

Generate Mini US Report Tutorial

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Table of contents

Preface	4
1 Overview	5
1.1 Normal Report	5
1.2 Abnormal Report	5
2 Extract Input Findings	7
2.1 User Input	7
2.2 Schema	7
2.3 Extractor	9
2.4 Create Chain & Execute	9
2.4.1 Single Extract	9
2.4.2 Multiple Extract	10
2.5 Final Wrapper	10
3 Retrieve Abnormal Template	12
3.1 Load Abnormal Findings Markdown Docs	12
3.2 Split Markdown by headers	13
3.3 Function: <code>load_split_md_docs()</code>	14
3.4 Create Vector Storage	15
3.5 Retriever	15
3.5.1 Function: <code>get_chroma_retrievers()</code>	15
3.5.2 HowTo: Retriever Single Doc	16
3.5.3 HowTo: Retriever Multi Docs	17
3.5.4 Test Retrieve	17
3.6 Retrieve Abnormal Docs	18
3.6.1 Function: <code>retrieve_abnormal_docs()</code>	18
3.6.2 HowTo: Retrieve Abnormal Docs	19
3.7 Alternative: Using LLM to Search (Expensive)	20
4 Construct Prompt	22
4.1 User input to findings	22
4.2 RAG	23
4.2.1 Retrievers	23
4.2.2 Retrieve Using Findings	23

4.3	Prompt	24
4.3.1	Function: <code>get_prompt_template()</code>	24
4.3.2	HowTo: Construct Prompt	25
5	Chaining Workflow	32
5.1	User Input	32
5.2	Abnormal Docs	33
5.3	Prompt	33
5.4	Chain	33
5.4.1	Final Wrapper: <code>generate_report()</code>	33
5.5	Execute	34

Preface

i Note

How to generate mini US report

1 Overview

```
from us_report_ext import generate_report
```

1.1 Normal Report

```
report1 = generate_report("Generate normal US report")
print(report1)
```

****US OF THE UPPER ABDOMEN (MINI)****

****FINDINGS:****

****Liver:**** Normal size and parenchymal echogenicity. No focal lesion.

****Gallbladder:**** Well-distended gallbladder. No stone or mass.

****Kidneys:**** Normal size and parenchymal echogenicity of both kidneys. No stone, hydronephrosis.

****IMPRESSION:****

- Normal liver parenchyma without focal lesion.

1.2 Abnormal Report

```
# User Text to Extract
user_text2 = """Generate US report with these findings:
- Mild fatty liver
- A 6-mm left renal stone, A 5-mm right renal cyst
"""

report2 = generate_report(user_text2)
print(report2)
```

****US OF THE UPPER ABDOMEN (MINI)****

****FINDINGS:****

****Liver:**** Normal size with mildly increased parenchymal echogenicity of the liver. No focal

****Gallbladder:**** Well-distended gallbladder. No stone or mass.

****Kidneys:**** Normal size and parenchymal echogenicity of both kidneys. A 6-mm left renal stone.

****IMPRESSION:****

- Mild fatty liver without focal lesion.

- A 6-mm left renal stone.

- A 5-mm right renal cyst.

```
# User Text to Extract
```

```
user_text3 = """Generate US report with these findings:
```

```
- Severe fatty liver
```

```
- A 1-cm left renal stone, A few simple left renal cysts
```

```
- 2-cm gallstone
```

```
"""
```

```
report3 = generate_report(user_text3)
```

```
print(report3)
```

****US OF THE UPPER ABDOMEN (MINI)****

****FINDINGS:****

****Liver:**** Normal size with diffusely increased parenchymal echogenicity of the liver, causing

****Gallbladder:**** Distended gallbladder containing a 2-cm gallstone. No gallbladder wall thickening.

****Kidneys:**** Normal size and parenchymal echogenicity of both kidneys. A 1-cm non-obstructing

****IMPRESSION:****

- Severe fatty liver without focal lesion.

- A 1-cm non-obstructing caliceal stone at the left kidney.

- A few simple left renal cysts.

2 Extract Input Findings

Goal: Extract abnormal findings from user input for each organs

```
from typing import Optional, List
from langchain_openai import ChatOpenAI
from langchain_core.pydantic_v1 import BaseModel, Field
from langchain_core.prompts import ChatPromptTemplate
```

```
llm = ChatOpenAI(model="gpt-3.5-turbo")
```

2.1 User Input

```
# User Text to Extract
user_text1 = """Generate US report with these findings:
- Mild fatty liver
- 2-mm left renal stone, 5-mm right renal cyst
"""
```

2.2 Schema

```
class Organ(BaseModel):
    """Base class for organ-related information"""
    finding: Optional[str] = Field(default=None, description="")

    def __init__(self, **data):
        super().__init__(**data)
        # Dynamically set the description
        cls_nm = self.__class__.__name__
        self.__fields__["finding"].field_info.description = f"Abnormal finding for the {cls_nm}"
```

```

class Config:
    # This ensures that the fields are allowed to be inherited and validated correctly.
    allow_population_by_field_name = True

class Liver(Organ):
    """Information about Liver finding"""

class Kidney(Organ):
    """Information about Kidney finding"""

class GallBladder(Organ):
    """Information about GallBladder finding"""

class Findings(BaseModel):
    """Extracted information from each organs."""
    # Creates a model so that we can extract multiple entities.
    abnormal_liver: List[Liver]
    abnormal_kidney: List[Kidney]
    abnormal_gallbladder: List[GallBladder]

    def to_dict(self):
        return {
            "abnormal_liver": [sub.finding for sub in self.abnormal_liver],
            "abnormal_kidney": [sub.finding for sub in self.abnormal_kidney],
            "abnormal_gallbladder": [sub.finding for sub in self.abnormal_gallbladder],
        }

# Example usage
liver_instance = Liver()
kidney_instance = Kidney()
gallbladder_instance = GallBladder()

print(liver_instance.__fields__["finding"].field_info.description)
print(kidney_instance.__fields__["finding"].field_info.description)
print(gallbladder_instance.__fields__["finding"].field_info.description)

```

Abnormal finding for the Liver. If findings about Liver is not provided or Liver is normal, 1

Abnormal finding for the Kidney. If findings about Kidney is not provided or Kidney is normal, 1

Abnormal finding for the GallBladder. If findings about GallBladder is not provided or GallB

2.3 Extractor

```
# Define a custom prompt to provide instructions and any additional context.
# 1) You can add examples into the prompt template to improve extraction quality
# 2) Introduce additional parameters to take context into account (e.g., include metadata
#     about the document from which the text was extracted.)
prompt = ChatPromptTemplate.from_messages(
    [
        (
            "system",
            "You are an expert extraction algorithm. "
            "Only extract relevant information from the text. "
            "If you do not know the value of an attribute asked to extract, "
            "return `None` for the attribute's value.",
        ),
        # Please see the how-to about improving performance with
        # reference examples.
        # MessagesPlaceholder('examples'),
        ("human", "{input_text}"),
    ]
)
```

2.4 Create Chain & Execute

2.4.1 Single Extract

```
runnable_liver = prompt | llm.with_structured_output(schema=Liver)
runnable_kidney = prompt | llm.with_structured_output(schema=Kidney)
runnable_gallbladder = prompt | llm.with_structured_output(schema=GallBladder)
```

```
# User Text to Extract
print(user_text1)
```

Generate US report with these findings:

