THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

Praxis Development for Artificial Intelligence

Professor Hamza F. Alsarhan

SEAS 8599 – DA2

Lecture 1

August 31, 2024

Agenda

1. Introductions – Instructor and Students
2. Course Overview
3. Praxis Structure
4. Scope of Work (SOW) Definition
5. Research Topic Selection
6. Assignment Structure Overview

Instructor Introduction

- Academic Background
  - D.Eng. in EM, GWU
  - MEM, Dartmouth College
  - BE, Computer Engineering, Dartmouth College
  - BA, Computer Science, Middlebury College
- Professional Background
  - Founder of an AI-based startup
  - VP of Customer Experience & Programs, Unirac
  - Director of Digital Lending, Global Lending Services
  - Financial Engineer, CMBS, Moody's Analytics
  - iOS Engineer, iDialogs

Student Introductions

As I call your name, please give a **1-minute introduction** including the following:

- Your most recent work experience
- Your academic experience
- Your background in AI
- A topic of interest for your praxis

Course Overview (1 of 6)

Syllabus for
SEAS 8599 – DA2
Praxis Development for AI
Fall-1 2024

Instructor: Hamza F. Alsarhan, D.Eng.
Email: hamzaalsarhan@gwu.edu
Credit Hours: 3 credit hours
Course Website: Blackboard
Class Time and Dates:

- Time: Saturdays 1:00 pm – 4:10 pm (Eastern)
- All Class Meeting Dates: Aug. 31; Sep. 7, 14, 21, 28; Oct. 5, 12, 19, 26; Nov. 2
- Attendance is normally expected at all sessions. If an absence from a class meeting is needed (due to family/medical or work-related emergency), students must contact the instructor in advance.
- Online classes are conducted via Zoom; Links are provided in Blackboard.
- Zoom link for office hours: gwu-edu.zoom.us/my/alsarhan

Office Hours:

- Every Sunday, 5:30 pm – 6:30 pm (Eastern)
- Every Wednesday, 6:00 pm – 8:00 pm (Eastern)

- Email works best for communication. Please include SEAS 8599 in your email subject.
- If you must skip a class, please communicate with me as soon as possible to discuss a plan for you to make up for the missed class.
- Office hours are for you to ask questions and seek help. No new material will be covered during office hours.

Course Overview (2 of 6)

Bulletin Description of the Course:

- Overview of research methods. Aims and purpose of the Praxis. Development of Praxis research strategies. Formulation and defense of a Praxis proposal. Restricted to Students in the D.Eng. in the field of artificial intelligence and machine learning program.

Course Learning Objectives:

Upon completing the course, students will know how to:

1. Develop research skills, such as choosing appropriate research methods and tools, collecting and analyzing data, and reporting findings.
2. Write a clear, concise, and well-structured problem statement and thesis statement.
3. Develop critical thinking skills to evaluate research literature and identify gaps in knowledge.
4. Create a research proposal that effectively communicates the research questions, research hypotheses, methodology, and expected results.

Textbooks and References:

No textbooks are required.

Average Amount of Out-of-Class or Independent Learning Expected per Week:

Over the 10-week semester, students meet with the instructor for at least 30 hours of guided instruction and are expected to spend about 80 hours researching and producing the report, for a total of about 130 hours of work for the semester.

- This course will prepare you for the second phase of this program: the research phase.
- The research phase of the program requires a great deal of self-organization and motivation. This course will shed the light on some methods to help you stay on track during the research phase.
- This course does not have a textbook, and the recommended research and Praxis development methods will all be covered in lecture slides.

Course Overview (3 of 6)

Class Schedule and Assignments:

Class	Topic/Activity	Assignment Due
1	Course Overview, Praxis Structure, Scope of Work Definition, and Research Topic Selection	
2	Problem Statement, Thesis Statement, Research Questions, and Research Hypotheses	HW #1
3	Student Presentations (Group A)	HW #2
4	Student Presentations (Group B)	
5	Academic Writing and Referencing, Library Resources, Annotated Bibliography, and Literature Review	

Lectures 1, 2, 5, and 8 of the course will cover the essential building blocks of academic research with a focus on Praxis development.

The rest of the course will offer you a chance to present your research development progress and iterate on it.

The class will be broken into two groups that will alternate with presentations over the course of the academic term.

Course Overview (4 of 6)

6	Student Presentations (Group B)	HW #3
7	Student Presentations (Group A)	
8	Data Sourcing, Data Analysis, Research Methodology, Results, and Conclusion	
9	Student Presentations (Group A)	Final Praxis Proposal
10	Student Presentations (Group B)	

- This course will help you work on your Praxis title, problem statement, thesis statement, research questions, research hypotheses, data source identification, as well as a methodology to carry out your research project.

