Medical practitioner's roles in the AI era

Kickstarting your data-driven and medical AI projects

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Medical practitioner's roles

User

Auditor

Developer

https://www.alcimed.com/en/insights/ai-medical-imaging/

https://msosh.org.my/auditor-registration/

https://enterprisersproject.com/article/2020/7/artificial-intelligence-ai-developer-job-how-get

Medical practitioner's tasks

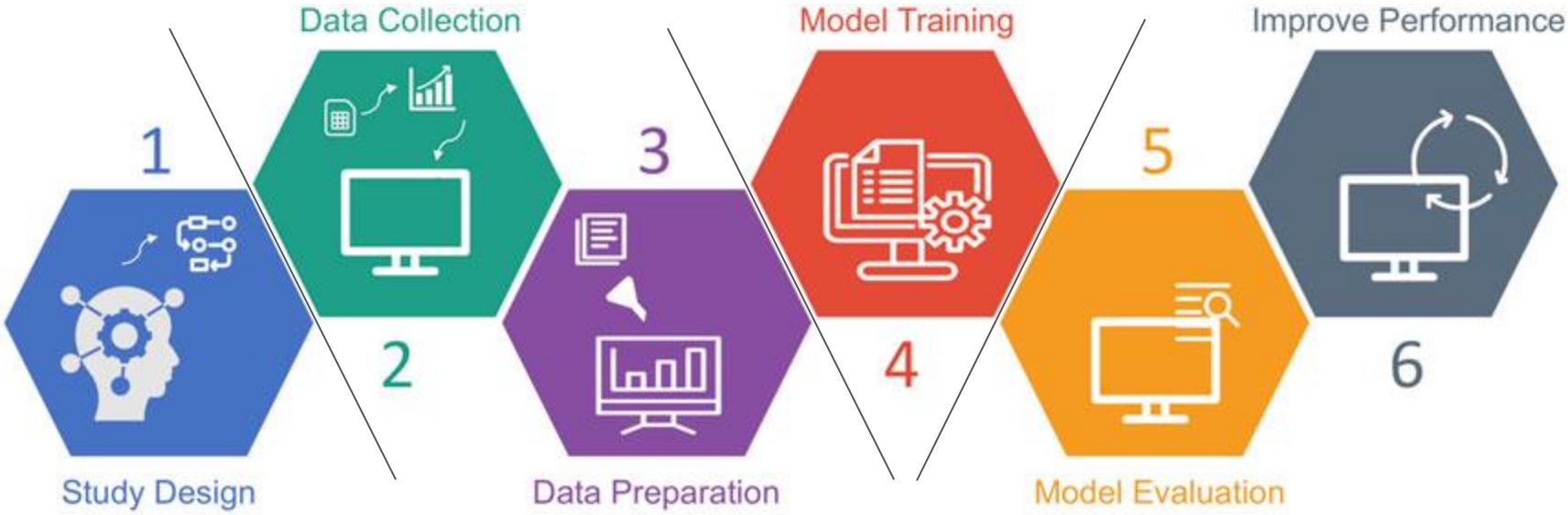
- How to read medical AI literature?
- How to evaluate/work with medical AI?
- How to get involved in medical AI development?
- How to communicate with AI developer?

How to read medical AI literature?

