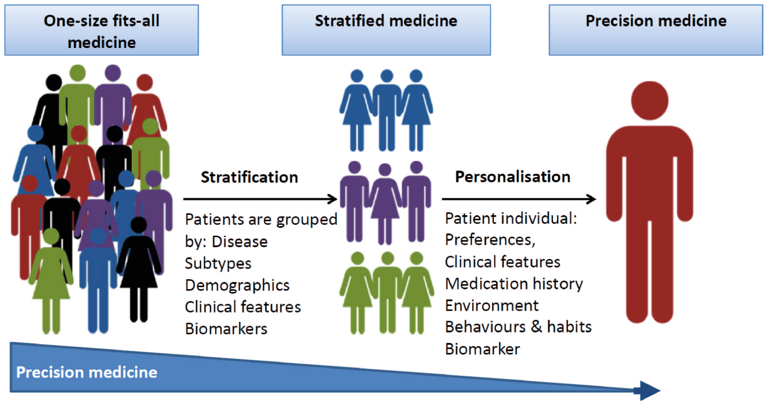
COMP 3411/9414
Artificial Intelligence

AI in Computer Vision – Part 3

AI in Biomedical Imaging

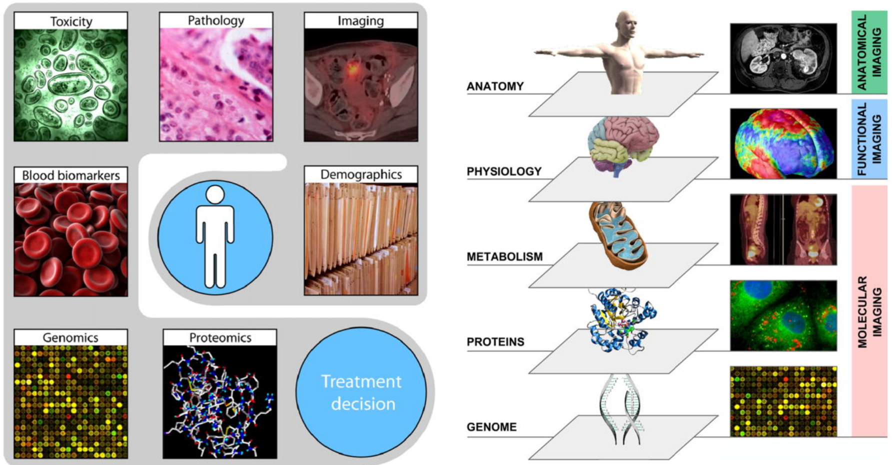
- Why do we need Biomedical Images?
- Why do we need AI for it?
- Is there any particular challenge in this?
- How do we address these challenges?

Precision Medicine



Source: Manchester Precision Medicine Institute

Biomedical Imaging in Precision Medicine

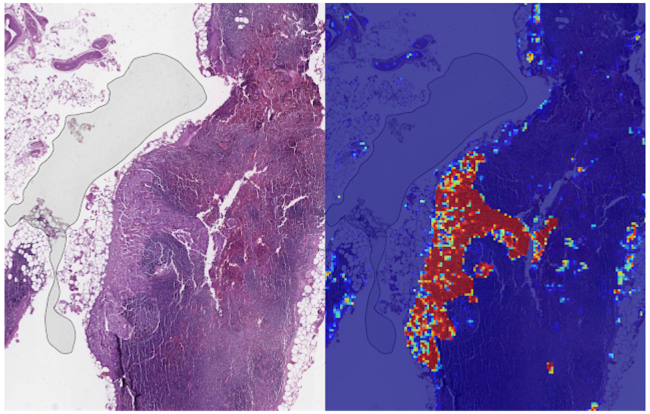


Source: P. Lambin *et al.*, *Eur J Cancer* 48(4):441-446, 2012

AI in Biomedical Imaging

- Biomedical services and research produce lots of imaging data
- With big data, analysis becomes a huge problem
- AI is essential in achieving automated, effective and reproducible analysis of biomedical imaging data
- There are however many unique challenges with biomedical images compared to general non-medical images
- Companies such as GE, Siemens and Google invest heavily in AI-based biomedical imaging applications

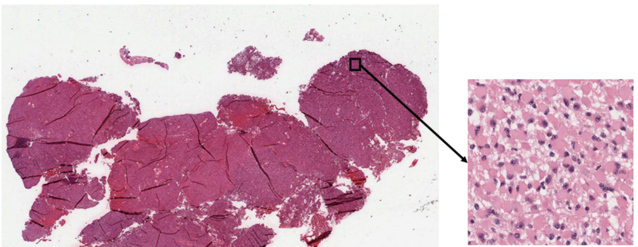
Cancer Detection



Source: https://ai.googleblog.com/2018/10/applying-deep-learning-to-metastatic.html

Cancer Detection

- Whole-slide image (WSI): very high resolution images
- A shift to fully digital environment for pathology



