

University of Stuttgart
Institute of Industrial Automation
and Software Engineering

Large Language Model Agents for AI-Assisted Document Editing for Manufacturing Process Compliance

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Examiner: Prof. Dr. Ing. Michael Weyrich

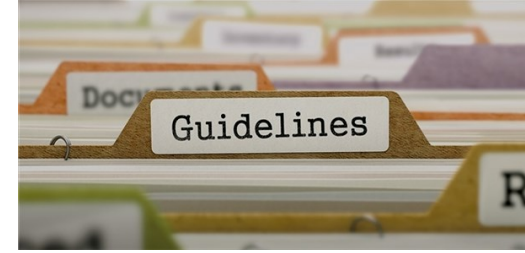
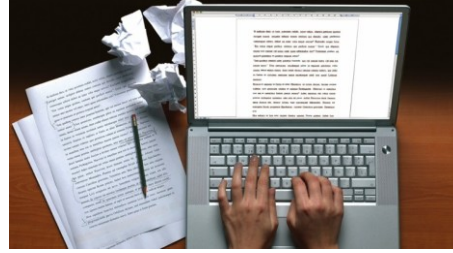
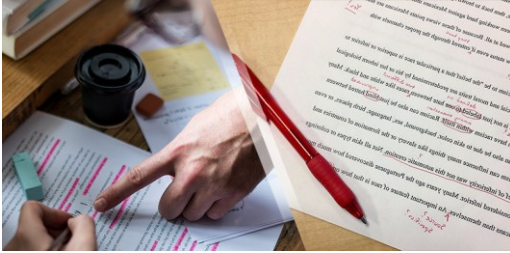


1 Introduction

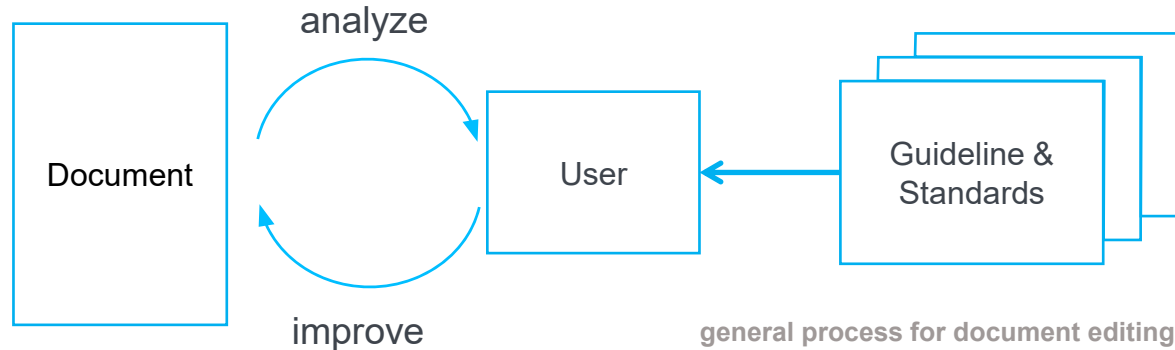
- Current editing process
- Industrial use case

Introduction

Current editing process

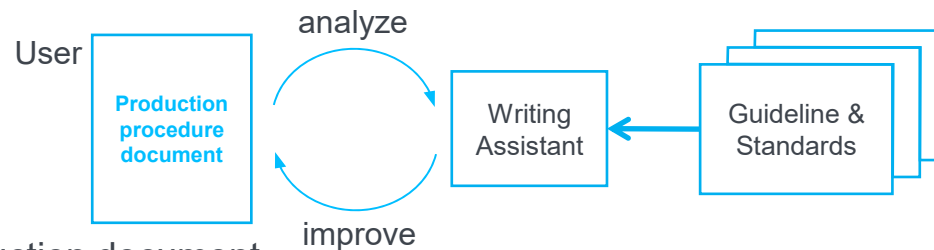


- Document Editing/ Improve Paper work
 - Analyze documents (based on **guidelines & standards**)
 - Involves **multiple rounds of review, correction, and improvement**



Introduction

Industrial use case



- Chemical engineer: keep track on a production document
- Pharmaceutical companies: **revise a manufacturing process document**

->editing **Production procedure document**

(detailed & regulated)



Challenge

Traditional knowledge utilization method

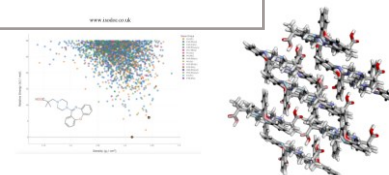
- Knowledge-Intensive
Complex structure, multiple levels, highly specialized
- Manual verification
Extremely attentive, easily overlook details

! Quality deviations Drugs, **wasted time**, **higher production costs**, and even **health risks** in the final product, resulting in it being **unable to enter the market**.

A template for a 'PRODUCTION PROCEDURE' document, ISO 9001:2015 Documents. It includes a table for 'Prepared By' and 'Approved By' with fields for Name, Design, Date, and Signature. Below the table is a disclaimer: 'All employees of the organization are allowed to study and apply this document, but any changes to this document must be made by the representative of management.' The website 'www.tandem.co.uk' is listed at the bottom.

What if:

- Storage of data in structured Database
- Large Language Model(LLM) Retrieval
 - Guideline & Standards



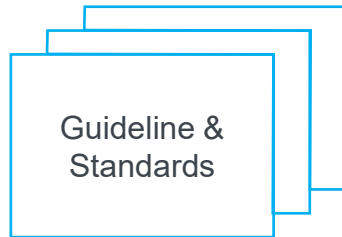
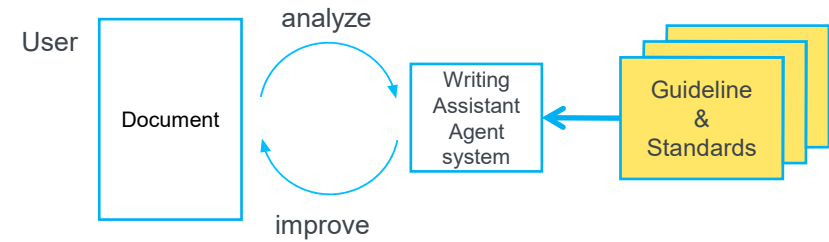
2 Basics

- **Guideline & Standards**
- **State of the art**

Basics

Guideline & Standards

- When editing **Production procedure document**:
 - **GMP**(Good Manufacturing Practices)
 - Ensures consistent quality control throughout the drug production process.



- Good Manufacturing Practices **(GMP)**
- Current Good Manufacturing Practice (CGMP)
- Good distribution practice(GDP)

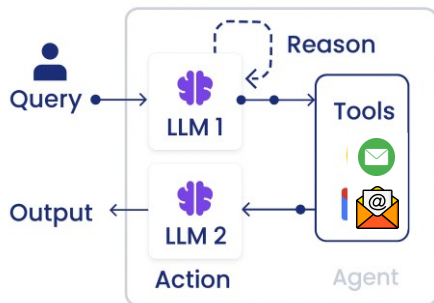
- EUROPEAN MEDICINES AGENCY (**EMA**)
- U.S. FOOD AND DRUG ADMINISTRATION (**FDA**)
- Medicines and Healthcare products Regulatory Agency (**MHRA, UK**)
- World Health Organization (**WHO**)

- 21 CFR Part 210+211 (**main regulations**) - GMP standards for **drug manufacturing, processing, packaging, and storage** in the U.S.
- 21 CFR Part 207 - Database registration of drug manufacturers for FDA **supply chain monitoring**
- 21 CFR Part 11 - Compliance **framework** for **electronic records** and **signatures** under FDA supervision
- 21 CFR Part 206 (suitable for **prescription drugs**) - **Distinguish prescription drugs** to prevent errors and enable quick recall
- ICH Q7 (adopted by the FDA) - GMP guidelines for **active pharmaceutical ingredient (API) manufacturing**

