Information Retrieval Models

This project implements three information retrieval models: Probabilistic Retrieval Model, Non-Overlapped List Model, and Proximal Nodes Model. The project is built using Django and includes preprocessing, document scoring, and retrieval functionalities.

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Installation

1. Clone the repository:

   ```
   git clone https://github.com/KhadimHussainDev/Ir-retrieval-models
   cd Ir-retrieval-models
   ```

2. Install the required packages:

   ```
   pip install -r requirements.txt
   ```

3. Apply migrations:

   ```
   python manage.py migrate
   ```

4. Run the development server:

   ```
   python manage.py runserver
   ```

Usage

Navigate to `http://127.0.0.1:8000/retrieval` in your web browser to access the search interface. You can use the following endpoints:

- `/search/` for Probabilistic Retrieval Model
- `/search_non_overlap/` for Non-Overlapped List Model
- `/search_proximal_nodes/` for Proximal Nodes Model

Models

Probabilistic Retrieval Model

The Probabilistic Retrieval Model uses the Binary Independence Model (BIM) to score and rank documents based on their relevance to the query.

Non-Overlapped List Model

The Non-Overlapped List Model retrieves documents that contain either of the specified terms without overlapping results.

Proximal Nodes Model

The Proximal Nodes Model retrieves documents that are connected to specified proximal nodes in a network graph.

Code Explanation

Views

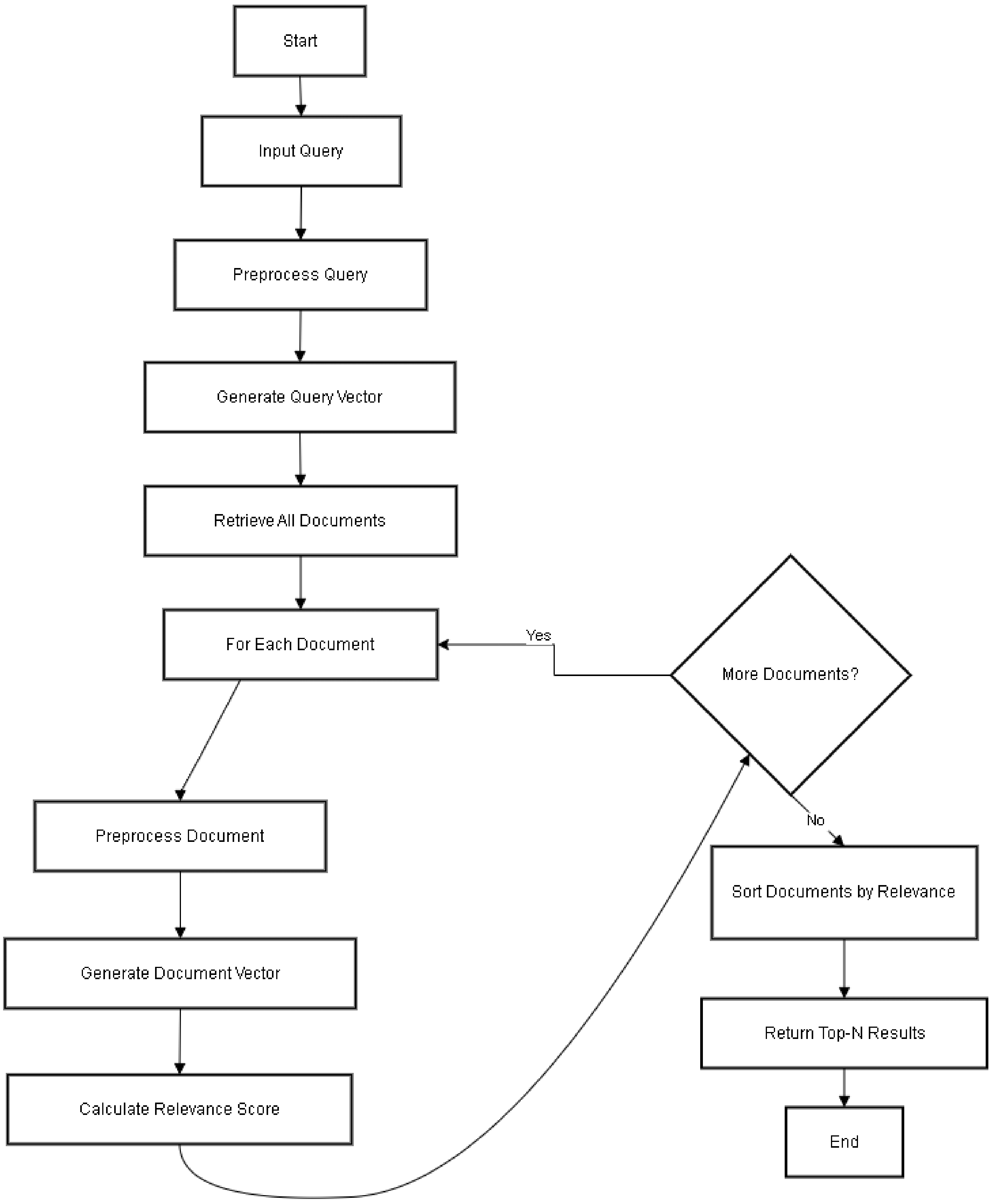
The `views.py` file contains the main logic for handling search requests and rendering results.

