

AI 驱动 软件研发 全面进入数字化时代

中国·深圳 11.24-25

AI+
software
Development
Digital
summit



当需求工程遇上人工智能 ——应用与挑战

石琳 北京航空航天大学

科技生态圈峰会 + 深度研习



—1000+ 技术团队的选择



K+全球软件研发行业创新峰会

会议时间：2024.05.24-25



K+全球软件研发行业创新峰会

会议时间：2024.09.20-21



AI+ 软件研发数字峰会

会议时间：2023.11.24-25



AI+ 软件研发数字峰会

会议时间：2024.07.19-20



AI+ 软件研发数字峰会

会议时间：2024.11.15-16

▶ 演讲嘉宾



石琳

北京航空航天大学 教授

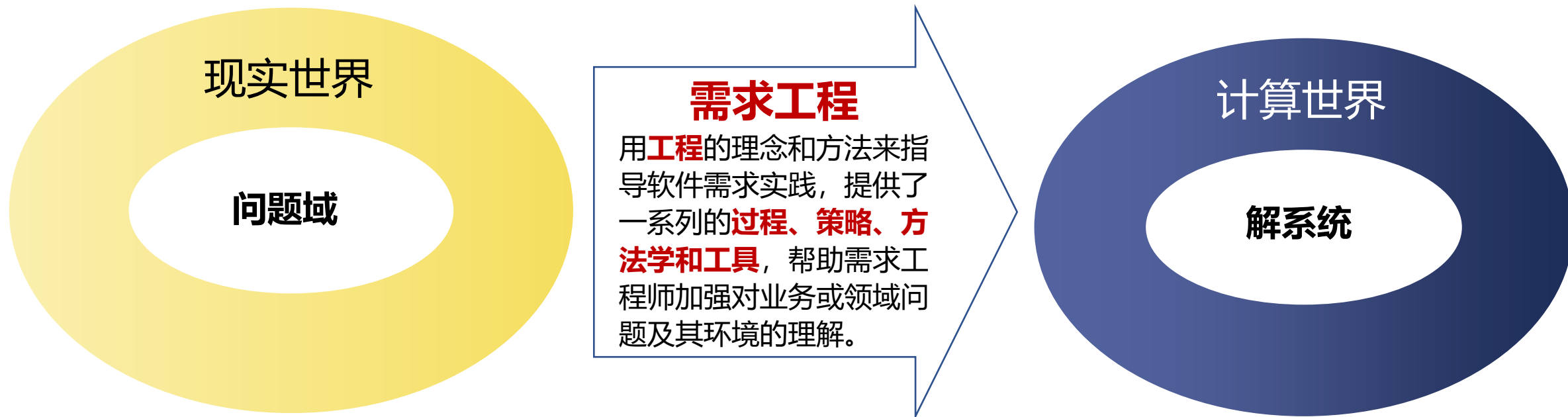
现任北京航空航天大学软件学院教授，CCF高级会员，美国南加州大学访问学者，2022年度中国科学院软件研究所杰出青年科技人才。研究方向为智能软件工程，包括代码生成、智能需求工程、经验软件工程、开源社区挖掘、开源软件安全等。曾在人工智能、软件工程领域的高水平国际会议IJCAI，ICSE，FSE，ASE等发表论文50余篇，三次获得杰出论文奖：ACM SIGSOFT 杰出论文奖（ASE21）、连续两次获国际需求工程大会杰出论文奖（RE21，RE20）。入选中科院青促会，主持参与多项国家自然科学基金基金项目、国防科技创新项目、国家重点研发项目等。同时担任多个国际知名会议期刊包括ICSE、ASE、FSE、Automated Software Engineering期刊、Requirements Engineering期刊、软件学报等审稿人。

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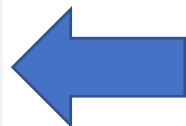
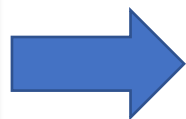
1. 背景与介绍
2. 智能需求工程中的关键性挑战
3. 解决思路及效果
4. 大语言模型在需求工程的初探
5. 总结与展望

► 软件是现实世界解决方案在计算世界的映射



▶ 背景

需求工程



人工智能



需求获取

需求追溯

需求分类

异味需求检测

需求分析

需求生成

.....

机器学习

深度学习

大数据

数据挖掘

知识图谱

推荐系统

逻辑推理

自然语言处理

机器人

计算机视觉

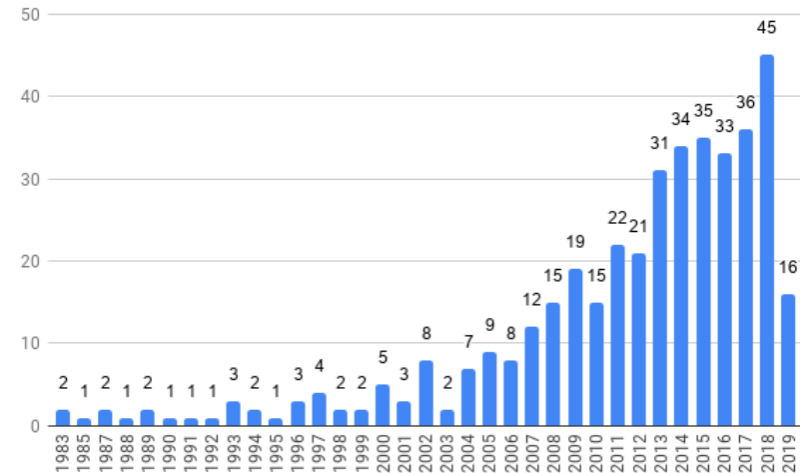
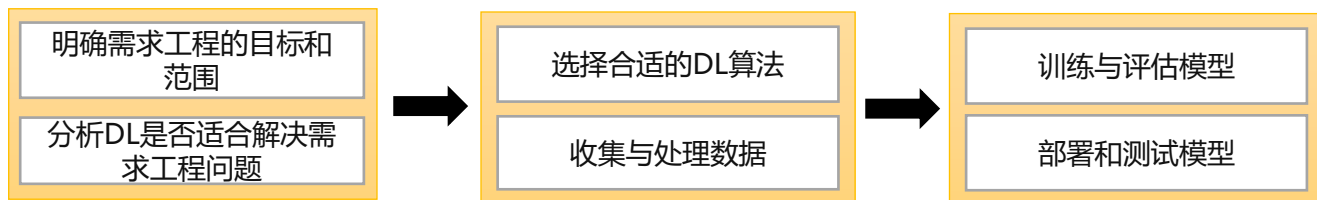
TensorFlow

.....

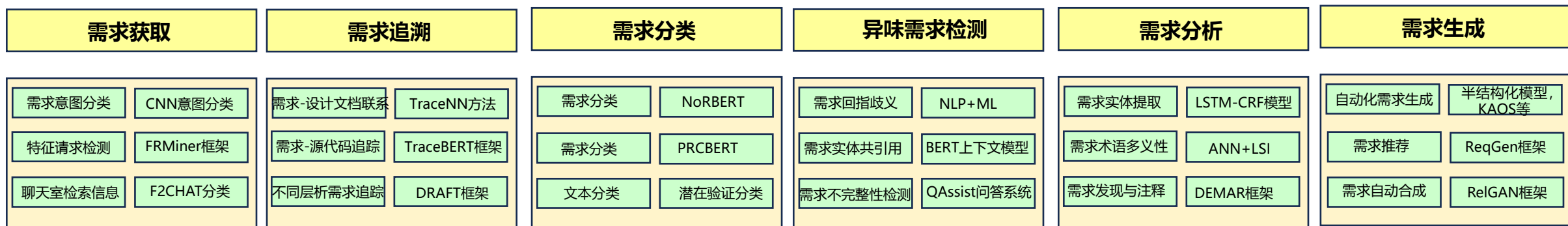
基于人工智能的需求工程技术受到学术界广泛的关注

背景:

最近，越来越多的需求工程研究采用深度学习技术来获取、分析、跟踪、验证和管理软件需求。



深度学习在软件需求工程中的应用



“Deep Learning-based Software Engineering: Progress, Challenges, and Opportunities”, Lu Zhang et al., 2023

PART 02

智能需求工程中的关键性挑战

Key Challenges in AIRE

挑战一：如何应对需求数据匮乏？

➤ 公开数据集稀少，信息含量单一

Dataset	Volume	
PURE	79 SRS of different types	
Modis	49 low level requirements	19 high level requirements
CM1	220 low level requirements	235 high level requirements

```
<element name="p">
  <complexType mixed="false">
    <sequence>
      <element ref="title" minOccurs="0" maxOccurs="1"/>
      <choice maxOccurs="unbounded">
        <element ref="p" minOccurs="0" maxOccurs="unbounded"/>
        <element ref="req" minOccurs="0" maxOccurs="unbounded"/>
        <element ref="b" minOccurs="0" maxOccurs="unbounded"/>
        <element ref="glossary" minOccurs="0" maxOccurs="1"/>
      </choice>
    </sequence>
    <attribute name="id" type="string"/>
  </complexType>
</element>
```

Search

Sign In

Software Requirements Dataset

Data Card Code (1) Discussion (0)

50 New Notebook Download (22 kB)

nfr.txt (67.39 kB)

PE:The system shall refresh the display every 60 seconds.
LF:The application shall match the color of the schema set forth by Department of Homeland Security
US: If projected the data must be readable. On a 10x10 projection screen 90% of viewers must be able to read the data.
A: The product shall be available during normal business hours. As long as the user has access to the system, the data must be available.
US: If projected the data must be understandable. On a 10x10 projection screen 90% of viewers must be able to understand the data.
SE:The product shall ensure that it can only be accessed by authorized users. The product will be accessible by authorized users.
US:The product shall be intuitive and self-explanatory. : 90% of new users shall be able to state the purpose of the system.
PE:The product shall respond fast to keep up-to-date data in the display.
F:The system shall have a MDI form that allows for the viewing of the graph and the data table.
F:The system shall display Events in a vertical table by time.

Data Explorer
Version 2 (78.01 kB)
nfr.txt
test.txt

挑战一：如何应对需求数据匮乏？

➤ 需求数据隐匿性强，获取成本高

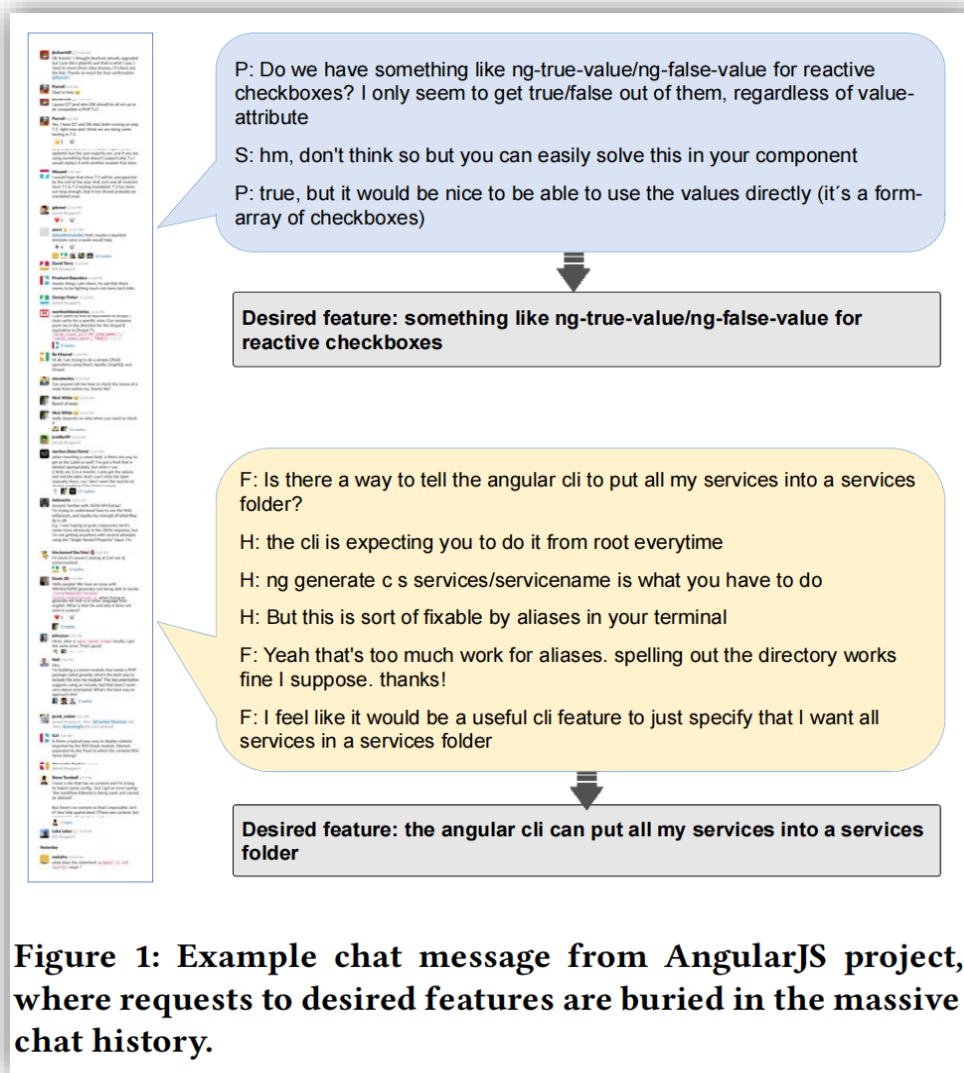
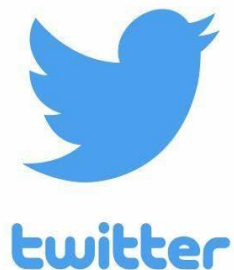


Figure 1: Example chat message from AngularJS project, where requests to desired features are buried in the massive chat history.

