Artificial Pathologists

Machine Learning Models for Histopathology

Aïcha BenTaieb and Ghassan Hamarneh
In Collaboration With: Hector Li-Chang and David Huntsman

SFU SIMON FRASER UNIVERSITY ENGAGING THE WORLD

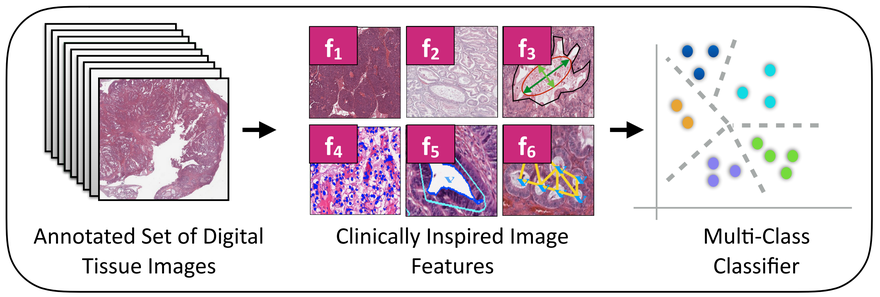
MIAL Medical Image Analysis Lab

BC Cancer Agency CARE & RESEARCH An agency of the Provincial Health Services Authority

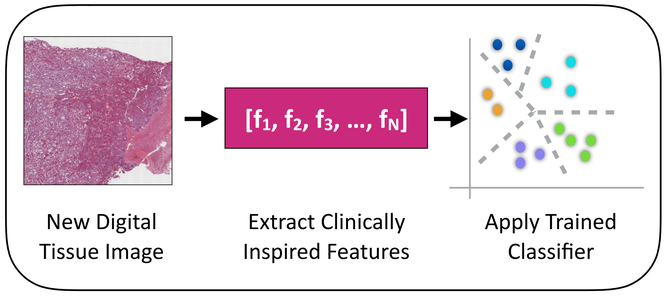
1. Quick Facts on Ovarian Cancers (OC)

- ~300 women are diagnosed[1] with OC each year in BC
- ~250 women die[1] from OC each year in the province
- In 2009, 5 subtypes[2] of OC have been identified
- In 2016, 2 new genetic subtypes[2] have been identified
- Accurately identifying OC from tumour biopsies is critical for a successful diagnosis and prognosis

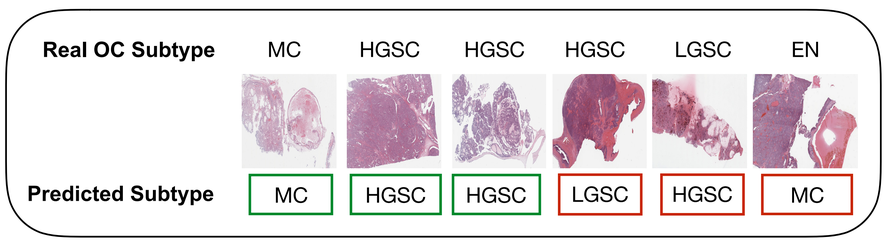
2. Teaching Computers to Mimic Pathologists



Automatic OC Diagnosis System Training Pipeline[3]



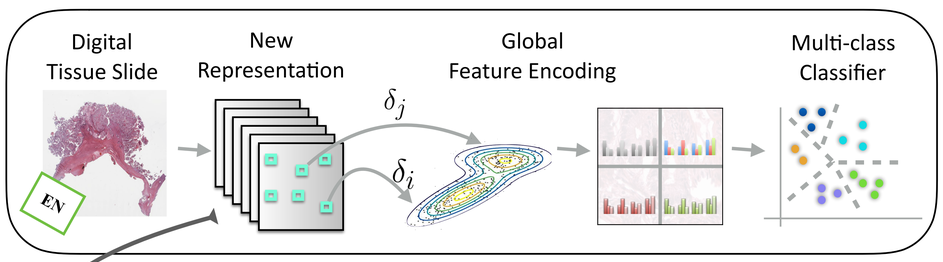
Predicting OC Subtypes on Unseen Test Images



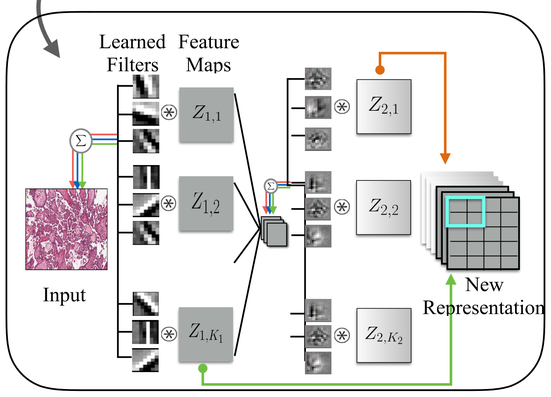
Leave-One-Out Validation on 40 Patients

- ☑ Automatically extracts relevant biomarkers
- ☑ Intuitively follows clinician's diagnostics
- ☑ Sensitive to variability in the data

