UTSA CS 4593: CS-CURE

Course-based Undergraduate Research Experience in CS

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Week 5: **Literature Review**

UTSA CS-CURE

Week 5

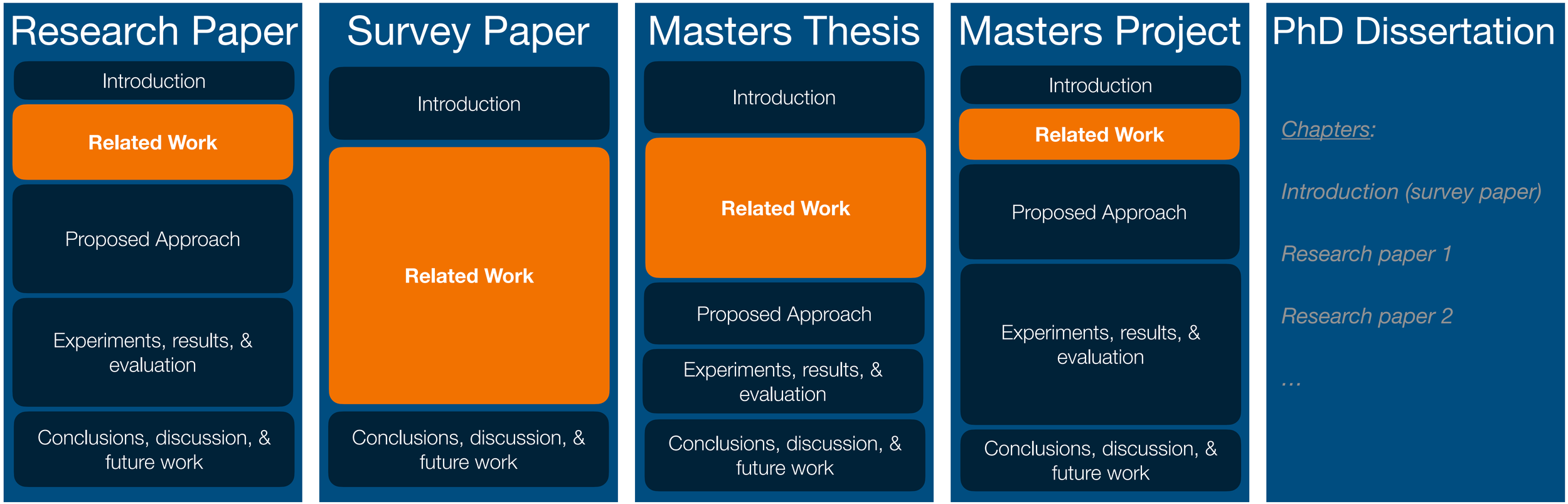
- Objectives:
    - Practice strategies for efficiently finding & summarizing relevant literature
    - Leverage tools to facilitate, organize, & guide your research

- Deliverables:
    - Activity 4: Effective Literature Reviews (in-class Thursday)
    - SIG Meeting 1: Literature in Your Field (in-class Thursday)

Literature Reviews

Literature Reviews

literature review = a survey of credible sources on a topic.



Literature reviews differ across disciplines

CS vs. other fields

- Emphasis on **technical details and methodologies** in CS.
- Greater use of specialized **technical terms** and citations.
- Importance of evaluating algorithms, models, and software **implementations**.
- Focus on **quantitative** analysis and evidence-based arguments.
- Peer-reviewed sources are more inclusive of **conferences & workshops**.

Characteristics of a good literature review

Guidelines for discussing SOTA

- **Focused & relevant**: *Narrow scope aligned with your research question and avoid tangential topics.*
- **Comprehensive**: *Cover key publications and seminal works (avoiding cherry-picking).*
- **Critical analysis**: *Don't just summarize! Evaluate methods, results, and contributions.*
- **Organized & well-structured**: *Logical flow, clear transitions, and proper citations. Group by strategy!*
- **Credible sources**: *Utilize peer-reviewed publications, reputable conferences, and relevant research platforms.*

Common pitfalls

Lit reviews

- **Superficiality**: *Avoid summaries without critical analysis or insights.*
- **Lack of context**: *Frame research within larger field and existing knowledge gaps.*
- **Bias**: *Maintain objectivity and acknowledge limitations of existing research.*
- **Limited scope**: *Ensure comprehensive coverage of relevant literature*.
- **Improper referencing**: *Cite correctly and avoid plagiarism.*

Getting Started:
Literature Review

Tools for Automating Research

Reminders

- **Finding articles**
    - Google Scholar, Research Gate, IEEE Collabratec, ResearchRabbit, …
- **Organizing articles**
    - Zotero, Mendeley, Endnote, …
- **Writing & citing**
    - Overleaf + bibtex

Advanced Search Techniques

Reminders

- **Boolean operators**: use “AND", “OR”, "NOT" for more precise searching!
- **Citation chaining**: follow citations from relevant papers to find related work.
- **CS-specific peer-reviewed sources:**
    - ACM Digital Library
    - IEEE Xplore

Advanced Search Techniques

Large language models (LLMs)

Don't:

Find papers on the topic of X.