Probabilistic Retrieval Model

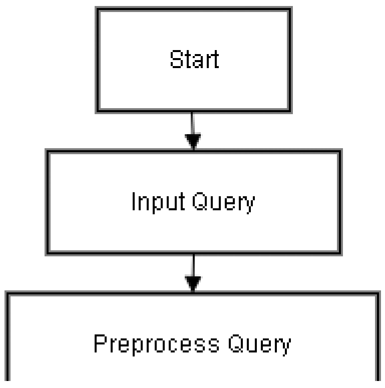
```
def search_documents(request):
    query = request.GET.get('query', '')
    results = []
    if query:
        query_terms = preprocess_text(query)
        all_terms = list(set(term for doc in Document.objects.all() for term in
preprocess_text(doc.content)))
        query_vector = create_binary_vector(query_terms, all_terms)

        for doc in Document.objects.all():
            doc_vector = create_binary_vector(preprocess_text(doc.content),
all_terms)
            score = np.dot(query_vector, doc_vector) /
(np.linalg.norm(query_vector) * np.linalg.norm(doc_vector))
            results.append({'document': doc, 'score': score})

        results = sorted(results, key=lambda x: x['score'], reverse=True)[:5]
    return render(request, 'retrieval/search.html', {'query': query, 'results':
results})
```