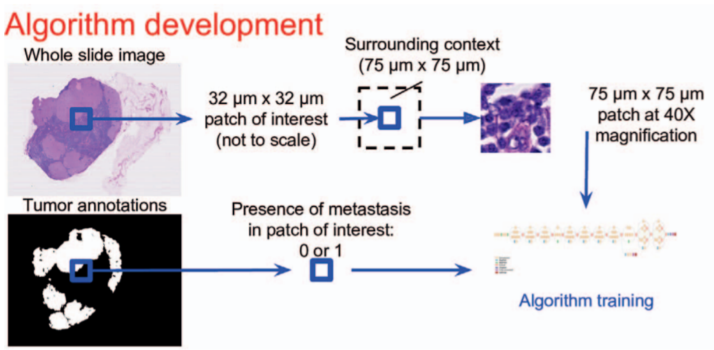
40x magnification

Cancer Detection

Source: https://ai.googleblog.com/2018/10/applying-deep-learning-to-metastatic.html

Cancer Detection

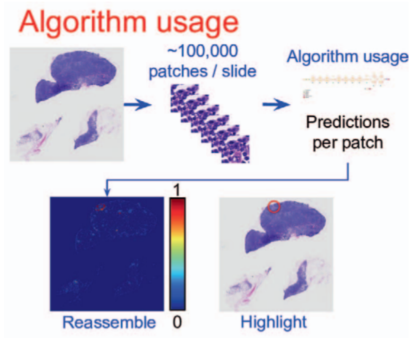
- Training stage:
  - Patch-wise processing with patch-level labels



Source: Y. Liu et al. *Artificial intelligence-based breast ancer nodal metastasis detection*. Arch Pathol Lab Med, 2018.

Cancer Detection

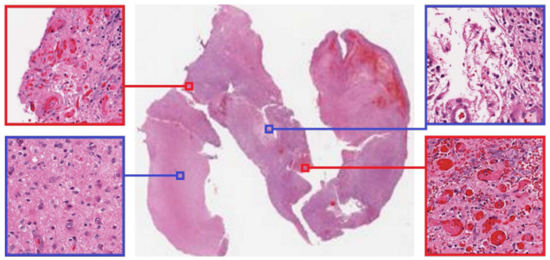
- Testing stage:
  - Patch-wise classification



Source: Y. Liu et al. *Artificial intelligence-based breast ancer nodal metastasis detection*. Arch Pathol Lab Med, 2018.

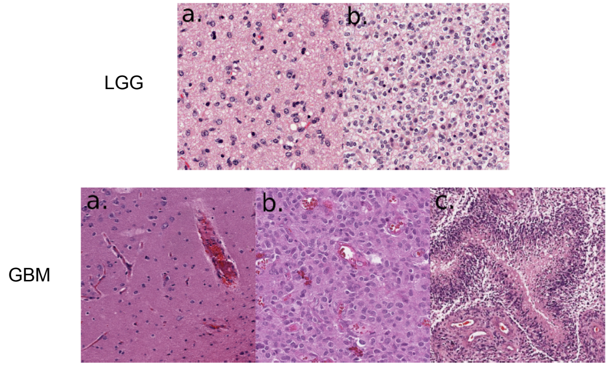
Real Challenges

- Challenge I:
  - Large image with image-level label only



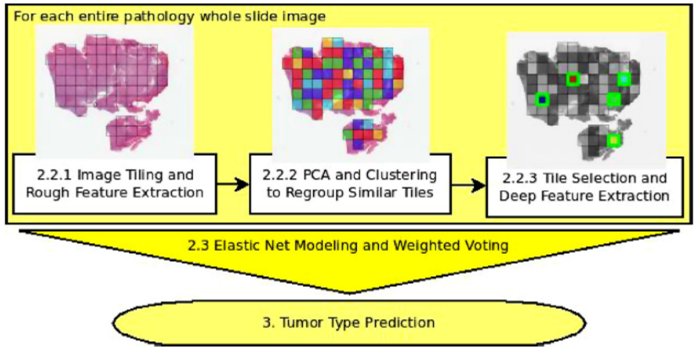
Real Challenges

- Challenge II:
  - Histology heterogeneity (subtypes and regional variations)



Clustering-based

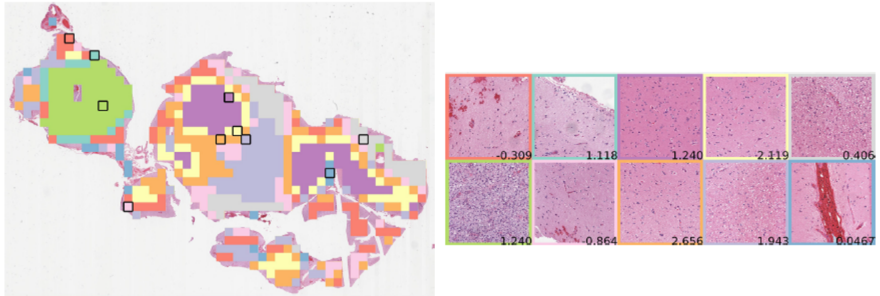
- Coarse and fine feature extraction:



J. Barker *et al.*, "Automated classification of brain tumor type in whole-slide digital pathology images using local representative tiles," *Medical Image Analysis*, 30(1):60-71, 2016.

