

## **Introduction:**

Retrieval-Augmented Generation (RAG) offers exciting possibilities for legal tasks like document summarization and case brief generation. However, current RAG systems can suffer from "hallucinations" when applied to legal documents. This assignment focuses on mitigating hallucinations and ensuring accurate and reliable legal information extraction.

## **Part 1: Sample Legal Document and Hallucinating RAG Model**

The document below details a lawsuit regarding a religious organization's tax-exempt status:

### **Document:**

**Case Name:** Church of Hope v. Internal Revenue Service (D.C. Md. 2023)

- The Church of Hope (Plaintiff), a religious organization, seeks to maintain its tax-exempt status.
- The IRS (Defendant) argues the Church engages in substantial commercial activities, disqualifying it from tax exemption.
- The Church claims its activities (e.g., bookstore, bakery) are primarily religious in nature, furthering its spiritual mission.

### **Citations (Ground Truth):**

1. IRC § 501(c)(3) (Internal Revenue Code - Defines religious organizations)
2. Bob Jones University v. Simon (472 U.S. 509 (1983)) (Landmark case on religious freedom and tax exemption)
3. Reynolds v. United States (98 F.3d 1127 (9th Cir. 1996)) (Case on commercial activity and tax-exempt status)
4. Eastern Montana College of Education v. Helena (924 F.2d 1322 (9th Cir. 1991)) (Case on substantial vs. incidental commercial activity)
5. Glock v. Commissioner (79 T.C. 449 (1982)) (Case on religious organizations engaging in commercial activities)
6. Speakman v. Commissioner (823 F.2d 1168 (6th Cir. 1987)) (Case on ancillary commercial activities for religious purposes)
7. Murdoch v. Commissioner (704 F.2d 1002 (9th Cir. 1983)) (Case on defining "religious purpose" for tax exemption)
8. Texas Heart Hospital of St. Luke's Episcopal Health Charities, Inc. v. United States (978 F.2d 280 (5th Cir. 1992)) (Case on religious hospitals and tax exemption)
9. United States v. The Sanctuary (49 F.3d 572 (9th Cir. 1995)) (Case on religious organizations providing social services)
10. Hermitage Ministries, Inc. v. Commissioner (73 T.C. 1106 (1979)) (Case on religious organizations and fundraising activities)

### **Sample Hallucinating RAG Algorithm:**

This simplified algorithm demonstrates hallucinations. A real RAG system would be more complex.

## Python

```
def find_citations(text):  
    citations = []  
    keywords = ["religious", "tax-exempt", "IRS", "commercial activity"]  
    for sentence in text.split("."):   
        if any(keyword in sentence.lower() for keyword in keywords):  
            citations.append(sentence) # <-- This line hallucinates  
    return citations
```

This algorithm identifies any sentence containing keywords related to the case topic, capturing irrelevant details and potentially missing actual citations.

## Part 2: Fixing Hallucinations

Your task is to improve the RAG algorithm by addressing hallucinations. Consider these approaches as non-binding suggestions, or feel free to devise new or use other algorithms:

1. **Named Entity Recognition (NER):** Utilize NER to identify legal entities like codes, case names, and court jurisdictions within sentences. This helps differentiate between legal citations and general discussions of religious activities and taxes.
2. **Regular Expressions:** Refine search criteria with regular expressions targeting specific citation formats (e.g., legal codes with section numbers, case names with year and court).
3. **Entity Linking:** Link recognized legal entities to external knowledge bases (e.g., legal databases) to confirm their validity as citations within the context of the document.
4. **Contextual Understanding:** Incorporate contextual information like sentence proximity to relevant keywords and legal terms. This helps distinguish between actual citations and irrelevant mentions of the keywords.

## Part 3: Evaluation

Evaluate your improved RAG system using metrics like precision, recall, and F1 score to measure how effectively it identifies relevant citations. You can create a larger dataset of legal documents with annotated citations. Additionally, consider human evaluation before you submit the assignment.