# Research on Named Entity Recognition from Patent Texts with Local Large Language Model

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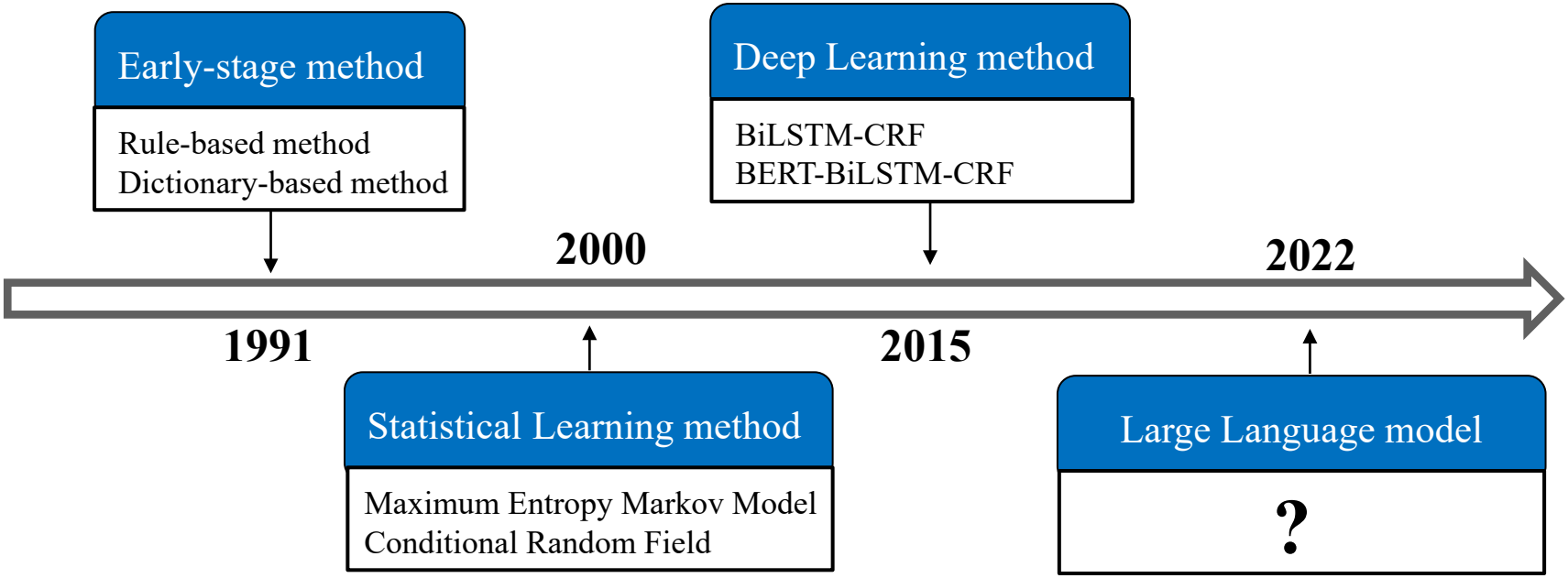
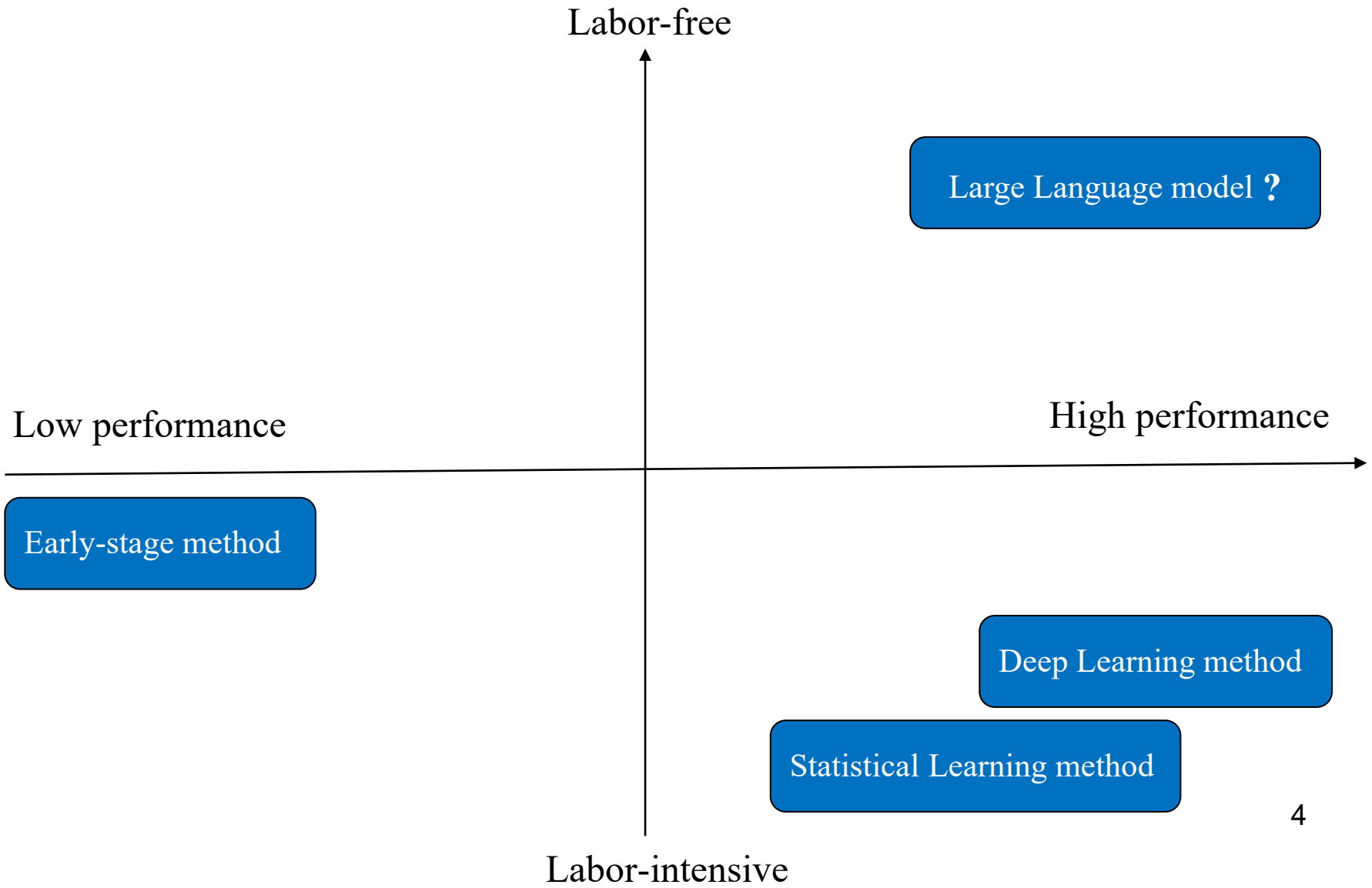
# 1.Background