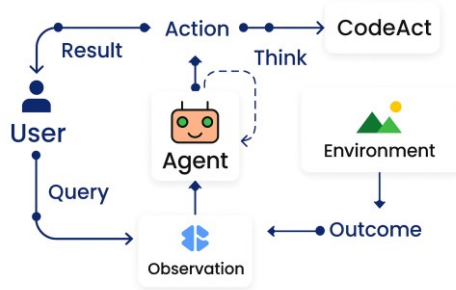
Basics

state of the art

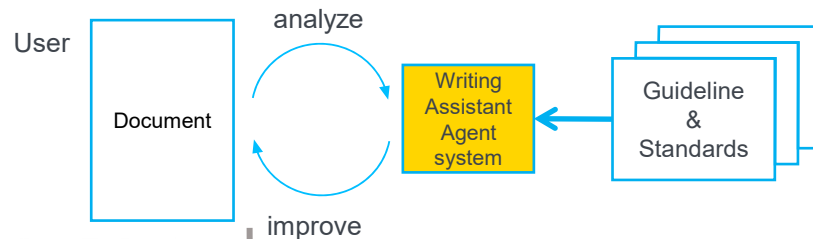
- Agent architecture



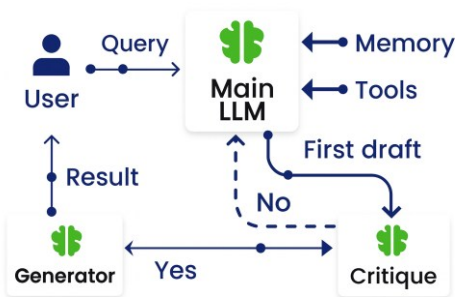
[1] ReAct: Synergizing Reasoning and Acting in Language Models



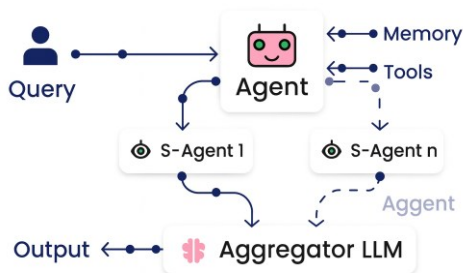
[2] Executable Code Actions Elicit Better LLM Agents



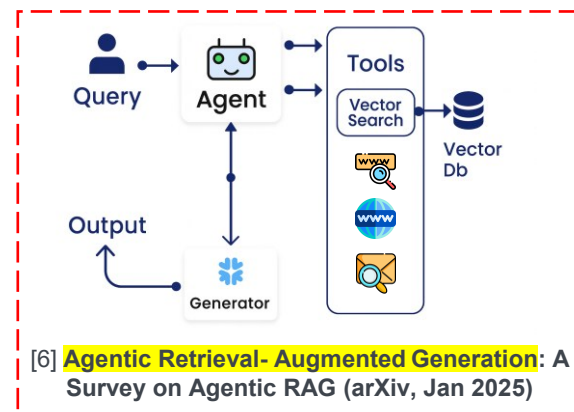
[3] A Review of Prominent Paradigms for LLM-Based Agents: Tool Use (Including RAG), Planning, and Feedback Learning (arXiv, 2024)



[4] Self-Reflection in LLM Agents: Effects on Problem-Solving Performance (arXiv, May 2024)



[5] A survey on LLM - based multi-agent systems: workflow, infrastructure and challenges



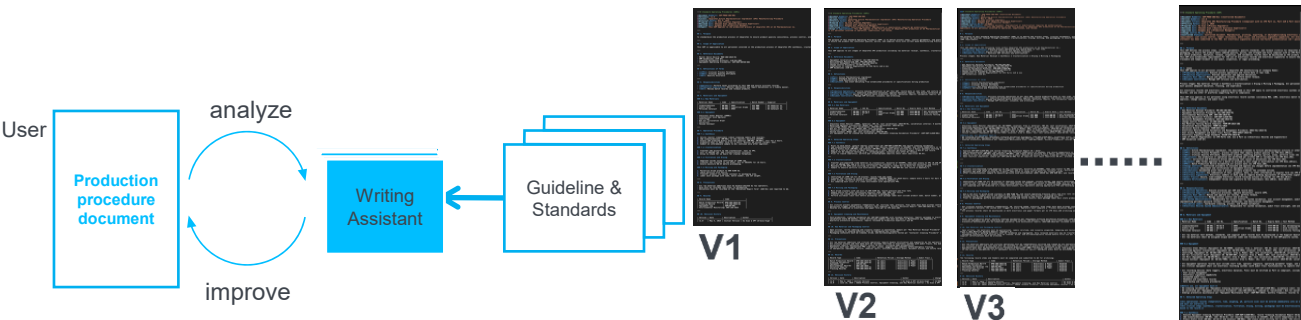
[6] **Agentic Retrieval- Augmented Generation: A Survey on Agentic RAG (arXiv, Jan 2025)**

3 Conceptual Design

- Use case illustration
- System Design
- Regulation document storage and utilization

Conceptual Design

Use case illustration



diff. file

```
# 13. Revision History
***diff
- ## 10. Revision History
+ ## 13. Revision History
+ | Version | Date | Description |
+ | Author | | |
+ |-----|-----|-----|
+ | v1.0 | May 5, 2025 | Initial Version | Sa Xiao & GPT
+ | v2.0 | June 16, 2025 | Added Process Control, Equipment
+ | Cleaning, and Raw Material Control | Sa Xiao & GPT
+ | o4-mini-high | CC-0002 |
+
+ | Environmental Records | ENV-LOG-2025 | 23
+ | Deviation Reports | DEV-IBU-2025-01 | 25
+ | Training Records | TRN-IBU-2025-01 | 25
+ | Electronic | Enabled |
+ | Electronic | Enabled |
```

Agent generates a difference file

V1 V2

The diagram shows a vertical stack of robot icons, each with a yellow arrow pointing to the right, representing an iterative process. The process starts with **V1** and continues to **V2**, and so on (indicated by a dotted line).

Agent updates the document file

V11 ✓

Iterative process
continue multiple
times

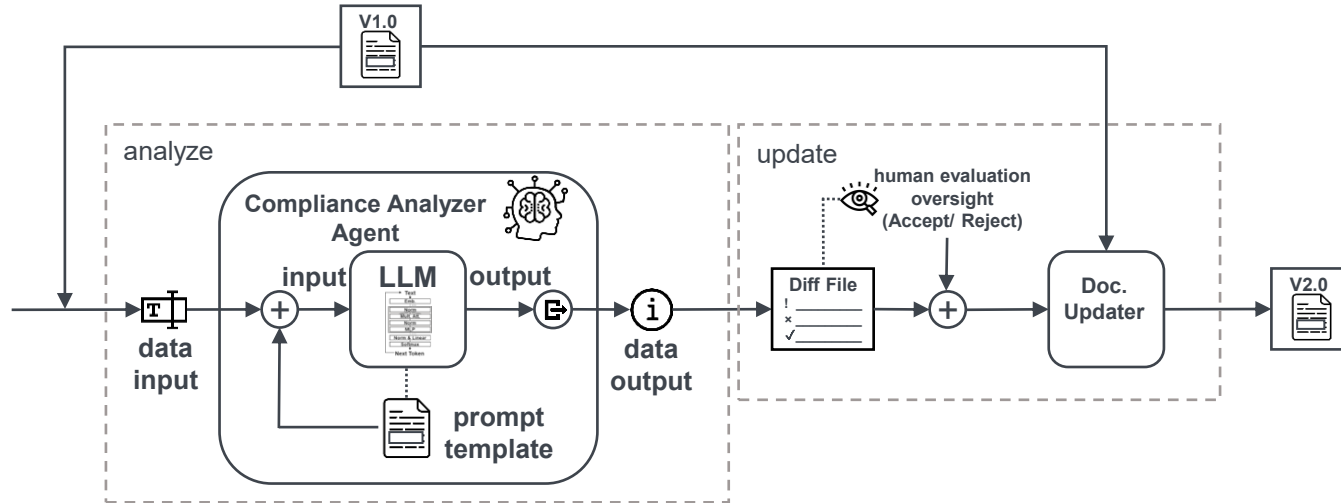
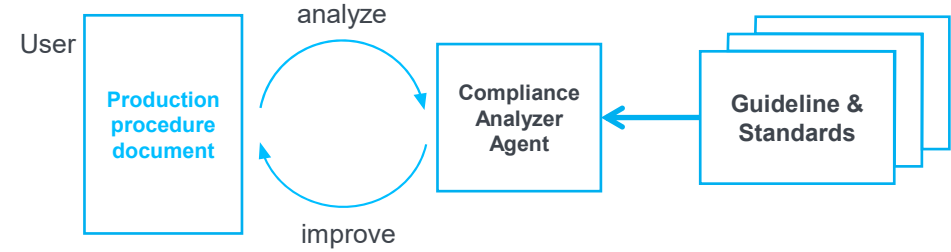
Conceptual Design

System Design

- Goal: target production line Ibuprofen

Questions

How did the system achieve **editing the Ibuprofen production procedure document**?