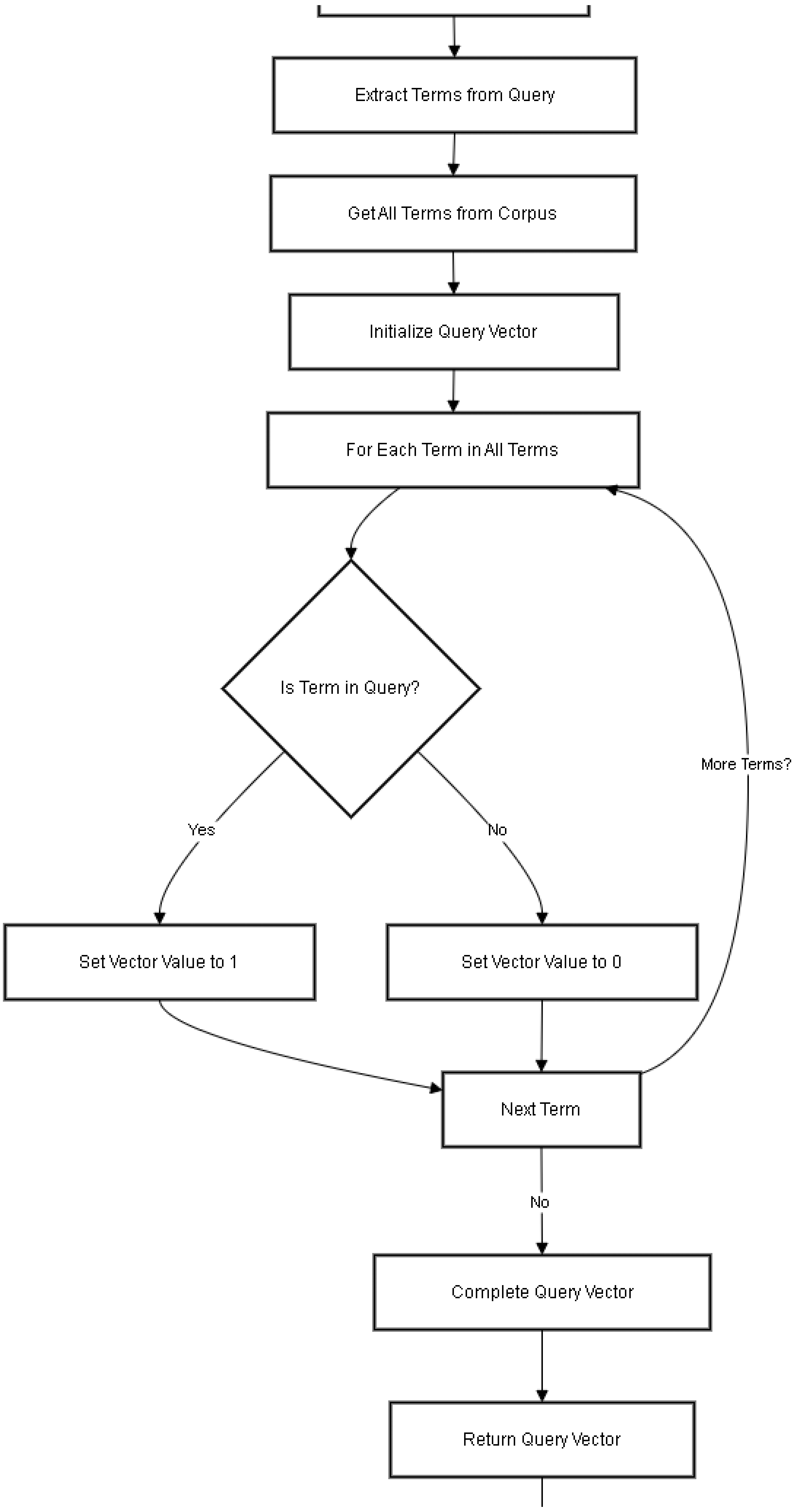
Explanation:

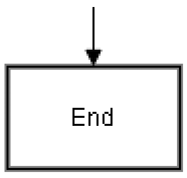
- `query = request.GET.get('query', '')`: Retrieves the search query from the request.
- `query_terms = preprocess_text(query)`: Preprocesses the query to extract terms.
- `all_terms = list(set(term for doc in Document.objects.all() for term in preprocess_text(doc.content)))`: Collects all unique terms from the document collection.
- `query_vector = create_binary_vector(query_terms, all_terms)`: Creates a binary vector for the query.
- The loop iterates over all documents, creating a binary vector for each document and calculating the similarity score using the dot product and cosine similarity.
- `results = sorted(results, key=lambda x: x['score'], reverse=True)[:5]`: Sorts the results by score and selects the top 5.
- `return render(request, 'retrieval/search.html', {'query': query, 'results': results})`: Renders the search results.