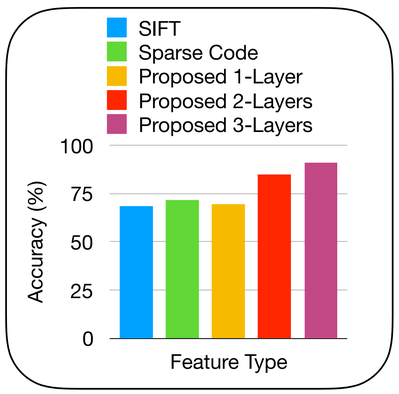
3. Learning Features Discriminative of Cancers



Automatic Feature Learning Pipeline[4]



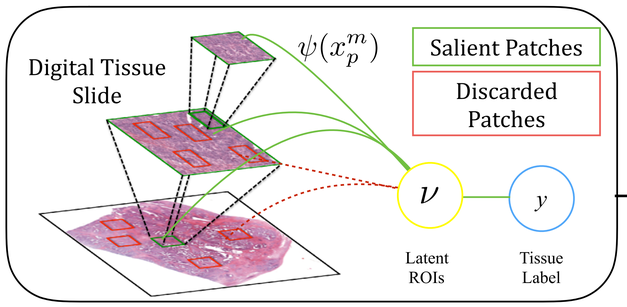
Learning Features with a 2-Layer Deconvolution Network



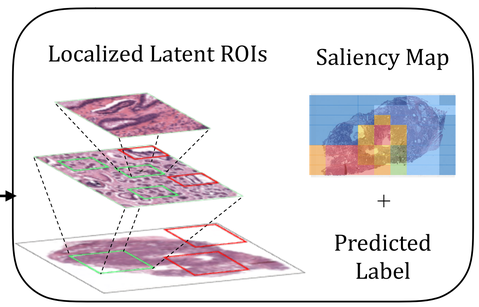
Validation on 80 Patients from different pathology centres

- ☑ Identifies discriminative features directly from tissues
- ☑ Generalizes well to tissue images from different centers
- ☑ Black-box architecture, unintuitive to analyze

4. Learning to Identify Abnormal Regions Indicative of OC Subtypes in Biopsies

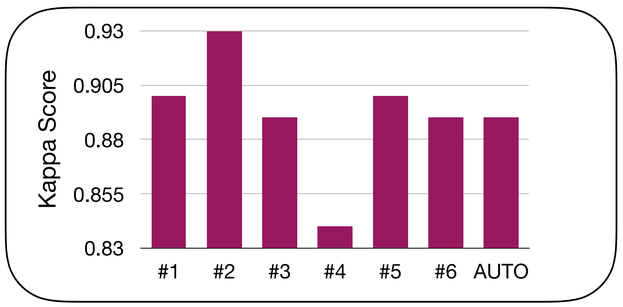


Proposed Context-Aware Classifier[5]

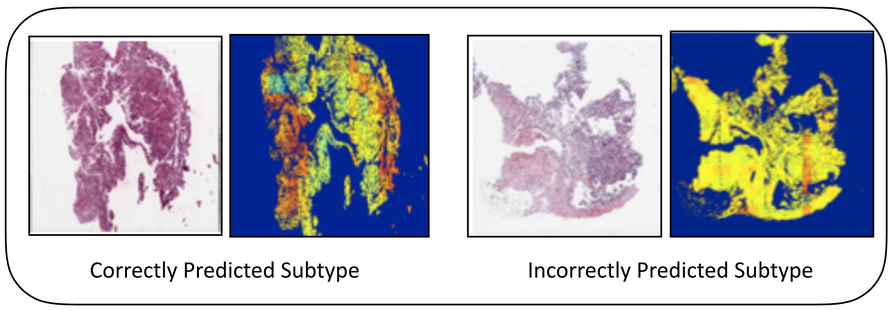


Classifier's Output

- ☑ Weakly-supervised
- ☑ Highlights abnormality
- ☑ More intuitive



Comparison of the automatic system with six experts



Validation on 150 patients from different pathology centres

1. http://www.bccancer.bc.ca/
2. A. McPherson et al. Divergent modes of clonal spread and intraperitoneal mixing in high-grade serous ovarian cancer, Nature 2016
3. A. BenTaieb et al. Clinically-Inspired Automatic Classification of Ovarian Carcinoma Subtypes. *Journal of Pathology Informatics, 2016*
4. A. BenTaieb et al. Automatic Diagnosis of Ovarian Carcinomas via Sparse Multiresolution Tissue Representation, MICCAI 2015
5. A. BenTaieb et al. A Structured Latent Model for Ovarian Carcinoma Subtyping from Histopathology Slides. *Medical Image Analysis, 2017*

CONTACTS: abentaie@sfu.ca , hamarneh@sfu.ca

MORE INFO: www.sfu.ca/~abentaie

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