Key evaluation components

3. What's the model?

4. How was it evaluated?

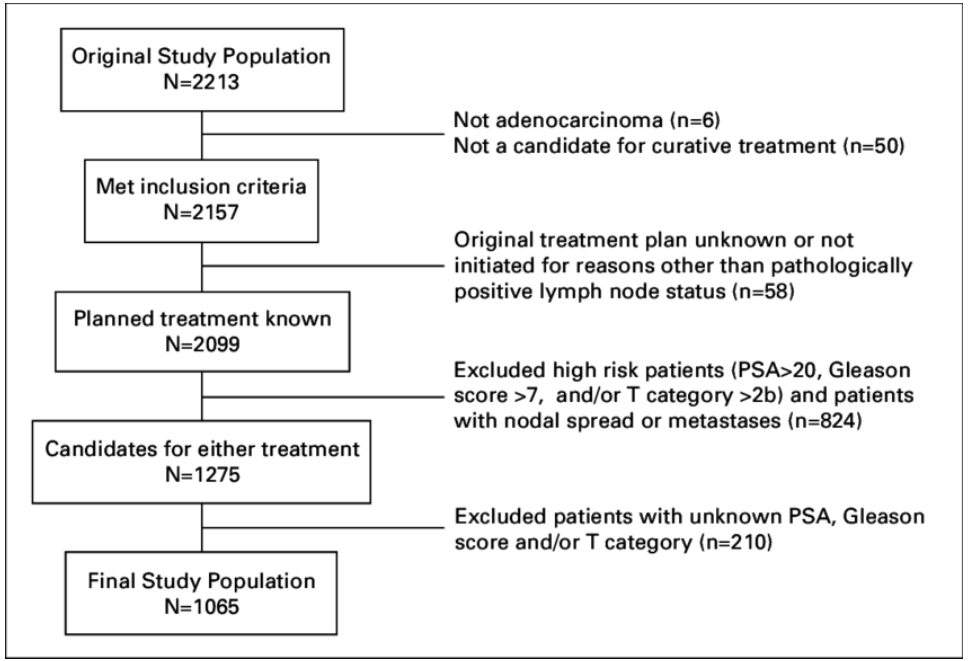


1. What's the task?

2. What's the data?

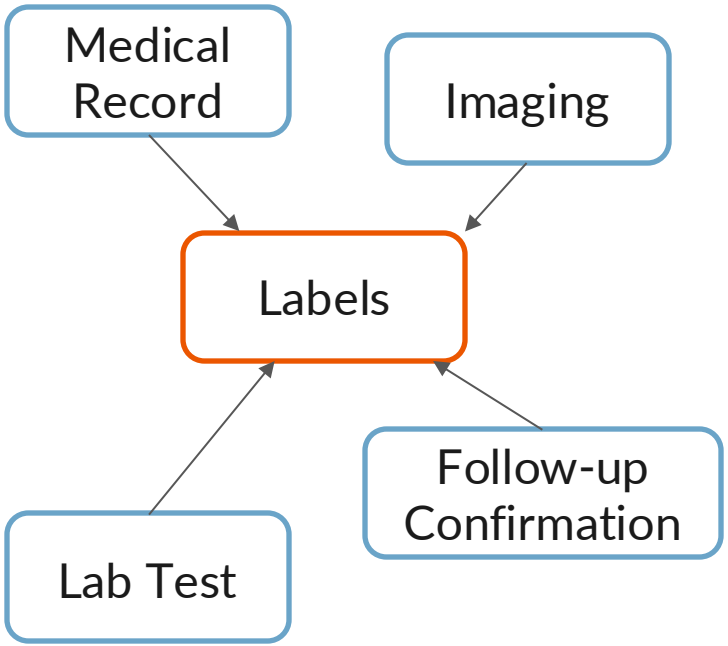
Peng, J. et al. Front. Pharmacol. 2021

Apply the same standard as clinical literature



- Does the dataset come from a well-controlled cohort?
- What could confound the AI?

Garbage in, garbage out



- Is the input data appropriate for predicting the output?
- Is the output properly defined, according to clinical practice?
- Be careful about **data leak**

Examples of good input-output definitions

Input	Output
Post-op clinical status	**Future clinical status**, such as survival or treatment response
Current clinical status	Diagnosis that required **clinical expertise**
Routine measurements	Results from **invasive or expensive** tests
Low-resolution images	**High-resolution** images of the same region

Difficult questions

- Is the sample size large enough?
  - There is no rule of thumb
  - Compare multiple literature together
- Can Y be predicted from X?
  - Trust your medical knowledge
  - Be careful about **wishful thinking**

Performance numbers can be misleading

Good

- Accuracy = (25 + 340) / 400 = 91%
- Specificity = 340 / 350 = 97%

Bad

- Precision = 25 / (25 + 10) = 71.4%
- Sensitivity = 25 / 50 = 50%

- Why is accuracy very high while sensitivity and precision are low?