挑战二：如何智能理解需求文档的内容？

- 需求通常是**自然语言描述**、**领域紧密相关的**

Requirement Text
The software shall store up to 2000 patient results.
The software shall provide a means for the user to browse the names of assays supported by the instrument.
The software shall allow the user to select the titration volume (2 ml to 10ml, ± 0.3ml)

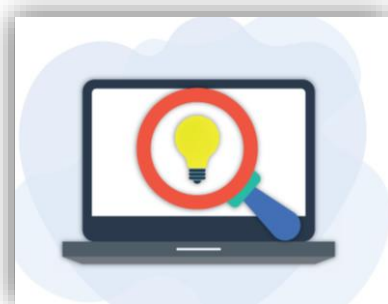


领域性强



二义性强

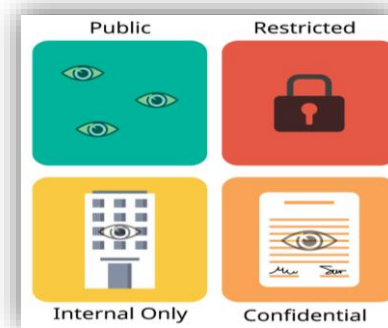
- 能否**正确理解**需求文档的内容，是下游任务实现**自动化**的关键



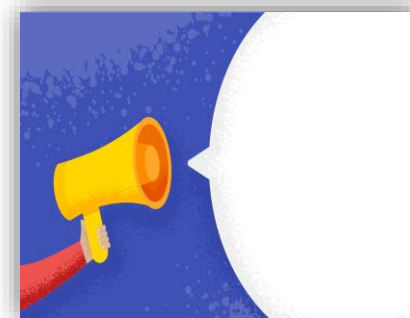
- 需求获取



- 需求追踪



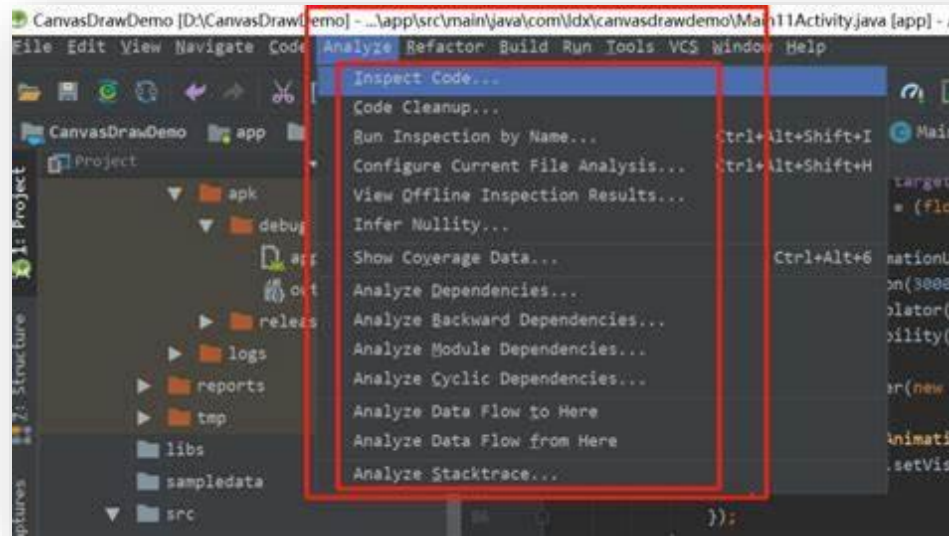
- 需求分类



- 需求变更影响分析

挑战三：如何智能保障需求质量？

代码静态检测工具



R1: The system shall provide users with an **industry-related term list** associated with finance through the online help tool.

R2: When browsing the **finance vocabulary list** through the online help tool, users can select the languages from system settings by a dropdown list.

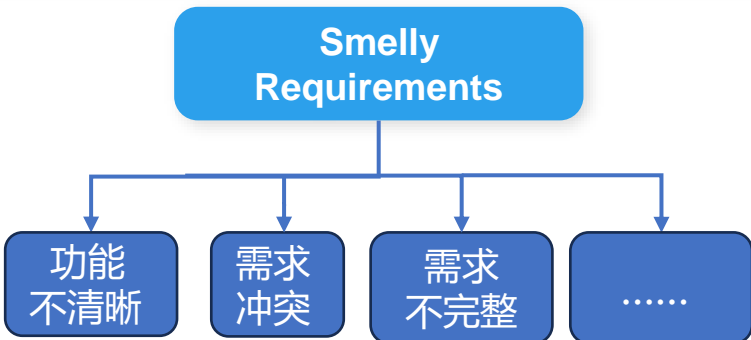
R3: When users browse the **finance word list** in the online help tool, it should display in double columns and be auto-adaptive to IE, Firefox, and Chrome.

Coreferent Entities

- E1: industry-related term list
- E2: finance vocabulary list
- E3: finance word list

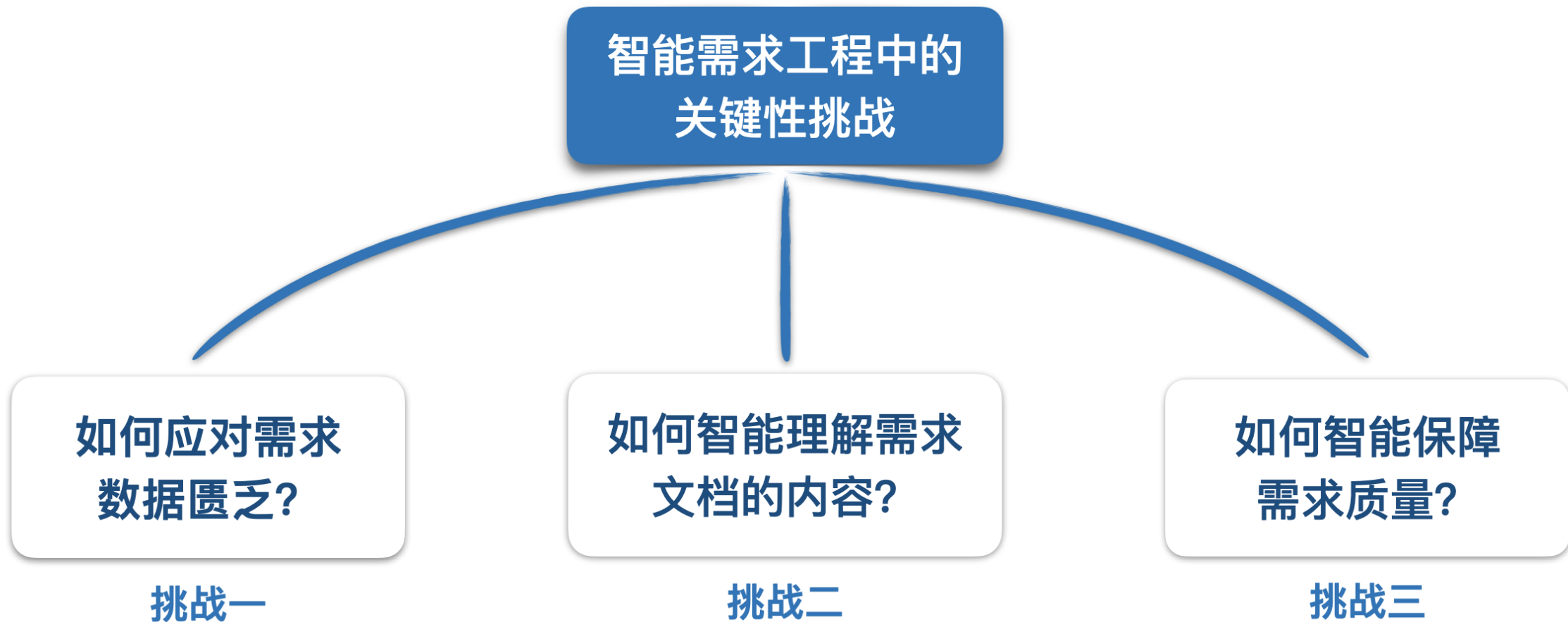


需求分析师



Smelly Requirements

▶ 智能需求工程中的关键性挑战



PART 03

解决思路及效果

Solutions and Evaluations

解决思路——挑战一

智能需求工程中的关键性挑战

挑战一：如何应对需求数据匮乏？

应对思路

需求智能获取技术

从社交媒体中挖掘隐匿用户需求：
app review、issue report、
mailing list、live chat

挑战二：如何智能理解需求文档的内容？

应对思路

需求智能分析技术

- 基于深度学习的需求领域实体检测
- 基于深度学习的需求功能点智能分析

挑战三：如何智能保障需求质量？

应对思路

需求质量智能评价

- 基于上下文的不一致需求实体检测
- 基于NLP和启发式规则的低质量需求检测

思路一：从开源社区问题报告中挖掘隐匿的用户需求



labor-intensive and time-consuming

Requirements Discovery Task

Requirements Annotation Task

Multitask Learning

Mingyang Li, Lin Shi, et al. A Deep Multitask Learning Approach for Requirements Discovery and Annotation from Open Forum. ASE2020
 Lin Shi, et al., Understanding Feature Requests by Leveraging Heuristic Fuzzy rules and Semantic Analysis. ASE 2017

思路一：从开源社区问题报告中挖掘隐匿的用户需求

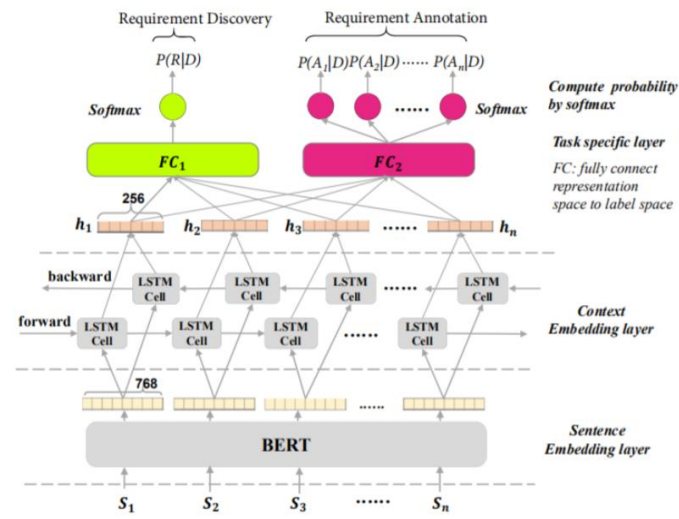
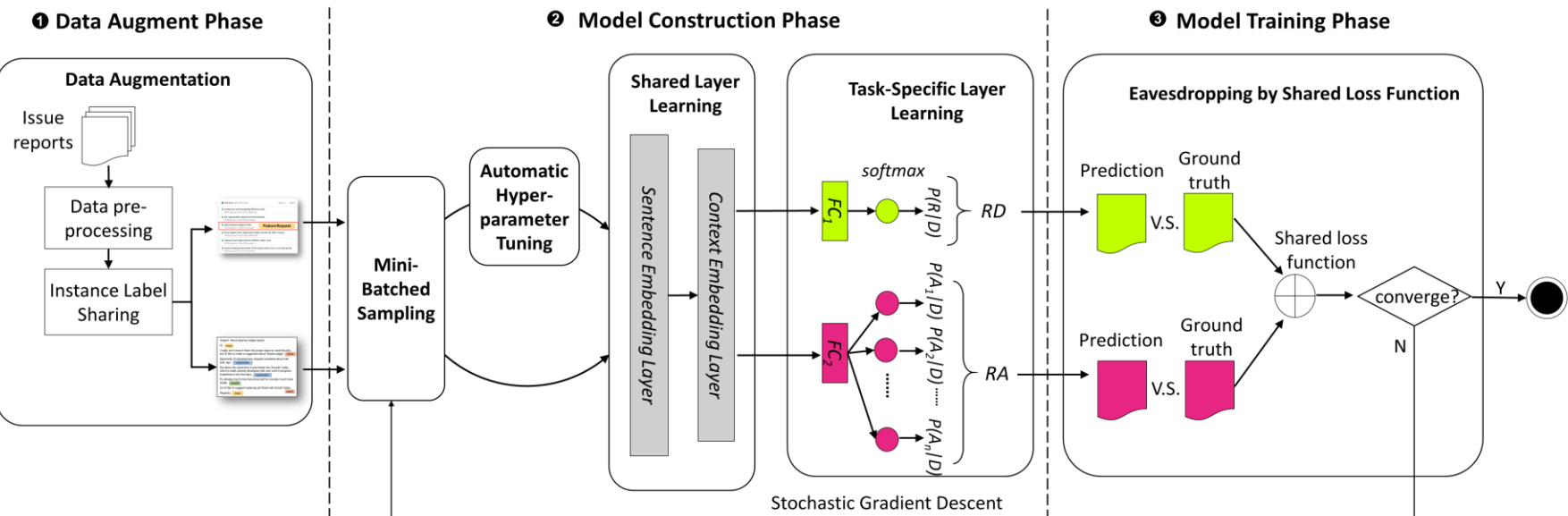


