AI Summer School 2025

Medical Imaging Informatics

University of Pittsburgh

Introduction to Medical Image Annotations

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IEEE COMPUTER SOCIETY

Learning Objectives

After completing this lecture, you should be able to:

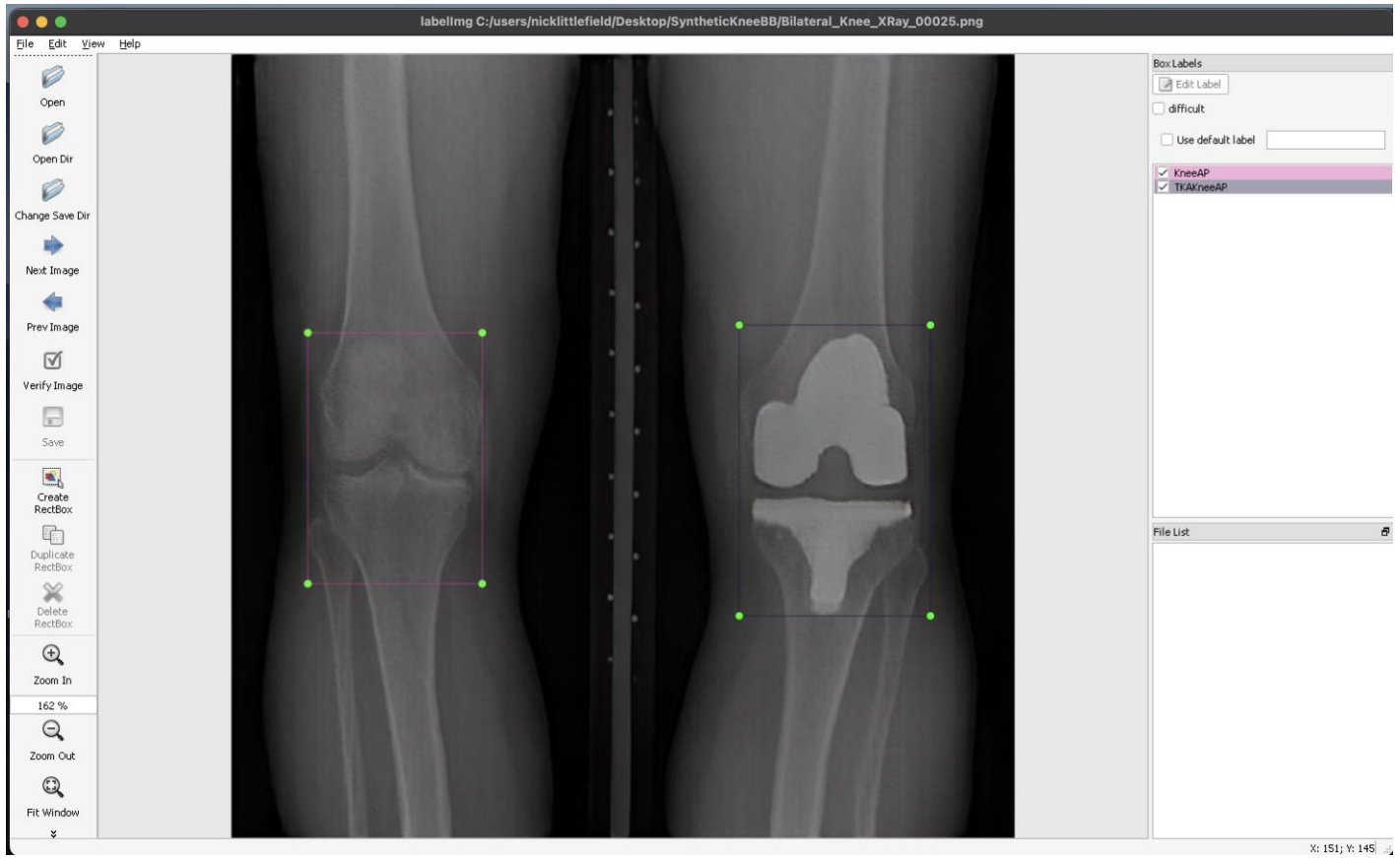
- Explain the overall process of medical image annotation
- Understand the different types of annotations
- Understand the primary steps in bounding box annotation for object detection
- Understand what tools are used for bounding box annotation
- Understand the common errors that occur in the annotation process