	Predict YES	Predict NO
Known YES	25	25
Known NO	10	340

Metrics must match the objective

Would you want to use this model if:

- YES = A high-risk procedure should be performed on the patient
- YES = A patient will be allergic to the given drug
- YES = Patient should be called in for a follow-up

	Predict YES	Predict NO
Known YES	25	25
Known NO	10	340

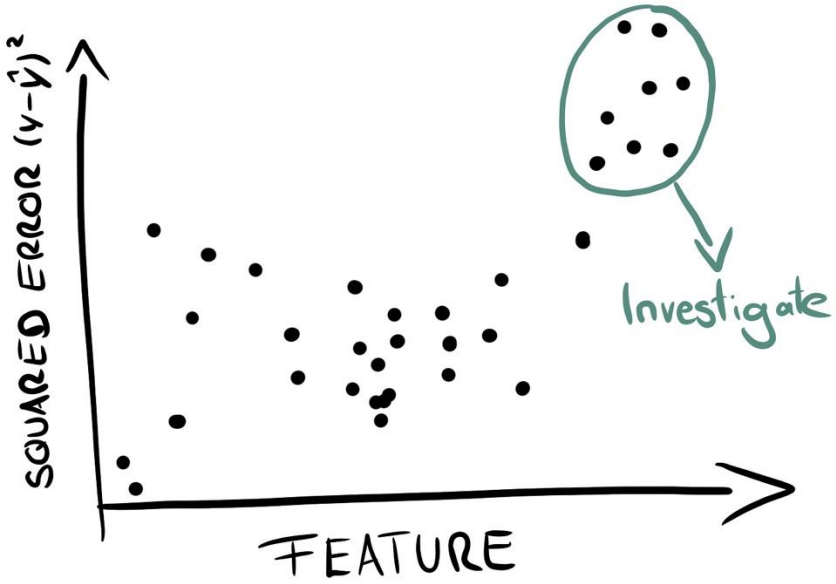
How to evaluate medical AI?

Prospective vs retrospective evaluation

- **Prospective:**
  - Aim = Usage experience and workflow integration
  - Clinical outcome is often not available at the time
  - Opportunity to collect data, AI output, and user feedback

- **Retrospective:**
  - Aim = AI performance and trustworthiness
  - Prepare gold standard datasets