Table 3: Comparison in RA task

Approach	F1							Accuracy
	INT	BE	DR	EXP	EXA	TRI	CB	
DEMARC	91.4%	76.2%	68.9%	87.2%	69.7%	88.0%	91.5%	83.3%
FRA	87.5%	84.9%	83.0%	83.0%	80.5%	82.0%	NA	81.5%
LR	70.5%	48.6%	56.8%	57.4%	71.0%	79.2%	77.4%	68.6%
NB	70.0%	45.7%	57.6%	46.7%	73.5%	79.0%	76.8%	69.4%
RF	75.9%	64.4%	72.5%	54.0%	60.4%	80.0%	78.5%	72.0%
SVM	75.8%	59.4%	69.4%	57.4%	71.8%	74.1%	77.9%	75.7%
TEXTCNN	74.9%	51.5%	61.7%	67.2%	54.9%	83.8%	78.0%	73.2%
TEXTRNN	57.7%	38.0%	58.5%	61.0%	53.4%	82.0%	47.3%	58.3%

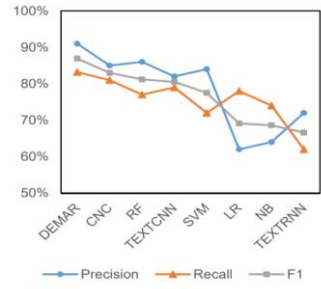
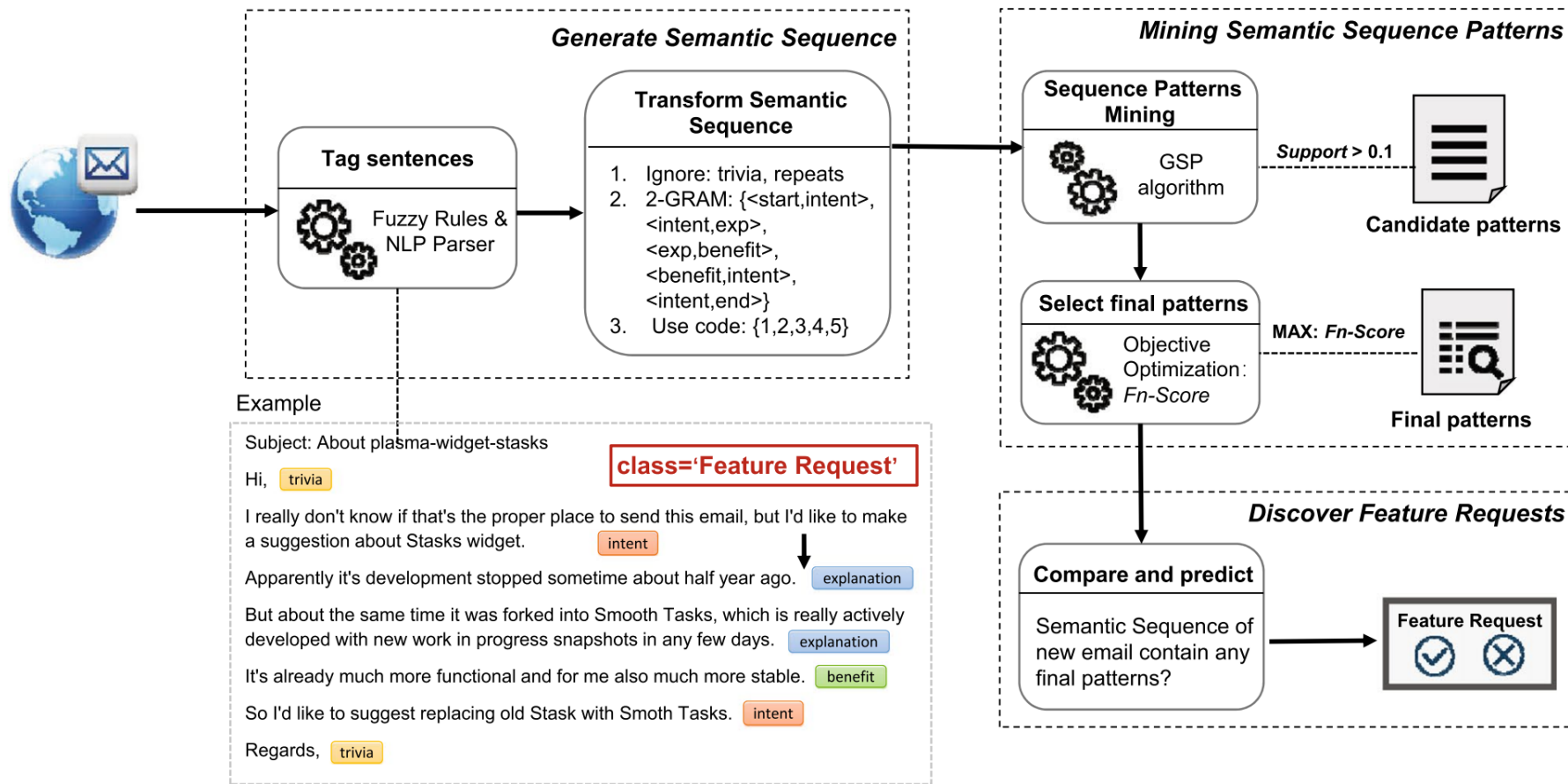


Figure 6: Comparison in RA task

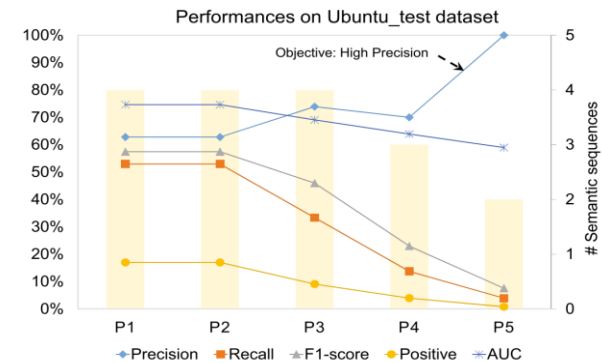
- 多任务学习框架同时给需求发现和需求标注任务带来了性能 (4% F1-4%, ACC-7.7%)
- 无论是需求发现还是需求标注，效果均显著优于现有方法

Mingyang Li, Lin Shi, et al. A Deep Multitask Learning Approach for Requirements Discovery and Annotation from Open Forum. ASE2020
 Lin Shi, et al., Understanding Feature Requests by Leveraging Heuristic Fuzzy rules and Semantic Analysis. ASE 2017

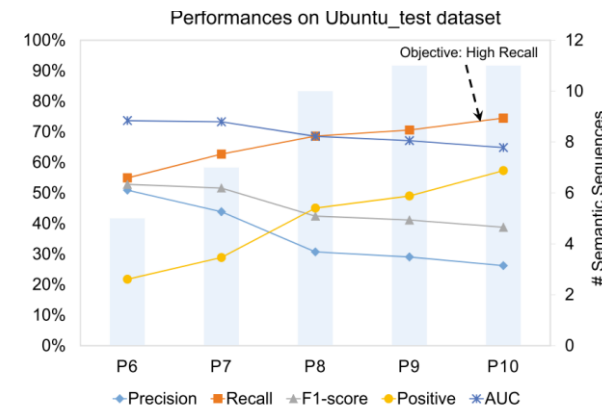
思路二：从开源社区邮件列表中挖掘隐匿的用户需求



Effectiveness



Generalizability



Lin Shi, Celia Chen, Qing Wang, Barry Boehm, Automatically detecting feature requests from development emails by leveraging semantic sequence mining (RE Journal 2021)

思路三：从开源社区聊天平台中挖掘隐匿的用户需求



Development Issues

- Discuss current issues
- Propose alternative solutions
- Argue/against alternatives

Patch reviews

- Code quality
- Design decisions

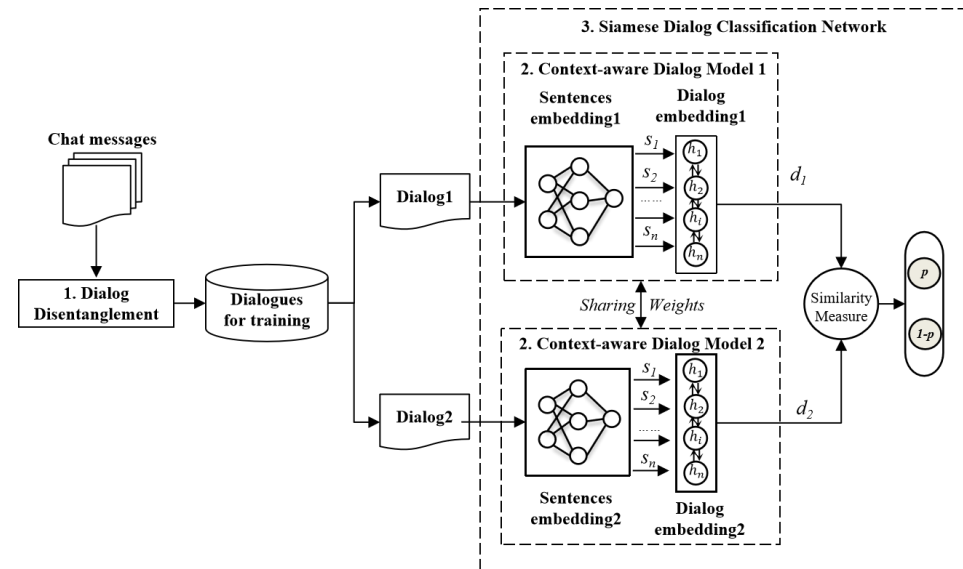
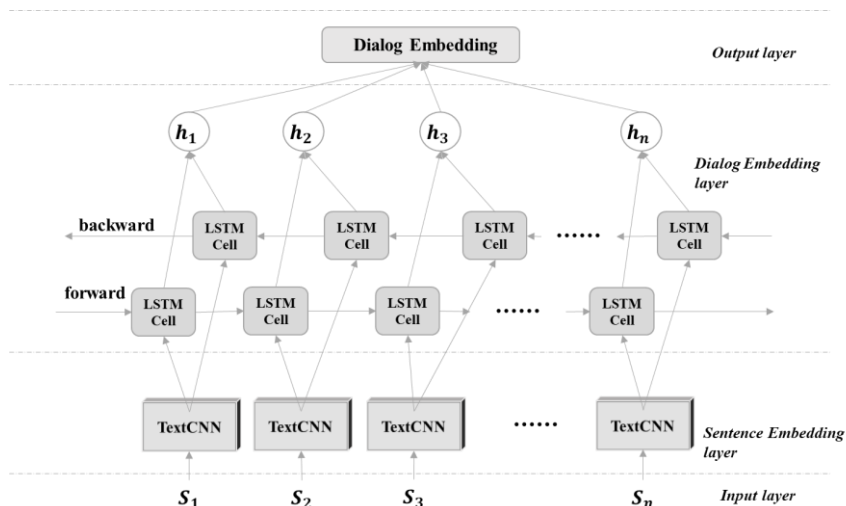
User Feedback

- Desired Features
- Complaints
- Share opinions and interesting insights

Social Events

- Arrange meetings
- Organizational issues
- Just for Leisure

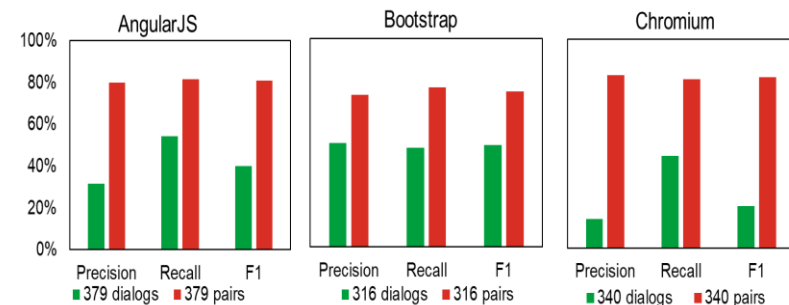
```
[03:05] <delire> hehe yes. does Kubuntu have
'KPackage'?
=== delire found that to be an excellent
interface to the apt suite in another
distribution.
=== E-bola [...@...] has joined #ubuntu
[03:06] <BurgerMann> does anyone know a
consoleprog that scales jpegs fast and
efficient?... this digital camera age kills me
when I have to scale photos :s
[03:06] <Seveas> delire, yes
[03:06] <Seveas> BurgerMann, convert
[03:06] <Seveas> part of imagemagick
=== E-bola [...@...] has left #ubuntu []
[03:06] <delire> BurgerMann: ImageMagick
[03:06] <Seveas> BurgerMann, i used that to
convert 100's of photos in one command
[03:06] <BurgerMann> Oh... I'll have a look..
thx =)
```