- Mild fatty liver
- 2-mm left renal stone, 5-mm right renal cyst

```
# Liver Findings
liver1 = runnable_liver.invoke({"input_text": user_text1})
print(liver1)

# Kidney Findings
kidney1 = runnable_kidney.invoke({"input_text": user_text1})
print(kidney1)

# Gallbladder Findings
gallbladder1 = runnable_gallbladder.invoke({"input_text": user_text1})
print(gallbladder1)
```

```
finding='Mild fatty liver'
finding='2-mm left renal stone, 5-mm right renal cyst'
finding=None
```

2.4.2 Multiple Extract

```
runnable = prompt | llm.with_structured_output(schema=Findings)
```

```
res = runnable.invoke({"input_text": user_text1})
res
```

```
Findings(abnormal_liver=[Liver(finding='Mild fatty liver')], abnormal_kidney=[Kidney(finding='2-mm left renal stone, 5-mm right renal cyst')], abnormal_gallbladder=[Gallbladder(finding=None)])
```

```
res.to_dict()
```

```
{'abnormal_liver': ['Mild fatty liver'],
 'abnormal_kidney': ['2-mm left renal stone', '5-mm right renal cyst'],
 'abnormal_gallbladder': []}
```

2.5 Final Wrapper

```

from langchain_openai import ChatOpenAI
from langchain_core.prompts import ChatPromptTemplate

def get_findings(input_text,
                  llm=ChatOpenAI(model="gpt-3.5-turbo")):
    prompt = ChatPromptTemplate.from_messages(
        [
            (
                "system",
                "You are an expert extraction algorithm. "
                "Only extract relevant information from the text. "
                "If you do not know the value of an attribute asked to extract, "
                "return `None` for the attribute's value.",
            ),
            # Please see the how-to about improving performance with
            # reference examples.
            # MessagesPlaceholder('examples'),
            ("human", "{input_text}"),
        ]
    )

    runnable = prompt | llm.with_structured_output(schema=Findings)
    res = runnable.invoke({"input_text": input_text})
    return res

```

```

get_findings("Fatty liver, 2-cm renal cyst")

```

```

Findings(liver_findings=[Liver(finding='Fatty liver')], kidney_findings=[Kidney(finding='2-cm renal cyst')])

```

3 Retrieve Abnormal Template

Goal: Retrieve abnormal findings from abnormal template by each organs

```
from langchain_community.document_loaders import DirectoryLoader, TextLoader
from langchain_core.runnables import RunnablePassthrough
# Local Package
from us_report_ext.findings import Findings
```

3.1 Load Abnormal Findings Markdown Docs

```
# Load all markdown files from `abnormal/` directory
loader = DirectoryLoader("abnormal", glob="**/*.md", loader_cls=TextLoader)
docs_list = loader.load()
```

```
print(docs_list[0].page_content[0:250] )
```

```
# Kidney Findings
```

Order findings as:

1. Kidney size and echogenicity
2. (If any) Renal cyst(s)
3. (If any) Renal stone, hydronephrosis, or solid mass.

```
```markdown
```

```
Kidneys: <kidney_size_echo>. <renal_cyst>. <renal_stone_hydro_solid_mass>.
```
```

```
from pathlib import Path

# Put into dictionary
docs_names = [Path(doc.metadata["source"]).stem for doc in docs_list]
docs_dict = dict(zip(docs_names, docs_list))
docs_dict
```

3.2 Split Markdown by headers

```
{
  'abnormal_kidney': [Document(page_content='Order findings as:\n1. Kidney size and echogenicity\n2. Renal cortex thickness\n3. Hydronephrosis\n4. Cystic lesions\n5. Calcifications\n6. Vascular changes\n7. Other findings\n8. Summary\n9. Recommendations\n10. Follow-up\n11. References\n12. Appendix\n13. Glossary\n14. Index\n15. Bibliography\n16. Figures\n17. Tables\n18. Appendices\n19. References\n20. Appendix\n21. Glossary\n22. Index\n23. Bibliography\n24. Figures\n25. Tables\n26. Appendices\n27. References\n28. Appendix\n29. Glossary\n30. Index\n31. Bibliography\n32. Figures\n33. Tables\n34. Appendices\n35. References\n36. Appendix\n37. Glossary\n38. Index\n39. Bibliography\n40. Figures\n41. Tables\n42. Appendices\n43. References\n44. Appendix\n45. Glossary\n46. Index\n47. Bibliography\n48. Figures\n49. Tables\n50. Appendices\n51. References\n52. Appendix\n53. Glossary\n54. Index\n55. Bibliography\n56. Figures\n57. Tables\n58. Appendices\n59. References\n60. Appendix\n61. 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Tables\n650. Appendices\n651. References\n652. Appendix\n653. Glossary\n654
```

```
Document(page_content='```\nmarkdown\n***Gallbladder:** Surgically absent gallbladder.\n````\n',  
Document(page_content='```\nmarkdown\n***Gallbladder:** Collapsed gallbladder with retained cl
```

3.3 Function: load_split_md_docs()

```
from typing import Dict, List  
from pathlib import Path  
from langchain_text_splitters import MarkdownHeaderTextSplitter  
from langchain_core.documents import Document  
from langchain_community.document_loaders import DirectoryLoader, TextLoader  
  
def load_split_md_docs(path: str) -> Dict[str, List[Document]]:  
    """Load and Split Markdown Documents  
  
    Args:  
        path (str): path to folder containing markdown docs  
  
    Returns:  
        _dict_: Dictionary containing list of Documents  
    """  
    # Load all markdown files from `abnormal/` directory  
    loader = DirectoryLoader(path = path, glob="**/*.md", loader_cls=TextLoader)  
    docs_list = loader.load()  
  
    ## Put into dictionary  
    docs_names = [Path(doc.metadata["source"]).stem for doc in docs_list]  
    docs_dict = dict(zip(docs_names, docs_list))  
  
    # Split  
    ## Split Headings  
    headers_to_split_on = [  
        ("#", "Header 1"),  
        ("##", "Header 2"),  
        ("###", "Header 3"),  
    ]  
  
    ## MD splits  
    markdown_splitter = MarkdownHeaderTextSplitter(  
        headers_to_split_on=headers_to_split_on, strip_headers=False  
    )
```



```
retriever_liver.invoke("Search the following only in `metadata` field: Paren")
```

```
[Document(page_content='```\n\nmarkdown\n\n**Liver:** Normal size and (mildly) `[increased | coarse`\n\nDocument(page_content='```\n\nmarkdown\n\n**Liver:** Normal size and (mildly) `[increased | coarse`
```

3.5.3 HowTo: Retriver Multi Docs

```
retriever_dict = {
    name: chroma.as_retriever(
        search_type="similarity",
        # For diversity
        search_kwargs={'k': 3},)
    for name, chroma in chroma_dict.items()
}
```

```
retriever_dict
```

```
{'abnormal_kidney': VectorStoreRetriever(tags=['Chroma', 'OpenAIEmbeddings'], vectorstore=<la
'abnormal_liver': VectorStoreRetriever(tags=['Chroma', 'OpenAIEmbeddings'], vectorstore=<la
'abnormal_gallbladder': VectorStoreRetriever(tags=['Chroma', 'OpenAIEmbeddings'], vectorsto
```

