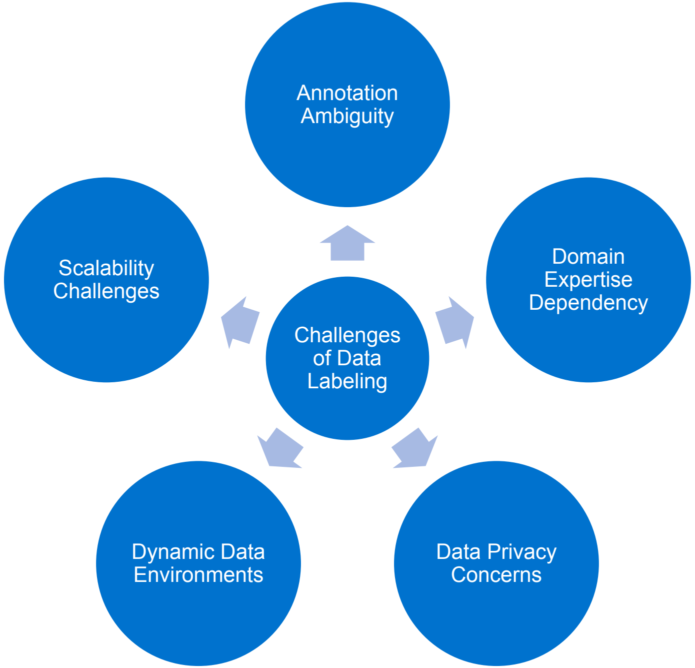
# Applied Generative AI

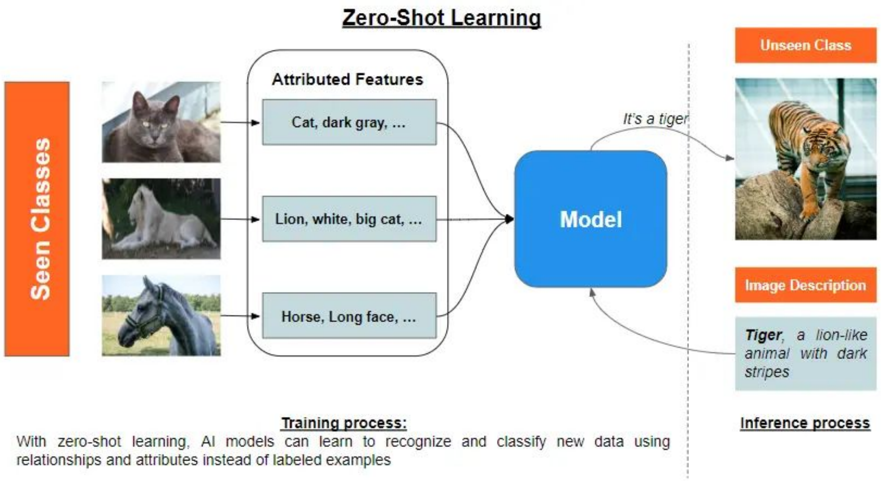
## Weak Supervision for Improved Text-to-Label Tasks

# The Labeled Data Bottleneck


Annotation Ambiguity
Scalability Challenges
Domain Expertise Dependency
Challenges of Data Labeling
Dynamic Data Environments
Data Privacy Concerns

- Quality, labeled data remains a frequent bottleneck for ML application.
- Data quality frequently determines ML project success.
- Getting quality, labeled data is frequently resource and time intensive.

