CSC 462: Machine Learning

7.8 Active Learning

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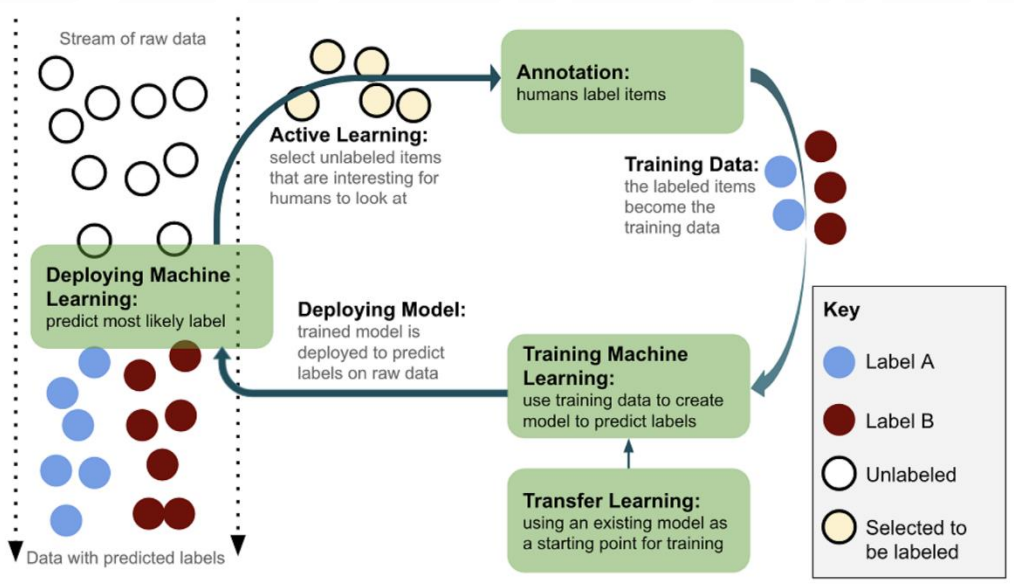
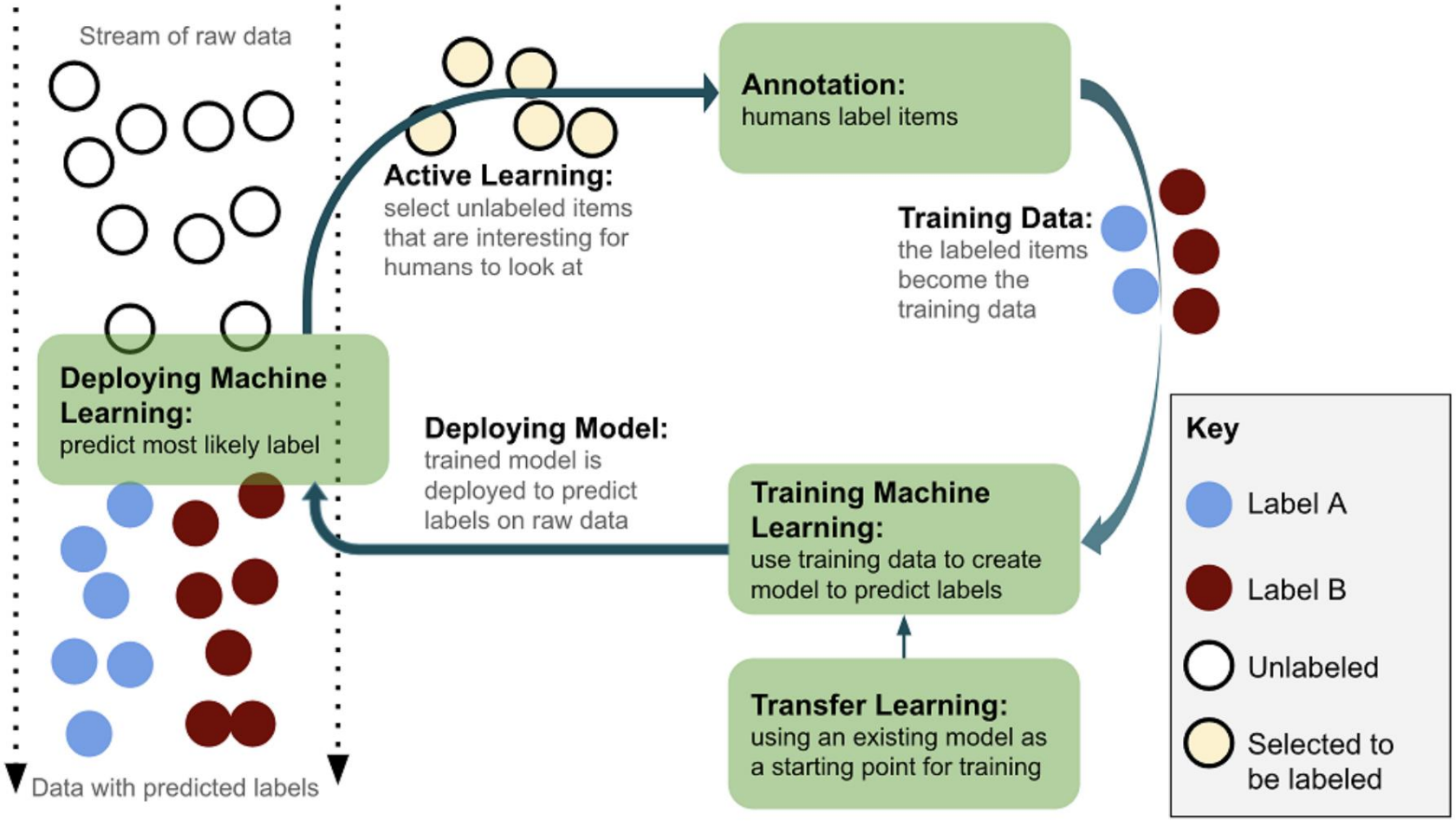
- Usually applied when obtaining labeled examples is **costly**
- The idea is that we start the learning with relatively **few labeled examples**, and a large number of unlabeled ones, and then add labels only to those examples that contribute the most to the model quality