3.5.4 Test Retrieve

```
retriever_dict["abnormal_gallbladder"].invoke("Search the following only in `metadata` field
```

```
[Document(page_content='#### Mild Fatty Liver \n\n```\n\nmarkdown\n\n**Liver:** Normal size with mi
Document(page_content='#### Mild Fatty Liver \n\n```\n\nmarkdown\n\n**Liver:** Normal size with mi
Document(page_content='```\n\nmarkdown\n\n**Liver:** Normal size and (mildly) `[increased | coarse`
```

```
retriever_dict["abnormal_gallbladder"].invoke("Search the following only in `metadata` field
```

```
[Document(page_content='Order findings as:\n1. Kidney size and echogenicity\n2. (If any) Ren
Document(page_content='Order findings as:\n1. Kidney size and echogenicity\n2. (If any) Ren
Document(page_content='```\n\nmarkdown\n\n**Kidneys:** Normal size and parenchymal echogenicity o
```

3.6 Retrive Abnormal Docs

3.6.1 Function: `retrieve_abnormal_docs()`

```

from typing import Dict, List
import itertools
from langchain_core.documents import Document

def retrieve_abnormal_docs(retriever_dict: Dict[str, VectorStoreRetriever], findings: Findings) -> Dict[str, List[Document]]:
    out_dict = {}

    for key, retriever in retriever_dict.items():
        # Loop per organs
        query_list = findings.to_dict()[key]
        out_dict[key] = remove_duplicates(list(
            # Un-nest List
            itertools.chain(
                # Query for each item in findings
                *[retriever.invoke(f"Search only in the `metadata` field\n\nQuery: {query}")
                  for query in query_list]
            )
        ))

    return out_dict

# Helper
def remove_duplicates(objects):
    unique_objects = []
    for obj in objects:
        if obj not in unique_objects:
            unique_objects.append(obj)
    return unique_objects

abn_doc_dict1 = retrieve_abnormal_docs(retriever_dict, findings1)
abn_doc_dict1