The technological evolution of NER methods



# 1.Background



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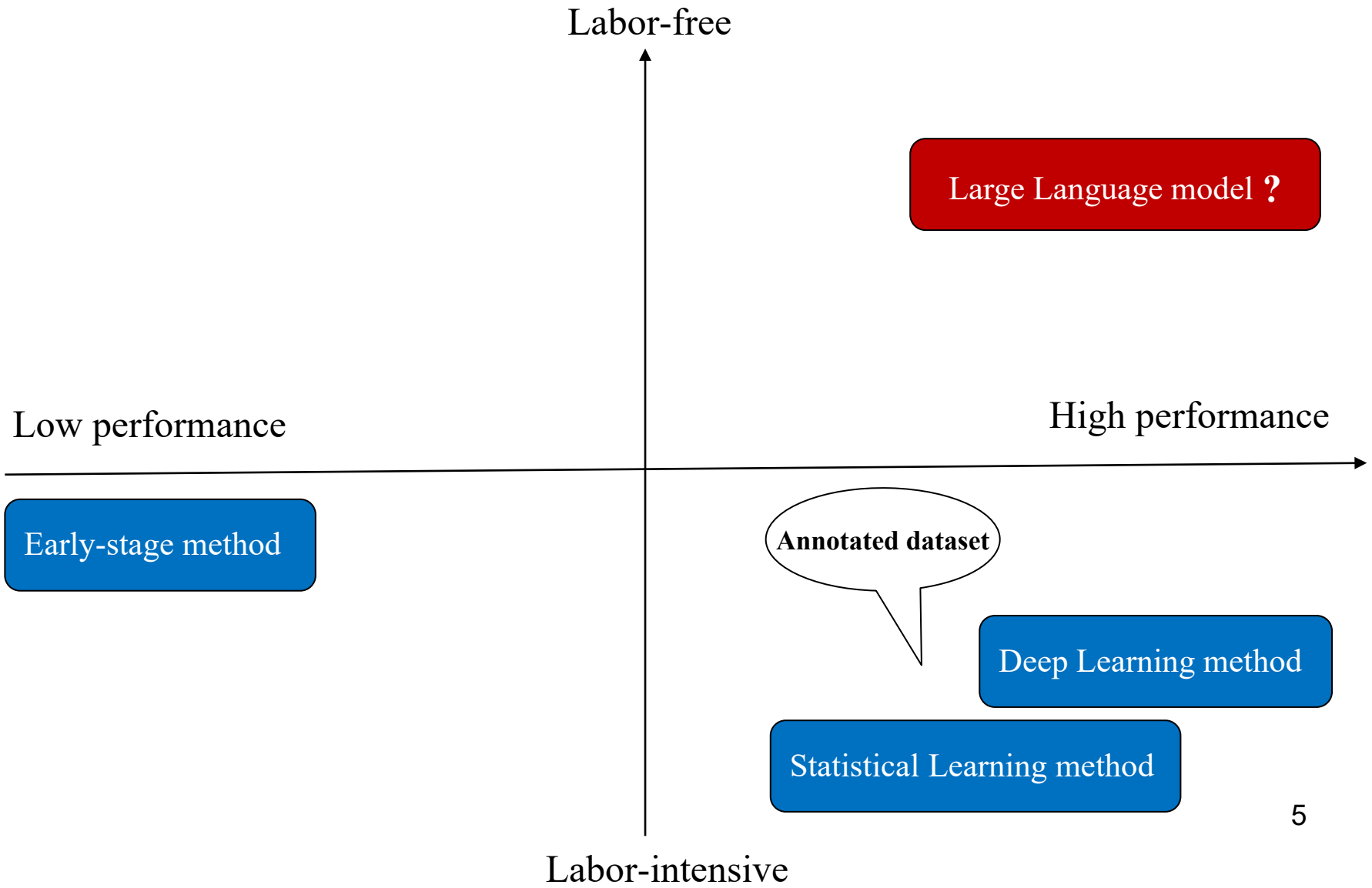
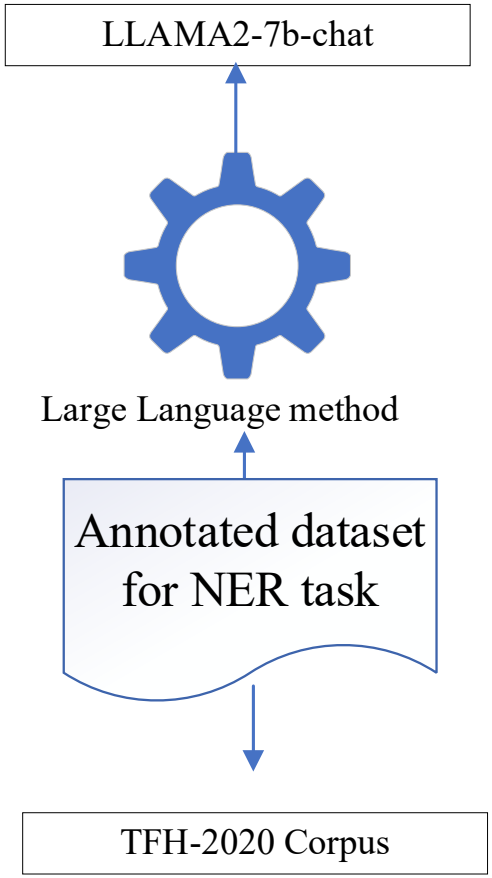