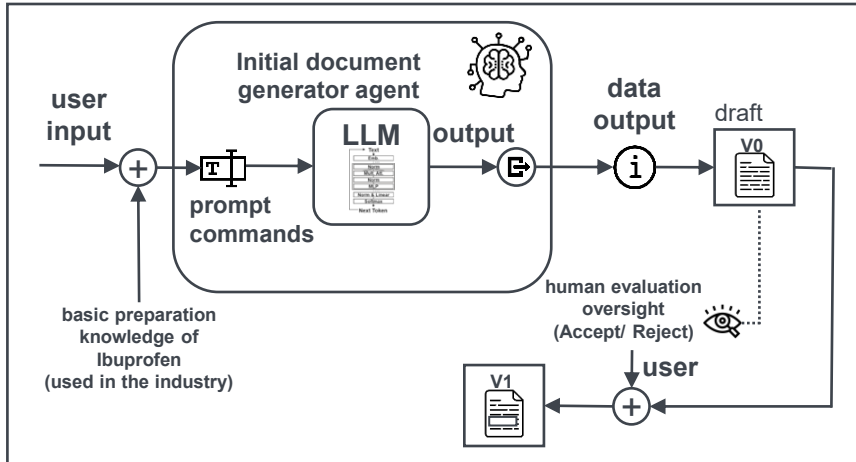
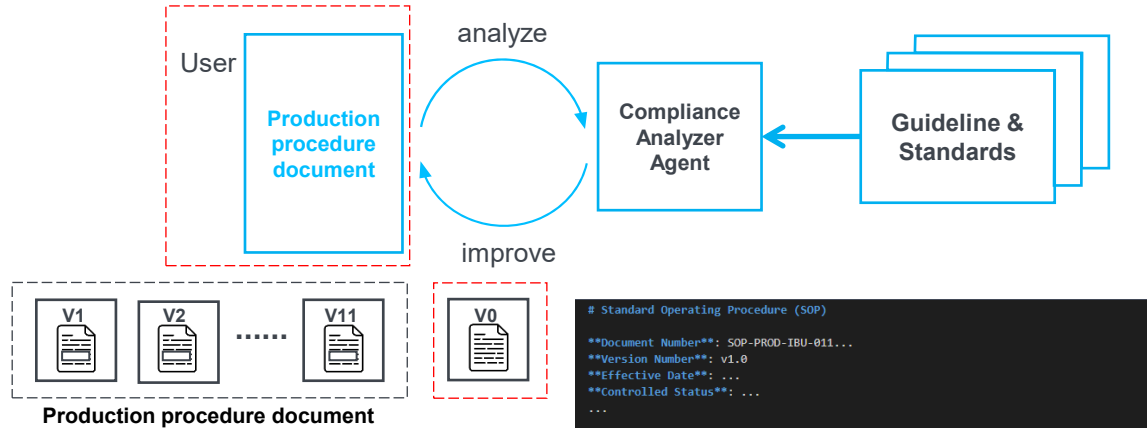


Conceptual Design

System Design

Questions

How to create the initial version of production process document?



```
# Standard Operating Procedure (SOP)

**Document Number**: SOP-PROD-IBU-011...
**Version Number**: v1.0
**Effective Date**: ...
**Controlled Status**: ...
...

## 1. Purpose
This SOP defines the process steps ...

## 2. Scope
This SOP applies to all personnel involved ...

## 3. Reference Documents
- GMP Guideline
- ...

## 4. Definitions
- **API**: Active Pharmaceutical Ingredient, ...
- ...

## 6. Materials and Equipment

### 6.1 Raw Materials
| Material Name | Code | CAS No. | Specification ...
|---|---|---|---|
...

### 6.2 Equipment
- Stainless Steel Reactor (Equipment ID: EQ-3000R; Location: Area 1; material: ...)
- ...

**Before use, all equipment must:**...

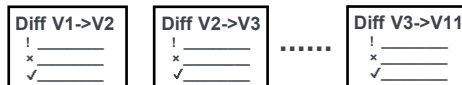
## 7. Detailed Operating Steps

### 7.1 Synthesis
1. Execute Equipment Cleaning Validation Procedure...

## 13. Revision History
| Version | Date | Description | | |
|---|---|---|---|---|
| v1.0 | May 5, 2025 | Initial Version | Quality Assurance Department | CC-0001 |
...

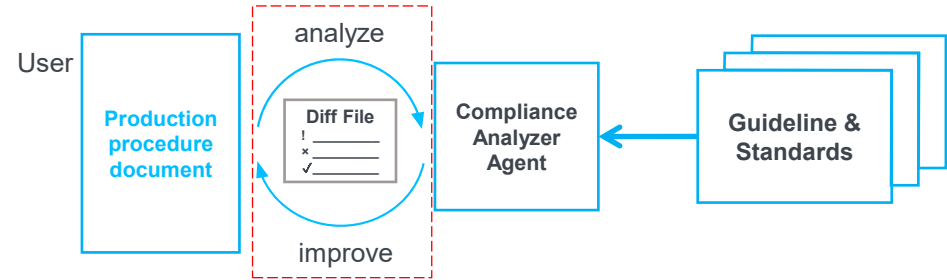
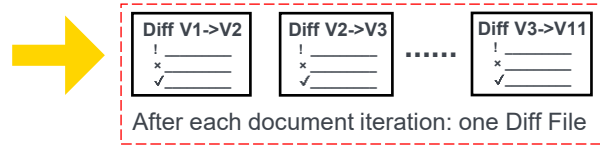
```

- What is **Diff File**?



Conceptual Design

System Design



```

# 0. Document Header Changes
---diff
- **Document Number**: SOP-PROD-IBU-001
+ **Document Number**: SOP-PROD-IBU-002
- **Version**: v1.0
+ **Version Number**: v2.0
- **Title**: Ibuprofen Active Pharmaceutical Ingredient (API) Manufacturing Procedure
+ **Document Title**: Ibuprofen Active Pharmaceutical Ingredient (API) Manufacturing Operation Procedure
+ **Effective Date**: May 5, 2025
+ **Prepared by**: Sa Xiao (Process Engineer)
+ **Reviewed by**: Shouwen Xiao (Quality Assurance Supervisor)
+ **Approved by**: Hongmei Qiu (Production Manager)
+ **Controlled Status**: Controlled document. Reproduction or modification requires QA authorization.
+ **Scope**: This SOP applies to the production process of Ibuprofen API at XX Pharmaceutical Co.
+ **Scope of Application**: This SOP applies to the full process of Ibuprofen API production at XX Pharmaceutical Co., from raw material receipt, synthesis, crystallization, drying, milling, to packaging, applicable to all personnel involved in operation, supervision, and review.
...

**change reason:**
1. The scope description was incomplete: the original only stated "production process" without specific stages; added raw material receipt, synthesis, crystallization, drying, milling, and packaging.
2. The responsible positions were unclear: GMP documentation requires defining which roles the SOP applies to.
3. Lack of traceability: without clear definition, audit boundaries and responsibilities are ambiguous.

**Regulatory references:**
- 21 CFR §211.22(d): The quality unit shall ensure procedures are followed and apply to all relevant departments.
- 21 CFR §211.180(a): Records must be maintained and readily available, with clear responsibility, version, and effective date.
- 21 CFR §211.100(a): Procedures must have complete execution controls and defined personnel applicability.

**Impact Analysis:**
- Improved traceability and version control reduces the risk of using outdated or incorrect procedures, enhancing drug safety.
- Clear scope and responsibilities decrease ambiguity and process deviations, supporting product stability.
- Better documentation control improves regulatory audit readiness, reducing potential economic losses from non-compliance.
  