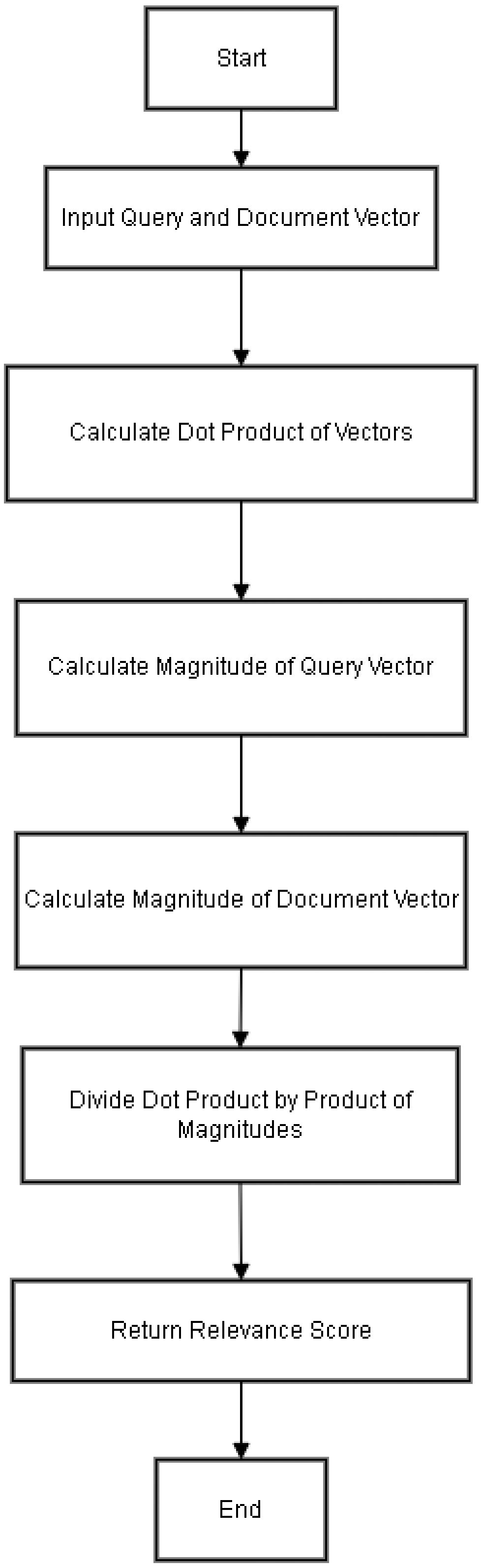
`Generating Query Vector`




Extract Terms from Query
Get All Terms from Corpus
Initialize Query Vector
For Each Term in All Terms
Is Term in Query?
Yes
No
Set Vector Value to 1
Set Vector Value to 0
More Terms?
Next Term
No
Complete Query Vector
Return Query Vector