Clustering-based

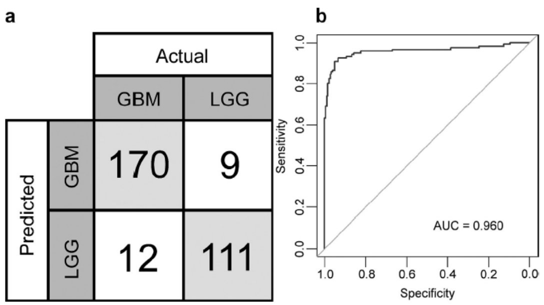
- Coarse and fine feature extraction:
  - Clustering-based representative tile extraction



J. Barker *et al.*, "Automated classification of brain tumor type in whole-slide digital pathology images using local representative tiles," *Medical Image Analysis*, 30(1):60-71, 2016.

Clustering-based

- Coarse and fine feature extraction:



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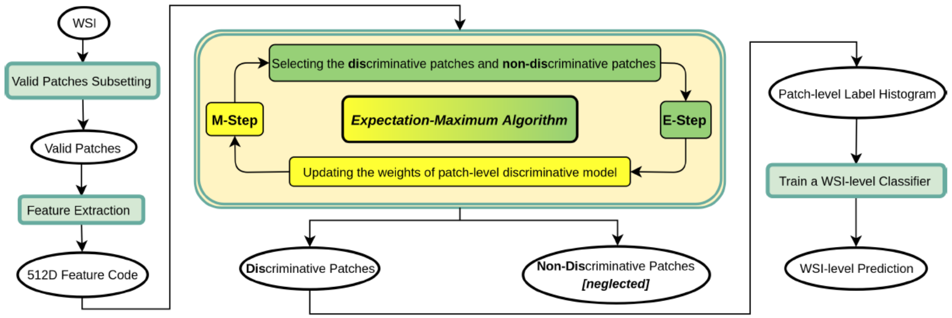
Pruning-based

- Discriminative patch-based CNN:
  - EM-based discriminative patch extraction



Source: C. Zhang et al. *Whole slide image classification via iterative patch labelling*. ICIP, 2018.

Pruning-based

- Discriminative patch-based CNN:
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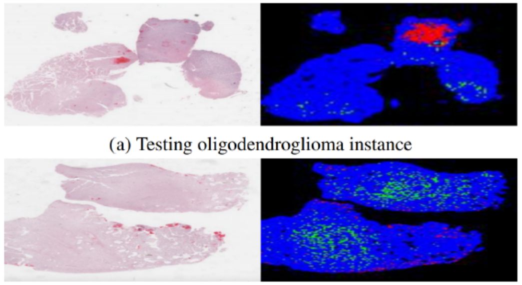


(a) Testing oligodendroglioma instance

(b) Testing astrocytoma instance

Source: C. Zhang et al. *Whole slide image classification via iterative patch labelling*. ICIP, 2018.

Pruning-based

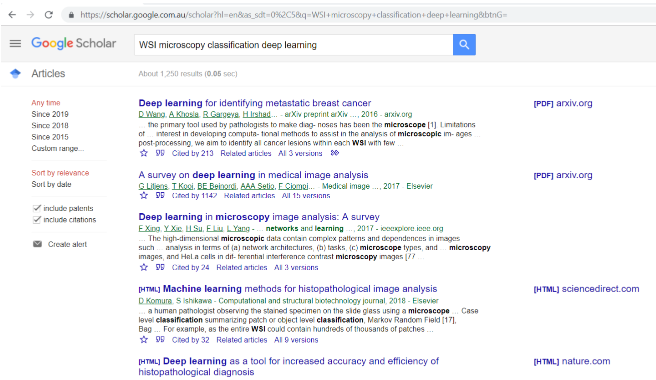
- Results on the CBTC challenge dataset:
  - 32 WSI images, with 16 astrocytoma and 16 oligodendroglioma cases

Methods	Acc.
CNN-Feat-SVM	62.50%
Finetune-CNN-Feat-SVM	69.13%
Iter-Finetune-CNN-SVM[Discriminative]	76.62%
Iter-Finetune-CNN-SVM[Both]	**84.38%**

Source: C. Zhang et al. *Whole slide image classification via iterative patch labelling*. ICIP, 2018.

More Studies

- There are many other approaches for WSI analysis.
  - Do a search in *Google Scholar*
  - Keywords: WSI, microscopy, classification, deep learning



Summary

- Biomedical imaging is critical in precision medicine.
- There are unique challenges when analysing biomedical images:
  - Insufficient ground truth
  - Highly heterogeneous data
- This is a very active area both in industry and research.