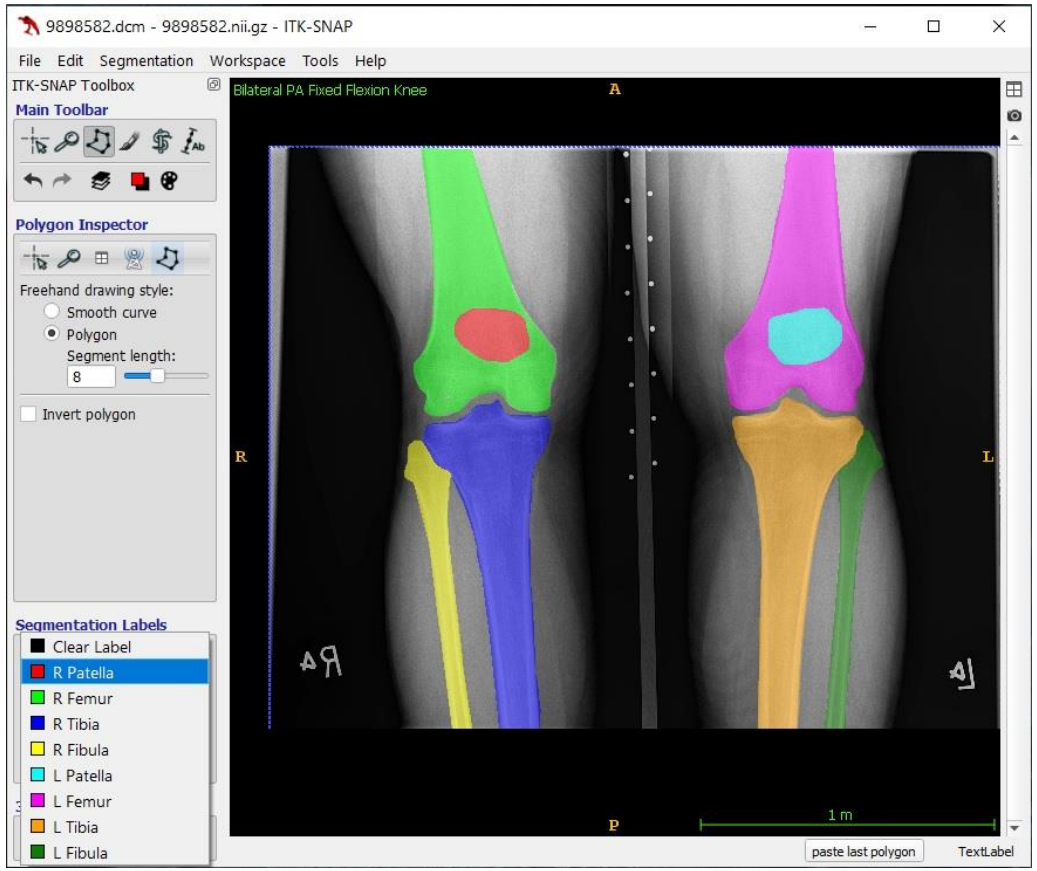
Outline

- Medical Image Annotation: What and Why?
- Types of Annotations in Medical Imaging
- Annotation Pipelines
- Challenges
- Annotation Tools
- Common Errors

Medical Image Annotation: What and Why?

- **Medical image annotation** is the process of labeling medical images to highlight specific features, structures, or abnormalities.
- Aids in training AI models, improving clinical decision support, research and development