`Calculating Relevance Score`

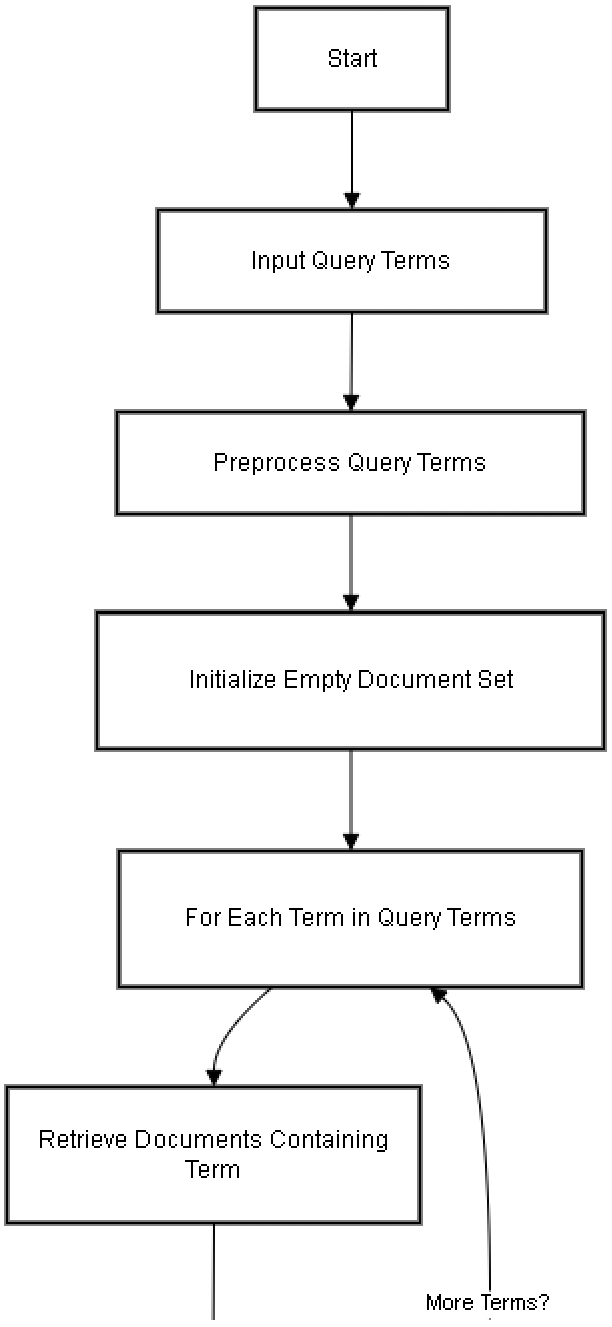

Start
Input Query and Document Vector
Calculate Dot Product of Vectors
Calculate Magnitude of Query Vector
Calculate Magnitude of Document Vector
Divide Dot Product by Product of Magnitudes
Return Relevance Score
End

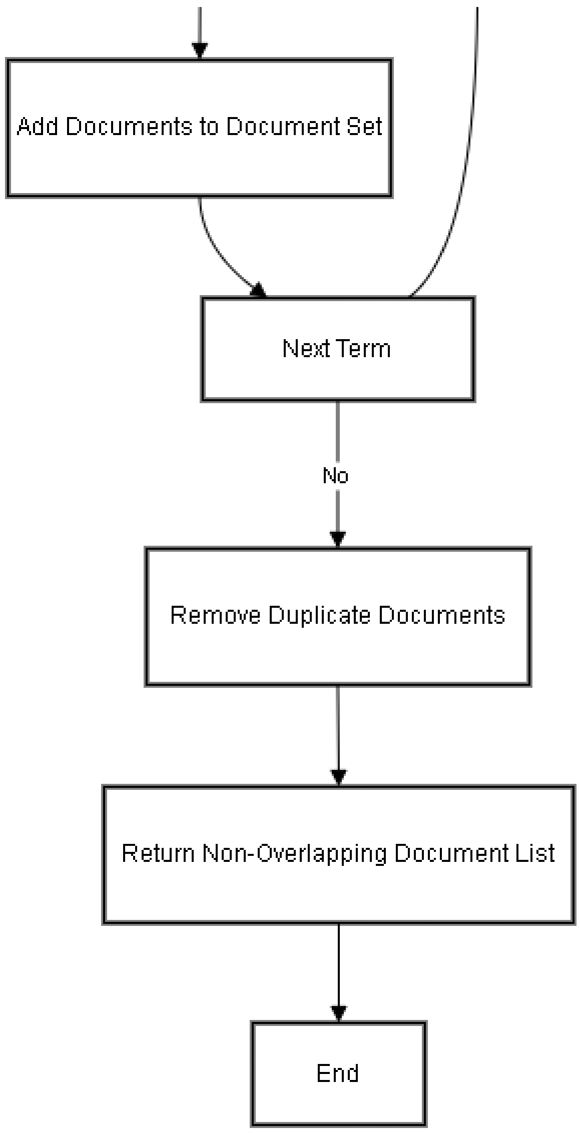
Non-Overlapped List Model

```
def search_non_overlapping_documents(request):
    query = request.GET.get('query', '')
    results = []
    if query:
        terms = preprocess_text(query)
        results = get_non_overlapping_documents(terms)

    return render(request, 'retrieval/search_non_overlap.html', {'query': query,
'results': results})
```

Explanation:

- `query = request.GET.get('query', '')`: Retrieves the search query from the request.
- `terms = preprocess_text(query)`: Preprocesses the query to extract terms.
- `results = get_non_overlapping_documents(terms)`: Retrieves documents that contain any of the terms without overlapping results.
- `return render(request, 'retrieval/search_non_overlap.html', {'query': query,`


Start
Input Query Terms
Preprocess Query Terms
Initialize Empty Document Set
For Each Term in Query Terms
Retrieve Documents Containing Term
More Terms?


Add Documents to Document Set
Next Term
No
Remove Duplicate Documents
Return Non-Overlapping Document List
End

`'results': results})`: Renders the search results.