- Resources won't be peer-reviewed (unless specified)
- Most credible-looking citations are fake

Do:

I'm interested in topic X.

Can you summarize the latest approaches?

- Provides organized feedback
- Summarizes the concepts
- *Doesn't help find papers!*

Evaluating Research Quality

Lit reviews

- **Read all papers skeptically**!
- *Is the research well-supported?*
    - **Data collection and analysis:** Assess the quality of data collection and whether the analysis is appropriate and rigorous.
    - **Transparency and replicability:** Check if the research methods and data are clearly described, allowing for replication of the study.
- *Are there clear results and discussion?*
    - ***Evidence and support:*** *Are the findings well-supported by data and evidence presented in the research?*
    - ***Limitations and future work:*** *Acknowledge the study's limitations and identify potential areas for future research.*
    - ***Originality and contribution:*** *Does the research offer new insights, contribute to existing knowledge, or address unresolved questions?*

Writing Strategies

Structuring a literature review

- Doing a literature review is critical to ensure you are contributing to a field.
    - Writing a good summary of the SOTA is equally important!
- There are general structures you can follow to make it easier.
    - Use just one or layer multiple.
    - Example: **Chronological**

Best for..

Tracing historical development of a concept, understanding evolution of methodologies or theories.

Organization:

Order literature based on publication date, highlighting key advancements and shifts in focus over time.

Example Research:

How has the approach to natural language processing for sentiment analysis changed over time?

Writing Strategies

Structuring a literature review

- Structure: **Thematic**

Best for..

Identifying major themes, trends, or debates within a research area.

Organization:

Group literature around predefined themes (e.g., interpretability techniques, ethical considerations, comparison of different approaches).

Example Research:

What are the main challenges and proposed solutions for improving the explainability of deep learning models?

Writing Strategies

Structuring a literature review

- Structure: **Methodological**

Best for..

Comparing & contrasting different methodologies used in similar research areas.

Organization:

Group literature based on methodologies employed (e.g. specific AI/ML architectures, evaluation metrics, datasets used)

Example Research:

How do various convolutional neural network architectures differ in their effectiveness for image recognition tasks?

Writing Strategies

Structuring a literature review

- Structure: **Problem-solution**

Best for..

Exploring different solutions proposed to address a specific research problem.

Organization:

Organize literature around the problem, showcasing different proposed solutions & their evaluations.

Example Research:

What are the various approaches to mitigating bias in recommender systems?

Writing Strategies

Structuring a literature review

- Structure: **Comparison / Contrast**

Best for..

Critically evaluating similarities & differences between multiple existing concepts or methods.

Organization:

Analyze each approach separately, then directly compare & contrast their strengths, weaknesses, & suitability for different applications.