- Strategies
  1. Data density and uncertainty based
  2. Support vector-based

Active Learning



Data density and uncertainty based active learning

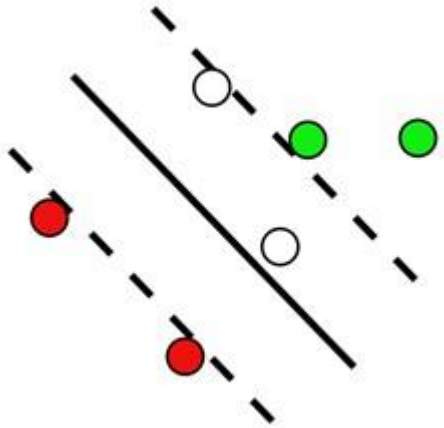
1. **Apply** the ML model (trained using the existing labeled examples) to each of the remaining unlabeled examples
   - Or to some random sample of them to save the computing time
2. For each unlabeled example x, the following **importance score** is computed:

$$\text{density}(x) \cdot \text{uncertainty}(x)$$

   - Density reflects how many examples surround x in its close neighborhood
   - Uncertainty reflects how uncertain the prediction of the model f is for x
3. Pick the one with the highest importance score and ask the expert to **annotate it**
4. Add the new annotated example to the training set, **rebuild** the model and continue the process until some stopping criterion is satisfied
   - A stopping criterion can be chosen in advance (the maximum number of requests to the expert based on the available **budget**)
   - Or depend on **how well** our model performs according to some metric.

Support vector-based active learning

1. **Build** an SVM model using the labeled data
2. Ask our expert to **annotate** the unlabeled example that lies the **closest** to the **hyperplane** that separates the two classes



- The idea is that if the example lies closest to the hyperplane, then it is the least certain and would contribute the most to