Lin Shi, et al., Detection of Hidden Feature Requests from Massive Chat Messages via Deep Siamese Network (ICSE 2020)

思路三：从开源社区聊天平台中挖掘隐匿的用户需求

	Massive chat messages			Sample		
	Duration	#dialogs	#sentences	#dialogs	#sentences	#FRs
<i>AngularJS</i>	2016.5-2019.4	38266	406553	316	9220	36
<i>Bootstrap</i>	2014.7-2019.5	10358	58871	379	2371	76
<i>Chromium</i>	2015.5-2019.7	16804	118890	340	4465	27
Total		65428	584314	1035	16056	139

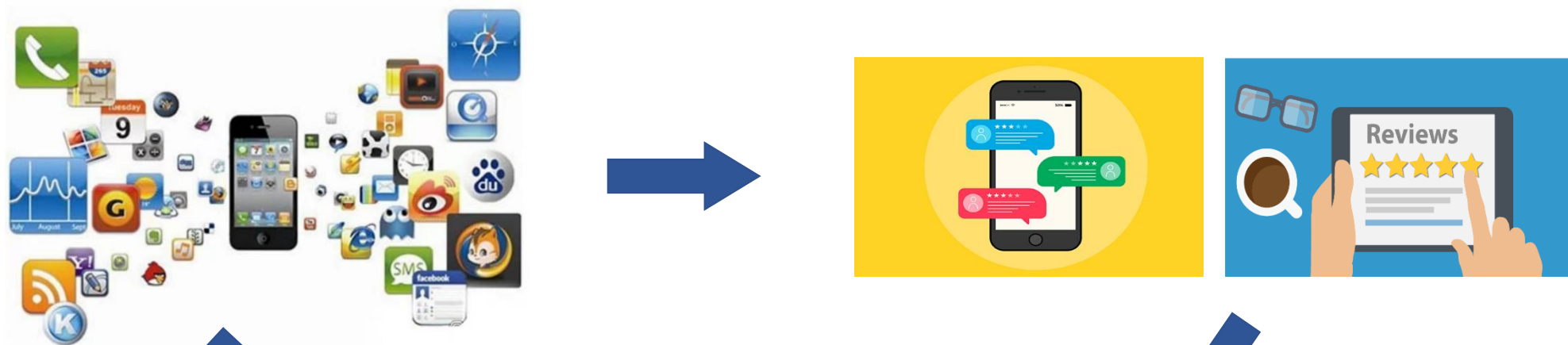


		Angular			Bootstrap			Chromium		
		Precision	Recall	F1	Precision	Recall	F1	Precision	Recall	F1
Our approach	<i>Siamese FRMiner</i>	85.23%	86.56%	85.89%	86.84%	85.89%	86.37%	85.87%	86.81%	86.34%
	<i>Plain FRMiner</i>	31.03%	50.00%	38.30%	27.56%	69.08%	39.40%	16.00%	50.00%	24.24%
Existing studies	<i>CNC</i>	7.70%	44.44%	13.13%	16.38%	34.21%	22.13%	9.10%	62.50%	15.70%
	<i>FRA</i>	13.67%	80.33%	23.35%	23.00%	48.67%	31.00%	16.00%	80.00%	27.00%
Text classification	<i>NB</i>	16.00%	75.00%	26.00%	27.00%	36.00%	31.00%	7.00%	26.00%	12.00%
	<i>GBDT</i>	18.00%	14.00%	16.00%	30.00%	11.00%	16.00%	20.00%	19.00%	19.00%
	<i>RF</i>	28.00%	14.00%	19.00%	37.00%	9.00%	15.00%	12.00%	26.00%	16.00%
	<i>FastText</i>	32.00%	19.00%	24.00%	43.00%	13.00%	20.00%	19.00%	11.00%	14.00%

- 使用孪生网络后效果明显提升
- 交叉项目验证表明，效果均显著优于现有方法

Lin Shi, et al., Detection of Hidden Feature Requests from Massive Chat Messages via Deep Siamese Network (ICSE 2020)

思路四：从App Store用户评论中挖掘隐匿的用户需求



Example

Instagram ★☆☆☆☆

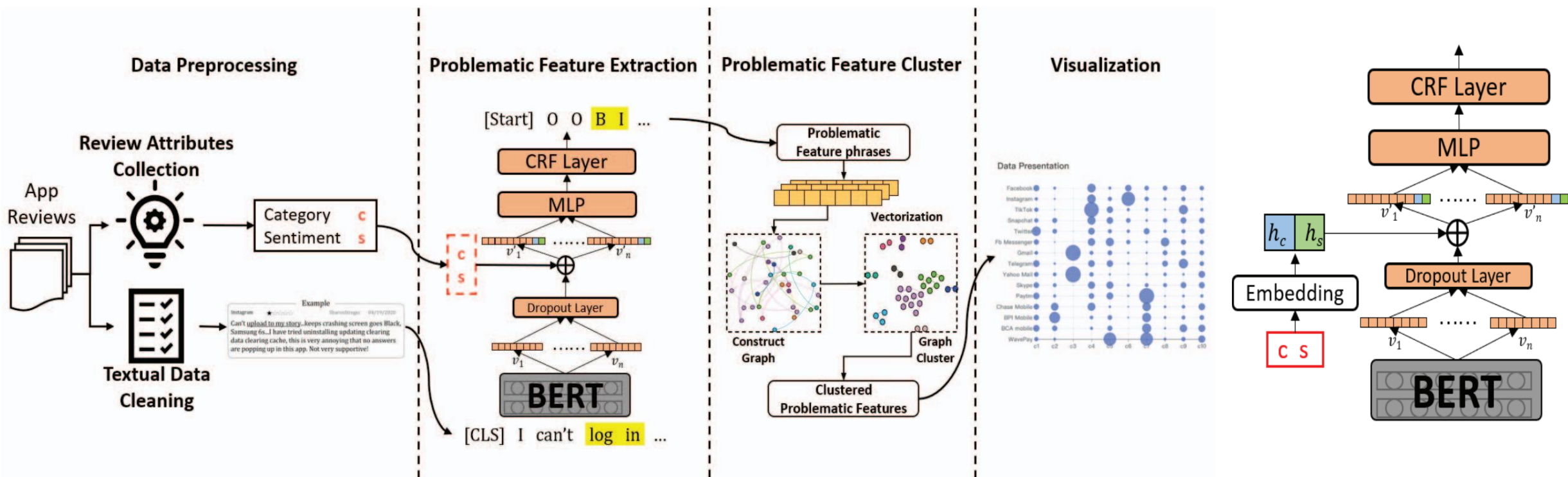
SharonStreger 04/19/2020

Can't upload to my story...keeps crashing screen goes Black, Samsung 6s...I have tried uninstalling updating clearing data clearing cache, this is very annoying that no answers are popping up in this app. Not very supportive!

Yawen Wang, Junjie Wang, Hongyu Zhang, Xuran Ming, Lin Shi, Qing Wang, Where is Your App Frustrating Users? (ICSE 2022)

思路四：从App Store用户评论中挖掘隐匿的用户需求

- 首先，线上爬取App 用户评论数据，并清洗以及获取评论属性；其次，以评论文本和评论属性作为BERT 模型训练的输入，然后，设计图聚类方法对抽象短语聚类，最后，可视化App缺陷特征分布。



Yawen Wang, Junjie Wang, Hongyu Zhang, Xuran Ming, Lin Shi, Qing Wang, Where is Your App Frustrating Users? (ICSE 2022)

解决思路——挑战二

智能需求工程中的关键性挑战

挑战一：如何应对需求数据匮乏？

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- 基于深度学习的需求领域实体检测
- 基于深度学习的需求功能点智能分析

挑战三：如何智能保障需求质量？

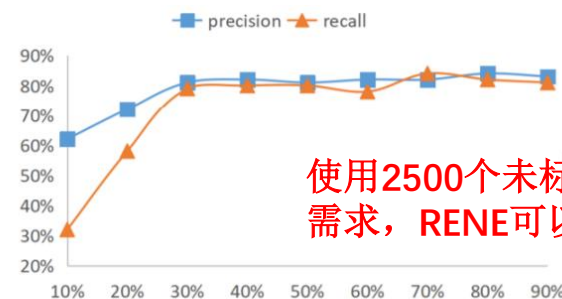
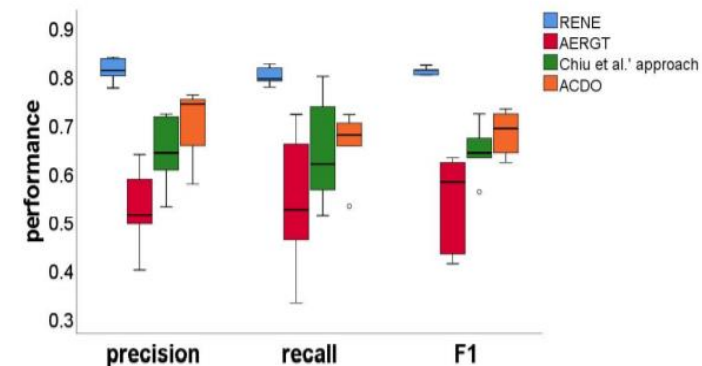
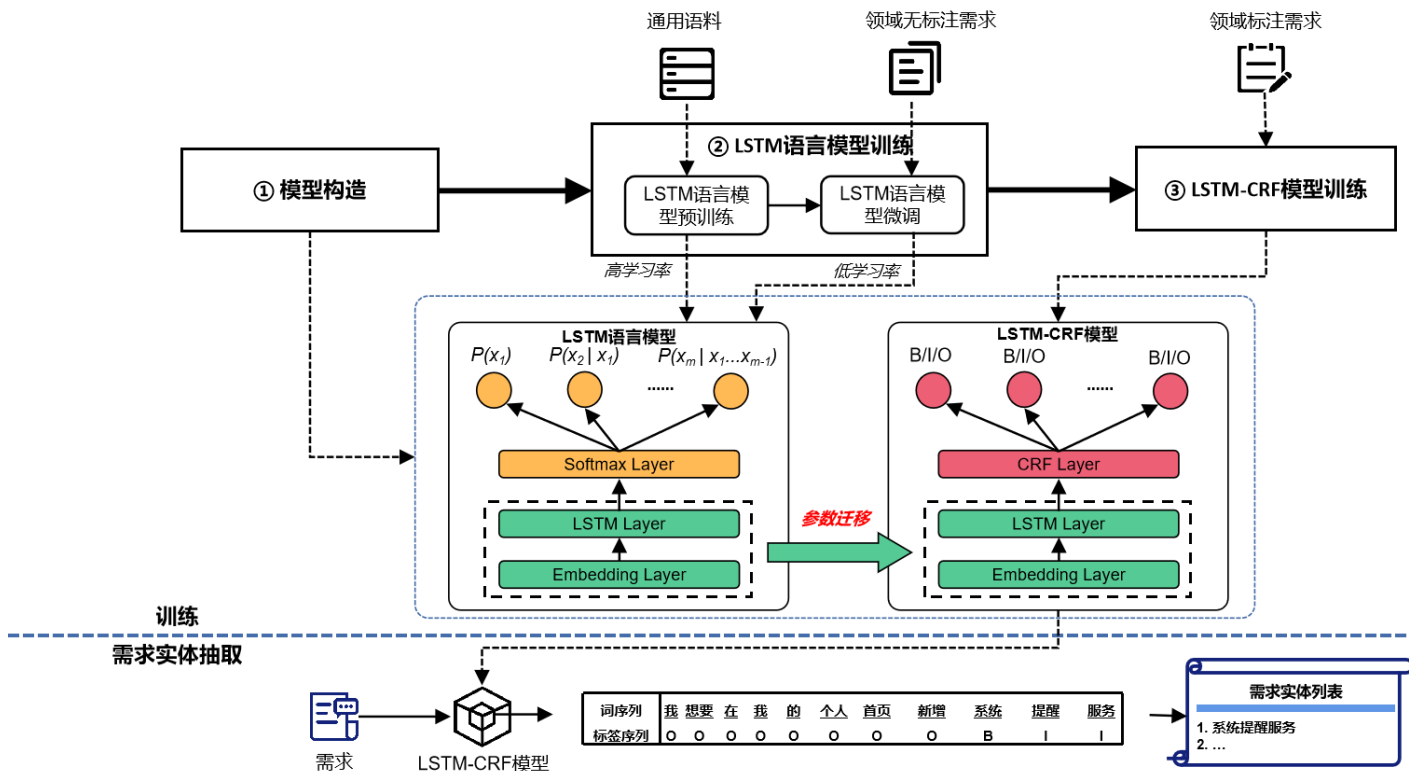
应对思路