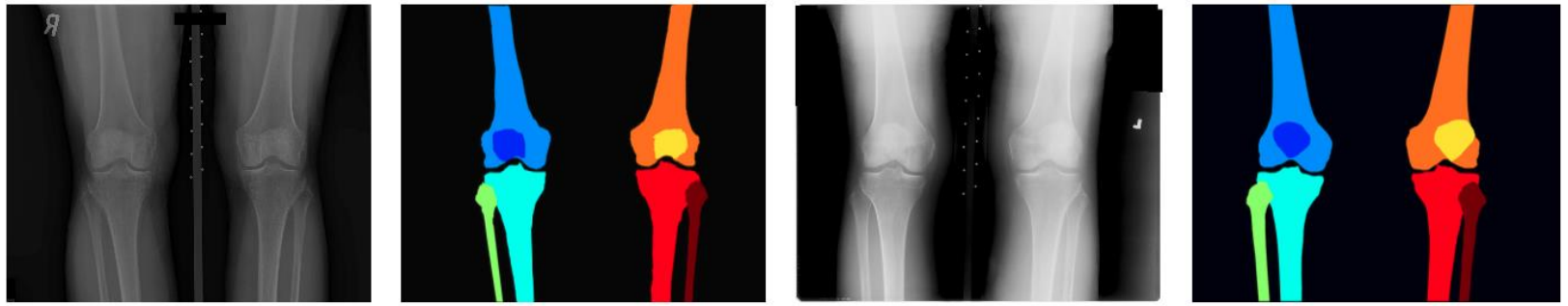


Types of Medical Image Annotation

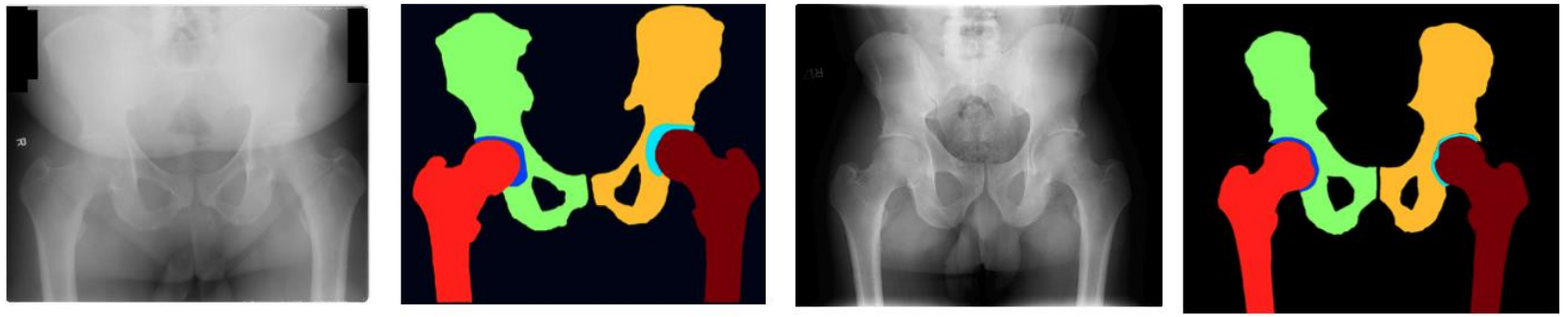
- There are multiple types of medical image annotations:
  - Object Detection
  - Segmentation
  - Classification

Types of Medical Image Annotation: Segmentation

- Outlines the boundaries of different structures (organs, tissue, bony anatomy)



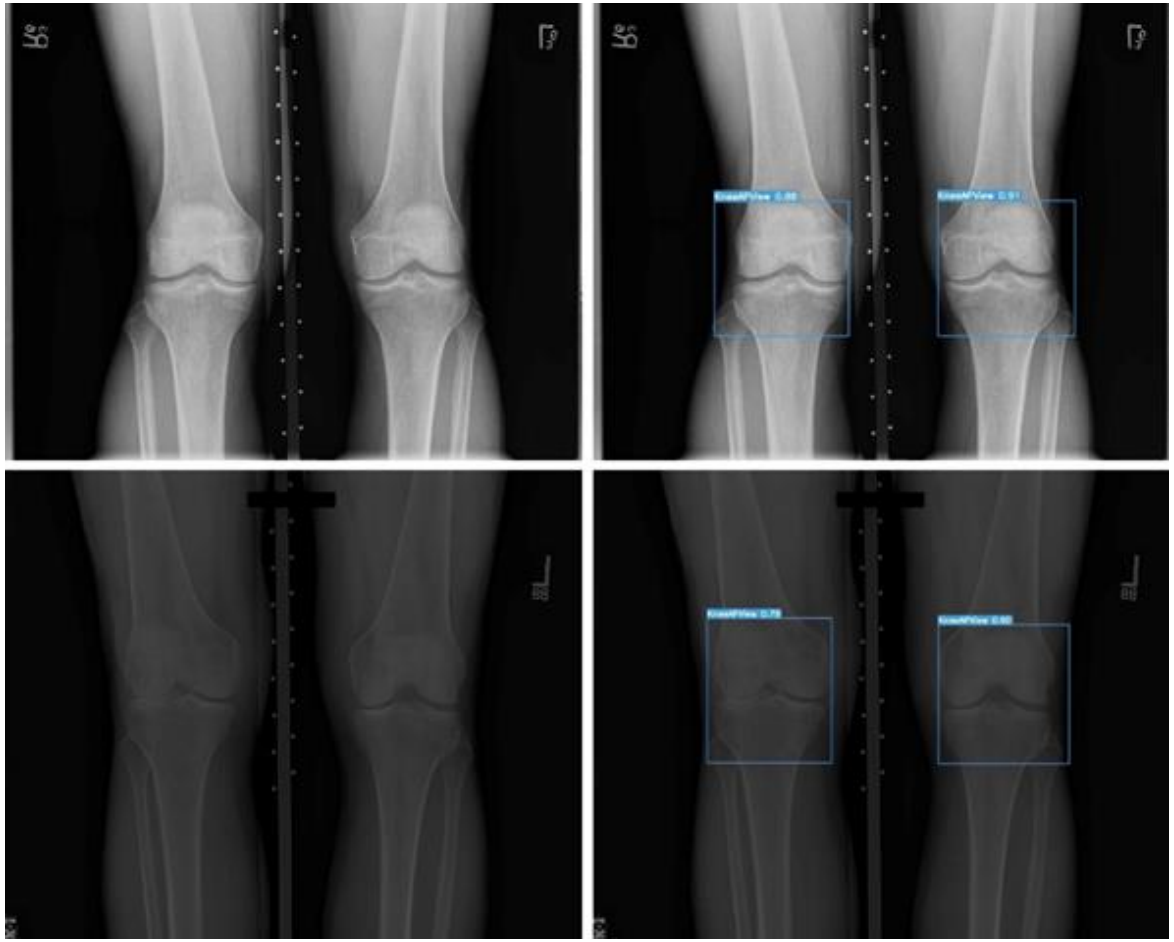
(a)