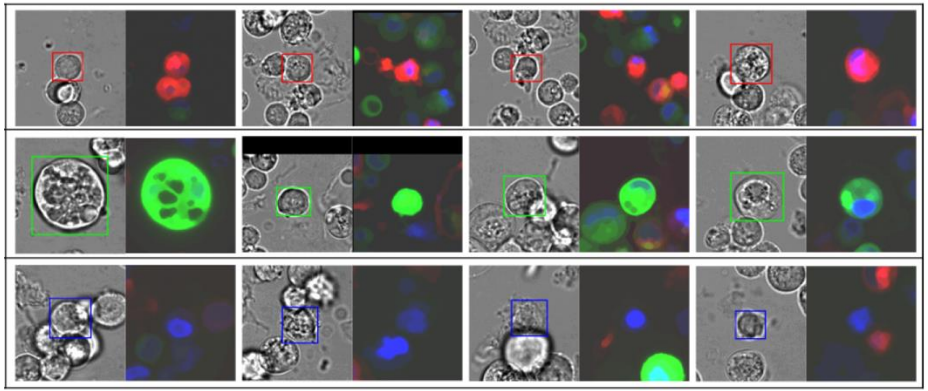
Error analysis tells a lot about an AI

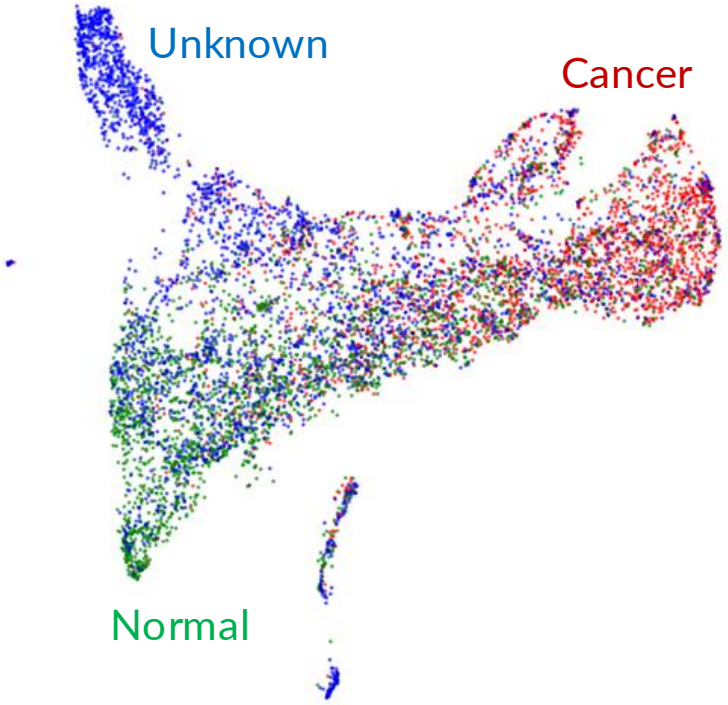


https://mindfulmodeler.substack.com/p/a-simple-recipe-for-model-error-analysis

- Many sources of errors
  - Hard cases
  - Confounding and bias
  - Spurious association
  - Out of distribution
  - Data quality
- When to use and how to improve the AI

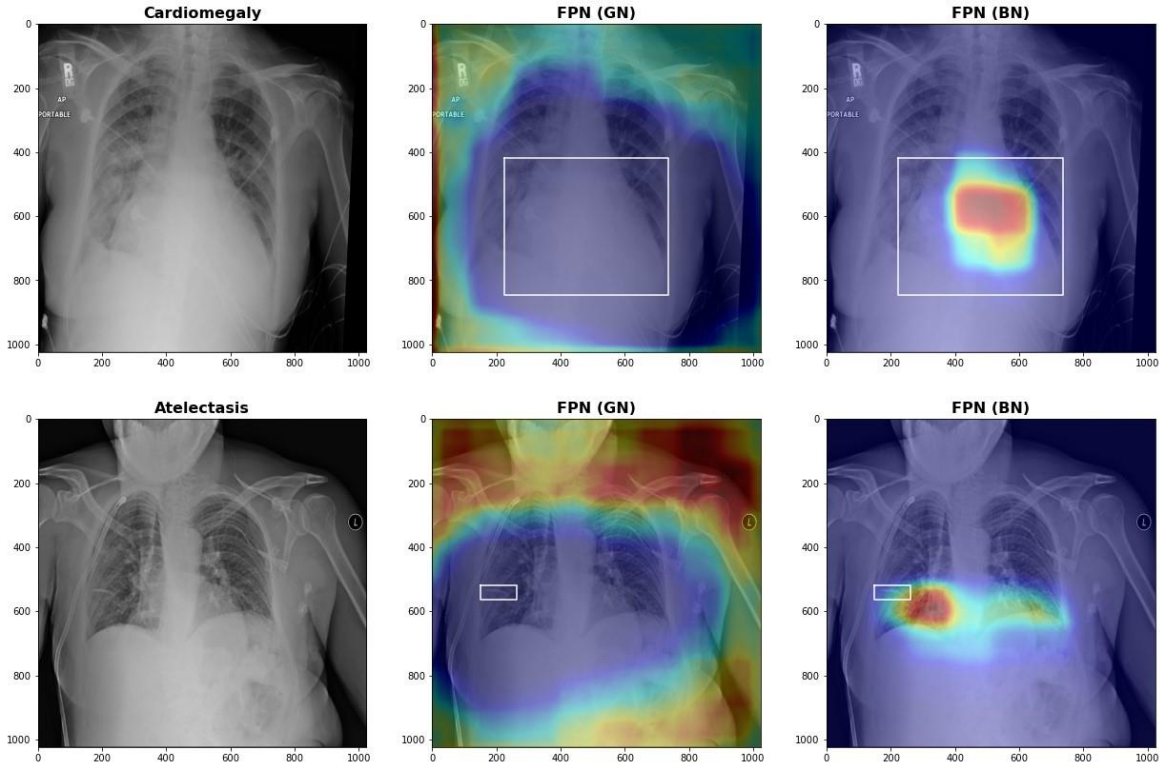
Sometimes, the problem is in the data





- Some cells do not stain well
- They have different morphology from both normal and cancer cells