需求质量智能评价

- 基于上下文的不一致需求实体检测
- 基于NLP和启发式规则的低质量需求检测

思路一：基于深度学习的需求领域实体检测

- 采用迁移学习的方法，从大规模通用语料中学习语言知识，并迁移到目标网络中，从而实现在小规模标注数据情况下的需求实体抽取。



使用2500个未标注需求和1000个标注需求，RENE可以达到理想的模型性能

图 4.6 标注需求样本量敏感度分析结果

Figure 4.6 The Sensitivity Analysis Results of the Number of Labeled Requirements

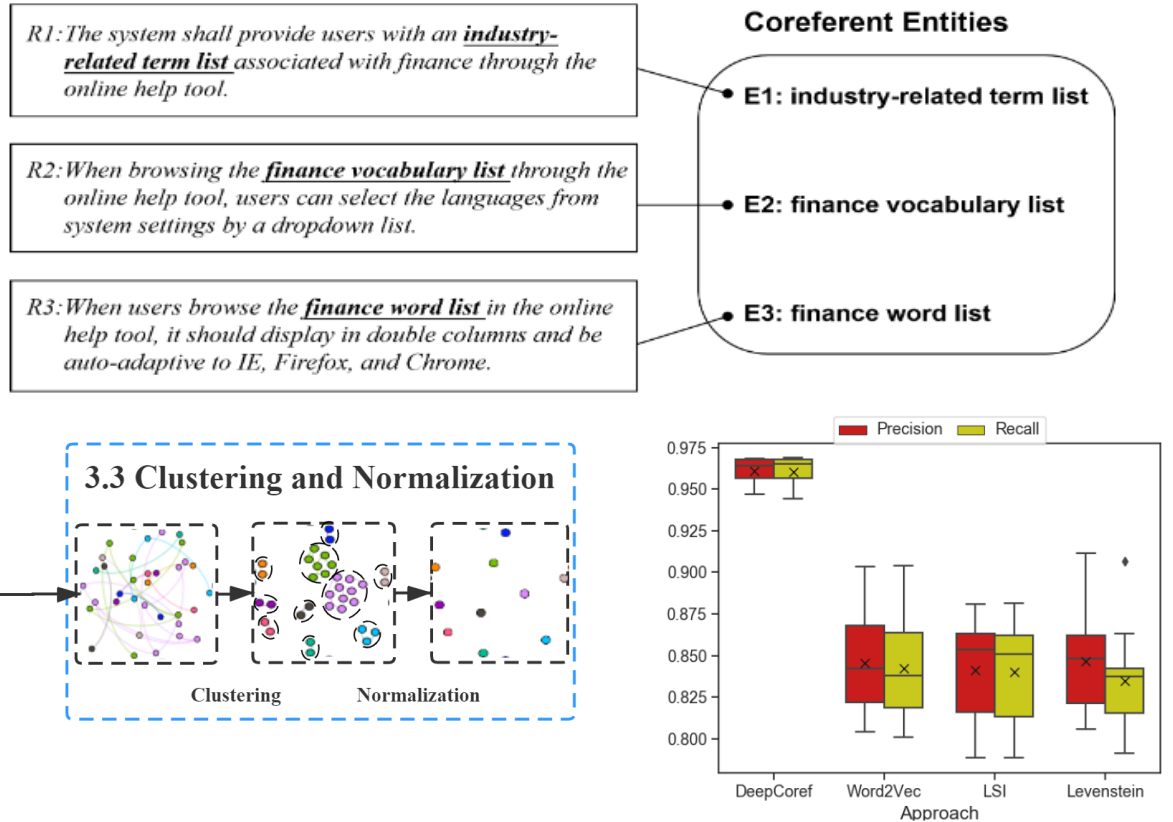
- Mingyang Li, Ye Yang, Lin Shi, et al., Automated Extraction of Requirement Entities by Leveraging LSTM-CRF and Transfer Learning, ICSME 2020

解决思路——挑战三



思路一：基于上下文的不一致需求实体检测

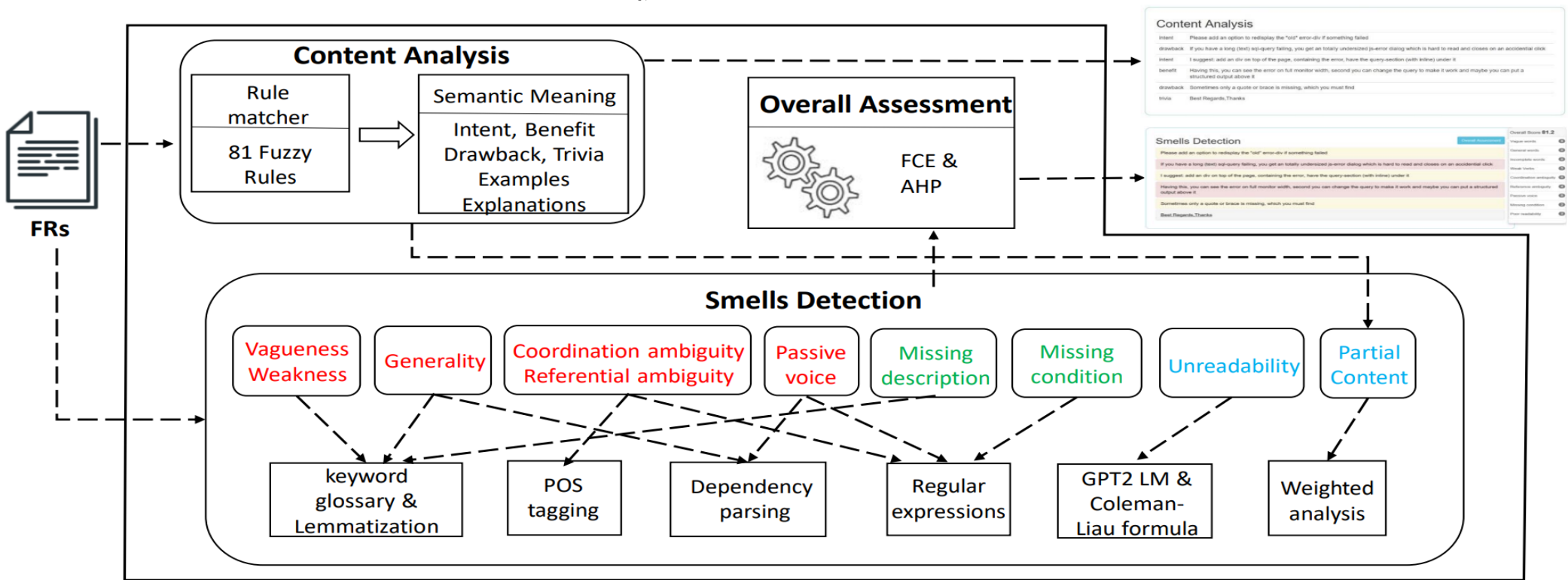
- 功能实体共指关系指的是不同的语言表达指向同一真实世界的特性短语。
- 导致对技术术语的误解，导致重复、错误的功能开发



- Yawen Wang, Lin Shi*, et al., “A Deep Context-wise Method for Coreference Detection in Natural Language Requirements”, RE20, **Distinguished Paper Award**
- Yawen Wang, Lin Shi*, Mingyang Li, Qing Wang, Yun Yang, “Detecting Coreferent Entities in Natural Language Requirements”, RE Journal 2022

思路二：基于NLP和启发式规则的低质量需求检测

- 首先，将特征请求中的句子分为六个语义类别（意图、解释、缺点...）；然后，总结特征请求中质量缺陷；最后，采用模糊综合评价特征请求质量。



- Fangwen Mu, Lin Shi*, Wei Zhou, Yuanzhong Zhang, Huixia Zhao, "NERO: A Text-based Tool for Content Annotation and Detection of Smelly Requirements", RE20

思路二：基于NLP和启发式规则的低质量需求检测

工具评估：人工评估 + 工具自动评分 对来自问题跟踪系统的10个功能请求进行排名

The screenshot displays the Smells Detection tool interface. On the left, the 'Input' section shows the 'FR Title' and 'FR Description' of a requirement. The 'Smells Detection' section in the center lists several detected issues with their corresponding text and readability scores. On the right, a sidebar provides an 'Overall Score' and a list of quality metrics with their respective counts.

Input

FR Title
option to disable JS-Windows for errors

FR Description
Please add an option to redisplay the "old" error-div if something failed
If you have a long (text) sql-query failing, you get an totally undersized js-error dialog which is hard to read and closes on an accidental click
I suggest: add an div on top of the page, containing the error, have the query-section (with inline) under it
Having this, you can see the error on full monitor width, second you can change the query to make it work and maybe you can put a structured output above it
Sometimes only a quote or brace is missing, which you must find
Best Regards,Thanks!

Smells Detection

Overall Assessment

Please add an option to redisplay the "old" error-div if something failed

If you have a long (text) sql-query failing, you get an totally undersized js-error dialog which is hard to read and closes on an accidental click

I suggest: add an div on top of the page, containing the error, have the query-section (with inline) under it

Having this, you can see the error on full monitor width, second you can change the query to make it work and maybe you can put a structured output above it

The sentence contains **vague** words: maybe , full

The sentence contains **weak** verb: can³

The sentence contains **referential** ambiguity: Matched Pattern:NN NN PRP(PRP: it²)

The sentence's readability : **hard**

Sometimes only a quote or brace is missing, which you must find

Best Regards,Thanks

Overall Score 81.2

- Vague words: 3
- General words: 3
- Incomplete words: 3
- Weak Verbs: 3
- Coordination ambiguity: 3
- Reference ambiguity: 4
- Passive voice: 3
- Missing condition: 2
- Poor readability: 3

- Fangwen Mu, Lin Shi*, Wei Zhou, Yuanzhong Zhang, Huixia Zhao, "NERO: A Text-based Tool for Content Annotation and Detection of Smelly Requirements", RE20

智能需求工程中的关键性挑战

挑战一：如何应对需求数据匮乏？

应对思路



需求智能获取技术

从社交媒体中挖掘隐匿用户需求：
app review、issue report、
mailing list、live chat

挑战二：如何智能理解需求文档的内容？

应对思路



需求智能分析技术

- 基于深度学习的需求领域实体检测
- 基于深度学习的需求功能点智能分析

挑战三：如何智能保障需求质量？

应对思路



需求质量智能评价

- 基于上下文的不一致需求实体检测
- 基于NLP和启发式规则的低质量需求检测

PART 04

大语言模型在需求工程的初探

LLM for RE

▶ 大模型用于需求工程

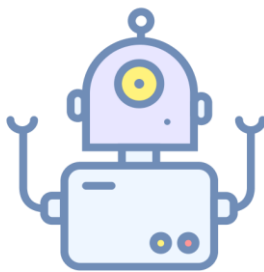
任务		任务描述	Prompt
需求获取	需求生成	通过问答、讨论或者解析文档的方式，生成软件需求	我想做一个类似上面“极客时间”这样的课程学习App,我首先要实现哪些功能? ---朱少民《GPT-4 开启“软件工程3.0”全新时代》
需求分析	需求分类	将需求按照功能性与非功能性进行分类	<ul style="list-style-type: none"> 图书管理系统 (通用性强) ,主要包含图书借阅、归还、逾期通知等主要功能 数据库扫描软件 (领域性强) , 检测数据模型与数据库不一致性。如, 类图与数据表之间的不匹配, 属性不一致。
	优先级排序	按照需求的关键性对需求进行优先级排序	图书管理系统 (通用性强) , 主要包含图书借阅、归还、逾期通知等主要功能
	需求冲突检测	检测需求之间是否存在冲突或潜在冲突	
需求管理	需求质量提升	检查自然语言描述的需求是否存在表述不清晰	
需求建模	需求文档化	根据自然语言描述的需求, 自动生成用例图、类图、流程图、ER图等	<ul style="list-style-type: none"> 用户如何使用OAuth2与web应用程序交互和登录? 基于云的文件存储系统与移动app交互 项目管理工具, 允许客户创建项目, 将任务分配给团队成员, 并跟踪项目的进度。 ---Adrian Tam 《Generating Diagrams with ChatGPT》 ---Khanh Mai 《ChatGPT to generate diagrams/graphs/charts with Mermaid.js.org》
需求验证	需求验证	根据需求, 自动生成验收标准、Test Case等	产品需求通过用户故事描述, 其中一个用户故事是这样描述的“我作为“携程” app的普通用户, 我想要一次性取消事先预定的一个旅游订单, 以操作简单, 不需要去酒店、机票门票等多次操作门票等多次操作”能否帮忙写出其验收标准? ---朱少民《GPT-4 开启“软件工程3.0”全新时代》

▶ 大模型用于需求获取

- **需求生成:** 通过问答、讨论或者解析文档的方式, 生成软件需求

我想做一个类似上面“极客时间”这样的课程学习App,我首先要实现哪些功能?

Prompt



GPT

HP 我想做一个类似上面“极客时间”这样的课程学习App, 我首先要实现哪些功能?