```

```
{ 'abnormal_kidney': [Document(page_content='``markdown\nKidneys: Normal size and parenchymal echotexture.\nOrder findings as:\n1. Kidney size and echogenicity\n2. (If any) Renal cysts or masses\n3. Hydronephrosis\n4. Other abnormalities\n5. Summary\n6. Impression\n7. Recommendation\n8. Follow-up\n9. Date of next exam\n10. Referring physician\n11. Referring institution\n12. Referring physician contact information\n13. Referring institution contact information\n14. Referring physician signature\n15. Referring institution signature\n16. Referring physician title\n17. Referring institution title\n18. Referring physician address\n19. Referring institution address\n20. Referring physician phone number\n21. Referring institution phone number\n22. Referring physician fax number\n23. Referring institution fax number\n24. Referring physician email address\n25. Referring institution email address\n26. Referring physician website\n27. Referring institution website\n28. Referring physician social media links\n29. Referring institution social media links\n30. Referring physician LinkedIn profile\n31. Referring institution LinkedIn profile\n32. Referring physician Twitter account\n33. Referring institution Twitter account\n34. Referring physician Facebook page\n35. Referring institution Facebook page\n36. Referring physician Instagram account\n37. Referring institution Instagram account\n38. Referring physician YouTube channel\n39. Referring institution YouTube channel\n40. Referring physician podcast feed\n41. Referring institution podcast feed\n42. Referring physician RSS feed\n43. Referring institution RSS feed\n44. Referring physician newsletter subscription\n45. Referring institution newsletter subscription\n46. Referring physician press release\n47. Referring institution press release\n48. Referring physician news story\n49. Referring institution news story\n50. Referring physician blog post\n51. Referring institution blog post\n52. Referring physician guest article\n53. Referring institution guest article\n54. Referring physician interview transcript\n55. Referring institution interview transcript\n56. Referring physician video recording\n57. Referring institution video recording\n58. Referring physician audio recording\n59. Referring institution audio recording\n60. Referring physician photo gallery\n61. Referring institution photo gallery\n62. Referring physician virtual tour\n63. Referring institution virtual tour\n64. Referring physician mobile app\n65. Referring institution mobile app\n66. Referring physician desktop application\n67. Referring institution desktop application\n68. Referring physician web browser extension\n69. Referring institution web browser extension\n70. Referring physician smartwatch app\n71. Referring institution smartwatch app\n72. Referring physician voice assistant integration\n73. Referring institution voice assistant integration\n74. Referring physician augmented reality experience\n75. Referring institution augmented reality experience\n76. Referring physician virtual reality experience\n77. Referring institution virtual reality experience\n78. Referring physician blockchain implementation\n79. Referring institution blockchain implementation\n80. Referring physician artificial intelligence integration\n81. Referring institution artificial intelligence integration\n82. Referring physician quantum computing research\n83. Referring institution quantum computing research\n84. Referring physician nanotechnology development\n85. Referring institution nanotechnology development\n86. Referring physician biotechnology innovation\n86. Referring institution biotechnology innovation\n87. Referring physician space exploration mission\n88. Referring institution space exploration mission\n89. Referring physician deep sea exploration project\n90. Referring institution deep sea exploration project\n91. Referring physician Mars colonization plan\n92. Referring institution Mars colonization plan\n93. Referring physician lunar base construction\n94. Referring institution lunar base construction\n95. Referring physician asteroid mining operation\n96. Referring institution asteroid mining operation\n97. Referring physician interplanetary trade network\n98. Referring institution interplanetary trade network\n99. Referring physician global communication system\n100. Referring institution global communication system\n101. Referring physician autonomous vehicle fleet\n102. Referring institution autonomous vehicle fleet\n103. Referring physician drone delivery service\n104. Referring institution drone delivery service\n105. Referring physician underwater robot swarm\n106. Referring institution underwater robot swarm\n107. Referring physician satellite constellation launch\n108. Referring institution satellite constellation launch\n109. Referring physician space station module upgrade\n110. Referring institution space station module upgrade\n111. Referring physician Mars rover deployment\n112. Referring institution Mars rover deployment\n113. Referring physician lunar lander mission\n114. Referring institution lunar lander mission\n115. Referring physician Venus probe launch\n116. Referring institution Venus probe launch\n117. Referring physician Europa orbiter mission\n118. Referring institution Europa orbiter mission\n119. Referring physician Titan lake sampling mission\n120. Referring institution Titan lake sampling mission\n121. Referring physician Enceladus plume analysis mission\n122. Referring institution Enceladus plume analysis mission\n123. Referring physician Io volcanic monitoring mission\n124. Referring institution Io volcanic monitoring mission\n125. Referring physician Juno Jupiter orbit insertion\n126. Referring institution Juno Jupiter orbit insertion\n127. Referring physician New Horizons Pluto flyby mission\n128. Referring institution New Horizons Pluto flyby mission\n129. Referring physician Voyager 2 Neptune encounter mission\n130. Referring institution Voyager 2 Neptune encounter mission\n131. Referring physician Cassini Saturn orbit mission\n132. Referring institution Cassini Saturn orbit mission\n133. Referring physician Hubble Space Telescope servicing mission\n134. Referring institution Hubble Space Telescope servicing mission\n135. Referring physician James Webb Space Telescope launch mission\n136. Referring institution James Webb Space Telescope launch mission\n137. Referring physician Perseverance Mars landing mission\n138. Referring institution Perseverance Mars landing mission\n139. Referring physician Curiosity Mars surface mission\n140. Referring institution Curiosity Mars surface mission\n141. Referring physician InSight Mars seismic mission\n142. Referring institution InSight Mars seismic mission\n143. Referring physician MAVEN Mars atmospheric mission\n144. Referring institution MAVEN Mars atmospheric mission\n145. Referring physician Mars Reconnaissance Orbiter mission\n146. Referring institution Mars Reconnaissance Orbiter mission\n147. Referring physician Mars Science Laboratory mission\n148. Referring institution Mars Science Laboratory mission\n149. Referring physician Mars Global Surveyor mission\n150. Referring institution Mars Global Surveyor mission\n151. Referring physician Mars Climate Orbiter mission\n152. Referring institution Mars Climate Orbiter mission\n153. Referring physician Mars Express mission\n154. Referring institution Mars Express mission\n155. Referring physician Mars Phoenix Lander mission\n156. Referring institution Mars Phoenix Lander mission\n157. Referring physician Mars Opportunity Rover mission\n158. Referring institution Mars Opportunity Rover mission\n159. Referring physician Mars Spirit Rover mission\n160. Referring institution Mars Spirit Rover mission\n161. Referring physician Mars Sojourner Rover mission\n162. Referring institution Mars Sojourner Rover mission\n163. Referring physician Mars rover sample return mission\n164. Referring institution Mars rover sample return mission\n165. Referring physician Mars surface habitat mission\n166. Referring institution Mars surface habitat mission\n167. Referring physician Mars subsurface drilling mission\n168. Referring institution Mars subsurface drilling mission\n169. Referring physician Mars polar ice core extraction mission\n170. Referring institution Mars polar ice core extraction mission\n171. Referring physician Mars methane detection mission\n172. Referring institution Mars methane detection mission\n173. Referring physician Mars water ice mapping mission\n174. Referring institution Mars water ice mapping mission\n175. Referring physician Mars dust storm observation mission\n176. Referring institution Mars dust storm observation mission\n177. Referring physician Mars ionosphere study mission\n178. Referring institution Mars ionosphere study mission\n179. Referring physician Mars magnetic field measurement mission\n180. Referring institution Mars magnetic field measurement mission\n181. Referring physician Mars gravity field mapping mission\n182. Referring institution Mars gravity field mapping mission\n183. Referring physician Mars topographic mapping mission\n184. Referring institution Mars topographic mapping mission\n185. Referring physician Mars geological survey mission\n186. Referring institution Mars geological survey mission\n187. Referring physician Mars mineral resource assessment mission\n188. Referring institution Mars mineral resource assessment mission\n189. Referring physician Mars climate simulation mission\n190. Referring institution Mars climate simulation mission\n191. Referring physician Mars weather forecasting mission\n192. Referring institution Mars weather forecasting mission\n193. Referring physician Mars air quality monitoring mission\n194. Referring institution Mars air quality monitoring mission\n195. Referring physician Mars soil composition analysis mission\n196. Referring institution Mars soil composition analysis mission\n197. Referring physician Mars rock composition analysis mission\n198. Referring institution Mars rock composition analysis mission\n199. Referring physician Mars atmosphere composition analysis mission\n200. Referring institution Mars atmosphere composition analysis mission\n201. Referring physician Mars surface temperature measurement mission\n202. Referring institution Mars surface temperature measurement mission\n203. Referring physician Mars surface humidity measurement mission\n204. Referring institution Mars surface humidity measurement mission\n205. Referring physician Mars surface wind speed measurement mission\n206. Referring institution Mars surface wind speed measurement mission\n207. Referring physician Mars surface pressure measurement mission\n208. Referring institution Mars surface pressure measurement mission\n209. Referring physician Mars surface radiation level measurement mission\n210. Referring institution Mars surface radiation level measurement mission\n211. Referring physician Mars surface UV radiation measurement mission\n212. Referring institution Mars surface UV radiation measurement mission\n213. Referring physician Mars surface cosmic ray flux measurement mission\n214. Referring institution Mars surface cosmic ray flux measurement mission\n215. Referring physician Mars surface neutron flux measurement mission\n216. Referring institution Mars surface neutron flux measurement mission\n217. Referring physician Mars surface gamma-ray flux measurement mission\n218. Referring institution Mars surface gamma-ray flux measurement mission\n219. Referring physician Mars surface X-ray fluorescence measurement mission\n220. Referring institution Mars surface X-ray fluorescence measurement mission\n221. Referring physician Mars surface infrared spectroscopy mission\n222. Referring institution Mars surface infrared spectroscopy mission\n223. Referring physician Mars surface visible light spectroscopy mission\n224. Referring institution Mars surface visible light spectroscopy mission\n225. Referring physician Mars surface ultraviolet spectroscopy mission\n226. Referring institution Mars surface ultraviolet spectroscopy mission\n227. Referring physician Mars surface microwave radiometry mission\n228. Referring institution Mars surface microwave radiometry mission\n229. Referring physician Mars surface radar altimetry mission\n230. Referring institution Mars surface radar altimetry mission\n231. Referring physician Mars surface laser ranging mission\n232. Referring institution Mars surface laser ranging mission\n233. Referring physician Mars surface interferometry mission\n234. Referring institution Mars surface interferometry mission\n235. Referring physician Mars surface seismology mission\n236. Referring institution Mars surface seismology mission\n237. Referring physician Mars surface geodesy mission\n238. Referring institution Mars surface geodesy mission\n239. Referring physician Mars surface magnetometry mission\n240. Referring institution Mars surface magnetometry mission\n241. Referring physician Mars surface gravimetry mission\n242. Referring institution Mars surface gravimetry mission\n243. Referring physician Mars surface hydrology mission\n244. Referring institution Mars surface hydrology mission\n245. Referring physician Mars surface oceanography mission\n246. Referring institution Mars surface oceanography mission\n247. Referring physician Mars surface glaciology mission\n248. Referring institution Mars surface glaciology mission\n249. Referring physician Mars surface cryobiology mission\n250. Referring institution Mars surface cryobiology mission\n251. Referring physician Mars surface astrobiology mission\n252. Referring institution Mars surface astrobiology mission\n253. Referring physician Mars surface microbiology mission\n254. Referring institution Mars surface microbiology mission\n255. Referring physician Mars surface botany mission\n256. Referring institution Mars surface botany mission\n257. Referring physician Mars surface zoology mission\n258. Referring institution Mars surface zoology mission\n259. Referring physician Mars surface entomology mission\n260. Referring institution Mars surface entomology mission\n261. Referring physician Mars surface mycology mission\n262. Referring institution Mars surface mycology mission\n263. Referring physician Mars surface virology mission\n264. Referring institution Mars surface virology mission\n265. Referring physician Mars surface immunology mission\n266. Referring institution Mars surface immunology mission\n267. Referring physician Mars surface pathology mission\n268. Referring institution Mars surface pathology mission\n269. Referring physician Mars surface pharmacology mission\n270. Referring institution Mars surface pharmacology mission\n271. Referring physician Mars surface toxicology mission\n272. Referring institution Mars surface toxicology mission\n273. Referring physician Mars surface forensic science mission\n274. Referring institution Mars surface forensic science mission\n275. Referring physician Mars surface anthropology mission\n276. Referring institution Mars surface anthropology mission\n277. Referring physician Mars surface archaeology mission\n278. Referring institution Mars surface archaeology mission\n279. Referring physician Mars surface linguistics mission\n280. Referring institution Mars surface linguistics mission\n281. Referring physician Mars surface history mission\n282. Referring institution Mars surface history mission\n283. Referring physician Mars surface geography mission\n284. Referring institution Mars surface geography mission\n285. Referring physician Mars surface geology mission\n286. Referring institution Mars surface geology mission\n287. Referring physician Mars surface astronomy mission\n288. Referring institution Mars surface astronomy mission\n289. Referring physician Mars surface astrophysics mission\n290. Referring institution Mars surface astrophysics mission\n291. Referring physician Mars surface cosmology mission\n292. Referring institution Mars surface cosmology mission\n293. Referring physician Mars surface physics mission\n294. Referring institution Mars surface physics mission\n295. Referring physician Mars surface chemistry mission\n296. Referring institution Mars surface chemistry mission\n297. Referring physician Mars surface biology mission\n298. Referring institution Mars surface biology mission\n299. Referring physician Mars surface environmental science mission\n300. Referring institution Mars surface environmental science mission\n301. Referring physician Mars surface planetary science mission\n302. Referring institution Mars surface planetary science mission\n303. Referring physician Mars surface earth and space science mission\n304. Referring institution Mars surface earth and space science mission\n305. Referring physician Mars surface interdisciplinary research mission\n306. Referring institution Mars surface interdisciplinary research mission\n307. Referring physician Mars surface collaborative research mission\n308. Referring institution Mars surface collaborative research mission\n309. Referring physician Mars surface international research mission\n310. Referring institution Mars surface international research mission\n311. Referring physician Mars surface open source research mission\n312. Referring institution Mars surface open source research mission\n313. Referring physician Mars surface citizen science mission\n314. Referring institution Mars surface citizen science mission\n315. Referring physician Mars surface volunteer research mission\n316. Referring institution Mars surface volunteer research mission\n317. Referring physician Mars surface crowdsourcing mission\n318. Referring institution Mars surface crowdsourcing mission\n319. Referring physician Mars surface gamification mission\n320. Referring institution Mars surface gamification mission\n321. Referring physician Mars surface education mission\n322. Referring institution Mars surface education mission\n323. Referring physician Mars surface training mission\n324. Referring institution Mars surface training mission\n325. Referring physician Mars surface mentorship mission\n326. Referring institution Mars surface mentorship mission\n327. Referring physician Mars surface networking mission\n328. Referring institution Mars surface networking mission\n329. Referring physician Mars surface community building mission\n330. Referring institution Mars surface community building mission\n331. Referring physician Mars surface leadership development mission\n332. Referring institution Mars surface leadership development mission\n333. Referring physician Mars surface entrepreneurship mission\n334. Referring institution Mars surface entrepreneurship mission\n335. Referring physician Mars surface innovation mission\n336. Referring institution Mars surface innovation mission\n337. Referring physician Mars surface creativity mission\n338. Referring institution Mars surface creativity mission\n339. Referring physician Mars surface problem solving mission\n340. Referring institution Mars surface problem solving mission\n341. Referring physician Mars surface decision
```

```
'abnormal_liver': [Document(page_content='#### Mild Fatty Liver \n``markdown\n**Liver:** I
'abnormal_gallbladder': []}]
```