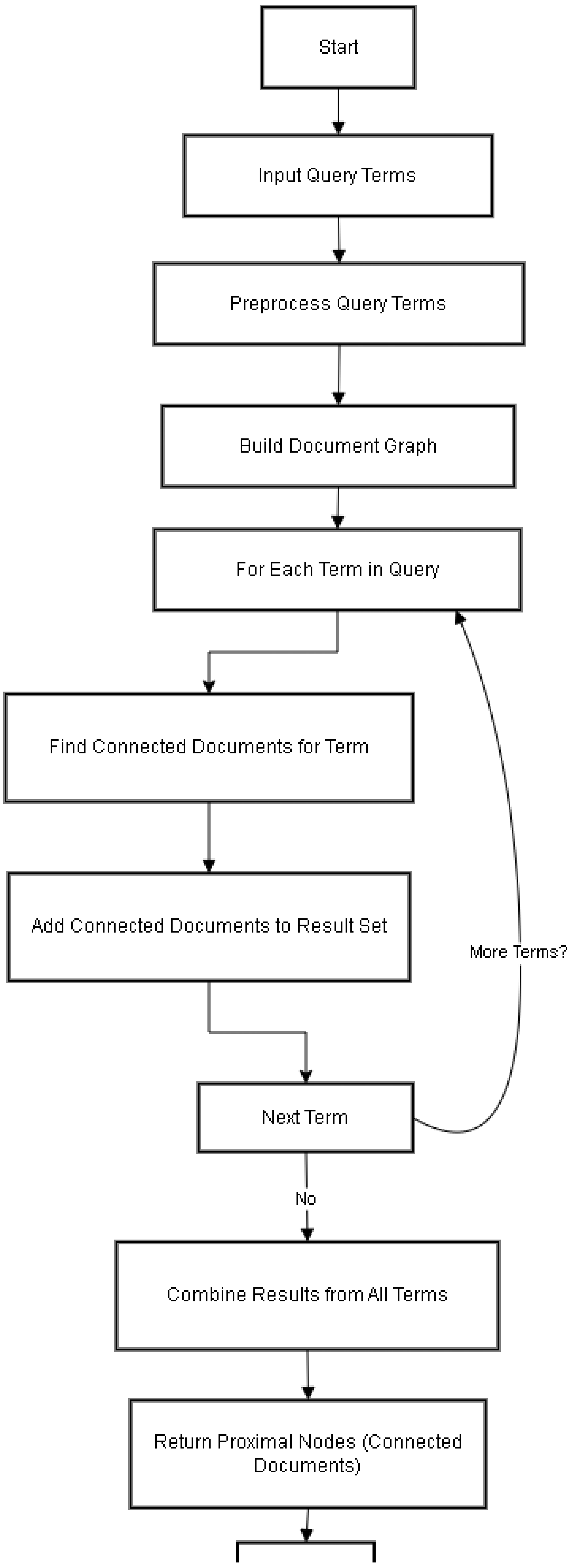
Proximal Nodes Model

```
def search_proximal_nodes(request):
    query = request.GET.get('query', '')
    results = []
    if query:
        preprocess_and_build_graph()
        terms = preprocess_text(query)
        results = document_graph.get_connected_documents(terms)

    return render(request, 'retrieval/search_proximal_nodes.html', {'query':
query, 'results': results})
```

Explanation:

- `query = request.GET.get('query', '')`: Retrieves the search query from the request.
- `preprocess_and_build_graph()`: Builds or updates the document graph.
- `terms = preprocess_text(query)`: Preprocesses the query to extract terms.
- `results = document_graph.get_connected_documents(terms)`: Retrieves documents connected to the query terms in the graph.

- `return render(request, 'retrieval/search_proximal_nodes.html', {'query': query, 'results': results})`: Renders the search results.


Start
Input Query Terms
Preprocess Query Terms
Build Document Graph
For Each Term in Query
Find Connected Documents for Term
Add Connected Documents to Result Set
More Terms?
Next Term
No
Combine Results from All Terms
Return Proximal Nodes (Connected Documents)

Utils

The `utils.py` file contains helper functions for preprocessing text, creating binary vectors, and building the document graph.