# The Labeled Data Bottleneck



With zero-shot learning, AI models can learn to recognize and classify new data using relationships and attributes instead of labeled examples

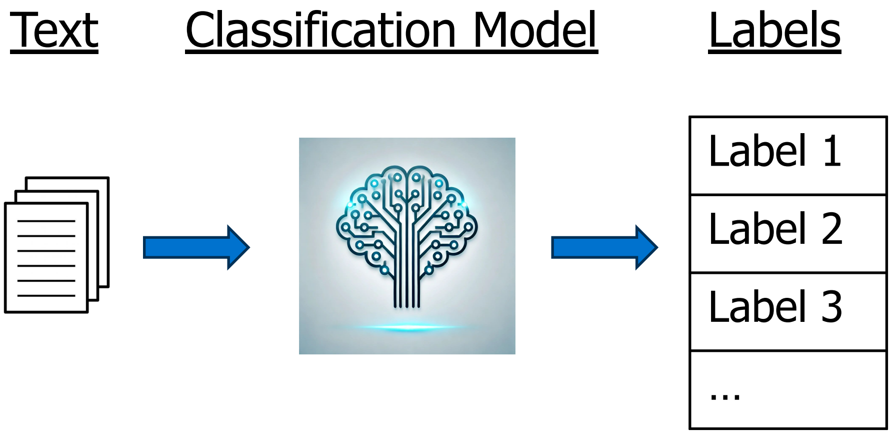
Vina, Abirami. *Understanding few-shot, zero-shot, and transfer learning*. Ultralytics Blog. 2025

- Several research fields attempt to address this problem
  - Zero-shot learning
  - Prompt Engineering
  - And many more…
- Recent emergent properties in large models are the primary method
  - Still frequently worse that in-domain models

# Agenda

- Review of Text-to-Label and Prompt Engineering
- Weak Supervision
- Combining GAI and Weak Supervision
- Code Example

# Text-to-Label Task Review



Text

Classification Model

Labels

Label 1

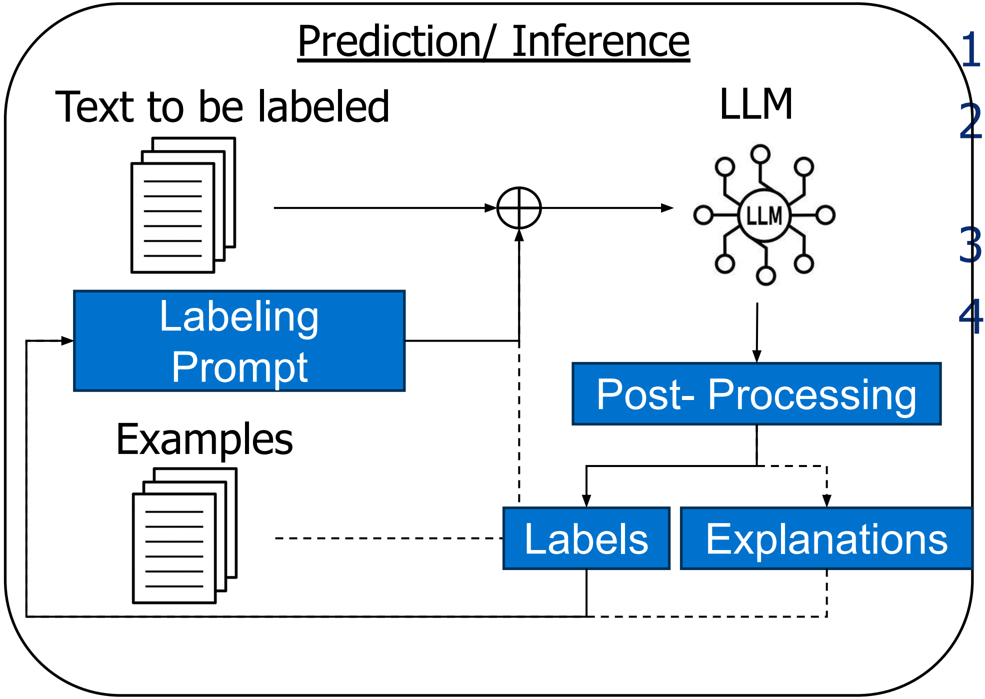
Label 2

Label 3

…

- Tasks involving classification or label assignment to text inputs.
- Examples:
  - Sentiment analysis
  - Topic classification
  - Spam detection
  - Code bugs

# Text-to-Label with Generative AI



- Labeling by Generative AI

1. Develop prompting scheme
2. Add text to be labeled to prompt and send model
3. Post-process output
4. Refine the prompt based on some labeled examples