为了创建一个类似于“极客时间”的课程学习App, 您需要考虑实现以下核心功能:

1. 用户注册与登录: 提供用户注册和登录功能, 支持邮箱、手机号或第三方登录 (如微信、QQ等)。
2. 个人信息管理: 允许用户查看和编辑个人信息, 如头像、昵称、密码等。
3. 课程浏览与搜索: 展示课程列表, 并提供搜索功能, 让用户能够方便地找到感兴趣的课程。
4. 课程分类与筛选: 按照不同的分类组织课程, 如技术、商业、设计等, 并提供筛选功能, 以便用户根据需求查找课程。
5. 课程详情: 展示课程的详细信息, 包括课程介绍、讲师介绍、课程大纲等。
6. 课程购买与支付: 提供购买课程的功能, 支持多种支付方式, 如支付宝、微信支付等。
7. 学习进度跟踪: 记录用户的学习进度, 包括已完成的课程、正在学习的课程以及学习时长等。
8. 视频播放: 提供视频播放功能, 支持多种视频格式和清晰度选择。同时, 提供播放控制功能, 如播放/暂停、快进/快退、倍速播放等。
9. 评论与互动: 允许用户在课程下方发表评论、提问和回答, 以实现用户之间的互动和交流。
10. 我的课程: 展示用户已购买的课程, 方便用户随时查看和学习。
11. 消息通知: 向用户发送课程更新、活动推广等相关通知。
12. 帮助与反馈: 提供帮助文档, 并允许用户提交反馈, 以便改进App功能和用户体验。

这些核心功能可以作为您的课程学习App的基础。您还可以根据自己的需求和目标用户群体, 添加其他辅助功能, 如积分系统、签到功能、社区论坛等, 以提高用户的参与度和留存率。

朱少民 《GPT-4 开启“软件工程3.0”全新时代》

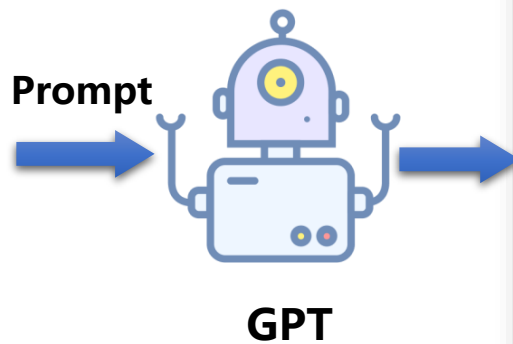
▶ 大模型用于需求分析

➤ 需求分类：功能/非功能, issue/enhancement/new feature

Please categorize the requirements below by functional and non-functional.

1. Users can borrow books by selecting them from the available inventory.
2. The system should implement secure authentication and protect user data.
3. The system should record the borrowing date and the due date for each borrowed book.
4. Users can renew books within one day of being overdue.
5. The system should be responsive and capable of handling a reasonable number of concurrent users.
6. The user interface should be intuitive, user-friendly, and accessible on various devices.
7. Users can return borrowed books to the library.
8. The system should have a robust error handling mechanism and should be able to recover gracefully from failures.
9. The system should be designed to handle future expansion in terms of users, books, and transactions.
10. The system updates the inventory and records the return date.
11. The system should automatically send notifications to users with overdue books.
12. The system starts recording fines once the book return date has passed.

需求来源：图书管理系统 (通用性强)
主要功能：图书借阅、归还、逾期通知等



GPT能很好的对需求进行功能和非功能分类。

Sure, I can help you categorize these requirements into functional and non-functional categories:

Functional Requirements:

1. Users can borrow books by selecting them from the available inventory.
2. The system should record the borrowing date and the due date for each borrowed book.
3. Users can renew books within one day of being overdue.
4. Users can return borrowed books to the library.
5. The system updates the inventory and records the return date.
6. The system should automatically send notifications to users with overdue books.
7. The system starts recording fines once the book return date has passed.

Non-Functional Requirements:

1. The system should implement secure authentication and protect user data.
2. The system should be responsive and capable of handling a reasonable number of concurrent users.
3. The user interface should be intuitive, user-friendly, and accessible on various devices.
4. The system should have a robust error handling mechanism and should be able to recover gracefully from failures.
5. The system should be designed to handle future expansion in terms of users, books, and transactions.

Functional requirements describe what the system should do, while non-functional requirements describe how the system should perform or what qualities it should have. Keep in mind that some requirements might have elements of both functional and non-functional aspects. For example, requirement 3 (Users can renew books within one day of being overdue) involves both functional (renewing books) and non-functional (timeliness of renewal) aspects.

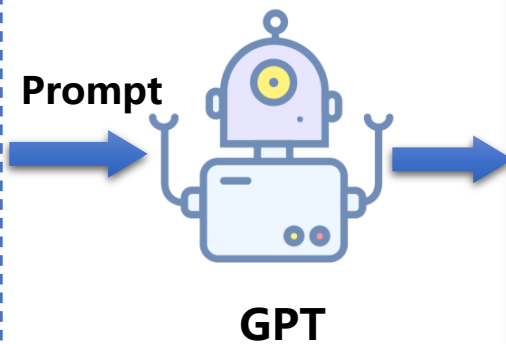
大模型用于需求分析

需求分类

需求来源：数据库扫描软件（领域性强）
主要功能：检测数据模型与数据库不一致性。如，类图与数据表之间的不匹配，属性不一致。

Please categorize the requirements below by functional and non-functional.

1. The system must provide appropriate data protection measures when accessing and modifying the database.
2. The system automatically analyzes the given class diagram to identify classes, general properties and relationships.
3. The system can be operated efficiently to avoid compromising the performance of existing systems.
4. The system should have a simple and intuitive user interface that facilitates the user experience.
5. The system is able to scan the database and detect mismatches and attribute inconsistencies between class diagrams and database tables.
6. To resolve detected inconsistencies, the system can provide suggestions for improvements to the class diagram, which may include reference scenarios such as adding new classes, modifying class attributes and relationships, etc.
7. The system should have the ability to adapt to new kinds of inconsistency detection and repair as business needs change.
8. The system should be able to automatically execute repair scripts to resolve some common, known inconsistencies.



Sure, I can help categorize these requirements into functional and non-functional categories:

Functional Requirements:

1. The system must provide appropriate data protection measures when accessing and modifying the database. ❌
2. The system automatically analyzes the given class diagram to identify classes, general properties, and relationships.
3. The system should have the ability to scan the database and detect mismatches and attribute inconsistencies between class diagrams and database tables.
4. To resolve detected inconsistencies, the system can provide suggestions for improvements to the class diagram, which may include reference scenarios such as adding new classes, modifying class attributes and relationships, etc. ❌
5. The system should be able to adapt to new kinds of inconsistency detection and repair as business needs change. ❌
6. The system should be able to automatically execute repair scripts to resolve some common, known inconsistencies.

Non-functional Requirements:

1. The system can be operated efficiently to avoid compromising the performance of existing systems.
2. The system should have a simple and intuitive user interface that facilitates the user experience.

These categorizations are based on the typical characteristics of functional requirements (what the system does) and non-functional requirements (how the system performs its functions). Functional requirements describe the system's behavior and capabilities, while non-functional requirements describe qualities such as performance, usability, and security.

错误地将系统的性能需求分类为功能性需求

错误地将系统的扩展性需求分类为功能性需求

▶ 大模型用于需求分析

➤ 需求优先级排序：自动按照关键性排序需求

Please rank the requirements in order of priority.

1. Users can borrow books by selecting them from the available inventory.
2. The system should implement secure authentication and protect user data.
3. The system should record the borrowing date and the due date for each borrowed book.
4. Users can renew books within one day of being overdue.
5. The system should be responsive and capable of handling a reasonable number of concurrent users.
6. The user interface should be intuitive, user-friendly, and accessible on various devices.
7. Users can return borrowed books to the library.
8. The system should have a robust error handling mechanism and should be able to recover gracefully from failures.
9. The system should be designed to handle future expansion in terms of users, books, and transactions.
10. The system updates the inventory and records the return date.
11. The system should automatically send notifications to users with overdue books.
12. The system starts recording fines once the book return date has passed.

需求来源：图书管理系统（通用性强）
主要功能：图书借阅、归还、逾期通知等

Prioritizing requirements depends on the specific goals and context of the project. Based on general considerations for a library management system, here's a priority ranking:

1. **2. The system should implement secure authentication and protect user data.**
 - Security and privacy are paramount, ensuring that user information is protected.
2. **5. The system should be responsive and capable of handling a reasonable number of concurrent users.**
 - Performance and scalability are crucial for ensuring the system can handle the expected load.
3. **6. The user interface should be intuitive, user-friendly, and accessible on various devices.**
 - A user-friendly interface is essential for a positive user experience, and accessibility ensures it can be used by a wide range of users.
4. **8. The system should have a robust error handling mechanism and should be able to recover gracefully from failures.**
 - A reliable system with good error handling is important for user trust and system stability.
5. **9. The system should be designed to handle future expansion in terms of users, books, and transactions.**
 - Future scalability ensures that the system can grow with the needs of the library.
6. **1. Users can borrow books by selecting them from the available inventory.**
 - This is a core functionality of the system and is crucial for its primary purpose.
7. **7. Users can return borrowed books to the library.**
 - This is a core functionality that complements the borrowing process.
8. **10. The system updates the inventory and records the return date.**
 - This is necessary for maintaining an accurate record of the library's inventory.
9. **4. Users can renew books within one day of being overdue.**
 - While important, this is a secondary functionality compared to the core borrowing and returning process.
10. **12. The system starts recording fines once the book return date has passed.**
 - Fines are important for managing overdue books, but they can be implemented once the core functionalities are in place.
11. **11. The system should automatically send notifications to users with overdue books.**
 - While important, this can be implemented after the basic borrowing and returning process is functioning properly.
12. **3. The system should record the borrowing date and the due date for each borrowed book.**
 - This is a core functionality that complements the borrowing process.

Keep in mind that this is a general prioritization and might not perfectly fit every specific scenario. Adjustments should be made based on the unique requirements and constraints of your project.

借阅、归还、逾期通知等核心功能没有优先；
反而强调用户界面、并发处理等附加能力。

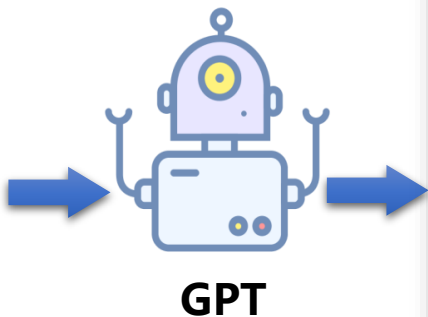
▶ 大模型用于需求分析

➤ 需求冲突检测：检查需求之间是否存在冲突

Please check for conflicts between the following requirements.

1. Users can borrow books by selecting the available inventory.
2. The system should implement secure authentication and protect user data.
3. The system should record the borrowing date and the due date for each borrowed book.
4. Users can renew books within one day of being overdue.
5. The system should be responsive and capable of handling a reasonable number of concurrent users.
6. The user interface should be intuitive, user-friendly, and accessible on various devices.
7. Users can return borrowed books to the library.
8. The system should have a robust error handling mechanism and should be able to recover gracefully from failures.
9. The system should be designed to handle future expansion in terms of users, books, and transactions.
10. The system updates the inventory and records the return date.
11. The system should automatically send notifications to users with overdue books.
12. The system starts recording fines once the book return date has passed.

需求来源：图书管理系统（通用性强）
主要功能：图书借阅、归还、逾期通知等



Upon reviewing the provided requirements, there don't seem to be any explicit conflicts. However, it's important to note some potential points of consideration:

1. **Authentication and Data Protection vs. Accessibility:** While security and data protection is crucial, it should not hinder user access. Balancing security measures and user-friendliness is important.
2. **Concurrent Users vs. Responsiveness:** Handling a large number of concurrent users while maintaining responsiveness may require careful system architecture and potentially load balancing.
3. **Renewal within One Day of Overdue vs. Fine Calculation:** Implementing the renewal policy within one day of being overdue might require a fine calculation mechanism that accounts for the overdue period. ✓
4. **Error Handling vs. Graceful Recovery:** The system's robust error handling mechanism should be designed to seamlessly recover from failures, ensuring a smooth user experience.
5. **Future Expansion vs. Scalability:** The system's design should be scalable to accommodate an increase in users, books, and transactions in the future.

GPT检测出超过还书日期，系统开始记录罚款与用户在逾期一天内可以续借图书之间存在冲突。

It's crucial to address these points during the design and development phase to ensure a cohesive and functional system. Additionally, conducting thorough testing, including security testing and load testing, will be essential to verify that all requirements are met without conflicts.

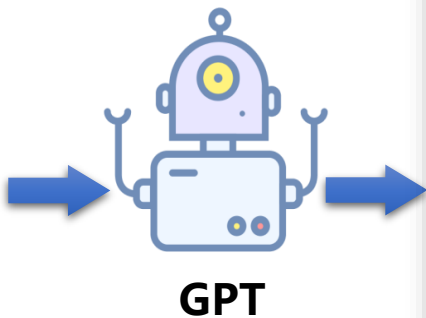
大模型用于需求分析

需求冲突检测

用户登录失败,
发送锁定通知

Please check for conflicts between the following requirements.