Course Overview (5 of 6)

How Student Performance Will Be Evaluated on Assignments:

Assignments must be on-time and will be graded accordingly based on correctness and completeness. Assignments are due by EOD Thursday prior to Assignment Due Date as noted on above Class Schedule and Assignment table. ***Late assignment up to 24 hours will assess a 25% penalty. Late assignment up to 48 hours will assess a 50% penalty. After 48 hours, a grade of zero will be assigned.*** For all assignments, the requirements are to submit using the following Format:

Assignment Format:

1. PowerPoint Slides Format:
    - Please strictly adhere to the PPT slide format. That includes using the slide layout, font size, look and feel, etc.
    - Please do not alter the slide format.
2. Oral Presentations:
    - Students have a few minutes to present each assignment. Please practice your presentation and strictly adhere to the allotted time.
    - Present using PowerPoint and Zoom Meetings.
    - **Test your connection beforehand to ensure you have good connection.**
    - Stay focused and speak distinctly.

- Assignments are due by 11:59 pm (ET) on Thursday prior to assignment due date.
- A template for progress presentations is provided, and the format is to be followed. Please adhere to the format provided.
- Oral presentations carried out during specific class times will be part of your graded assignments. Please be prepared to present and share your screen when it is your turn.

Course Overview (6 of 6)

Student Expectations:

- You are expected to attend all sessions regardless of whether you are presenting or not. Please listen intently to other presentations. There are guidance and questions that are discussed in each session that are useful.

Attending each lecture and attentively listening to feedback provided to classmates will assist you in refining your work and gaining valuable insights.

Grading:

GW's grading system for graduate students is: ***A,*** Excellent; ***B,*** Good; ***C,*** Satisfactory; ***F,*** Fail; other grades that may be assigned are ***A–, B+, B–, C+, C-***. In this course, grades are determined by weighted average values and based on a standard curve relative to the class average.

HW #1	10%
HW #2	25%
HW #3	25%
HW #4 (Final Praxis Proposal)	40%

Grading is focused on the assignments that you will be delivering and presenting in class.

Other Course Policies

- **Feedback on drafts:**
  - Please do not email work-in-progress and request feedback.
- **Missing deadlines:**
  - Medical issues need to be communicated in advance with documentation if required.
- **Remain engaged:**
  - Pay attention to lectures and classmate presentations, as the feedback provided will assist you with your own work.

Any questions about the syllabus or course structure?

Praxis Roadmap

This course

Documentation and Praxis writing

Research Formulation	Research Approach	Research Methodology	Data Collection	Data Analysis	Research Results
• Topic selection • Problem statement • Thesis statement • Literature review	• Research questions • Research hypotheses	• Methodology to achieve research goals • Research process flow	• Data finding • Data generation • Data cleaning • Data mapping	• Applying research methodology to data • Statistical analyses, ML, optimization, etc.	• Research validation • Results presentation

Praxis Phase FAQs (1 of 5)

- What happens after this class?
  - After this class, the research phase of the program will begin. You will be assigned your advisors, and you will be fully engaged with your research.
- How does the hand-off happen?
  - The hand-off will be managed by the EMSEOCP office.
- Realistically, how many months are needed to complete the Praxis?
  - It depends. We have allotted about a year for you to complete the research phase; extensions will be granted on a case-by-case basis.

Praxis Phase FAQs (2 of 5)

- When will my academic advisor be assigned?
  - After this course, everyone will be assigned an academic advisor by the department.
- Can I select my academic advisor?
  - No. Your advisors will be assigned by the EMSEOCP office based on research topics of interest.
- Can my Praxis work be leveraged towards a Ph.D.?
  - No. PhD and D.Eng. have different coursework, and they are two separate tracks. Even if you publish your Praxis, you will continue to be in the D.Eng. program.

Praxis Phase FAQs (3 of 5)

- Will I be required to travel to DC for defending my praxis?
  - No. The Praxis defense will take place over a Zoom meeting.
- Where is my praxis published?
  - Praxes are published in the university microfilms in the library.
- Can we utilize interviews from our peers as feedback for our developed models?
  - Feedback to develop the model is OK. But it cannot be used to validate your model.

Praxis Phase FAQs (4 of 5)

- Can I tweak my problem statement and/or Thesis statement early in the research phase after this class?
  - Academic research is an iterative process, and your Praxis is not done until it is done. You can continue to make changes to your work after this course.
- How do I deal with my/a company's confidential data?
  - You need to get stated clearance from the company before you proceed with their datasets. Sometimes, that means sanitizing the data. Your Praxis and datasets will be available in the public domain, so please be sure to get clearance for any private datasets you plan to use.