Preprocessing Text

```python
def preprocess_text(text):
    words = re.findall(r'\b\w+\b', text.lower())
    stop_words = set(stopwords.words('english'))
    words = [word for word in words if word not in stop_words]
    stemmer = PorterStemmer()
    words = [stemmer.stem(word) for word in words]
    return words
```

Explanation:

- `words = re.findall(r'\b\w+\b', text.lower())`: Tokenizes the text into words.
- `stop_words = set(stopwords.words('english'))`: Retrieves a set of English stop words.
- `words = [word for word in words if word not in stop_words]`: Removes stop words from the tokenized words.
- `stemmer = PorterStemmer()`: Initializes a Porter stemmer.
- `words = [stemmer.stem(word) for word in words]`: Applies stemming to the words.
- `return words`: Returns the preprocessed words.

Creating Binary Vectors

```python
def create_binary_vector(doc_terms, all_terms):
    return [1 if term in doc_terms else 0 for term in all_terms]
```

Explanation:

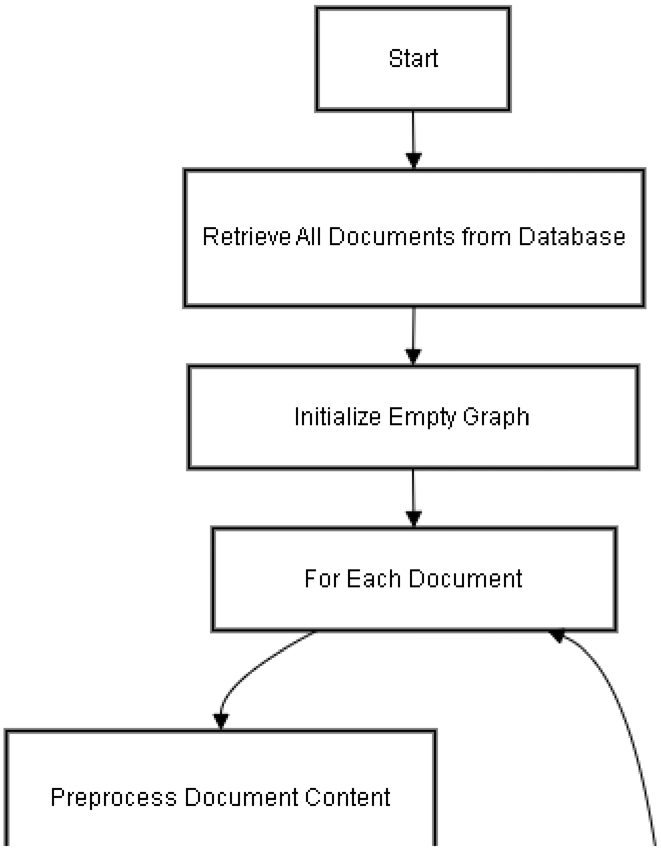
- `return [1 if term in doc_terms else 0 for term in all_terms]`: Creates a binary vector where each element is 1 if the term is present in the document terms, otherwise 0.