# 2.Methodology& Experiment



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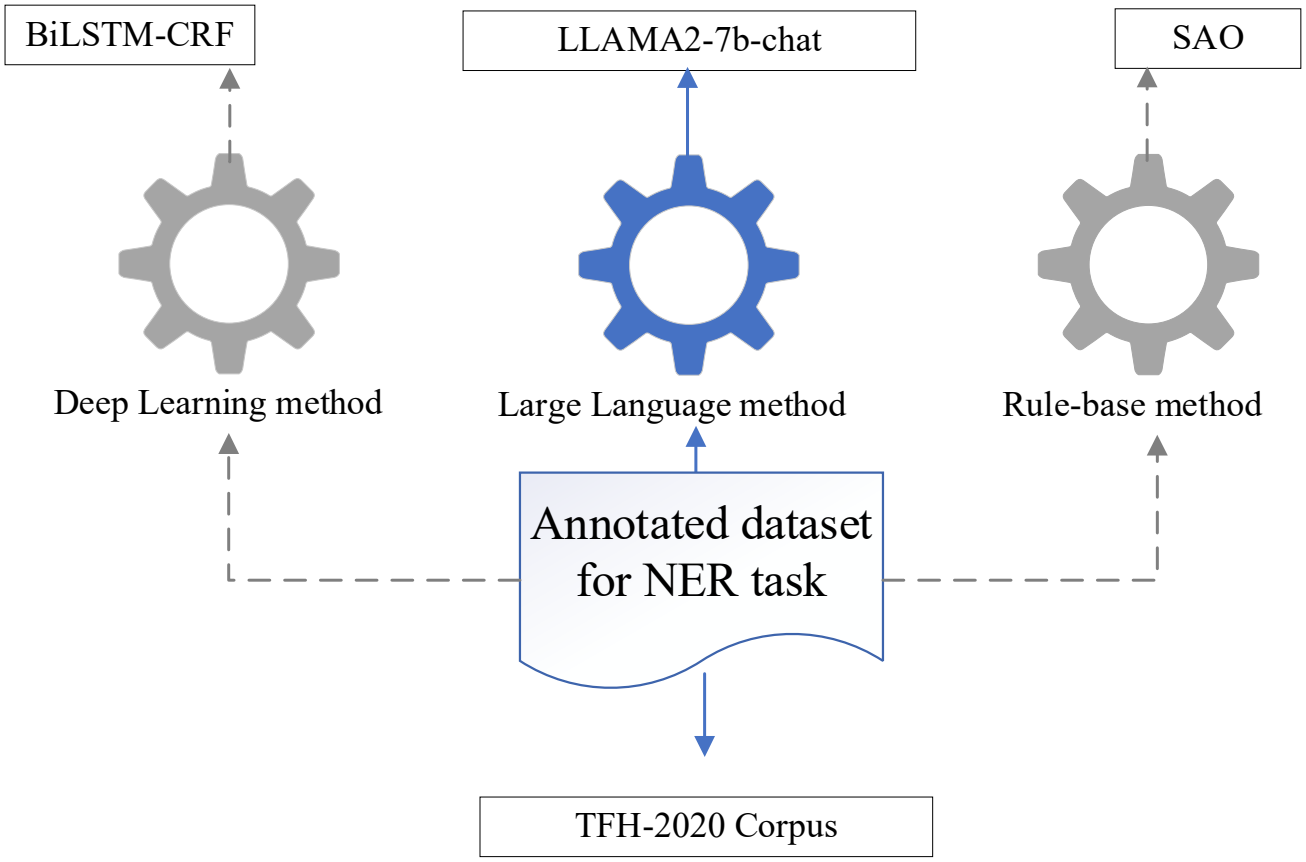


# 2.Methodology& Experiment

Description of TFH-2020 patent dataset:

- **Domain:** Thin film head technology in hard disk drive
- **Data source:** USPTO
- **Number of Entity mentions:** 22833
- **Number of Sentence:** 3996

1 A current-perpendicular-to-plane (CPP) giant magnetoresistive (GMR) sensor of the synthetic spin valve type is provided, the sensor comprising a GMR stack having a substantially square lateral cross-section, a Cu spacer layer of smaller square cross-section formed centrally on the GMR stack and a capped ferromagnetic free layer of substantially square, but even smaller cross-sectional area, formed centrally on the spacer layer.