```

Diff File

Diff code

- Differences between two Versions

```
---diff
```

```
+ add
```

```
original test
```

```
- delete
```

```
---
```

! **Change reason:**

- Why **modify** the content of this module
- Why **update** the output target content

× **Regulatory reference:**

- Based on which **specific provisions** in Guideline doc.

✓ **Impact analysis:**

- what **risks** will be **avoided**
- what **costs** will be **reduced**
- what **profit** will be **increased**

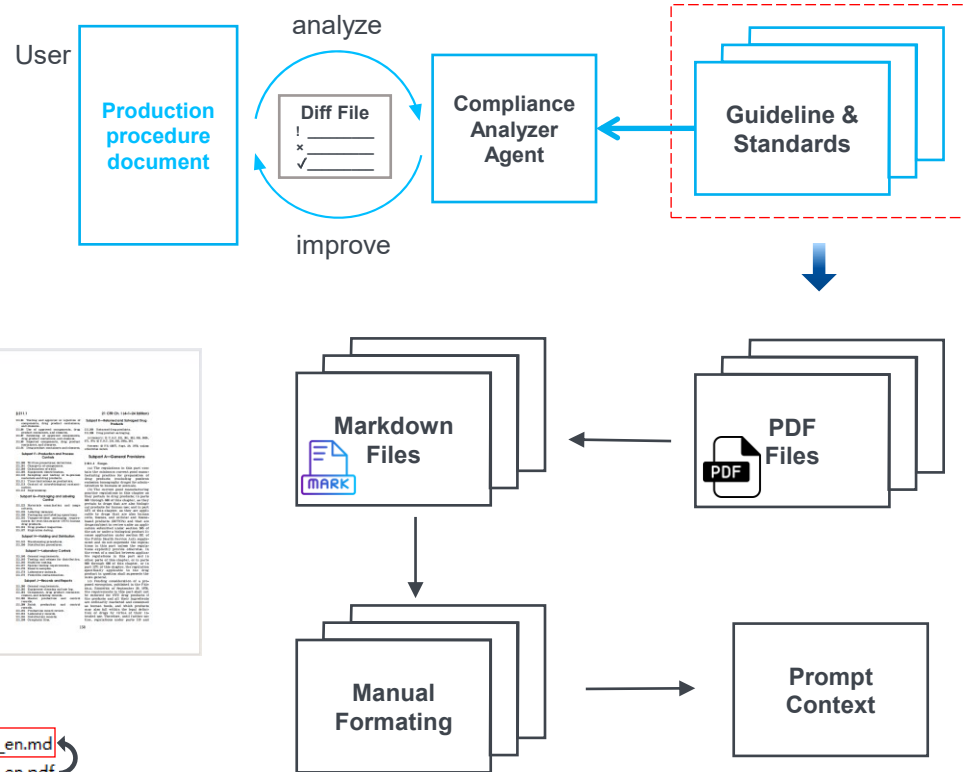
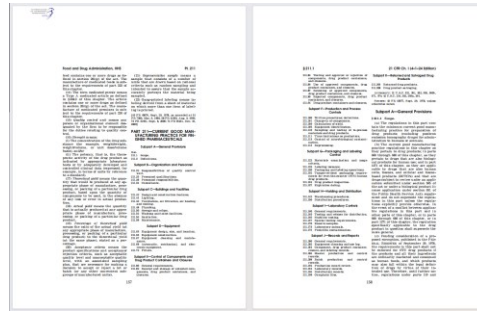
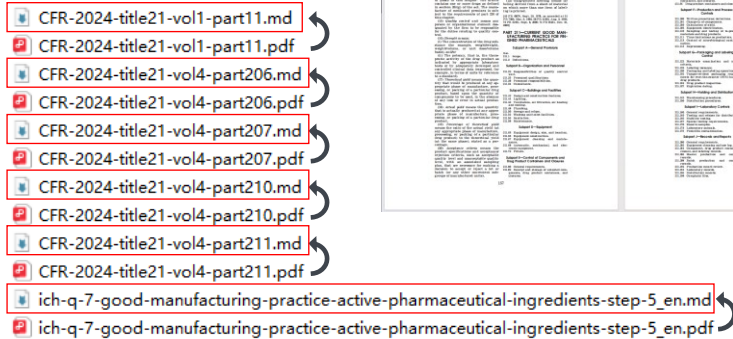
Conceptual Design

Regulation document storage and utilization

Questions

How are regulatory documents stored and utilized?

- Information **Pre- Processing**
- Guideline doc. in pdf -> Markdown
- 6 Guideline doc.

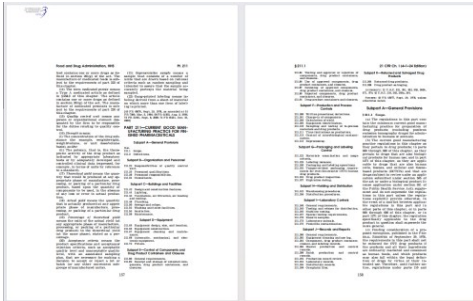


Conceptual Design

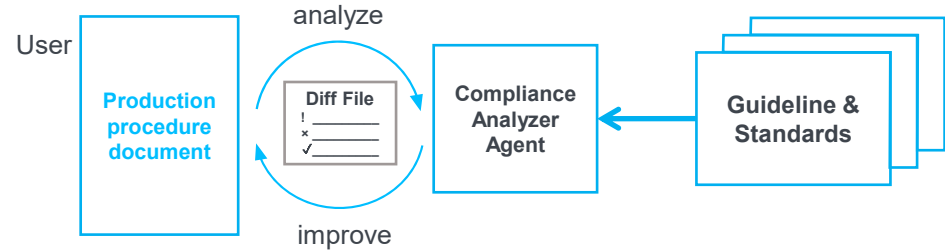
Questions

How are regulatory documents stored and utilized?

- Information **Pre- Processing**
- Guideline doc. in pdf -> Markdown
- 6 Guideline doc.



PDF file



```

Food and Drug Administration, 19HS Pt. 21 -- Current Good Manufacturing Practice for Finished Pharmaceutical Products
*21 CFR Ch. I (4-1-24 Edition)*
---
## Table of Contents ## Subpart A -- General Provisions

- [Subpart A --]
- [§ 211.1 Scope]
- [§ 211.3 Definitions]
- [Subpart B --]
- [§ 211.22 Responsibilities of Quality Control Unit]
- [§ 211.25]
- [§ 211.28]
- [§ 211.34]
- [Subpart C --]
- [§ 211.42]
- [§ 211.44]
- [§ 211.46]
- [§ 211.48]
- [§ 211.50]
- [§ 211.52]
- [§ 211.56]
- [§ 211.58]
- [Subpart D --]
- [§ 211.63]
- [§ 211.65]
- [§ 211.67]
- [§ 211.68]
- [§ 211.72]
- [Subpart E --]
- [§ 211.80]
- [§ 211.82]
- [§ 211.82]
- [Subpart F --]
- [§ 211.100]
- [§ 211.101]
- [§ 211.103]
- [§ 211.105]
- [§ 211.110]
- [Subpart G --]
- [§ 211.111]
- [§ 211.113]
- [§ 211.115]
- [Subpart H --]
- [§ 211.122]

(a) The regulations in this part contain the minimum current good manufacturing practice for the preparation of drug products (excluding positron emission tomography drugs) for administration to humans or animals.

(b) The current good manufacturing practice regulations in this chapter as they pertain to drug products; in parts 600 through 680, as they pertain to drugs that are also biological products for human use; and in part 1271, as they are applicable to drugs that are also human cells, tissues, and cellular and tissue-based products (HCT/PS) and that are drugs (subject to review under an application submitted under section 505 of the act or under a biological product license application under section 351 of the Public Health Service Act) supplement and do not supersede the regulations in this part unless the regulations explicitly provide otherwise. In the event of a conflict between applicable regulations in this part and in other parts of this chapter, or in parts 600 through 680, or in part 1271, the regulation specifically applicable to the drug product in question shall supersede the more general.

(c) Pending consideration of a proposed exemption published in the Federal Register of September 29, 1978, the requirements in this part shall not be enforced for OTC drug products if the products and all their ingredients are ordinarily marketed and consumed as human foods and which products may also fall within the legal definition of drugs by virtue of their intended use.

*Source: [43 FR 45077, Sept. 29, 1978, as amended at 62 FR 66522, Dec. 19, 1997; 69 FR 29828, May 25, 2004; 74 FR 65431, Dec. 10, 2009; 80 FR 56168, Sept. 17, 2015]*

## § 211.22 Responsibilities of Quality Control Unit

(a) There shall be a quality control unit with the responsibility and authority to approve or reject all components, drug product containers, closures, in-process materials, packaging materials, labeling, and drug products, and to review production records to assure that errors have been fully investigated. This unit is responsible for approving or rejecting drug products manufactured, processed, packed, or held under contract by another company.

(b) Adequate laboratory facilities for testing and approval (or rejection) of components, containers, closures, packaging