(b)

Types of Medical Image Annotation: Object Detection

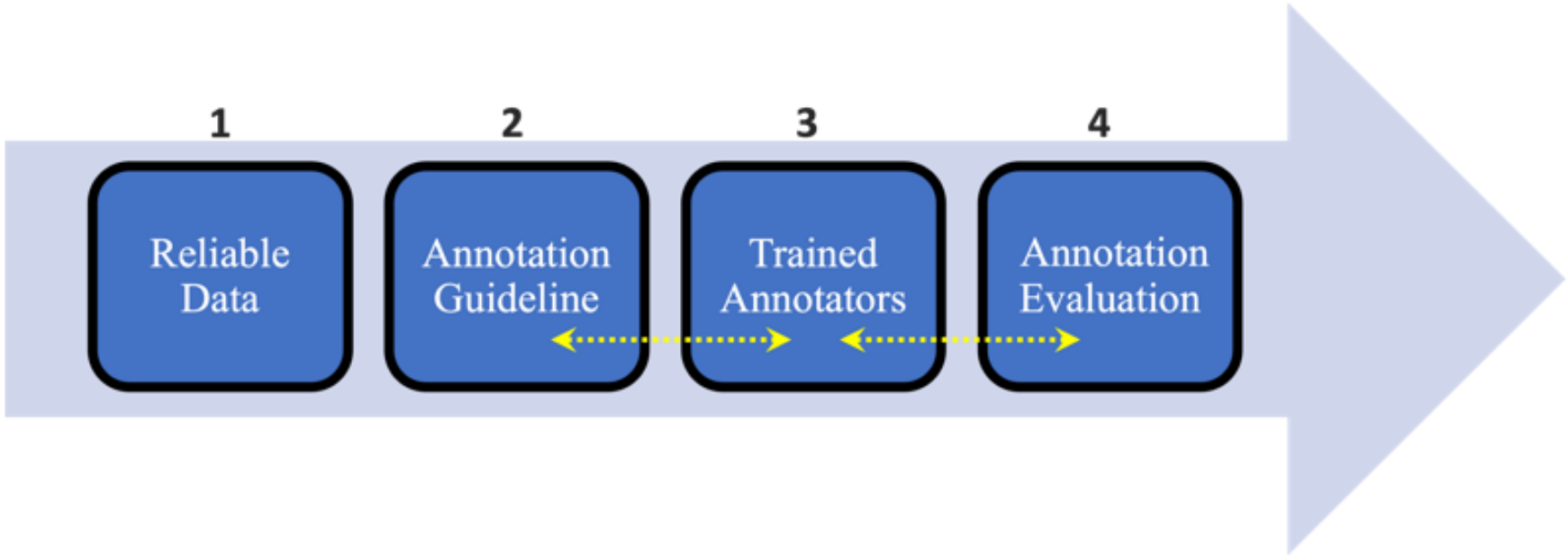
- Identifying and localizing regions of interest that contain specific objects
- Examples:
  - Cells in microscopic image
  - Knee joint area,
  - Brain tumors
  - Lung nodules



