtained results
- *governance/policy use throughout*
- *legal and ethical*



https://medicalfuturist.com/the-future-of-radiology-and-ai

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