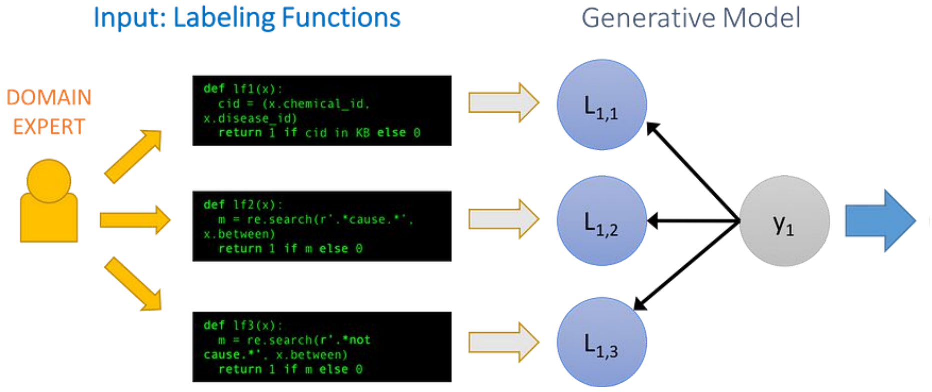
- Consider few-shot examples and batch prompting, if applicable

# Prompt Engineering for Text-to-Label

```
[prompt] Stance classification
is the task of understanding a
person’s opinion, either implied
or expressed, toward a target.
Classify the stance of the
statement below toward the
target below.
Target: {target}
Text: {text}
Stance:
```

- *Prompt Engineering* is the art and science of designing and structuring *prompts* (questions or tasks) fed to language models.
- When doing text-to-label, clear task instructions, definitions, and indicators are usually very important.
- Few-shot Prompting and Chain-of-Thought are frequently used patterns for Text-to-Label.

# What is Weak Supervision?



```
def lf1(x):
  cid = (x.chemical_id,
x.disease_id)
  return 1 if cid in KB else 0
```

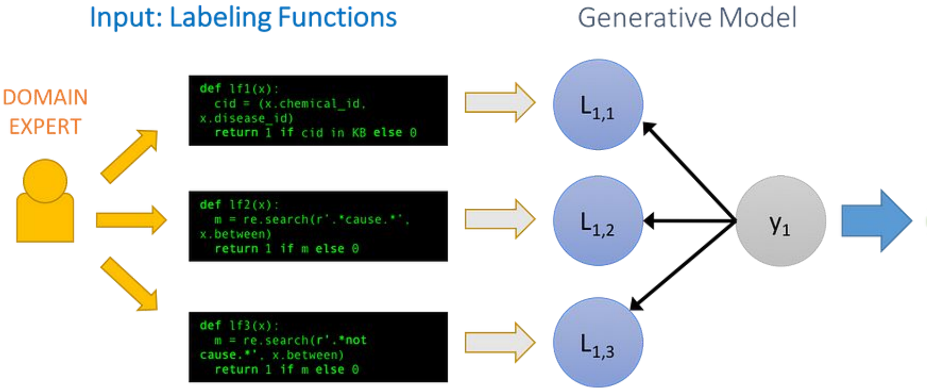
```
def lf2(x):
  m = re.search(r'.*cause.*',
x.between)
  return 1 if m else 0
```

```
def lf3(x):
  m = re.search(r'.*not
cause.*', x.between)
  return 1 if m else 0
```

SAIL Blog, *Weak Supervision: A New Programming Paradigm for Machine Learning* (2019)

- A technique for labeling data using noisy, incomplete, or imprecise sources.
  - Combines multiple weak signals to create higher-quality labels.
- Popular package for weak supervision is Snorkel
  - Consists of labeling functions and a generative labeling model.