Types of Medical Image Annotation: Classification

- Assigning labels or categories to images based on the content of the image
- Examples:
  - benign vs. malignant brain tumors
  - lung cancer screening – benign, pre-cancerous, malignant,
  - fracture types – simple, compound, …

Typical Annotation Pipeline



Challenges with Medical Image Annotations

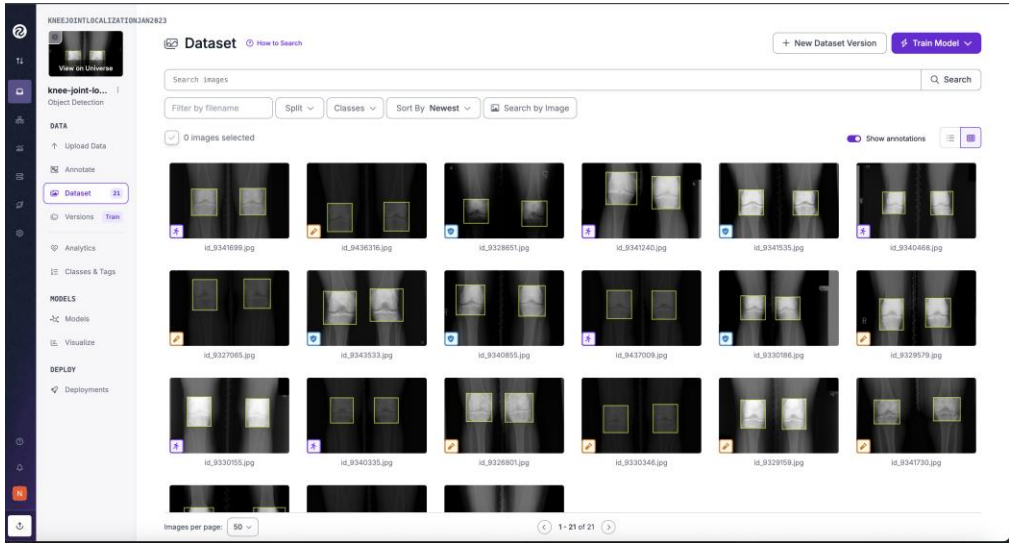
- Accuracy and precisions of annotations: Annotations need to be precise and highly accurate to train AI models
- Consistency of the annotations: different annotators can have varying interpretation of the same image
- Time consuming and costly: Detailed annotations take extensive amount of time
- Complexity of medical images: images have different modalities, quality, and can contain artifacts

Tools for Object Detection Annotations: LabelImg

- Lightweight and easy-to-use image annotation tool for labeling bounding boxes for object detection in images
- Generates XML file containing the class of an object and the bounding box coordinates for the **upper left** and **lower right corners**

Tools for Object Detection Annotations: Roboflow

- Platform designed to help developers build, train, and deploy computer vision models—particularly for tasks like object detection, classification, and segmentation
- Allows for data management:
  - Upload and organize image datasets.
  - Annotate images directly in the browser or import annotations from other tools.
  - Automatically convert between bounding box formats (e.g., COCO, YOLO, Pascal VOC).



Common Mistakes in Image Annotation

- **Inaccurate bounding boxes:** boxes that are too loose or too tight can lead to poor model performance.
- **Inconsistent labeling:** different annotators may label the same structure differently (e.g., one calls it “tumor,” another “mass”).
- **Missing annotations:** forgetting to annotate an object entirely can introduce false negatives during training.
- **Incorrect class labels:** assigning the wrong category (e.g., labeling a benign tumor as malignant).
- **Overlapping or redundant boxes:** placing multiple boxes around the same object can confuse the model.
- **Ignoring image artifacts:** failing to distinguish between real features and noise/artifacts from poor imaging.
- **Non-standard formats:** saving annotations in incompatible formats (e.g., mixing YOLO and Pascal VOC without conversion).

Hand-On Practice: Manual Annotations in Roboflow

Thank you!

Questions!