2 The stepped, reduced area geometry of the sensor provides a significant improvement in its GMR ratio (DR/R), a reduced resistance, R, and elimination of Joule heating hot-spots in regions of high resistance such as the antiferromagnetic pinning layer and its seed layer.

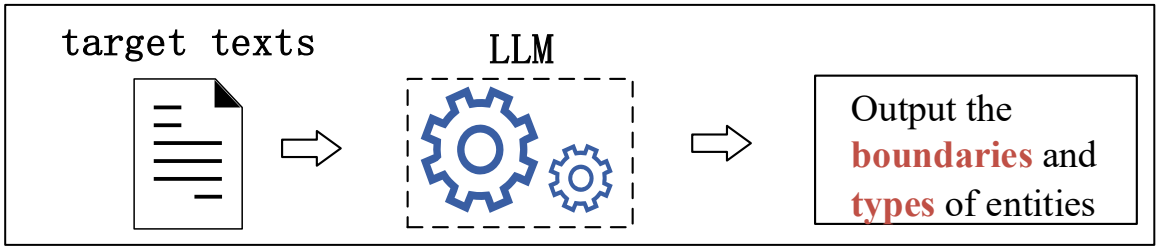
# 2.Methodology& Experiment

URL：https://github.com/awesome-patent-mining/TFH_Annotated_Dataset

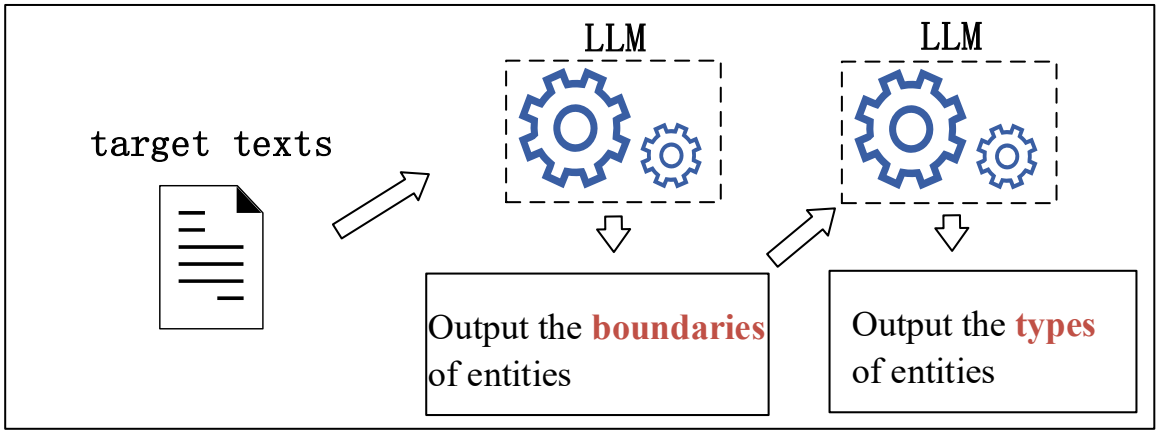
| Type | Comment | Example |
|---|---|---|
| Physical flow | Substance that flows freely | The **etchant solution** has a suitable solvent additive such as glycerol or methyl cellulose |
| Information flow | Information data | A camera using a film having a magnetic surface for recording **magnetic data** thereon |
| Energy flow | Entity relevant to energy | Conductor is utilized for producing **writing flux** in magnetic yoke |
| Measurement | Method of measuring something | The curing step takes place at the substrate **temperature** less than 200.degree |
| Value | Numerical amount | The curing step takes place at the substrate temperature less than **200.degree** |
| Location | Place or position | The legs are thinner near the pole tip than in the **back gap region** |
| State | Particular condition at a specific time | The MR elements are biased to operate in a **magnetically unsaturated mode** |
| Effect | Change caused an innovation | Magnetic disk system permits **accurate alignment** of magnetic head with spaced tracks |
| Function | Manufacturing technique or activity | A magnetic head having **highly efficient write and read functions** is thereby obtained |
| Shape | The external form or outline of something | **Recess** is filled with non-magnetic material such as glass |
| Component | A part or element of a machine | A pole face of **yoke** is adjacent edge of element remote from surface |
| Attribution | A quality or feature of something | A **pole face** of yoke is adjacent edge of element remote from surface |
| Consequence | The result caused by something or activity | This prevents the slider substrate from **electrostatic damage** |
| System | A set of things working together as a whole | A **digital recording system** utilizing a magnetoresistive transducer in a magnetic recording head |
| Material | The matter from which a thing is made | Interlayer may comprise material such as **Ta** |
| Scientific concept | Terminology used in scientific theory | **Peak intensity ratio** represents an amount hydrophilic radical |
| Other | Not belongs to the above entity types | **Pressure distribution** across air bearing surface is substantially symmetrical side |