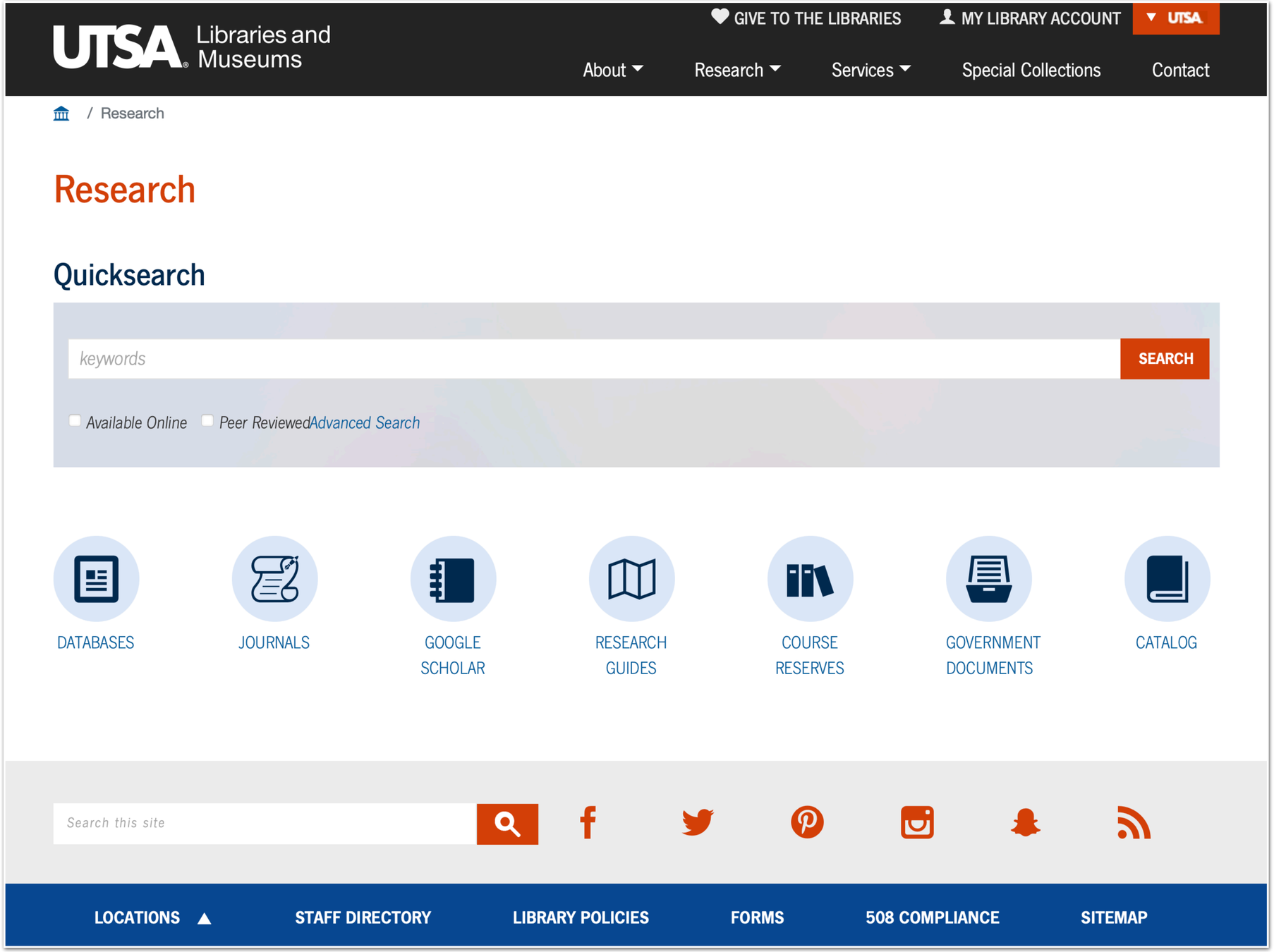
Example Research:

How do reinforcement learning & supervised learning approaches compare in their effectiveness for robotic manipulation tasks?

Writing Strategies

Avoiding plagiarism

- **plagiarism** = practice of taking someone else's work or ideas and passing them off as one's own.
    - *Paraphrasing counts!*
    - *Images/media count!*
    - *You can self-plagiarize, if you reuse your writing.*
- Tips:
    - **Always cite** any information you take from external sources, even if it's just for a single sentence or statistic.
    - **Use quotation marks** if using anything verbatim (*but this is largely discouraged in CS!)*
    - **Avoid AI or online "checkers"** - uploading your work to a company often means they now own it!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508 COMPLIANCE
SITEMAP

Beyond Traditional Reviews

Lit reviews

- **Grey literature** is a term for information produced outside of traditional publishing and distribution channels, like academic journals and commercial books.
    - Government agencies and departments**:** Reports, policy documents, technical manuals, white papers.
    - Non-governmental organizations (NGOs) and think tanks: Research reports, policy briefs, conference proceedings.
    - Academia**:** Working papers, dissertations, theses, conference presentations (not published in formal journals).
    - Industry**:** Market reports, technical reports, white papers, company publications.
    - Individual researchers and consultants: Blogs, websites, personal reports.

Beyond Traditional Reviews

Lit reviews

- A **systematic review** is a rigorous and structured approach to summarizing and evaluating existing research on a specific topic.
    - **Explicit research question:** *Clearly defined and focused on a specific issue.*
    - **Systematic search strategy:** *Extensive use of databases and search techniques to identify relevant studies.*
    - **Inclusion/exclusion criteria:** *Defined criteria for selecting studies based on specific characteristics (e.g., methodology, publication date).*
    - **Critical appraisal:** *Careful evaluation of the quality and potential biases of each included study.*
    - **Data synthesis:** *Summarizing and analyzing the findings of multiple studies in a transparent manner.*

Beyond Traditional Reviews

Lit reviews

- **meta-analysis** = a statistical technique used to combine the results of multiple studies addressing the same research question.