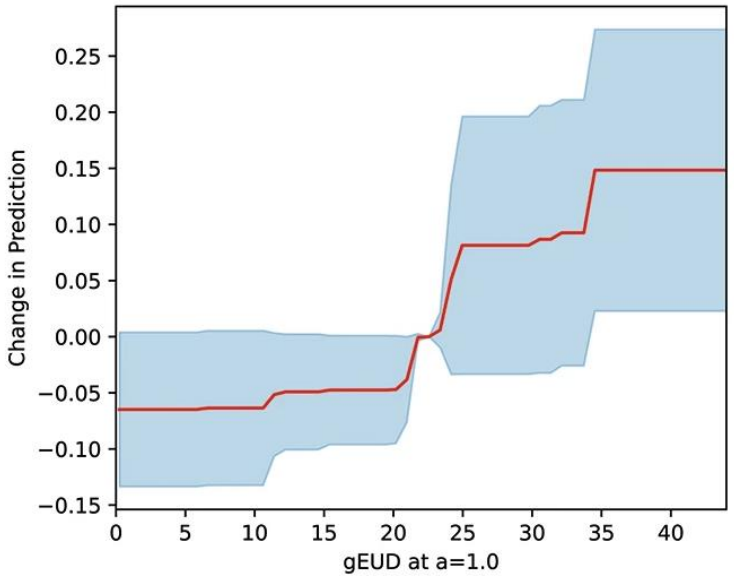
Always ask for explanation



- Good performance is specific to a dataset
- Good explanation generalizes better

Model-level explanation

Impact of radiation dose on complication

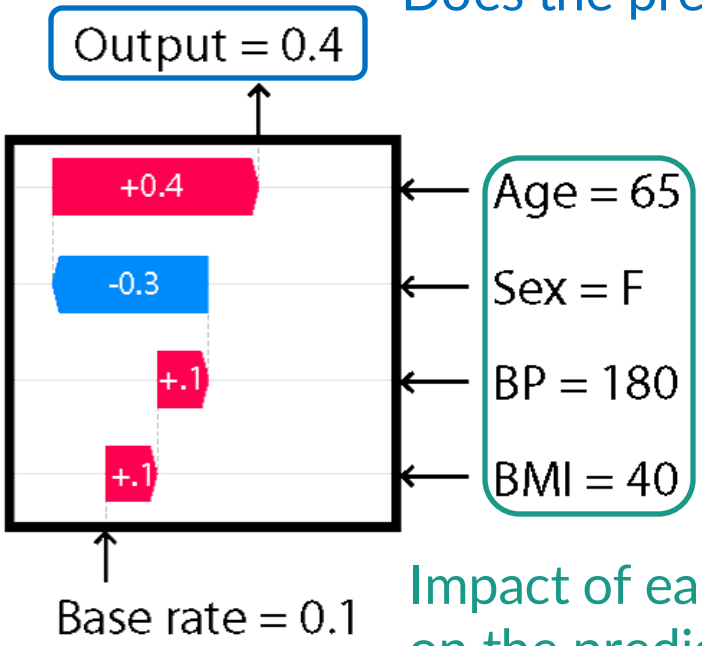


Prayongrat, A. *et al*. Radiation Oncology 2022

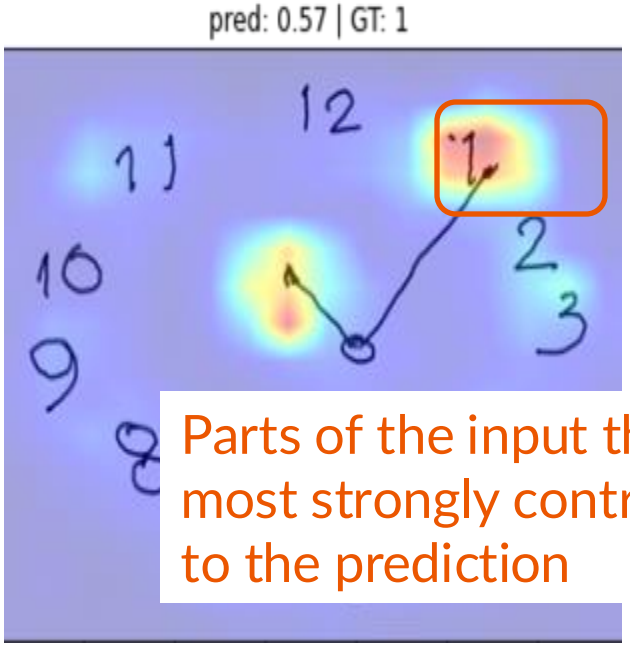
- Which features contribute the most to the model?
  - Feature importance
- How does the prediction change as the input change?
  - Try changing input