3.6.2 HowTo: Retrive Abnormal Docs

```
from us_report_ext.main import get_findings, load_split_md_docs
from us_report_ext.findings import Findings
```

```
# User Text to Extract
user_text1 = """Generate US report with these findings:
- Mild fatty liver
- 2-mm left renal stone, 5-mm right renal cyst
"""
findings1 = get_findings(input_text=user_text1)
findings1
```

```
Findings(abnormal_liver=[Liver(finding='Mild fatty liver')], abnormal_kidney=[Kidney(finding:
```

```
# Retriever
docs_dict = load_split_md_docs("abnormal")
retriever_dict = get_chroma_retrievers(docs_dict)
retriever_dict
```

```
{'abnormal_kidney': VectorStoreRetriever(tags=['Chroma', 'OpenAIEmbeddings'], vectorstore=<la
'abnormal_liver': VectorStoreRetriever(tags=['Chroma', 'OpenAIEmbeddings'], vectorstore=<la
'abnormal_gallbladder': VectorStoreRetriever(tags=['Chroma', 'OpenAIEmbeddings'], vectorstor
```

```
findings1.to_dict()
```

```
{'abnormal_liver': ['Mild fatty liver'],
'abnormal_kidney': ['2-mm left renal stone', '5-mm right renal cyst'],
'abnormal_gallbladder': []}]
```

```
query = "Mild fatty liver"
```

```
pr_temp_retriever = f"Search only in the `metadata` field\n\nQuery: {query}"
retriever_dict["abnormal_liver"].invoke(pr_temp_retriever)
```

```
[Document(page_content='#### Mild Fatty Liver \n```markdown\n**Liver:** Normal size with mi
Document(page_content='#### Mild Fatty Liver \n```markdown\n**Liver:** Normal size with mi
Document(page_content='#### Mild Fatty Liver \n```markdown\n**Liver:** Normal size with mi
```

```
import itertools

out_dict = {}

for key, retriever in retriever_dict.items():
    print(key, retriever)
    query_list = findings1.to_dict()[key]
    out_dict[key] = remove_duplicates(list(
        # Un-nest List
        itertools.chain(
            *[retriever.invoke(f"Search only in the `metadata` field\n\nQuery: {query}")
              for query in query_list]
        )
    ))

out_dict
```

```
abnormal_kidney tags=['Chroma', 'OpenAIEmbeddings'] vectorstore=<langchain_chroma.vectorstore
abnormal_liver tags=['Chroma', 'OpenAIEmbeddings'] vectorstore=<langchain_chroma.vectorstore
abnormal_gallbladder tags=['Chroma', 'OpenAIEmbeddings'] vectorstore=<langchain_chroma.vector
```

```
{'abnormal_kidney': [Document(page_content='```markdown\n**Kidneys:** Normal size and parench
Document(page_content='Order findings as:\n1. Kidney size and echogenicity\n2. (If any) Ren
'abnormal_liver': [Document(page_content='#### Mild Fatty Liver \n```markdown\n**Liver:** L
'abnormal_gallbladder': []}
```

3.7 Alternative: Using LLM to Search (Expensive)

```
from langchain_openai import ChatOpenAI
llm_query = ChatOpenAI(model="gpt-3.5-turbo-0125")
```

```
from langchain_core.prompts import PromptTemplate

pr_temp_retriever = PromptTemplate.from_template("""You are the document query assistance.
- User will provide search query.
```

```
- Your task is to return the matching document(s) by searching only in the `metadata` field of
```

```
Query: {query}
```

```
Output: """)
```

```
retriever_dict["abnormal_gallbladder"] | pr_temp_retriever
```

```
VectorStoreRetriever(tags=['Chroma', 'OpenAIEmbeddings'], vectorstore=<langchain_chroma.vectorstores.Chroma>  
| PromptTemplate(input_variables=['query'], template='You are the document query assistance.'))
```

```
rag_gb_chain = (  
    {"context": retriever_dict["abnormal_gallbladder"] , "query": RunnablePassthrough()}  
    | pr_temp_retriever  
    | llm_query  
)  
rag_gb_chain
```

```
{  
    context: VectorStoreRetriever(tags=['Chroma', 'OpenAIEmbeddings'], vectorstore=<langchain_chroma.vectorstores.Chroma>  
    query: RunnablePassthrough()  
}  
| PromptTemplate(input_variables=['query'], template='You are the document query assistance.')  
| ChatOpenAI(client=<openai.resources.chat.completions.Completions object at 0x3060e7ac0>, api_key='sk-')
```

```
rag_gb_chain.invoke("2-mm left renal stone")
```

```
AIMessage(content='Document 1:\n{\n    "title": "Patient Report: Kidney Stone Analysis",\n    "content": "A 45-year-old male patient presented with severe, colicky abdominal pain in the right flank area, lasting for approximately 6 hours. The pain was rated as 8/10 on a visual analog scale. The patient also reported nausea and vomiting. Physical examination revealed tenderness in the right upper quadrant and costovertebral angle tenderness. Laboratory tests showed a white blood cell count of 12,000/mm³ and a serum creatinine level of 1.2 mg/dL. A non-contrast CT scan of the abdomen revealed a 2-mm left renal stone. The patient was treated with intravenous fluids, antiemetics, and pain management. He was discharged on oral pain medication and advised to increase fluid intake. Follow-up is recommended in 2 weeks.'\n)
```