Praxis Phase FAQs (5 of 5)

- Can I use historical project related data from different companies?
  - You can combine different data sources if they have the same timelines and assumptions and can be assumed as independent sources.
- Can Third-party data be used, or do we have to use first party data (data that we collect firsthand)?
  - You can use published and recognized Third-party data.
- What are common methodologies used for Praxes?
  - Machine Learning, statistical analyses using Excel, Minitab, Matlab, etc.

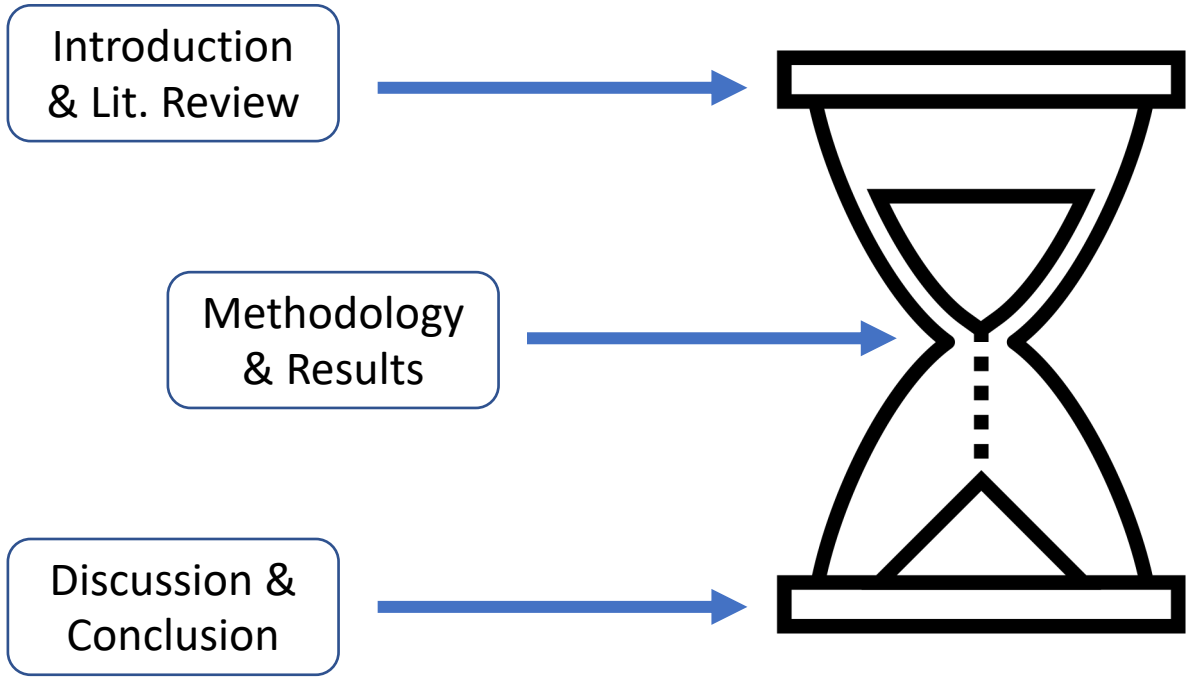
What is a Praxis?

What is a Praxis?

"A Praxis is a report on the **practical resolution** of an actual, **real-world problem** in **engineering**, it may be either a description of the problem and how existing tools or techniques can fruitfully be **applied to its resolution**, or a study of the application of advanced management tools or technologies in the resolution of an actual problem" (SEAS Online D.Eng. Student Guidelines, 2022).

Praxis Structure

- Introduction
- Literature Review
- Methodology
- Results
- Discussion & Conclusion



Praxis Structure – Introduction

- The introduction offers a concise overview of the issue at hand, providing contextual information that supports the need for the study. It elaborates on the importance and relevance of the problem being addressed. The introduction chapter must include the following:
  - **Problem Statement:** provides the reason and importance of the study.
  - **Thesis Statement:** the researcher's assertion and potential resolution to the problem.
  - **Research Objectives:** outlining the research direction and specific actions.
  - **Research Questions:** suggesting the relationship among variables that should be empirically testable.
  - **Research Hypotheses:** declarative statements regarding anticipated or predicted results of the research.

Praxis Structure – Literature Review

- Unlike a Ph.D. dissertation, which must include a comprehensive review of all published research on the subject reviewed, a D.Eng. praxis literature review needs to focus on writings that support the **limited practical application of the technology** or method researched.
  - **Sourced from:** books, **peer-reviewed journal papers**, websites, etc.
  - **Demonstrates:** your deep understanding of the topic and field researched.
  - **Includes:** a topic overview, comparison of existing literature, and an evaluation of the works reviewed**.**
  - **Focuses on:** application of theory in the field of study and gaps in the literature that will be addressed and fulfilled by the praxis.