```

processed regulatory documents - converted Markdown format

4 Test

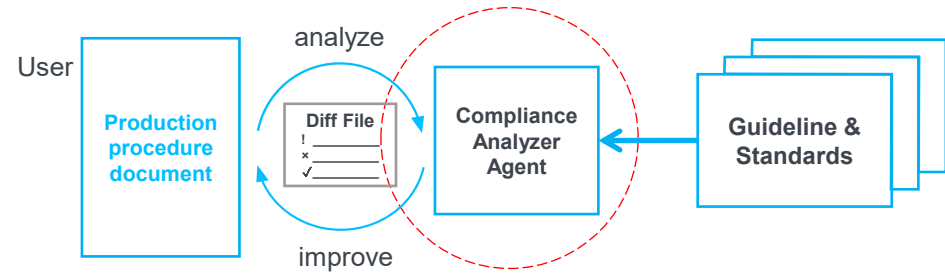
- Output discovery
- Fine-tuning model

Test

Output discovery

Questions

What can the Compliance Analyzer Agent actually do?



Data Operations

- Add new item
- Modify item
Detailed/enriched existing entries
- Delete item
- Add new **Section**

```
+ 4. Sample to measure particle size distribution (d50: 20-50 µm; d90 ≤80 µm) and record in Appendix C.
...
## 7.2 Crystallization
```diff
- 1. Transfer the mixture to the crystallizer. Cool to 5°C.

+ 1. Transfer pre-separated crude material to crystallizer, dissolve at 35-40°C, then cool slowly to 5°C (0.2-0.5°C/min), recording temperature curve.

5. Responsibilities
```diff
- **Operator**: Perform tasks according to this SOP and ensure accurate records.

+ # 9. Equipment Cleaning and Maintenance
+ - Post-production, cleaning validation per SOP-EQP-CLEAN-001 with residual detection; reports uploaded to electronic system.
```

adding missing content

adjusting temperature ranges/ details

doesn't meet compliance standards

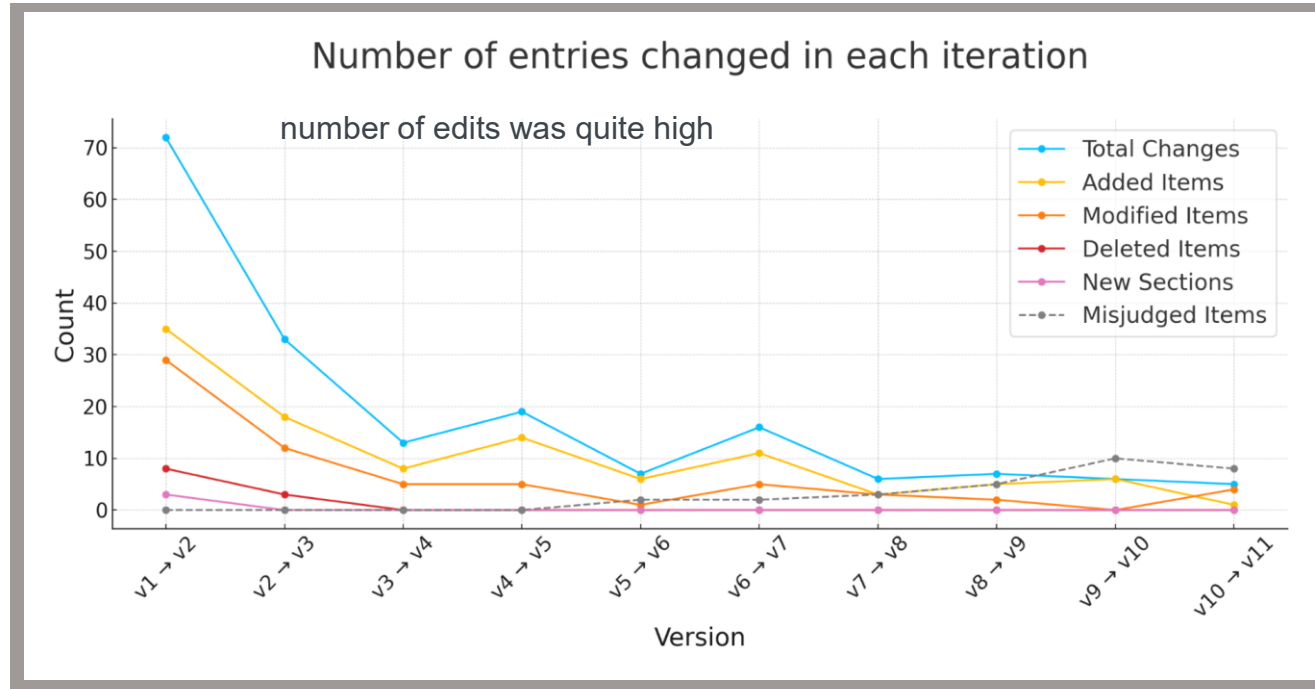
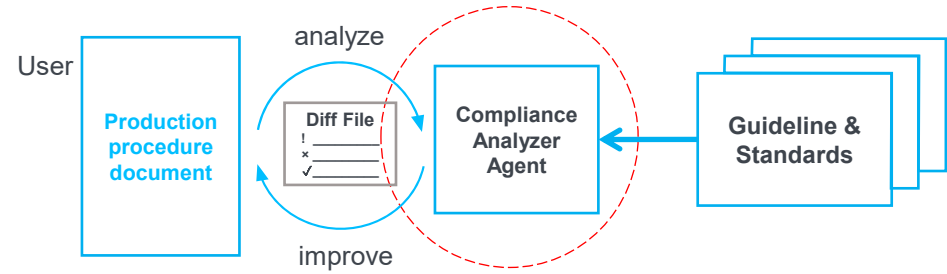
adding a missing procedure