4 Construct Prompt

```
from langchain_openai import ChatOpenAI, OpenAIEmbeddings
from us_report_ext import (get_findings,
                           load_split_md_docs,
                           get_chroma_retrievers,
                           retrieve_abnormal_docs)

from us_report_ext._utils import read_markdown
```

```
llm_main = ChatOpenAI(model="gpt-3.5-turbo") # Main LLM for Prompt
llm_input = ChatOpenAI(model="gpt-3.5-turbo") # LLM for instruct input
embedding = OpenAIEmbeddings() # Chroma Embedding
```

4.1 User input to findings

```
# User Text to Extract
user_text1 = """Generate US report with these findings:
- Mild fatty liver
- 2-mm left renal stone, 5-mm right renal cyst
- A 3-mm gallstone
"""
```

```
findings1 = get_findings(input_text=user_text1, llm = llm_input)
findings1
```

```
Findings(abnormal_liver=[Liver(finding='Mild fatty liver')], abnormal_kidney=[Kidney(finding='2-mm left renal stone, 5-mm right renal cyst')], abnormal_gallbladder=[Gallbladder(finding='A 3-mm gallstone')])
```

```
findings1.to_dict()
```

```
{'abnormal_liver': ['Mild fatty liver'],
 'abnormal_kidney': ['2-mm left renal stone', '5-mm right renal cyst'],
 'abnormal_gallbladder': ['3-mm gallstone']}
```

4.2 RAG

4.2.1 Retrivers

```
md_header_splits_dict = load_split_md_docs("abnormal")
retriever_dict = get_chroma_retrievers(md_header_splits_dict, embedding= embedding)
retriever_dict
```

```
{
  'abnormal_kidney': VectorStoreRetriever(tags=['Chroma', 'OpenAIEmbeddings'], vectorstore=llm.vectorstore),
  'abnormal_liver': VectorStoreRetriever(tags=['Chroma', 'OpenAIEmbeddings'], vectorstore=llm.vectorstore),
  'abnormal_gallbladder': VectorStoreRetriever(tags=['Chroma', 'OpenAIEmbeddings'], vectorstore=llm.vectorstore)
}
```

4.2.2 Retrieve Using Findings

```
abn_doc_dict1 = retrieve_abnormal_docs(retriever_dict, findings1)
abn_doc_dict1
```

```
{
  'abnormal_kidney': [Document(page_content='### Renal Stone \n``markdown\n**Kidneys:** Normal size and echogenicity.\nOrder findings as:\n1. Kidney size and echogenicity.\n2. Hydronephrosis.\n3. Calculus.\n4. Mass lesion.\n5. Other findings.', title='Renal Stone'), Document(page_content='# Kidney Findings \nOrder findings as:\n1. Kidney size and echogenicity.\n2. Hydronephrosis.\n3. Calculus.\n4. Mass lesion.\n5. Other findings.', title='Kidney Findings')],
  'abnormal_liver': [Document(page_content='### Fatty Liver \n#### Mild Fatty Liver \n``markdown\n**Liver:** Normal size | Enlarged capsule | Increased echogenicity.\nOrder findings as:\n1. Size and shape.\n2. Capsule.\n3. Parenchyma.\n4. Vessels.\n5. Biliary system.', title='Fatty Liver'), Document(page_content='# Liver Abnormal Findings \n#### Parenchymatous Liver Disease \n``markdown\n**Liver:** Normal size | Enlarged capsule | Increased echogenicity.\nOrder findings as:\n1. Size and shape.\n2. Capsule.\n3. Parenchyma.\n4. Vessels.\n5. Biliary system.', title='Liver Abnormal Findings'), Document(page_content='### Cirrhosis \n``markdown\n**Liver:** Normal size | Enlarged capsule | Increased echogenicity.\nOrder findings as:\n1. Size and shape.\n2. Capsule.\n3. Parenchyma.\n4. Vessels.\n5. Biliary system.', title='Cirrhosis')],
  'abnormal_gallbladder': [Document(page_content='### Gallstone(s) \n``markdown\n**Gallbladder:** Normal size | Enlarged capsule | Increased echogenicity.\nOrder findings as:\n1. Size and shape.\n2. Capsule.\n3. Lumen.\n4. Wall thickness.\n5. Biliary system.', title='Gallstone(s)'), Document(page_content='# Gallbladder Abnormal Findings \nOrder findings as:\n1. Size and shape.\n2. Capsule.\n3. Lumen.\n4. Wall thickness.\n5. Biliary system.', title='Gallbladder Abnormal Findings'), Document(page_content='### Bile sludge \n``markdown\n**Gallbladder:** Normal size | Enlarged capsule | Increased echogenicity.\nOrder findings as:\n1. Size and shape.\n2. Capsule.\n3. Lumen.\n4. Wall thickness.\n5. Biliary system.', title='Bile sludge')]
}
```

```
format_docs(abn_doc_dict1["abnormal_kidney"])
```

```
'### Renal Stone \n```markdown\n**Kidneys:** Normal size and parenchymal echogenicity of bot
```

```
[docs.page_content
 for docs in abn_doc_dict1["abnormal_kidney"]]
```

```
[### Renal Stone \n``markdown\nKidneys: Normal size and parenchymal echogenicity of b
'# Kidney Findings \nOrder findings as:\n1. Kidney size and echogenicity\n2. (If any) Renal
'### Renal Cortical Cyst(s) \nHere is how to report renal cortical cyst according to Bosni
```

4.3 Prompt

4.3.1 Function: get_prompt_template()

```
def format_docs(docs):
    if docs == []:
        return ""
    else:
        return "\n\n".join(doc.page_content for doc in docs)

from typing import Dict, List
from langchain_core.prompts import ChatPromptTemplate
from langchain_core.documents import Document

def get_prompt_template(abnormal_doc_dict: Dict[str, List[Document]]):

    pr_text_intro = read_markdown("prompt/1_introduction.md")
    pr_text_eng = read_markdown("prompt/2_english_style_guide.md")
    pr_text_report_structure = read_markdown("prompt/3_report_structure.md")
    pr_text_temp_normal = read_markdown("prompt/4_report_template_normal.md")
    pr_text_temp_abn = read_markdown("prompt/5_abnormal.md")
    pr_abn_extracted = f""

    liver:\n{format_docs(abnormal_doc_dict["abnormal_liver"])}

    kidney:\n{format_docs(abnormal_doc_dict["abnormal_kidney"])}

    gallbladder:\n{format_docs(abnormal_doc_dict["abnormal_gallbladder"])}
    ""

    # Join them
    pr_text = "\n\n".join([pr_text_intro, pr_text_eng,
                           pr_text_report_structure, pr_text_temp_normal,
                           pr_text_temp_abn, pr_abn_extracted])

    prompt = "\n\n".join([pr_text,
                           ""
                           User input: {user}

                           Output:
```



```

    """)

    prompt_temp = ChatPromptTemplate.from_template(prompt)
    return prompt_temp

```

```

get_prompt_template(abn_doc_dict1)

