Bunch of Barcode for Identification of Histopathology Images

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Shivam Kalra (speaker)
Agenda

- Type of AI applications
- Importance of search
- Indexing for fast retrieval
  - Bunch of Barcodes (BoB).
- Validation of search
What can AI do with Images?

**Prediction**
- Cancer/Not Cancer
- 70% cellularity

**Segmentation**

**Searching**

**supervised**

**unsupervised**
Prediction vs Search

**Prediction:** emphasis on decision making

- ?
- pathologist
- Yes/No
- AI Software

**Search and retrieval:** emphasis on “virtual peer review”

- pathologist
- similar cases
- AI Software
Can AI replace the pathologist?

No, because Alan Turing is right!

• Human operator is the ultimate **validator** of AI performance
• No **FULL** automation possible!
DIAGNOSIS

(A) THYMUS AND PERICARDIUM:
THYMOMA, SPINDLE CELL, INVASIVE.
Margin of resections, negative for tumor.

(B) LUNG, RIGHT MIDDLE LOBE, WEDGE:
Fragments of lung parenchyma with focal ossification.

GROSS DESCRIPTION

(A) THYMUS AND PERICARDIUM - A well circumscribed mass, 9.5 x 7.0 x 5.8 cm, fibroadipose tissue, 15.0 x 10.0 x 1.5 cm and one piece of pericardium, 9.0 x 5.0 cm. A resection margin inked black. The specimen is serially sliced. Cut surface reveal a well encapsulated white-tan lobular and nodular soft tumor. No necrosis and hemorrhage are identified in the tumor.

SECTION CODE: A1, A2, tumor and pericardium with resection margin of pericardium; A3, A4, tumor and closest resection margin of soft tissue; A5-A9, tumor and around soft tissue; A10, representative section of adipose tissue.

(B) RIGHT MIDDLE LOBE WEDGE -- One pale tan wedge specimen (1.6 x 0.4 x 0.4 cm) with pale tan pleura with focal hemorrhage. The parenchymal resection margin is inked and specimen. serially sectioned perpendicular to the parenchymal resection margin. One pale gray, firm nodule (0.2 x 0.2 x 0.2 cm) is identified, located at 0.4 cm from parenchymal resection margin and abutting the pleura. Specimen entirely submitted.

INK CODE: Blue -- resection margin of parenchyma.

SECTION CODE: BI, nodule with adjacent tissue; B2, remainder of the specimen.

Can AI replace the pathologist?
No, because AI is weak!
Why search?

AI algorithms operating on indexed image archive
Why search?

We are already doing image search!

Pathology Consultation

Source: www.aruplab.com

Source: epl-inc.com

Source: cancer.osu.edu
Why using AI for image search?

“Virtual Peer Review”

Query
Whole Slide Image

Image Search Engine

Papillary thyroid carcinoma
>> read more

Thyroid Medullary carcinoma
>> read more

Noninvasive follicular thyroid neoplasm with papillary-like nuclear features
>> read more
Image Characterization

CONVOLUTION
SUBSAMPLING

CONVOLUTION
SUBSAMPLING

X

Class
WSI Content Barcoding

Using MinMax barcoding scheme

Bunch of Barcode Index

WSI ~ 300-400 MB
Index ~ 15-17 KB
<table>
<thead>
<tr>
<th>Tissue</th>
<th>Disease/Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenal</td>
<td>Pheochromocytoma</td>
</tr>
<tr>
<td>Bone</td>
<td>Giant cell tumor</td>
</tr>
<tr>
<td>Brain</td>
<td>GLIOBLASTOMA</td>
</tr>
<tr>
<td>Breast</td>
<td>LOBULAR CARCINOMA IN SITU</td>
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<tr>
<td>Breast</td>
<td>INVASIVE DUCTAL CARCINOMA</td>
</tr>
<tr>
<td>GI</td>
<td>KAPOSI’S SARCOMA</td>
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<tr>
<td>Kidney</td>
<td>ANGIOMYOLIPOMA</td>
</tr>
<tr>
<td>Lung</td>
<td>Adenocarcinoma</td>
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<tr>
<td>Prostate</td>
<td>PROSTATIC ADENOCARCINOMA</td>
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<tr>
<td>Salivary gland</td>
<td>BASAL CELL ADENOCARCINOMA</td>
</tr>
<tr>
<td>Skin</td>
<td>Merkel cell carcinoma</td>
</tr>
<tr>
<td>Thyroid</td>
<td>Papillary thyroid carcinoma</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Source of Data:**
Dr. Liron Pantanowitz
More than 500 classes for image search
Search Results

- We search horizontally (across all body parts)
- No training! Nothing has been adjusted for search
- For a given WSI we retrieve similar WSIs
- Harsh validation: if not same class, then counted as wrong!
Validation – Correct Retrieval

First match correct: 92%
Second match correct: 87%
Third match correct: 84%
Validation – Correct Retrieval

Brain
Glioblastoma Multiforme

Successful Distance: 91

Successful Distance: 93

Successful Distance: 96
Validation – Correct Retrieval

Lung
Lung Adenocarcinoma

Successful
Distance: 78

Successful
Distance: 78

Failed (Lung Squamous Cell Carcinoma)
Distance: 79
Validation – Distance vs Pathologist Opinion

Hamming distance aligns with pathologist’s opinion.
Validation - Classification

Classification using top-5
- Brain Lower Grade Glioma
- Glioblastoma Multiforme

Accuracy: 87%
Summary

• AI can help in many different ways
• Search is a pathologist-centric AI approach
• Search can establish “virtual peer review”
• Search can contribute to “consensus”
Support

Ontario Research Fund – Research Excellence
Thank you. Question?