Test

Output discovery - Test Results

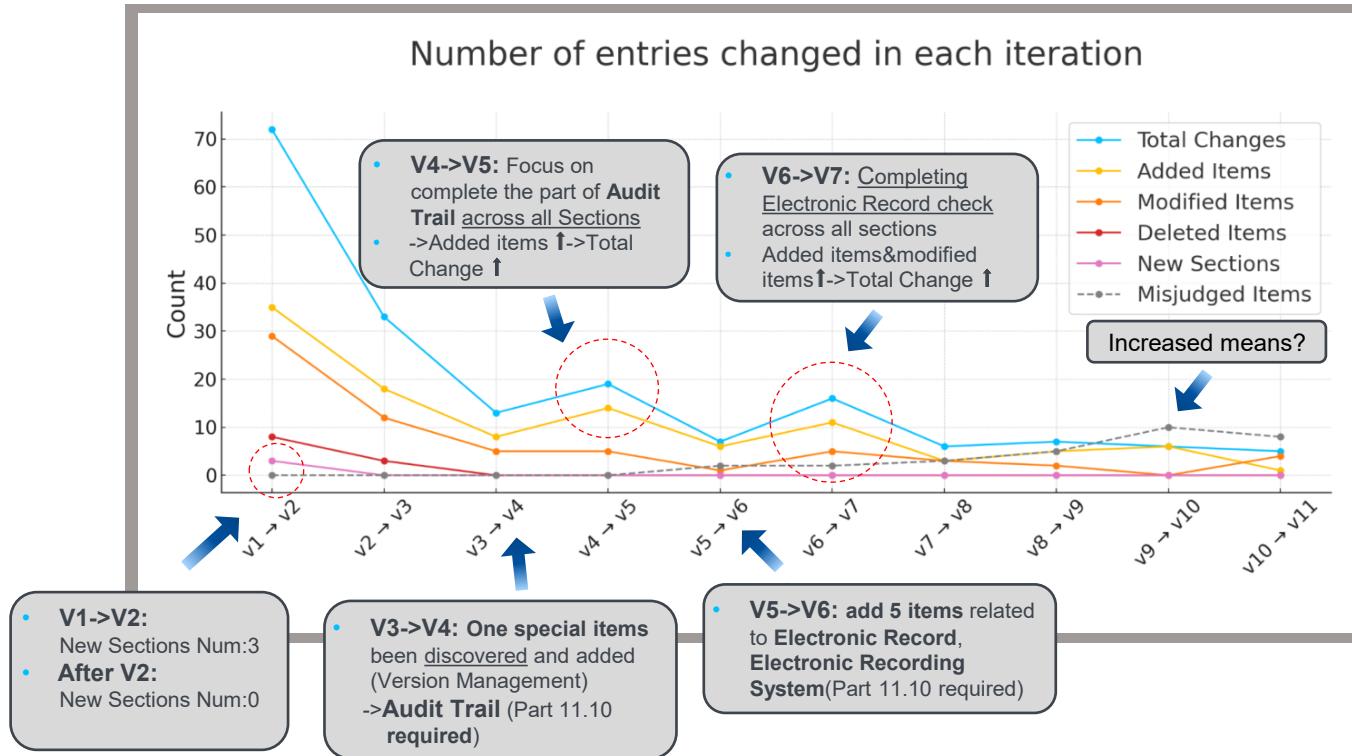
Questions

How the document evolved over time?



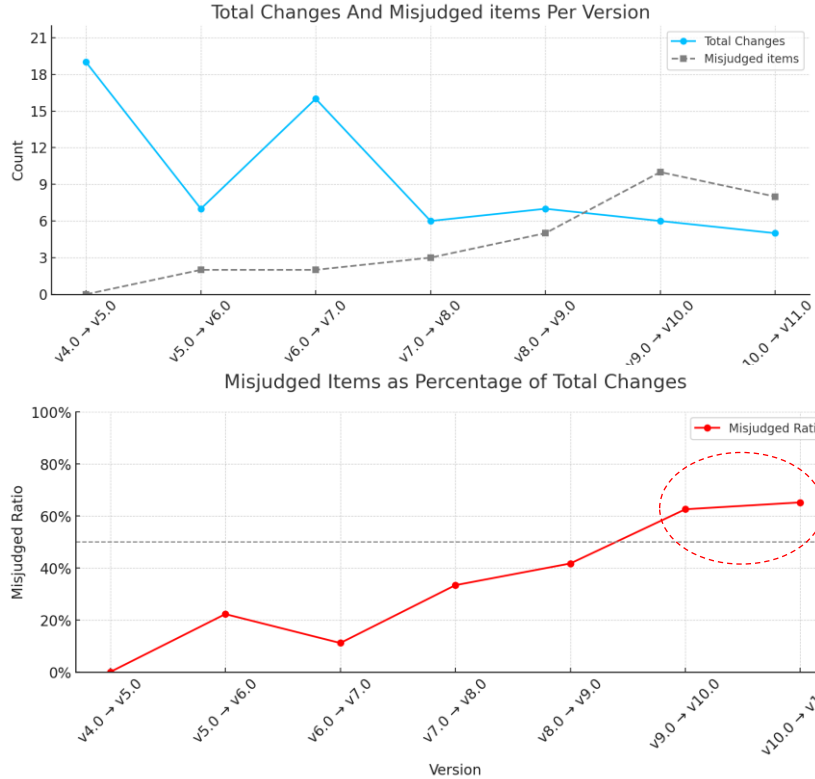
Test

Output discovery - more insights behind the changes



Test

Output discovery - Overediting



Misjudged items

- **Unnecessary:** Change a sentence but ended up adding the unnecessary content
- **Repeatedly:** Repeatedly modifying items: have already been modified; added content being completely identical to the original content.

$$\text{Misjudged Ratio} = \frac{\text{Misjudged items}}{\text{Total Changes}}$$

Misjudged ratio $\geq 50\%$

Half of the edits made were unnecessary after the whole process converged.

Insights

-> avoid this overediting **by early stop**

5 Model Fine-tuning

- Dataset and Model
- Training process
- Validation Result

Model Fine-tuning

Questions

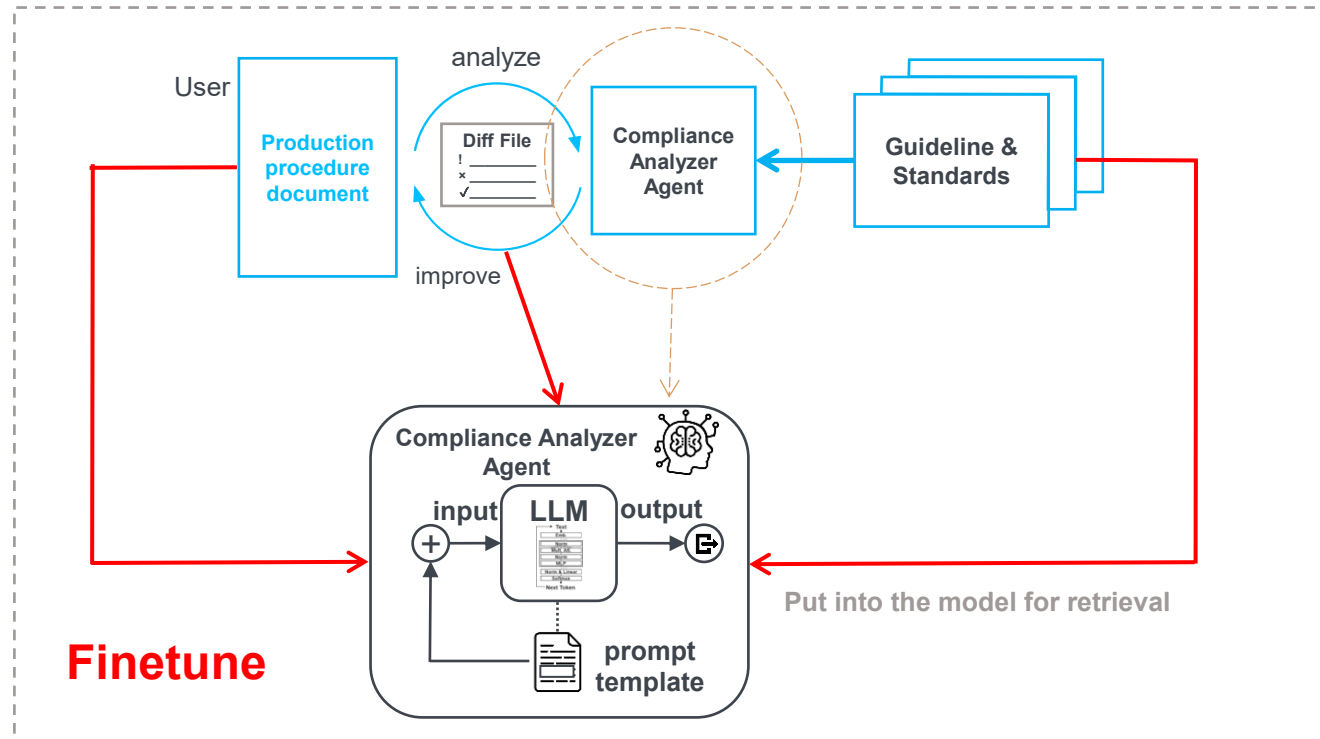
How to improve task specific capability of Agent?