# 2.Methodology& Experiment

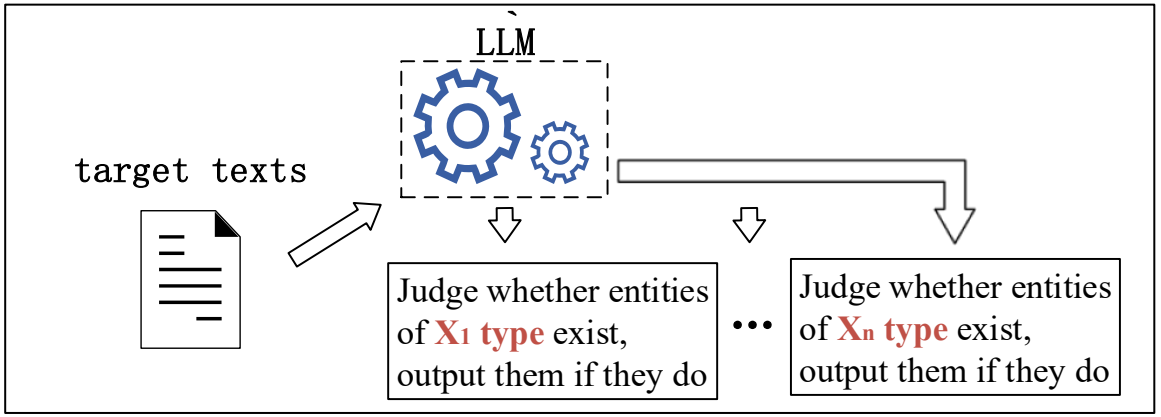
(1) Baseline Prompt




(2) Two-step Prompt




(3) multi-entity-type Prompt



# 2.Methodology& Experiment

## Baseline Prompt Example：Follow Alpaca Instruction Template

**Below is an instruction that describes a task, paired with an input that provides further context. Write a response that appropriately completes the request.**

**### Instruction:**

The following is a content of the patent for a hard disk head, the task is to identify named entities, including 12 types of entities suitable for describing process methods and processes: system, part, function, effect, consequence, attribute, measurement, numerical value, orientation, material, shape, scientific concept, and 4 types of entities that highlight the state of existence and physical characteristics: Physical flows, information flows, energy flows, states, as well as entities that still exist that are not covered, are classified as 'other'. Extract entities from the following text and return it in json format.

To help you understand the task better, some examples are provided. Please use these examples as a reference to format your entity list correctly.

examples

**input:** A thin film structure suitable for use as a shield for a read element of a transducing head has a first ferromagnetic layer, a second ferromagnetic layer, a spacer layer and a bias layer.

**Output:** {"System": ["thin film structure"], "Component": ["shield", "read element", "transducing head", "first ferromagnetic layer", "second ferromagnetic layer", "spacer layer", "bias layer"]}"

**You need to extract the entity from the following text. Ensure that the data is returned accurately in the format of the provided example.**