- Key steps:
  - **Standardizing data:** Ensuring data from different studies is comparable.
  - **Calculating effect sizes:** Quantifying the magnitude and direction of the observed effect in each study.
  - **Pooling data:** Combining effect sizes across studies using appropriate statistical methods.
  - **Analyzing heterogeneity:** Assessing whether the studies are similar enough to be pooled and addressing any inconsistencies.
  - **Presenting results:** Reporting the overall effect size and its confidence interval, along with potential limitations and sources of variability.

Collaborations & **Literature Review**

SIG Literature Review Collaborations

- Each **SIG** has a page on Canvas now (*Modules > SIGs)*

- Includes a link to a shared Overleaf document **for collaboration** on useful papers & discussions.
    - *Also good practice area for learning LaTeX & Bibtex!*
    - This **will not be a graded component** of the course, but will allow your instructor to provide resources (papers & info) useful to your projects and to your SIG in general.

Wrap-Up

Tuesday

- Practice strategies for efficiently finding & summarizing relevant literature
- Leverage tools to facilitate, organize, & guide your research

- To Do:
    - Activity 4: Effective Literature Reviews (in-class Thursday)
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    - **Review your proposal feedback** (on Canvas) - *message me before Thursday if not yet accepted!*

See you Thursday!

AI Applications

- Deep learning for early detection of illness in exotic birds
- Impacts and efficacy of deep learning for drug discovery
- How can we use deep learning for more efficient drug discovery?
- ?

AI Ethics & Fairness

- Ethical AI for autonomous driving
- Ethics of AI for CS Education
- ?
- ?

Cybersecurity (general)

- How can Digital Twins secure Cyber-Physical Systems?
- Physical security assurance of quantum systems
- Misinformation detection on social media
- Mitigating cyberattacks on medical devices

Cybersecurity (networks & systems)

- Blockchain solutions for improving the security of IoT devices
- Cybersecurity systems for protection of personal data
- ?
- ?

Algorithms & Quantum

- Quantum programming
- ?

Systems

- Lack of memory protection in unikernels
- Optimizing and validating secure memory allocation techniques
- ?

Computer Vision

- How can 3d reconstruction through a single image be implemented for spatial recognition and interfacing with augmented reality
- Improving bird eyes view for object detection in autonomous vehicles by fusing camera data with radar data
- Can existing consumer devices utilize gesture control through computer vision in situations where physical touch is not possible?
- VR HCI through haptics or visual feedback to improve immersion and reduce cybersickness

Data Science

- Predicting traffic congestion in urban areas
- Sentiment analysis
- Optimizing ML to minimize energy consumption with big data
- ?

SIG Meeting 1:
Literature in Your Field

SIG Meeting 1: Literature in Your Field

Identifying & defining the state-of-the-art (SOTA)

- Share your research question/problem with your SIG
- Identify collaboration opportunities
- Share early feedback & questions
- Brainstorm additional resources or search strategies within your field
- What kind of support can your instructor provide?

Activity 4:
Effective Literature Reviews

Activity 4: Effective Literature Reviews

Thorough & objective search through the state-of-the-art (SOTA)

- What are some of the types/categories of approaches to your research problem?
    - ***Literature review worksheet***

- What is your next step in conducting your literature review?

Activity 4: Literature Reviews

Category: _____

Characteristics: _____

_____

Relevant papers: _____

_____

_____

Category: _____

Characteristics: _____

_____

Relevant papers: _____

_____

_____

Research Problem

Category: _____

Characteristics: _____

_____

Relevant papers: _____

_____

_____

Category: _____

Characteristics: _____

_____

Relevant papers: _____

_____

_____

Instructions: Begin by writing your research problem in the center circle. Review the most relevant research paper to your problem (*you can use the one you identified in your approved research proposal!).* If the paper identifies categories of related approaches to the problem, write 1 in each box. If it does not categorize the approaches, look for how they differentiate their contribution from other existing work, then write their approach in 1 box and the other approaches in another box. Write the "relevant papers" down as "author-publisher-year" (e.g. Smith-AAAI-2023"). As you find additional papers, try to fit them into one of the boxes here, or add them to a new box if they represent a new category.

Wrap-Up

Thursday

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    - **Review your proposal feedback** (on Canvas) - *all proposals must be accepted this week!*

See you next week!