Organized Thesis Ideas

Here are the organized and refined thesis ideas based on existing notes:

1. Attention Mechanisms and Information Retrieval

- **Rectangular Attention for Triples:** Explore using rectangular attention to focus transformer models on specific "triples" within a sequence, ensuring that the triples themselves are not self-attending and the rest of the context is also considered. This concept builds upon rectangular attention.
- **Attention with Subdivisions and Matching:** Develop a project that combines the attention idea with matching techniques, potentially similar to those used in RetroLLM. This could involve subdividing text and creating triples (fact -> citation, and other combinations). The idea also extends to quantifying counterfactuals to measure credit for past actions, leading to more effective policy gradient methods for limited data.
- **Efficient Search with Data Structures:** Investigate the use of the Burrows–Wheeler transform and FM-index for efficient citation generation and context matching within the model. Additionally, explore the Wavelet Tree for efficient search operations.

2. Large Language Models (LLMs) and Agent-Based Systems

- **LLMs as Meta-Agents:** Propose a system where LLMs act as meta-agents, responsible for creating plans, scheduling actions, and either executing them or delegating tasks to other LLMs. This aligns with the concept of meta agent.
- **LLM Workflow for Explanations:** Design an LLM-driven workflow that integrates Manim for visualizations and Speech synthesis for audio, to generate comprehensive explanations. This forms the basis of a manim agent.
- **Structured Input Formats:** Define an input format for LLMs where content is primarily media (audio, PDF, images) with accompanying text at the end. This is crucial for input format.
- **Framework for Thesis Development:** Establish a "smarter to smaller" framework for thesis development, focusing on high-level "vibe coding" and then detailing specific instructions and relations, avoiding over-complication in smaller steps. This is outlined in framework thss.
- **Guides as Consistent Scratchpads:** Implement the concept of creating guide files that function as consistent scratchpads for intermediate computations with language models, inspired by Show Your Work: Scratchpads for Intermediate Computation with Language Models.
- **Digital Twins for Intelligent Agents:** Explore the use of digital twins to provide intelligent agents with a mechanism for verifying information and actions, as seen in small rooms.
- **Agent Research Workflow:** Define a precise two-step workflow for agent research:
  1. **Accurate Factual Extraction:** Utilizing methods like Claimify (as seen in metropolitanskyEffectiveExtractionEvaluation2025), ensure precise factual extraction.
  2. **Consistent Idea Entailing:** Employ techniques like Chain of Thought from Prompt engineering for coherent idea development. This is a core part of research agents workflow idea.
- **Report Writer Agent:** Develop an agent that can generate text in markdown files within Obsidian and automatically cite sources, functioning as a report writer.
- **Query and Workflow Agent:** Implement a workflow where a model first generates a plan to identify relevant text and relational information from semi-structured data, and then an LLM agent traverses this data to extract the necessary information. This is the basis for a query and workflow idea.

3. Multimodal LLMs and Spatial Understanding

- **Spatial Understanding with Gaussian Splatting:** Investigate the integration of Gaussian splatting within Large language models to facilitate a form of spatial understanding. This is a key aspect of spatial understanding.
- **Native Image Generation from PDFs:** Explore the use of Gemini's Native Image Generation capabilities to extract and include images from PDF documents into Surveys. This concept is explored in figures gemini.