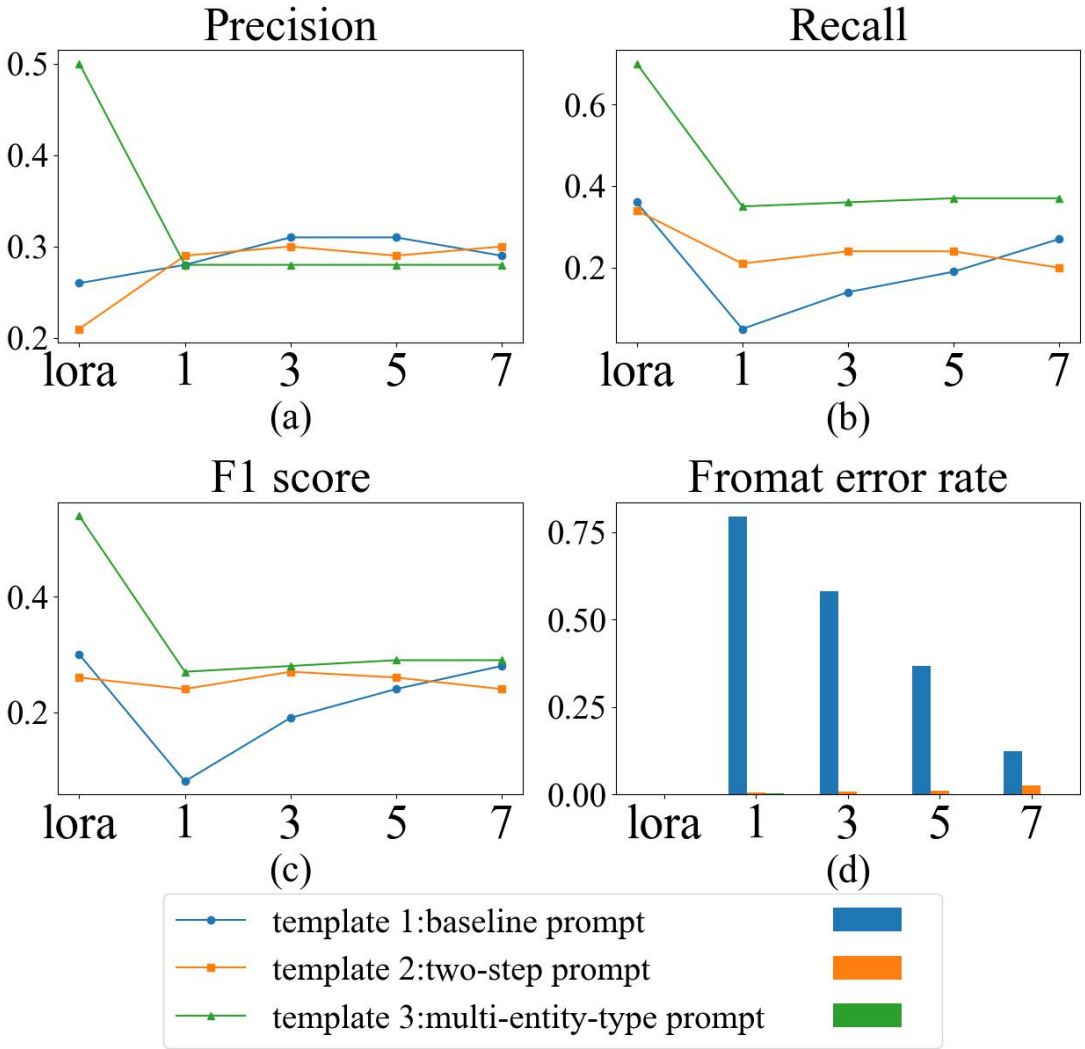
**### Input:**

This invention relates to a multi-layer lithographically fabricated device used to produce improved thin-film recording heads. It further relates to a focused particle beam system for milling a recording head pole-tip assembly without irradiating a sensitive structure, e.g. a read head, of the recording head.