Collect:

- document inputs
- the diff output

->feed them back as training data

Fine-tune the LLM directly



Model Fine-tuning

Dataset and Model

- Build my dataset

Use data generated from my project

- Supervised fine-tuning

Dataset design

- JSONL format
- QA Pairs design
- 101 QA Pairs

- 44519 words
- 83 pages

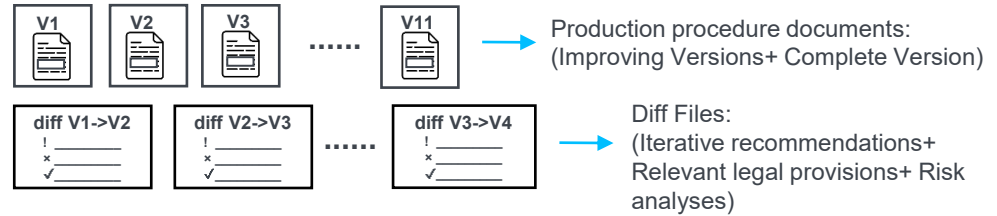
(Font style: Consolas, 10.5)

Questions

What the Fine-tune file format look like?

Model Selection

- gpt 4o - mini (200,000 tokens per min, TPM)
 - gpt 4o: limit (30,000 tokens per min, TPM)
- > gpt 4o - mini



```
{ "messages": [{"role": "user", "content": "Answer the question in accordance with spe"},  
{"role": "assistant", "content": "Answer the question in accordance with spe"},  
{"role": "user", "content": "Why are the sections \"Process Control,\" \"E"},  
{"role": "assistant", "content": "Answer based on specific legal provisions:"}]
```

“role”s

“User”

“content”:

(user prompt)

- Who are you?
- Whats your **task**?
- Scope of **legal provisions** to be searched?
- How should you provide answers?(output format description)
- **One section** production procedure document **text** (that you need to deal with)

“Assistant”

“content”:

(assistant response)

- Diff Files (for the given One section)

```
{ "messages": [{"role": "user", "content": "Answer the question in accordance with spe"},  
{"role": "assistant", "content": "Answer the question in accordance with spe"},  
{"role": "user", "content": "Why are the sections \"Process Control,\" \"E"},  
{"role": "assistant", "content": "Answer based on specific legal provisions:"}]
```

Model Fine-tuning

Training process



- Loss

step 12 -> 2.130
step 269 -> 1.011
step 275 -> 0.380

- Accuracy

step 12 -> 0.581
step 269 -> 0.739
step 275 -> 0.901

- **Smoothing -> 0.5**

- Loss decreases and approaches good convergence
- Accuracy increases, is learning effectively and performing better

Model Fine-tuning

Validation Result - Effect of fine-tuning

Number of items changed in the first iteration
(v1->v2, before vs. after fine-tuning)

	Added items	modified items	Deleted items	Added Sections	Total changes
before Fine-tuning	36	32	8	3	76
after Fine-tuning	31	33	8	3	75

Quantity Level
x

```
diff_v1.0_to_v2.0_en_withoutFT.md
35  ## 1. Purpose
36
37  ## 2. Scope of Application
38  ---diff
39  - This SOP is applicable to all personnel involved
40  in the production process of Ibuprofen API
41  synthesis, crystallization, filtration, drying,
42  crushing, and packaging.
43  + This SOP applies to all stages of Ibuprofen API
44  production including raw material receipt,
45  synthesis, crystallization, filtration, drying,
46  milling, and packaging.
47  ---
48  **change reason:**
49  1. The wording "all personnel involved in
50  production" was unclear; revised to specify all
51  production stages and avoid ambiguous language.
52  2. Added "raw material receipt" as it is a critical
53  GMP control point.
54  3. Clarified which types of positions the SOP
55  applies to.
56
57  **Regulatory references:**
58  - 21 CFR §211.80(a): Requires written procedures
59  for receipt and sampling of materials.
60  - 21 CFR §211.22(c): Quality unit must review and
61  approve each stage.
62  - 21 CFR §211.100(a): Written procedures must be
63  implementable, supervised, and recorded.
64
65  **Impact Analysis:**
66  - Inclusion of raw material receipt prevents
67  contamination or mix-ups, improving product safety.
68  - Defined stages minimize variability, supporting
69  consistent product quality.
70  - Enhances process standardization, reducing rework
71  and associated costs.
```

before Fine-tuning

vague and incomplete

```
diff_v1.0_to_v2.0_101.md
38  ## 1. Purpose
39
40  ## 2. Scope of Application
41  ---diff
42  - This SOP is applicable to all personnel involved
43  in the production process of Ibuprofen API
44  synthesis, crystallization, filtration, drying,
45  crushing, and packaging.
46  + This SOP applies to the following roles within
47  Ibuprofen API production at XX Pharmaceutical Co.
48  + - **Production Operator**:: Execute process
49  operations and record data in real time
50  + - **Production Supervisor**:: Oversee execution
51  and approve deviations
52  + - **Quality Unit (QA)**:: Review records and
53  perform product release
54  + - **Document Controller**:: Maintain SOP versions
55  and distribution
56  + Process stages: Raw Material Receipt → Synthesis
57  → Crystallization → Drying → Milling → Packaging
58
59  **Change reason:** Clarified the scope by defining
60  the responsible roles and listing the process
61  sequence explicitly.
62
63  **Legal basis:** § 211.22(c) requires QA review of
64  production steps; § 211.100(a) requires written
65  procedures defining role responsibilities.
66
67  **Risk/Cost/Profit:** Clear responsibilities reduce
68  communication errors, improve production
69  efficiency, and lower human error costs.
70
71  ## 3. Reference Documents
72  ---diff
73  - ## 3. Reference Documents
74  - Master Batch Record: MBR-IBU-2025-01
75  - GMP Guidelines (ICH Q2)
```

after Fine-tuning

much more accurate and detailed result

```
testcase1_ibuprofen_v11.0.md
15  ## 1. Purpose
16
17  ## 2. Scope
18  This SOP applies to all personnel involved in
19  Ibuprofen API manufacturing at [Company Name]:
20  - **Production Operators**:: Execute process
21  operations and record data in real time.
22  - **Production Supervisors**:: Oversee operations
23  and approve deviations.
24  - **Quality Unit (QA)**:: Review and approve
25  records, perform batch release.
26  - **Document Controller**:: Manage SOP versions and
27  distribution.
28  Process stages: Raw material receipt → Synthesis →
29  Crystallization → Drying → Milling → Packaging. All
30  personnel must complete periodic GMP and Part 11
31  training, with training records retained for 5
32  years. Operators must possess adequate education,
33  training, and experience.
34
35  All electronic records and electronic signatures
36  described in this SOP apply to controlled
37  electronic systems including Manufacturing
38  Execution Systems, Laboratory Information
39  Management Systems, Electronic Batch Records, and
40  any other IT platforms supporting Part 11
41  compliance.
42
43  This SOP also applies to all personnel using
44  electronic record systems (including MES, LIMS,
45  electronic batch records, and electronic deviation
46  management systems) for production, testing,
47  release, deviation approval, change control, and
48  audit trail.
```

Final version

Quality Level
✓

Model Fine-tuning

Validation Result - Summarizes

- **Technical** verification of LLM output level
 - Training has effect:
 - **loss decreased**
- Validation of **document** quality
 - text quality **difficult to quantify**
 - need **expert knowledge**
 - but we see effects
- > result **more comprehensive**