Sample-level explanation

Does the predicted confidence match your expectation?



Impact of each input on the prediction



Parts of the input that most strongly contribute to the prediction

How to get involved in medical AI development?

Realize that you are the most valuable asset

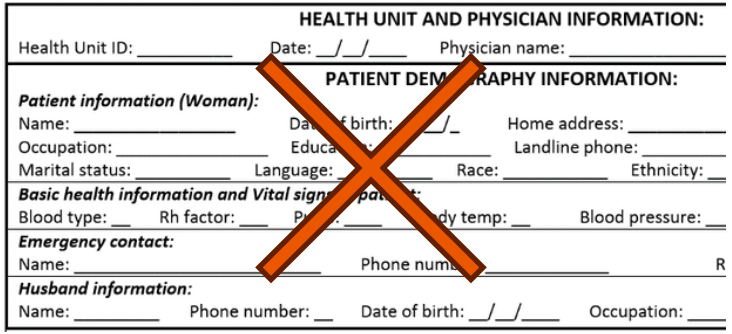
- You know the gaps in medical workflow
  - **The right task**
- You understand medical data
  - **The right input & output**
  - **Appropriate model design**
- You make the final decision
  - **The right evaluation and UX/UI design**

Keep up-to-date with AI literature

- Stay on top of what AI can do in your field (and preferably related fields)
- Compare the data used in those study with your institute's
- Imagine how AI's capability fit into your workflow

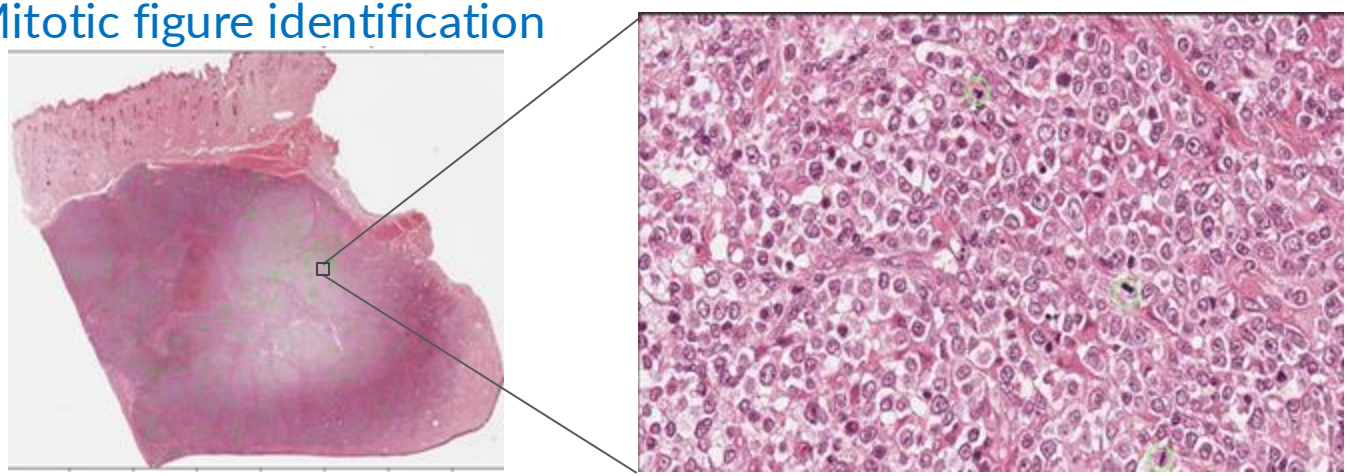
Start curating data early and digitally

- Human-readable is not the same as machine-readable
- Standardization is required when there are multiple data inputter
- You are not alone!
  - Software can be developed to make your life easier



Strike a balance between effort and performance

Mitotic figure identification



- Would you **label 10^6 cells** to get a model that can detect every mitotic figure? Or **label 10^4 cells** and get a model that can tell you where to count?