**### Response:**

# 2.Methodology& Experiment

Experimental results of LLM with and without efficient fine-tuning



# 2.Methodology& Experiment

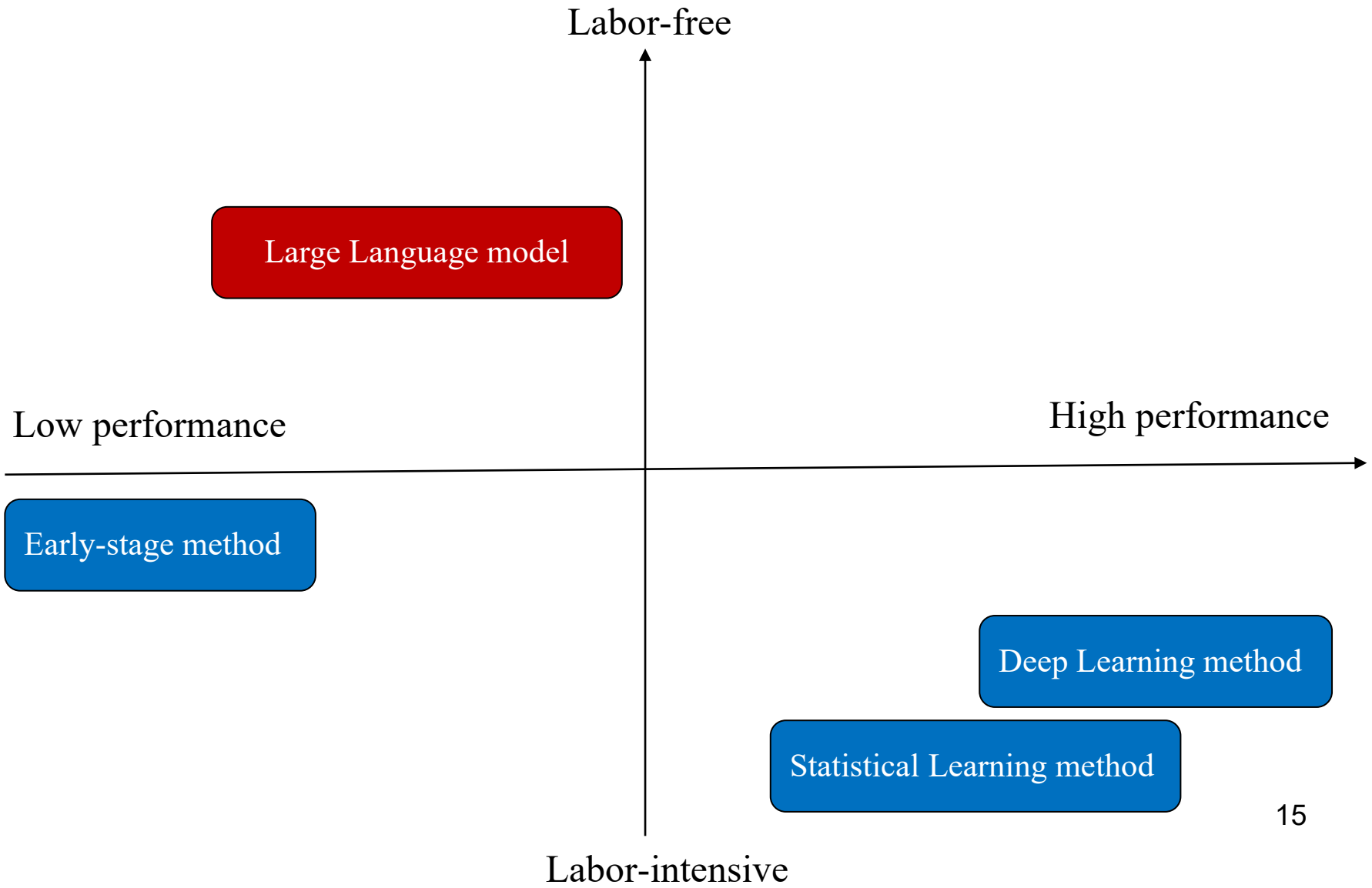
Experimental results of NER with different methods

| Weighted-average | LLM with efficient fine-tuning | | BiLSTM-CRF | PC-LDA | SAO |
|---|---|---|---|---|---|
| | YES | NO | | | |
| P (%) | 50.0 | 28.0 | **78.5** | 20.5 | 3.0 |
| R(%) | 70.0 | 37.0 | **78.0** | 9.7 | 1.2 |
| F1(%) | 54.0 | 29.0 | **78.2** | 13.2 | 1.7 |

# 3. Conclusion

- ✓ Prompt template is crucial for NER task with LLM, it not only determines the quality of response yielded by LLM, but the performance of efficient fine-tuning method as well.
- ✓ For the task of NER from patent texts, there is a significant gap between LLM and the SOTA method, namely pretrain model with fine-tuning algorithm.
- ✓ Without annotated patent dataset, LLM will outperform previous methods, such as SAO, topic models by a large margin.

# 3. Conclusion



# Thanks For Your Attention!
# Q&A