1. After three continues failed login attempts, the account would be locked by the system.
2. Once the account is locked, the system sends an account lock notification email to the account's owner.
3. Once an account is locked, the system would also send a SMS message to the account's owner to notify him about the situation owner.
4. If a user has already received a notification via email, he will not receive the same notification via SMS.



GPT



There don't seem to be any inherent conflicts between the four requirements you've listed. However, it's important to consider the implementation details to ensure a seamless and secure system. Here are some points to consider:

1. **Locking Mechanism:** Make sure the system effectively locks the account after the consecutive failed login attempts. It should have a reliable mechanism to distinguish between legitimate and illegitimate login attempts.
2. **Email Notification:** The system should be capable of sending account lock notification emails. Ensure that the email notification contains enough information for the account owner to understand the situation and take appropriate action.
3. **SMS Notification:** Implement a system to send SMS notifications after an account is locked. Ensure that the SMS notification is clear and provides the necessary information for the account owner to address the issue.
4. **Notification Logic:** Implement a logic to track whether an account has already received an email notification. This logic should prevent redundant notifications, ensuring that the user doesn't receive the same notification via both email and SMS.
5. **Security Considerations:** Ensure that the notification system is secure and that sensitive information is not exposed in notifications. Also, consider implementing additional security measures, such as two-factor authentication, to enhance account security.
6. **User Preferences:** Consider providing users with the option to opt in or out of receiving notifications via email or SMS. This allows for a more personalized user experience.
7. **Testing:** Thoroughly test the entire account locking and notification system to identify and address any potential issues. This includes testing scenarios with failed login attempts, successful notifications, and variations in user responses.

By carefully considering these points during the implementation phase, you can help ensure that the system meets the specified requirements without conflicts and provides a secure and user-friendly experience.

形式重于内容

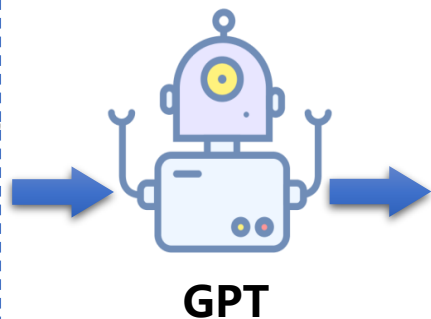
▶ 大模型用于需求分析

➤ 需求质量提升：检查自然语言描述的需求是否存在表述不清晰

- Please rank the requirements in order of priority.
1. Users can borrow books by selecting the available inventory.
 2. The system should implement secure authentication and protect user data.
 3. The system should record the borrowing date and the due date for each borrowed book.
 4. Users can renew books within one day of being overdue.
 5. The system should be responsive and capable of handling a reasonable number of concurrent users.
 6. The user interface should be intuitive, user-friendly, and accessible on various devices.
 7. Users can return borrowed books to the library.
 8. The system should have a robust error handling mechanism and should be able to recover gracefully from failures.
 9. The system should be designed to handle future expansion in terms of users, books, and transactions.
 10. The system updates the inventory and records the return date.
 11. The system should automatically send notifications to users with overdue books.
 12. The system starts recording fines once the book return date has passed.

GPT未能检测出：

- 用户借书：借书数量限制不明确
- 计算罚款：罚款计算规则不明确



Overall, the requirements are well-defined and specific. However, there are a few points that could use some clarification or additional information:

1. **"Reasonable number of concurrent users"**: This is somewhat subjective and could vary depending on the context. It might be helpful to specify an expected range or define what is considered reasonable in this scenario.
2. **"Renew books within one day of being overdue"**: It would be good to specify whether there are any limits on how many times a book can be renewed, and if so, what those limits are.
3. **"Intuitive, user-friendly interface"**: While this is a good goal, it might be beneficial to include some specific design principles or features that should be considered to achieve this.
4. **"Recover gracefully from failures"**: This is a good requirement, but it would be helpful to specify what types of failures are expected and how the system should handle them.
5. **"Future expansion in terms of users, books, and transactions"**: This is a good requirement for scalability, but it would be even better to provide some specific examples of what the system should be designed to handle.
6. **"Automatically send notifications to users with overdue books"**: Specify the frequency and method of notifications (e.g., email, SMS) and any escalation process if the user does not respond. ✓

GPT只检测出逾期通知发送需求是模糊的。

Overall, these requirements provide a clear and comprehensive outline for the system. Adding a bit more detail in these areas would further refine and clarify the expectations.

▶ 大模型用于需求建模

- 根据自然语言描述的需求，自动生成用例图、类图、流程图、ER图等
- 帮助建立Requirements Glossary

“ How can a user interact with an webapp and login using OAuth2? Please generate a sequence diagram in PlantUML syntax to explain.

“ Certainly! I can help you generate a sequence diagram in PlantUML syntax to illustrate how a user can interact with a web app and login using OAuth2. Here's the diagram:

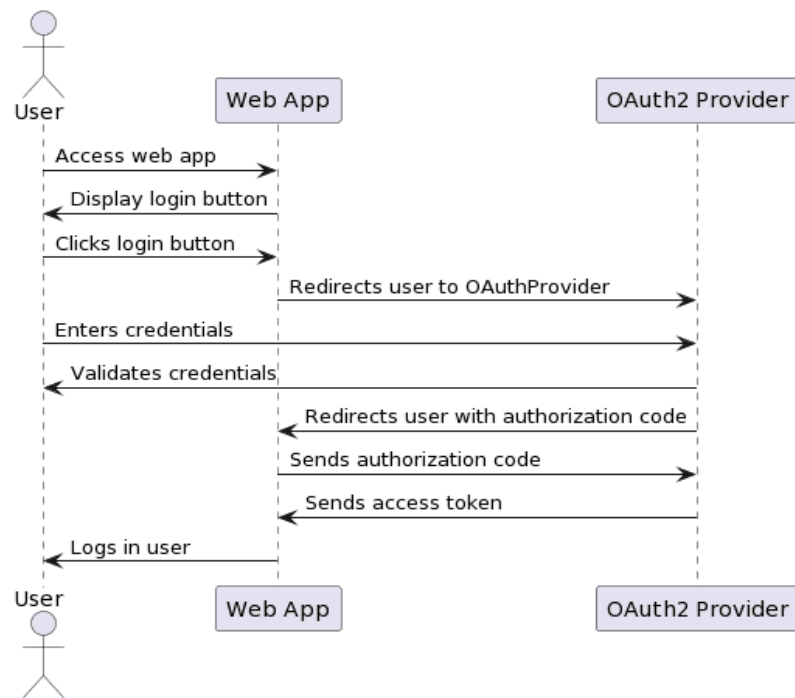
```
plantuml
Copy code
@startuml
actor User
participant "Web App" as WebApp
participant "OAuth2 Provider" as OAuthProvider

User -> WebApp: Access web app
WebApp -> User: Display login button
User -> WebApp: Clicks login button
WebApp -> OAuthProvider: Redirects user to OAuthProvider
User -> OAuthProvider: Enters credentials
OAuthProvider -> User: Validates credentials
OAuthProvider -> WebApp: Redirects user with authorization code
WebApp -> OAuthProvider: Sends authorization code
OAuthProvider -> WebApp: Sends access token
WebApp -> User: Logs in user
@enduml
```

In this diagram, the steps are as follows:

1. The User accesses the web app.
2. The Web App displays a login button to the User.
3. The User clicks the login button.
4. The Web App redirects the User to the OAuth2 Provider.
5. The User enters their credentials on the OAuth2 Provider's login page.
6. The OAuth2 Provider validates the User's credentials.
7. The OAuth2 Provider redirects the User back to the Web App with an authorization code.
8. The Web App sends the authorization code to the OAuth2 Provider.
9. The OAuth2 Provider exchanges the authorization code for an access token.
10. The OAuth2 Provider sends the access token back to the Web App.
11. The Web App logs in the User using the access token.

Please note that this diagram provides a high-level overview of the OAuth2 login process and may not include all the intricacies of the protocol or specific implementation details. It serves as a simplified representation of the general flow.



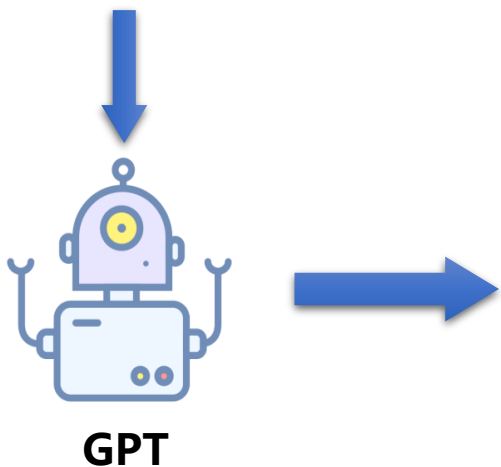
Adrian Tam 《Generating Diagrams with ChatGPT》

▶ 大模型用于需求建模

➤ 根据自然语言描述的需求，自动生成类图

A small software development company wants to build a new project management tool for its clients. The tool will allow clients to create projects, assign tasks to team members, and track the progress of the project.

Please create a class diagram for this using the Mermaid syntax.



项目管理工具：允许客户创建项目，将任务分配给团队成员，并跟踪项目的进度。

GPT生成的Mermaid代码存在语法错误。不能够转换为类图。

ChatGPT
Certainly! Mermaid is a simple markdown-like script language for creating diagrams. Below is an example of a class diagram for a project management tool using Mermaid syntax:

```
mermaid
classDiagram
class Project {
+String projectId
+String projectName
+Date startDate
+Date endDate
+List<Task> tasks
+void addTask(Task task)
+void removeTask(Task task)
+void updateProgress()
}
class Task {
+String taskId
+String taskName
+String description
+Date startDate
+Date endDate
+TaskStatus status
+List<TeamMember> assignedTeamMembers
+void assignTeamMember(TeamMember teamMember)
+void unassignTeamMember(TeamMember teamMember)
+void updateStatus(TaskStatus status)
}
```

Diagram Pan & Zoom

Error: Lexical error on line 32. Unrecognized text. ... enum TaskStatus { TODO IN_PR -----^

```
class TeamMember {
+String memberId
+String memberName
+String email
}
enum TaskStatus {
TODO
IN_PROGRESS
DONE
}
```

enum 语法错误



Khanh Mai 《ChatGPT to generate diagrams/graphs/charts with Mermaid.js.org》

大模型用于需求建模

➤ 根据自然语言描述的需求，自动生成类图

第1次提示GPT有语法错误，但没有说明错误细节。

第2次提示GPT存在语法错误细节，生成无语法错误的代码。

Prompt 1: A syntax error with the above code, pls regenerate.

Prompt 2: A syntax error exists in the above code. The error details are Error: Lexical error on line 32. Unrecognized text enum TaskStatus . Please regenerate.

ChatGPT
I apologize for the confusion. It seems there was an error in the Mermaid syntax. Here's a corrected version:

ChatGPT
I apologize for the oversight. It appears there's an issue with the `enum` keyword in Mermaid syntax. Let's modify the diagram to represent the `TaskStatus` enum without using the `enum` keyword:

```
mermaid
classDiagram
class Project {
+String projectId
+String projectName
+Date startDate
+Date endDate
+List<Task> tasks
+void addTask(Task task)
+void removeTask(Task task)
+void updateProgress()
}
class Task {
+String taskId
+String taskName
+String description
+Date startDate
+Date endDate
+TaskStatus status
}
class TeamMember {
+String memberId
+String memberName
+String email
}
Project "1" -- "*" Task : contains
Task "0..*" -- "*" TeamMember : assigned to
TeamMember --> Project : assignedTeamMembers
TeamMember --> TeamMember : assignTeamMember(TeamMember teamMember)
TeamMember --> TeamMember : unassignTeamMember(TeamMember teamMember)
TeamMember --> TeamMember : updateStatus(TaskStatus status)
```

依然存在相同的语法错误。



```
mermaid
classDiagram
class Project {
+String projectId
+String projectName
+Date startDate
+Date endDate
+List<Task> tasks
+void addTask(Task task)
+void removeTask(Task task)
+void updateProgress()
}
class Task {
+String taskId
+String taskName
+String description
+Date startDate
+Date endDate
+String status
}
Project "1" -- "*" Task : contains
Task "0..*" -- "*" TeamMember : assigned to
TeamMember --> Project : assignedTeamMembers
TeamMember --> TeamMember : assignTeamMember(TeamMember teamMember)
TeamMember --> TeamMember : unassignTeamMember(TeamMember teamMember)
TeamMember --> TeamMember : updateStatus(String status)
```

```
+void assignTeamMember(TeamMember teamMember)
+void unassignTeamMember(TeamMember teamMember)
+void updateStatus(String status)
}
class TeamMember {
+String memberId
+String memberName
+String email
}
Project "1" -- "*" Task : contains
Task "0..*" -- "*" TeamMember : assigned to
```

In this modified version, I've replaced the `enum TaskStatus` with a `String status` attribute in the `Task` class. The possible values for `status` are "TODO," "IN_PROGRESS," and "DONE." This should resolve the syntax error.