How to communicate with AI developer?

Clarify the task and the input/output upfront

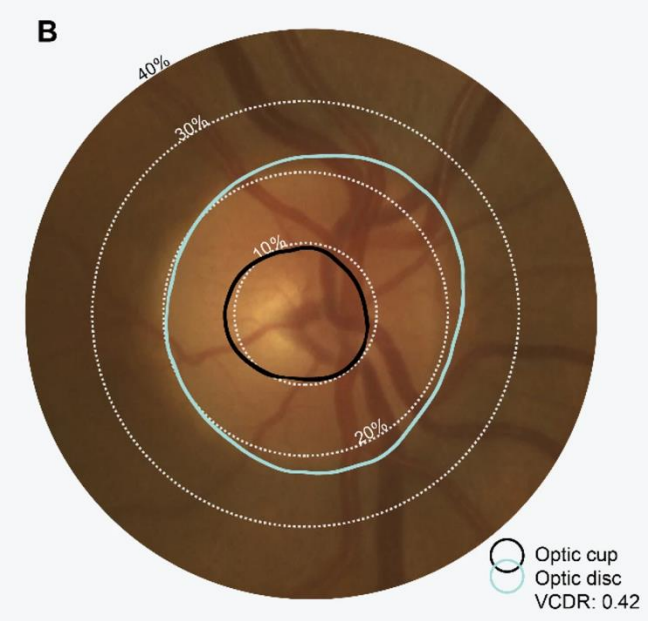
We want an AI that speeds up CXR reading workflow, by proposing the location of high-probability lesions and drafting a report.

We want an AI that can be deployed in CXR van to screen for TB in rural area and identify patients that should be swabbed.

Prepare data and literature

- Point AI developers to similar public datasets
- Preliminary evaluation on local data is highly valuable
  - Feasibility
  - Estimate data curation
- Provide assurance to AI developers

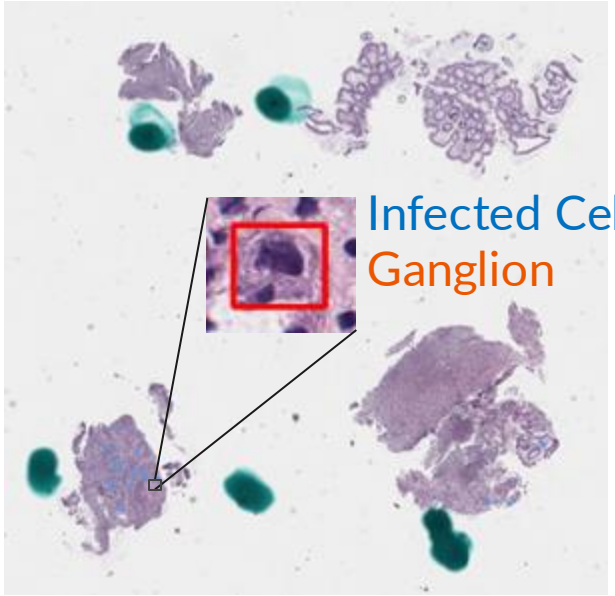
Provide domain knowledge



Hemelings, R. et al. Scientific Reports. 2021

- Medical tasks often require specialized model design and data curation
  - Uncommon features
  - Context dependency
- AI developers need your insights to deliver the best model

Be adaptive, poor performance is not the end



Infected cell classification performance

F1	Precision	Recall
17.78	10.00	79.69

- With AI, pathologist only need to examine <100 cells that are predicted as infected

Take-home messages

- You are the MVPs of medical AI

- Appraise medical AI the same way you did your peers
  - AI is not exempted from clinical standard
  - Task, data, evaluation

- Start curating data today!

- Be an active participant in development process
  - Your expertise is as important as deep learning techniques