# Using Weak Supervision in Snorkel



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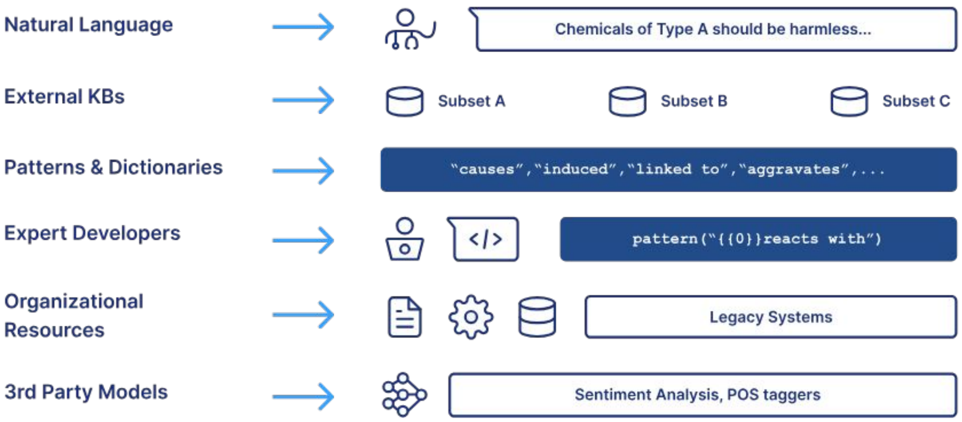
SAIL Blog, *Weak Supervision: A New Programming Paradigm for Machine Learning* (2019)

- Objective is to combine multiple weak signals of the label to create higher-quality labels.
- For snorkel, we need to define the weak labels by “Labeling Functions”
- After the producing the weak labels, we can evaluate them and combine them with a generative model to produce the quality labels

# Creating Labeling Functions



Natural Language → Chemicals of Type A should be harmless...

External KBs → Subset A, Subset B, Subset C

Patterns & Dictionaries → "causes", "induced", "linked to", "aggravates", ...

Expert Developers → pattern("{{0}}reacts with")

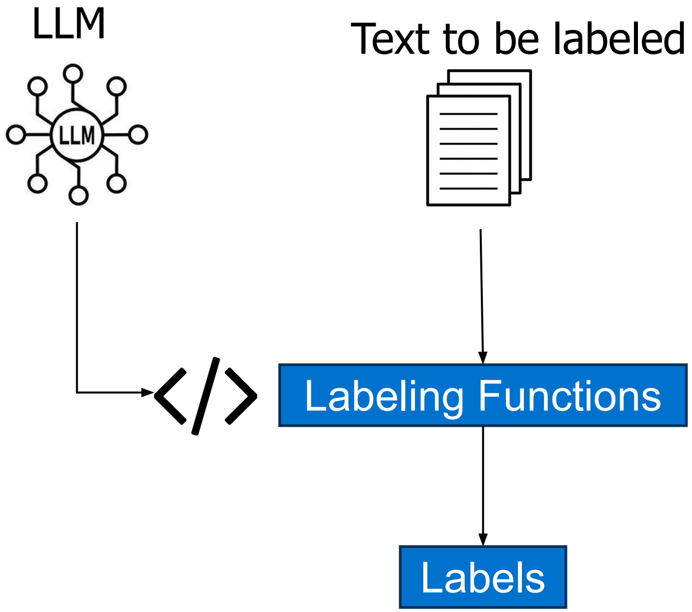
Organizational Resources → Legacy Systems

3rd Party Models → Sentiment Analysis, POS taggers

Snorkel Team, *Weak Supervision* (2023)

- Take in an example and produce a weak label.
  - Weak label can also be an "abstain" or no-label
- Functions are normal Python functions marked with labeling function decorator
- Can basically use just about anything (and any kind of signal) to create labeling functions