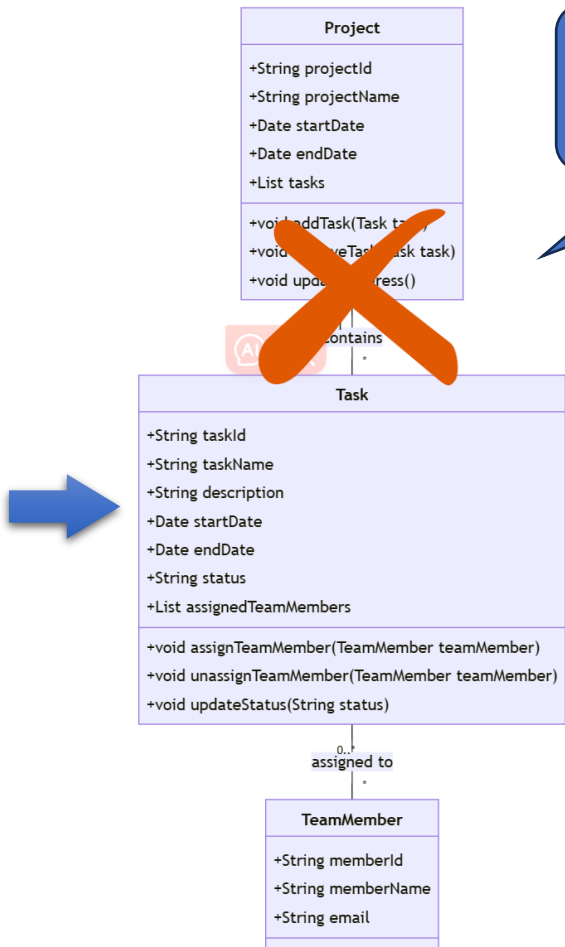
Please let me know if you have any further questions or if there's anything else I can assist you with!

Khanh Mai 《ChatGPT to generate diagrams/graphs/charts with Mermaid.js.org》

大模型用于需求建模

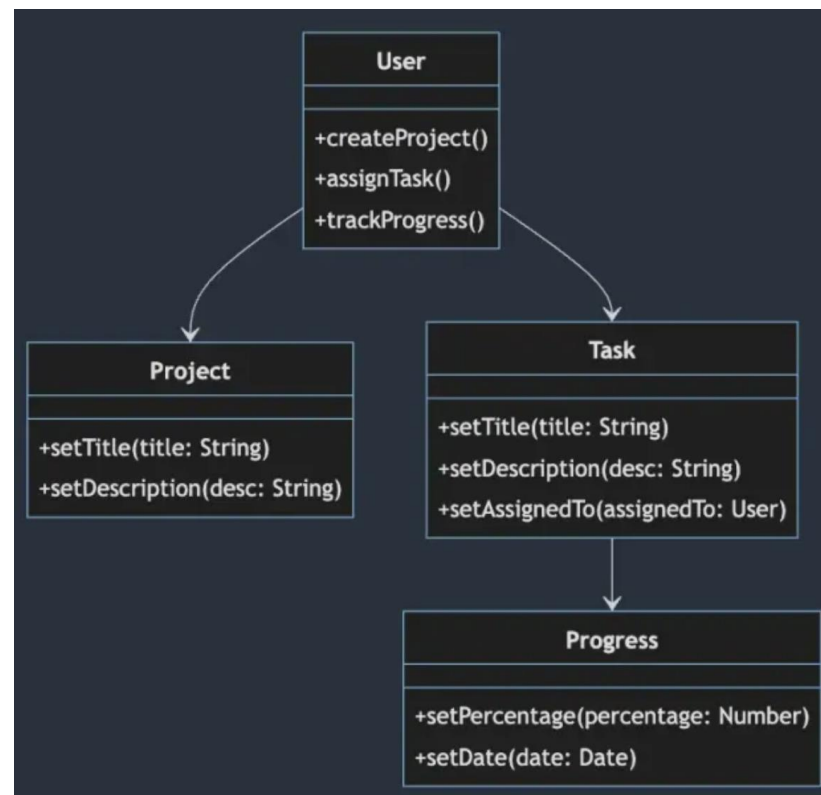
第2次提示后的无语法错误代码。
将其转为类图。

```
mermaid
classDiagram
class Project {
+String projectId
+String projectName
+Date startDate
+Date endDate
+List<Task> tasks
+void addTask(Task task)
+void removeTask(Task task)
+void updateProgress()
}
class Task {
+String taskId
+String taskName
+Date startDate
+Date endDate
+String status
+List<TeamMember> assignedTeamMembers
+void assignTeamMember(TeamMember teamMember)
+void unassignTeamMember(TeamMember teamMember)
+void updateStatus(String status)
}
class TeamMember {
+String memberId
+String memberName
+String email
}
Project "1" -- "*" Task : contains
Task "0..*" -- "*" TeamMember : assigned to
```



类图中没有体现客户创建项目，
并将任务分配给团队成员。

参考类图:



Khanh Mai 《ChatGPT to generate diagrams/graphs/charts with Mermaid.js.org》

▶ 大模型用于需求验证

➤ 根据需求，自动生成验收标准、Test Case



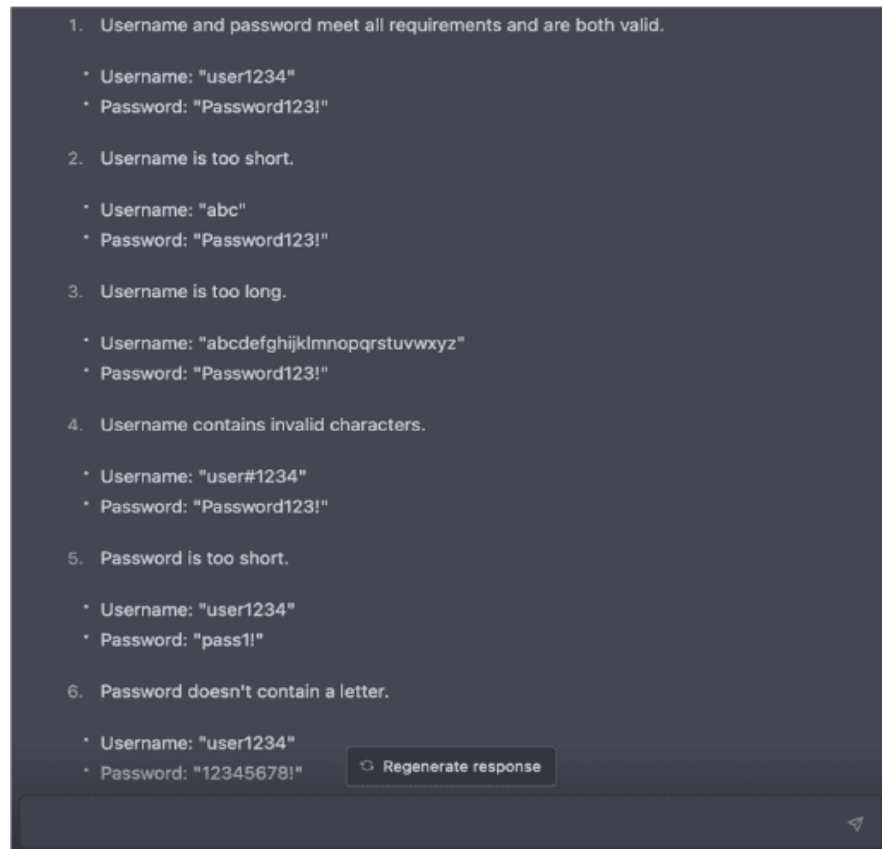
HP 产品需求通过用户故事描述，其中一个用户故事是这样描述的：
“我作为“携程”app的普通用户，我想要一次性取消事先预订的一个旅游订单，以便操作简单，不需要去酒店、机票、门票等进行多次操作。”
能否帮忙写出其验收标准？

当然可以。根据您提供的用户故事，我们可以为这个功能编写以下验收标准：

1. 用户能够在“携程”app中找到并轻松访问“我的订单”功能。
2. 在“我的订单”页面，用户可以清晰地看到他们预订的旅游订单。
3. 用户在选定的旅游订单旁边找到一个选项，允许他们一次性取消整个订单。
4. 在用户选择取消整个订单后，系统应弹出一个确认对话框，以避免误操作。
5. 用户确认取消后，系统应自动处理订单中包含的所有子订单（如酒店、机票、门票等）的取消操作。
6. 取消操作完成后，用户应收到一个通知，确认订单已被成功取消，包括子订单的详细信息。
7. 用户的订单状态应更新为“已取消”，并在“我的订单”页面中反映出这一更改。
8. 取消操作应遵循相应的退款政策，例如，用户应在一定时间内收到相应的退款（如果有）。

这些验收标准旨在确保开发团队充分理解用户故事的需求，从而为“携程”app的普通用户提供简单、一键式的旅游订单取消功能。

There are some requirements which a password and a username should fulfill: the username must be at least 4 characters but not more than 15 and can include letters and numbers; the password must be at least 8 characters and contain at least one letter and one number or special character. The password can not be the same as the username.



1. Username and password meet all requirements and are both valid.
* Username: "user1234"
* Password: "Password123!"
2. Username is too short.
* Username: "abc"
* Password: "Password123!"
3. Username is too long.
* Username: "abcdefghijklmnopqrstuvwxyx"
* Password: "Password123!"
4. Username contains invalid characters.
* Username: "user#1234"
* Password: "Password123!"
5. Password is too short.
* Username: "user1234"
* Password: "pass!"
6. Password doesn't contain a letter.
* Username: "user1234"
* Password: "12345678!"

Regenerate response

朱少民《GPT-4 开启 “软件工程3.0” 全新时代》

▶ 大模型应用于需求工程的优越性

- **适用通识性强的软件：**需求分类、需求质量评价任务上，通识领域基本准确。
- **解决从0到1：**需求生成、需求建模、需求验证等任务上，不完全准确，但至少能产生一个start point，以此为基础交互式修改

▶ 大模型应用于需求工程的局限性

- **难以捕捉需求中的“隐藏知识”**：需求中很多重要信息存在分析师脑海中，需求分析背后也有大量的方案对比和推敲，需求本身的高度抽象性和模糊性，也是大模型难以逾越的障碍
- **遗漏重要需求**：大模型生成的需求主要依据常识或某类软件的共性特征，可能遗漏一些重要需求
- **缺乏创新**：大模型是求同的，创新性或个性化需求依赖开发人员进行补充
- **可靠性问题**：大模型在需求优先级排序、冲突检测等方面，产生的结果不稳定

▶ 智能需求工程的未来展望

• 交互增强：

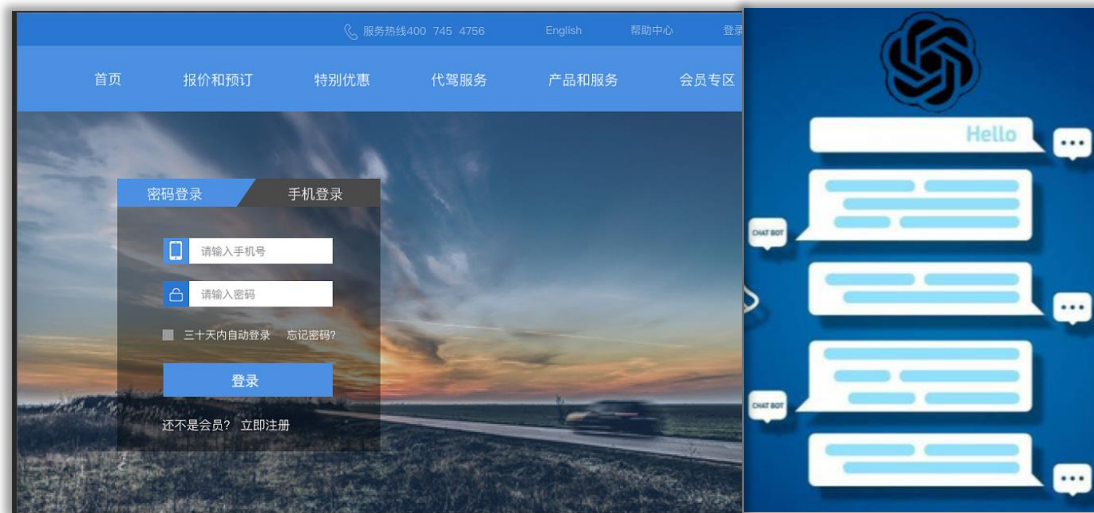
- 如何利用LLM人机交互能力增强需求获取？在人机交谈中明确、澄清需求？
- Fast Prototype

• 创新增强：

- 如何结合复杂的业务上下文和外部知识，生成**个性化**需求？

• 应用增强：

- 如何将大模型用于**版本演化**中的需求生成？
- 如何**系统**评价大模型的应用效果？
- 更加重视需求工程基本**能力建设**：数字化、知识化



需求工程最核心的任务是“ Understand the organisation, its stakeholders, their needs, and their high-level proposals”。

—— 在大模型时代，需求工程显得更为重要！

THANKS