```

```

ChatPromptTemplate(input_variables=['user'], messages=[HumanMessagePromptTemplate(prompt=Prom

```

4.3.2 HowTo: Construct Prompt

```

pr_text_intro = read_markdown("prompt/1_introduction.md")
pr_text_eng = read_markdown("prompt/2_english_style_guide.md")
pr_text_report_structure = read_markdown("prompt/3_report_structure.md")
pr_text_temp_normal = read_markdown("prompt/4_report_template_normal.md")
pr_text_temp_abn = read_markdown("prompt/5_abnormal.md")

pr_abn_extracted = f"""

liver:\n{format_docs(abn_doc_dict1["abnormal_liver"])}

kidney:\n{format_docs(abn_doc_dict1["abnormal_kidney"])}

gallbladder:\n{format_docs(abn_doc_dict1["abnormal_gallbladder"])}
"""

# Join them
pr_text = "\n\n".join([pr_text_intro, pr_text_eng,
                        pr_text_report_structure, pr_text_temp_normal,
                        pr_text_temp_abn, pr_abn_extracted])

prompt = "\n\n".join([pr_text,
                      """])
User input: {user}

Output:
""")

```

```
# prompt = "\n\n".join([prompt, f""
# Input findings:
# - The following are schema of findings extracted from the user input. if it is empty, cons
# {findings1.to_dict()}
#
# """])

print(prompt)
```

You are a radiology report writer in my institution.

I will provide you:

- "English Style Guide" for the preferred ways to write phrases or sentences in the report.
- "Reporting Structure" provides blueprint to build radiology report for each studies.
- "Normal Report Template" provides normal reporting template and normal findings for each s
- "Abnormal Report Template" provide template to write abnormal findings and corresponding in

User role:

- The user (radiologist) will provide you with ultrasound findings.
- If findings for each specific organ is not provide, assume normal findings for that organ.
- If the user ask "How do I use you?", provide the "User guide", or if not provided, generat

Your task:

- Build radiology report using "Reporting Structure", "Normal Report Template", and "Abnormal
- Return output as markdown format (without code block).

English Style Guide

Here is the preferred style guide to write report for each description task (grouped by mark

Quantifying countable lesion(s) (`<quantifier>`)

One lesion

Syntax: `?`-`unit` `lesion`

Examples:

- "A 4.2-cm gallstone"
- "A 5.0-cm renal cyst"

If multiple dimensions for one lesion is provided, use "x" to separate each dimensions.

Examples: "A 5.3x2.5-cm renal cyst" or "A renal cyst, measuring 5.3x2.5 cm"

Two or more lesions

Here are the preferred quantifiers and measurement descriptors to write two or more lesion(s)

- Preferred quantifiers: "a few", "several", "many"

- measurement descriptors:

- "measuring up to ...", "up to ..."

- "ranging from ... to ..."

Examples:

- "A few renal cysts, measuring up to 2.0 cm"

- "A few renal cysts, ranging from 1.5 to 2.0 cm"

- "Several gallstones, up to 2.0 cm"

- "Multiple gallstones, up to 3.0 cm"

Reporting Structure

Here is the radiology report structure for the study "ultrasound of the upper abdomen" (in t

```
```markdown
```

```
US OF THE UPPER ABDOMEN
```

```
FINDINGS:
```

```
Liver: <liver_findings>
```

```
Gallbladder: <gallbladder_findings>
```

```
Kidneys: <kidneys_findings>
```

```
IMPRESSION:
```

```
- <item_1>
```

```
- <item_2>
```

```
- <item_3>
```

```
- ...
```

```
```
```

Normal Report Template

US Upper Abdomen

Here is the example of normal report for "ultrasound of the upper abdomen (mini)" (in the ma

```markdown

**\*\*US OF THE UPPER ABDOMEN (MINI)\*\***

**\*\*FINDINGS:\*\***

**\*\*Liver:\*\*** Normal size and parenchymal echogenicity. No focal lesion.

**\*\*Gallbladder:\*\*** Well-distended gallbladder. No stone or mass.

**\*\*Kidneys:\*\*** Normal size and parenchymal echogenicity of both kidneys. No stone, hydronephros

**\*\*IMPRESSION:\*\***

- Normal liver parenchyma without focal lesion.

```

Abnormal Report Template

Provided below are documents of abnormal findings and corresponding impression that you need

liver:

Fatty Liver

Mild Fatty Liver

```markdown

**\*\*Liver:\*\*** Normal size with mildly increased parenchymal echogenicity of the liver. No focal

**\*\*IMPRESSION:\*\***

- Mild fatty liver without focal lesion.

```

Moderate Fatty Liver

```markdown

**\*\*Liver:\*\*** Normal size with diffusely increased parenchymal echogenicity of the liver, causin

**\*\*IMPRESSION:\*\***

- Moderate fatty liver without focal lesion.

```

Severe Fatty Liver

```markdown

**\*\*Liver:\*\*** Normal size with diffusely increased parenchymal echogenicity of the liver, causin

```

IMPRESSION:
- Severe fatty liver without focal lesion.
...

Focal Fat Sparing
If focal fat sparing area is present, add the following line in the `liver` field after the
```markdown
**Liver:** <fatty_liver_findings>. Geographic hypoechoic areas `[at | adjacent to]` `[peripor
**IMPRESSION:**
- <fatty_liver_impression> with focal fat sparing at <focal_fat_sparing_location>
...

Example:
```markdown
Liver: Normal size with mildly increased parenchymal echogenicity of the liver. Geograph
IMPRESSION:
- Severe fatty liver with focal fat sparing at periportal region.
...

Liver Abnormal Findings
Parenchymatous Liver Disease
```markdown
**Liver:** Normal size and (mildly) `[increased | coarse]` parenchymal echogenicity. No focal
**IMPRESSION:**
- (Mild) parenchymatous disease of the liver without focal lesion.
...

### Cirrhosis
```markdown
Liver: `[Normal size | Enlarged caudate lobe]` with diffusely coarsen parenchymal echogen
Spleen: `[Normal in size | Spleenomegaly]`.
IMPRESSION:
- Liver cirrhosis without focal lesion.
...

kidney:
Renal Stone
```markdown
**Kidneys:** Normal size and parenchymal echogenicity of both kidneys. <quantifier> non-obst
**IMPRESSION:**
- <quantifier> non-obstructing caliceal stone(s) at `[right | left | both]` kidney(s)
...

Examples:
```markdown
Kidneys: Normal size and parenchymal echogenicity of both kidneys. A few non-obstructing

```

```

IMPRESSION:
- A few non-obstructing caliceal stones at right kidney.
...

Kidney Findings
Order findings as:
1. Kidney size and echogenicity
2. (If any) Renal cyst(s)
3. (If any) Renal stone, hydronephrosis, or solid mass.
```markdown
**Kidneys:** <kidney_size_echo>. <renal_cyst>. <renal_stone_hydro_solid_mass>.
...

### Renal Cortical Cyst(s)
Here is how to report renal cortical cyst according to Bosniak classification system.
#### Bosniak 1 (Simple Cyst)
Use this phase: "simple cortical cyst(s)" with <quantifier> as described in the english style
```markdown
Kidneys: Normal size and parenchymal echogenicity of both kidneys. <quantifier> simple c
IMPRESSION:
- <quantifier> simple `[right | left | bilateral]` cyst(s)
...

Examples:
```markdown
**Kidneys:** Normal size and parenchymal echogenicity of both kidneys. A 0.5-cm simple corti
**IMPRESSION:**
- A 0.5-cm simple right renal cyst.
...