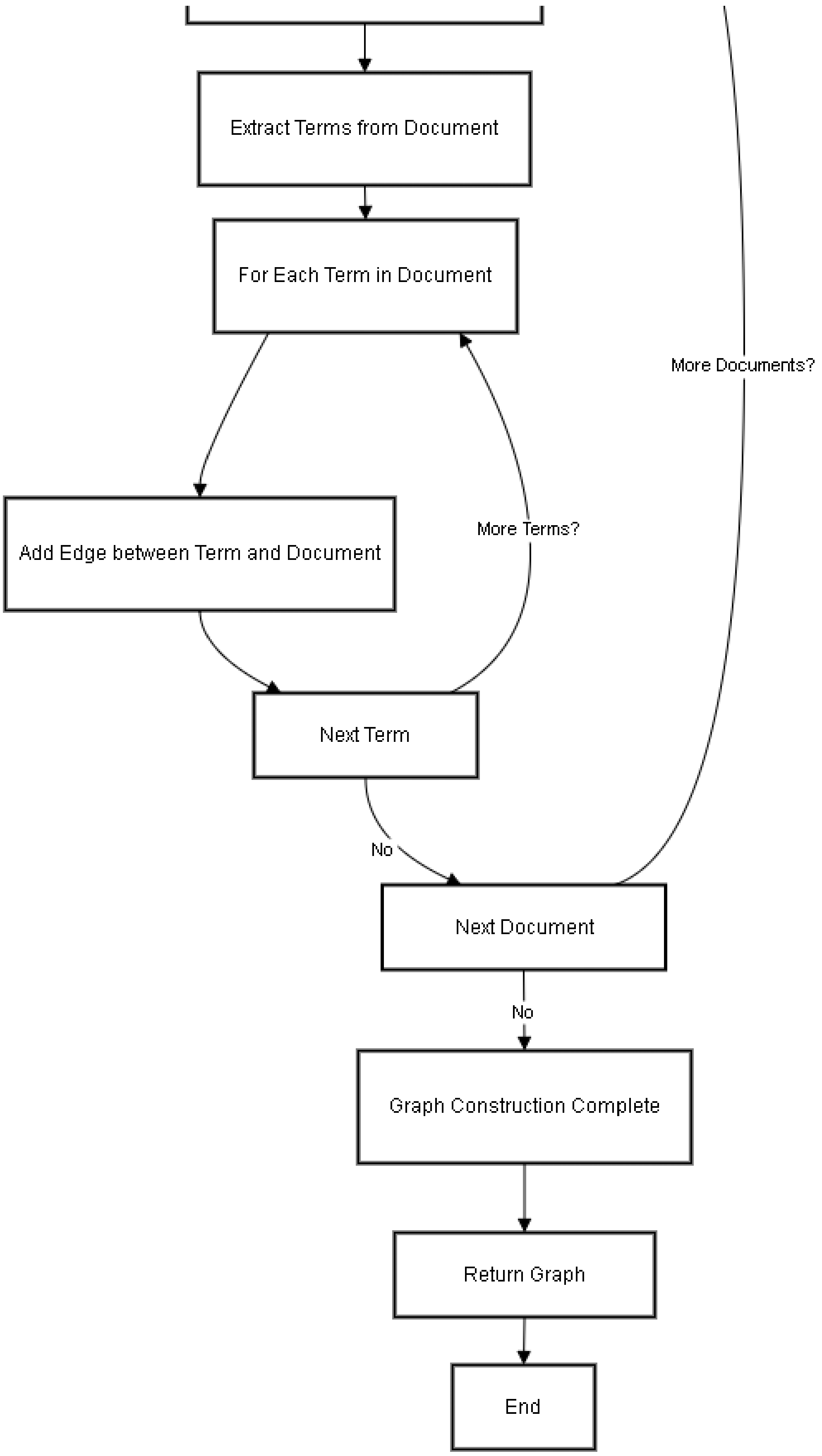
Building Document Graph

```python
class DocumentGraph:
    def __init__(self):
        self.graph = defaultdict(list)

    def add_edge(self, term, document):
        self.graph[term].append(document)
    def get_connected_documents(self, terms):
        connected_documents = set()
        for term in terms:
            if term in self.graph:
                connected_documents.update(self.graph[term])
        return list(connected_documents)

document_graph = DocumentGraph()
is_graph_built = False

def preprocess_and_build_graph():
    global is_graph_built
    if not is_graph_built:
        document_graph.graph.clear()
        for doc in Document.objects.all():
            content_terms = preprocess_text(doc.content)
            for term in content_terms:
                document_graph.add_edge(term, doc)
        is_graph_built = True
```

Explanation:

- `class DocumentGraph`: Defines a class for the document graph.
- `self.graph = defaultdict(list)`: Initializes the graph as a defaultdict of lists.
- `def add_edge(self, term, document)`: Adds an edge between a term and a document.
- `def get_connected_documents(self, terms)`: Retrieves documents connected to the given terms.
- `document_graph = DocumentGraph()`: Creates a global instance of the document graph.
- `is_graph_built = False`: Initializes a flag to check if the graph is built.
- `def preprocess_and_build_graph()`: Preprocesses documents and builds the graph if it is not


Start
Retrieve All Documents from Database
Initialize Empty Graph
For Each Document
Preprocess Document Content


Extract Terms from Document
For Each Term in Document
Add Edge between Term and Document
More Terms?
More Documents?
Next Term
No
Next Document
No
Graph Construction Complete
Return Graph
End

already built.

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