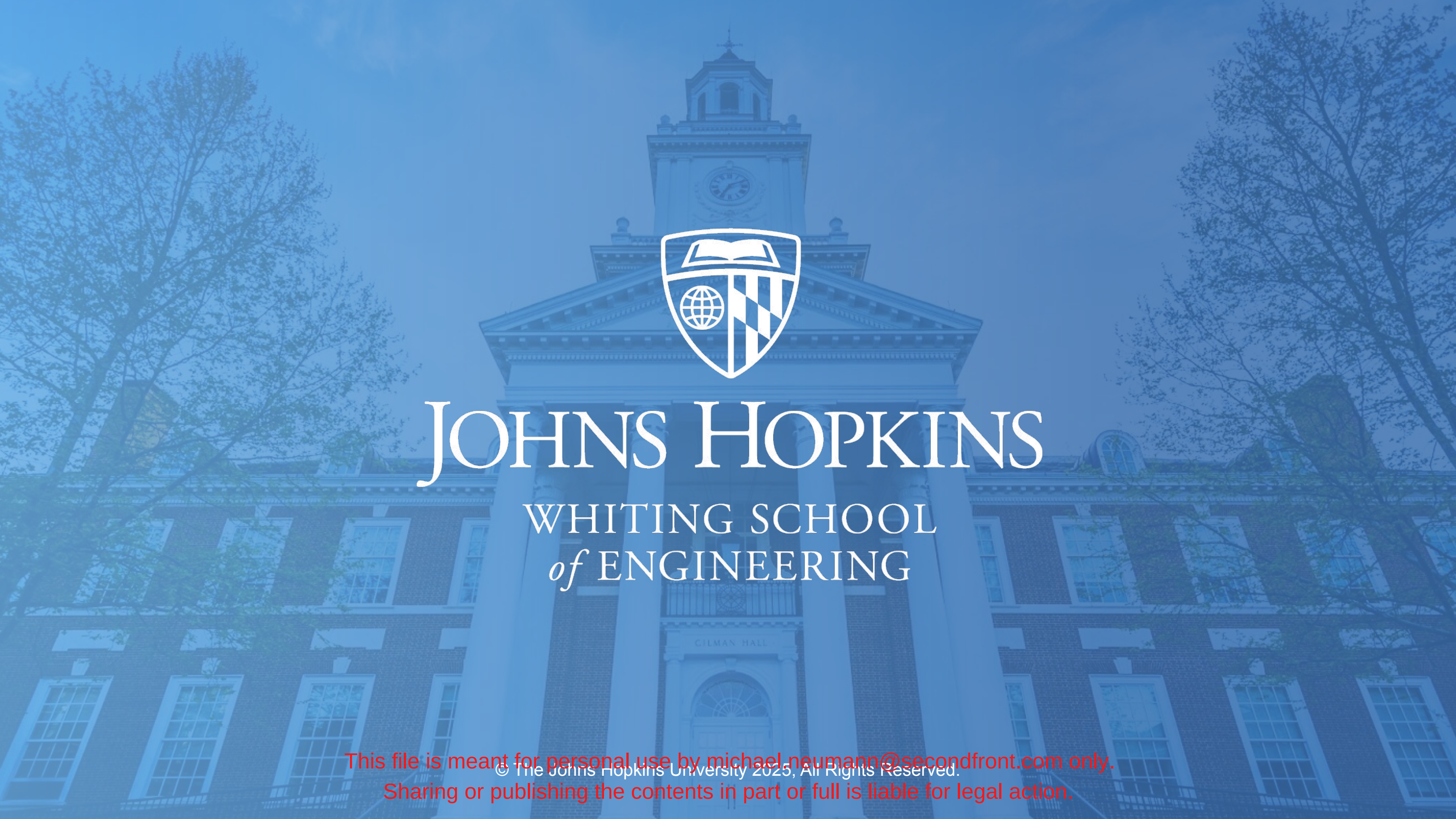
# Creating Labeling Functions by LLM



- First proposed by Huang et al. in 2024, ALCHEmist approach uses a LLM to create labeling functions.
- Much more scalable approach than direct labeling
- Typically works well only when combined with weak supervision

# Key Takeaways

- Weak supervision is a great way to turbo-charge your GAI derived labels when creating text-to-label solutions
- Weak supervision is a great way to combine various types of signals to create quality data labels
- Typically, you want to combine the final labels from weak supervision with a lot of data and training a model to then iterate toward even higher quality labels and models



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WHITING SCHOOL of ENGINEERING