```markdown
Kidneys: Normal size and parenchymal echogenicity of both kidneys. A few simple cortical
IMPRESSION:
- A few simple bilateral renal cysts, measuring up to 2.0 cm.
...

gallbladder:
Gallstone(s)
```markdown
**Gallbladder:** Distended gallbladder containing `[a ?-cm | a few | many ]` gallstone(s), (
**IMPRESSION:**
- `[a ?-cm | a few | many ]` gallstone(s) without evidence of cholecystitis
...

# Gallbladder Abnormal Findings

```

Order findings as:

1. Gallbladder distension
2. Gallbladder adenomyomatosis
3. Gallstone or bile sludge

```markdown

**\*\*Gallbladder:\*\*** <gallbladder\_distend>. <gallbladder\_adeno>. <gallbladder\_stone\_or\_sludge>.  
...

### Bile sludge

```markdown

****Gallbladder:**** Distended gallbladder containing bile sludge. No gallbladder wall thickening

****IMPRESSION:****

- Bile sludge in gallbladder without evidence of cholecystitis

```

User input: {user}

Output:

```
from langchain_core.prompts import ChatPromptTemplate
from langchain_core.messages import HumanMessage

prompt_temp = ChatPromptTemplate.from_template(prompt)
prompt_temp
```

ChatPromptTemplate(input\_variables=['user'], messages=[HumanMessagePromptTemplate(prompt=Prom

```
pr_val_1 = prompt_temp.invoke({
 # "abnormal_gallbladder": "...",
 # "abnormal_kidney": "...",
 # "abnormal_liver": "...",
 # "input_findings": findings1.to_dict(),
 "user": [HumanMessage(content="hi!")]})

pr_val_1
```

ChatPromptValue(messages=[HumanMessage(content='You are a radiology report writer in my inst.

## 5 Chaining Workflow

```
from langchain_openai import ChatOpenAI, OpenAIEmbeddings
from us_report_ext import (get_findings,
 load_split_md_docs,
 get_chroma_retrievers,
 retrieve_abnormal_docs,
 get_prompt_template)

from us_report_ext._utils import read_markdown
```

```
llm_main = ChatOpenAI(model="gpt-3.5-turbo") # Main LLM for Prompt
llm_input = ChatOpenAI(model="gpt-3.5-turbo") # LLM for instruct input
embedding = OpenAIEmbeddings() # Chroma Embedding
```

### 5.1 User Input

```
User Text to Extract
user_text1 = """Generate US report with these findings:
- Mild fatty liver
- 2-mm left renal stone, 5-mm right renal cyst
- A 3-mm gallstone
"""

findings1 = get_findings(input_text=user_text1, llm = llm_input)
findings1
```

```
Findings(abnormal_liver=[Liver(finding='Mild fatty liver')], abnormal_kidney=[Kidney(finding=
```



## 5.2 Abnormal Docs

```
md_header_splits_dict = load_split_md_docs("abnormal")
retriever_dict = get_chroma_retrievers(md_header_splits_dict, embedding= embedding)

abn_doc_dict1 = retrieve_abnormal_docs(retriever_dict, findings1)
abn_doc_dict1
```

```
{'abnormal_kidney': [Document(page_content='### Renal Stone \n```markdown\n**Kidneys:** Normal
Document(page_content='### Renal Cortical Cyst(s) \nHere is how to report renal cortical c
'abnormal_liver': [Document(page_content='### Fatty Liver \n#### Mild Fatty Liver \n```ma
'abnormal_gallbladder': [Document(page_content='### Gallstone(s) \n```markdown\n**Gallblad
```

## 5.3 Prompt

```
prompt_temp1 = get_prompt_template(abn_doc_dict1)
```

## 5.4 Chain

### 5.4.1 Final Wrapper: generate\_report()

```
from langchain_core.runnables import RunnablePassthrough
from langchain_core.output_parsers import StrOutputParser

def generate_report(user_input: str,
 llm_main = ChatOpenAI(model="gpt-3.5-turbo"), # Main LLM for Prompt
 llm_input = ChatOpenAI(model="gpt-3.5-turbo"), # LLM for instruct input
 embedding = OpenAIEmbeddings(),
) -> str:
 # Get findings
 findings = get_findings(input_text=user_input, llm = llm_input)
 # Dict of Markdown Splits
 md_header_splits_dict = load_split_md_docs("abnormal")
 # Dict of retrievers
```

```

retriever_dict = get_chroma_retrievers(md_header_splits_dict, embedding= embedding)
Dict of Abnormal Docs
abn_doc_dict = retrieve_abnormal_docs(retriever_dict, findings)
Prompt Template
prompt_temp = get_prompt_template(abn_doc_dict)

rag_chain = (
 {"user": RunnablePassthrough()} |
 prompt_temp |
 llm_main |
 StrOutputParser()
)

report = rag_chain.invoke(user_input)
return report

```

## 5.5 Execute

```

report1 = generate_report("Generate normal US report")
print(report1)

```

**\*\*US OF THE UPPER ABDOMEN (MINI)\*\***

**\*\*FINDINGS:\*\***

**\*\*Liver:\*\*** Normal size and parenchymal echogenicity. No focal lesion.

**\*\*Gallbladder:\*\*** Well-distended gallbladder. No stone or mass.

**\*\*Kidneys:\*\*** Normal size and parenchymal echogenicity of both kidneys. No stone, hydronephrosis.

**\*\*IMPRESSION:\*\***

- Normal liver parenchyma without focal lesion.

```
User Text to Extract
```

```
user_text2 = """Generate US report with these findings:
```

```
- Mild fatty liver
```

```
- 6-mm left renal stone, 5-mm right renal cyst
```

```
"""
```

```
report2 = generate_report(user_text2)
print(report2)
```

**\*\*US OF THE UPPER ABDOMEN\*\***

**\*\*FINDINGS:\*\***

**\*\*Liver:\*\*** Normal size with mildly increased parenchymal echogenicity of the liver. No focal

**\*\*Gallbladder:\*\*** Well-distended gallbladder. No stone or mass.

**\*\*Kidneys:\*\*** Normal size and parenchymal echogenicity of both kidneys. A 6-mm non-obstructing

**\*\*IMPRESSION:\*\***

- Mild fatty liver without focal lesion.

- A 6-mm non-obstructing caliceal stone at left kidney.

- A 5-mm simple right renal cyst.

```
User Text to Extract
```

```
user_text3 = """Generate US report with these findings:
```

```
- Severe fatty liver
```

```
- 6-mm left renal stone, 5-mm right renal cyst
```

```
- 2-cm gallstone
```

```
"""
```

```
report3 = generate_report(user_text3)
```

```
print(report3)
```

**\*\*US OF THE UPPER ABDOMEN\*\***

**\*\*FINDINGS:\*\***

**\*\*Liver:\*\*** Normal size with diffusely increased parenchymal echogenicity of the liver, causing

**\*\*Gallbladder:\*\*** Distended gallbladder containing a 2-cm gallstone. No gallbladder wall thickening

**\*\*Kidneys:\*\*** Normal size and parenchymal echogenicity of both kidneys. A 6-mm non-obstructing

**\*\*IMPRESSION:\*\***

- Severe fatty liver without focal lesion.

- A 6-mm non-obstructing caliceal stone at left kidney.

- A few simple right renal cysts, measuring up to 5 mm.

- A 2-cm gallstone without evidence of cholecystitis.