Without Fintuning	With Fintuning
<pre>diff_v1.0_v2.0_en_withoutFT.md 35 # 1. Purpose 36 37 # 2. Scope of Application 38 ***diff 39 - This SOP is applicable to all personnel involved 40 in the production process of Ibuprofen API 41 synthesis, crystallization, filtration, drying, 42 crushing, and packaging. 43 + This SOP applies to all stages of Ibuprofen API 44 production including raw material receipt, 45 synthesis, crystallization, filtration, drying, 46 milling, and packaging. 47 48 *** 49 50 **change reason:** 51 1. The wording "all personnel involved in 52 production" was unclear; revised to specify all 53 production stages and avoid ambiguous language. 54 2. Added "raw material receipt" as it is a critical 55 GMP control point. 56 3. Clarified which types of positions the SOP 57 applies to. 58 59 **Regulatory references:** 60 - 21 CFR §211.80(a): Requires written procedures 61 for receipt and sampling of materials. 62 - 21 CFR §211.22(c): Quality unit must review and 63 approve each stage. 64 - 21 CFR §211.100(a): Written procedures must be 65 implementable, supervised, and recorded. 66 67 68 **Impact Analysis:** 69 - Inclusion of raw material receipt prevents 70 contamination on mix-ups, improving product safety. 71 - Defined stages minimize variability, supporting 72 consistent product quality. 73 - Enhances process standardization, reducing rework 74 and associated costs.</pre>	<pre>diff_v1.0_v2.0_101.md 38 # 1. Purpose 39 40 # 2. Scope of Application 41 ***diff 42 - This SOP is applicable to all personnel involved 43 in the production process of Ibuprofen API 44 synthesis, crystallization, filtration, drying, 45 crushing, and packaging. 46 + This SOP applies to the following roles within 47 Ibuprofen API production at XX Pharmaceutical Co.: 48 + - **Production Operator**: Execute process 49 operations and record data in real time 50 + - **Production Supervisor**: Oversee execution 51 and approve deviations 52 + - **Quality Unit (QA)**: Review records and 53 perform product release 54 + - **Document Controller**: Maintain SOP versions 55 and distribution 56 + Process stages: Raw Material Receipt -> Synthesis 57 + Crystallization -> Drying -> Milling -> Packaging 58 59 ***change reason:** Clarified the scope by defining 60 the responsible roles and listing the process 61 sequence explicitly. 62 63 **Legal basis:** § 211.22(c) requires QA review of 64 production steps; § 211.100(a) requires written 65 procedures defining role responsibilities. 66 67 **Risk/Cost/Profit:** Clear responsibilities reduce 68 communication errors, improve production 69 efficiency, and lower human error costs. 70 71 # 3. Reference Documents 72 ***diff 73 - ## 3. Reference Documents 74 - - Master Batch Record: MBR-IBU-2025-01 75 - - GMP Guidelines (ICH Q7)</pre>

6 Summary & Outlook

Summary and Outlook

Summary

- Designed a system for **improving production documents**
(Combines regulatory documents & industrial standards)
- Ensures **version traceability** & improves **document precision**
- Reduces **manual editing** & enhances **productivity**

Limitation & Future Work

- need **expert input** to validate the results
- **Final approval** still depends on **human expertise**
(even system improves technical quality)



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Thank you!



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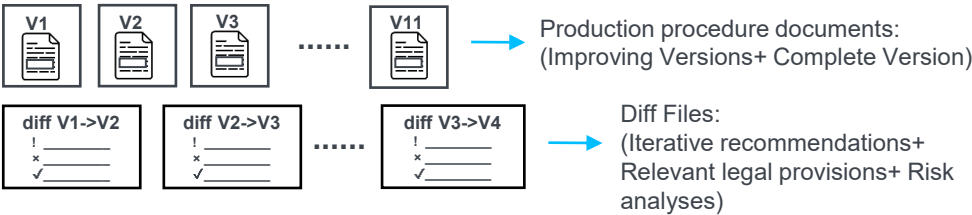
Quelle

- <https://arxiv.org/abs/2210.03629>
- <https://arxiv.org/abs/2402.01030>
- <https://arxiv.org/abs/2406.05804>
- <https://arxiv.org/abs/2405.06682>
- <https://link.springer.com/article/10.1007/s44336-024-00009-2>
- <https://arxiv.org/abs/2501.09136>
- <https://platform.openai.com/settings/organization/limits>

Model Fine-tuning

Dataset

- Use data generated from my project
- Build my dataset



Questions

What Data I obtained in my project?

```
{ "messages": [{"role": "user", "content": "Answer the question in accordance with spe"}, {"role": "assistant", "content": "Answer the question in accordance with spe"}, {"role": "user", "content": "Why are the sections \"Process Control,\" \"E"}, {"role": "assistant", "content": "Answer based on specific legal provisions:"}]}
```

“role”

- Supervised fine-tuning (为什么用这个方法?)

Dataset design

- JSONL format
- QA Pairs design

```
{ "messages": [{"role": "user", "content": "You are a consultant who help me do the analysis of compliance quality, safety, and economic risks analysis of SOP(standard operating procedure) document and improvement them, by refining and improving the SOP document content while with the goal of achieving compliance improving quality, safety, and economic risks analysis."}, {"role": "assistant", "content": "I will be happy to help you with that. Please provide me with the SOP document content, and I will provide you with the analysis and improvement suggestions."}, {"role": "user", "content": "I have a SOP document titled 'Chapter 1: Safety'."}, {"role": "assistant", "content": "I will be happy to help you with that. Please provide me with the content of Chapter 1: Safety, and I will provide you with the analysis and improvement suggestions."}, {"role": "user", "content": "Chapter 1: Safety\n1.1. Purpose\nThe purpose of this chapter is to ensure the safety of the product and the safety of the personnel who are working with the product. It is to ensure that the product is safe to use and that the personnel are aware of the risks associated with the product.\n1.2. Scope\nThis chapter applies to all personnel who are working with the product, including those who are responsible for the design, development, testing, and production of the product. It also applies to those who are responsible for the distribution and use of the product.\n1.3. Responsibilities\nThe responsibilities of the personnel who are working with the product are as follows:\n- Design: The design team is responsible for ensuring that the product is safe to use and that it meets the requirements of the applicable regulations.\n- Development: The development team is responsible for ensuring that the product is developed in a safe and secure manner and that it is tested thoroughly before it is released to the market.\n- Testing: The testing team is responsible for ensuring that the product is tested thoroughly and that the results of the testing are used to improve the product.\n- Production: The production team is responsible for ensuring that the product is produced in a safe and secure manner and that it is distributed to the market in a safe and secure manner.\n- Distribution: The distribution team is responsible for ensuring that the product is distributed to the market in a safe and secure manner and that it is used in a safe and secure manner.\n1.4. Safety Measures\nThe following safety measures should be taken to ensure the safety of the product and the safety of the personnel who are working with the product:\n- Design: The design team should ensure that the product is designed to be safe to use and that it meets the requirements of the applicable regulations.\n- Development: The development team should ensure that the product is developed in a safe and secure manner and that it is tested thoroughly before it is released to the market.\n- Testing: The testing team should ensure that the product is tested thoroughly and that the results of the testing are used to improve the product.\n- Production: The production team should ensure that the product is produced in a safe and secure manner and that it is distributed to the market in a safe and secure manner.\n- Distribution: The distribution team should ensure that the product is distributed to the market in a safe and secure manner and that it is used in a safe and secure manner.\n1.5. Conclusion\nThis chapter provides a comprehensive overview of the safety measures that should be taken to ensure the safety of the product and the safety of the personnel who are working with the product. It is the responsibility of all personnel who are working with the product to ensure that these measures are followed and that the product is safe to use and that the personnel are aware of the risks associated with the product."}]}
```

“User”
“content”:
(requirement, prompt)

- Your **role**?
- Your **task**?
- Scope of **legal provisions** to be searched?
- How should you provide answers?(output format description)
- **One section** production procedure document **text** (that you need to deal with)

“Assistant”
“content”:
(desired output of the model)

- Diff Files (for the given One section)

101 QA Pairs

31 QA Pairs -> redesign

“User”
“content”:
(requirement, prompt)

- summarize the phenomenon
- “Answer questions using legal provisions.”
- “Why is it necessary/important to add/delete those information if (this phenomenon occurs)?”

“Assistant”
“content”:
(desired output of the model)

- Relevant legal provisions

70 QA Pairs +31 redesign QA Pairs

Model Fine-tuning

Evaluation

Fine-tuning experimental phenomena - 31+70 QA pair

- 要出统计数据

Summary and future work

Experimental details and findings

Summary:

- If some items in the dataset are missing Risk/Cost/Profit, even if the playground assistant prompt has multiple cases with Risk/Cost/Profit, the output on the right side will not produce Risk/Cost/Profit. Next, requesting the output of Risk/Cost/Profit will produce the desired result.
- The results cannot supplement missing sections. If you input whether to supplement new sections, it will increase
- The model cannot distinguish between the “-” and “ -” in the ```diff``` file. Therefore, special attention should be paid to distinguishing them in the future, such as using “@@@” instead of the original database's “ -”
- The prompt is quite critical: “When designing the 30 QA pairs: Why must stirring speed and heating rate be quantified if they are not quantified in the original version?” If changed to “when,” it might cause ambiguity, leading to poor training results.
- Based on the training curve of the fine-tuned model, the dataset needs to be expanded.