Praxis Structure – Methodology

- This chapter focuses on how the research was conducted and what the steps taken to accept or reject the research hypotheses were. A process flow of the different methods used in this chapter is helpful. Sections covered in this chapter include, but are not limited to, the following:
  - **Dataset:** covers the method of acquisition of the dataset, as well as the format and structure of the data.
  - **Exploratory data analysis:** visualization and summary of the dataset to gain insights into what steps to carry out in the data preprocessing stage.
  - **Data preprocessing:** data cleaning, standardization, balancing, encoding, etc.
  - **Overview of tools used:** method(s) used to conduct the research. Methods commonly used in praxes are ML, statistical analyses, etc.

Praxis Structure – Results

- This chapter demonstrates the output of the steps described in the methodology chapter. This chapter highlights the results accomplished after each step of the methodology followed in the praxis, but it does not discuss how those results relate to the research questions or hypotheses. This chapter includes, but is not limited to, the following:
  - **Descriptive Statistics:** covers the findings and insights from the EDA step, such as mean, standard deviation, minimum, maximum values, and distributions for each numerical feature in the dataset.
  - **Visuals:** charts, tables, and any other visual representations of the work conducted as part of the praxis.
  - **Summary of key findings:** comparing results of various methods examined, final performance metrics of a model, etc.

Praxis Structure – Discussion & Conclusion

- This chapter outlines how the findings of the study are connected to the research questions and hypotheses. It also draws upon the literature review for any comparison against previous solutions developed to a similar problem. Sections covered in this chapter include, but are not limited to, the following:
  - **Research Hypotheses:** discusses whether the results of the praxis, covered in chapter 4, confirm and prove each hypothesis.
  - **Conclusions:** encapsulates the main points that the researcher intends for the reader to retain.
  - **Contributions to the body of knowledge:** covers the novel contributions from this research to the body of knowledge.
  - **Limitations and future work:** cover items outside the scope of the praxis that could be worked on in future research.

Scope of Work (SOW) Definition

- What does defining the Scope of Work (SOW) / or Scope of Research for the praxis mean?
- Why is it important to define the SOW for the research phase?
- What parts of the praxis need to have a clear SOW?
- What are the benefits of having a clear SOW for the praxis?
- What are the risks of not having a clear SOW for the praxis?

Scope of Work (SOW) Definition

- Defining the Scope of Work (SOW) for the research phase includes, but is not limited to, setting the defined boundaries for the study. It outlines the targets of the study in terms of the parameters such as the **objectives, methodologies, and deliverables**.
- SOW definition is crucial to a successful research phase as it provides **clarity and focus** and makes it clear to stay on track. It also helps in assessing the **feasibility** of the project.
- One of the main risks of not having a clear SOW for the praxis is the inability to complete the goals of the study within the allocated amount of time.

Scope of Work (SOW) Definition

- Global Cyber Threat Landscape Analysis using Machine Learning and Simulations: Conducting an examination of all cyber threats, vulnerabilities, and emerging trends on a global scale, spanning various industries and geographical regions.
    - Any thoughts on this topic?
    - Is the topic specific?
    - Are the boundaries clear?
    - Can it be accomplished within a year of research by a single researcher?

Scope of Work (SOW) Definition

- Advanced Intrusion Detection System Development: Creating and implementing cutting-edge systems that can identify and neutralize any complex cyber threat effectively.
    - Any thoughts on this topic?
    - Is the topic specific?
    - Are the boundaries clear?
    - Can it be accomplished within a year of research by a single researcher?

Scope of Work (SOW) Definition

- Both are exciting topics to work on, but they try to address large issues that can be broken down into various praxis research projects.
- They also lack specificity and boundaries in terms of a clear SOW for the methodologies used.
- They also lack specificity and boundaries in terms of a clear SOW for the region addressed.
- They also lack specificity and boundaries in terms of a clear SOW for the industry/application targeted.

Scope of Work (SOW) Definition

- Preventing Ransomware Attacks in the U.S. Healthcare Sector using **Deep Learning**: Developing an **Intrusion Detection System** using incident response data to **detect and prevent ransomware attacks** on **healthcare organizations in the United States between 2017 and 2020**.

    - Specific sector, cyberattack type, timeframe, region, and methodology.
    - Clear objectives, methodologies, and deliverables.
    - Clear boundaries.
    - Can it be accomplished within a year of research by a single researcher?

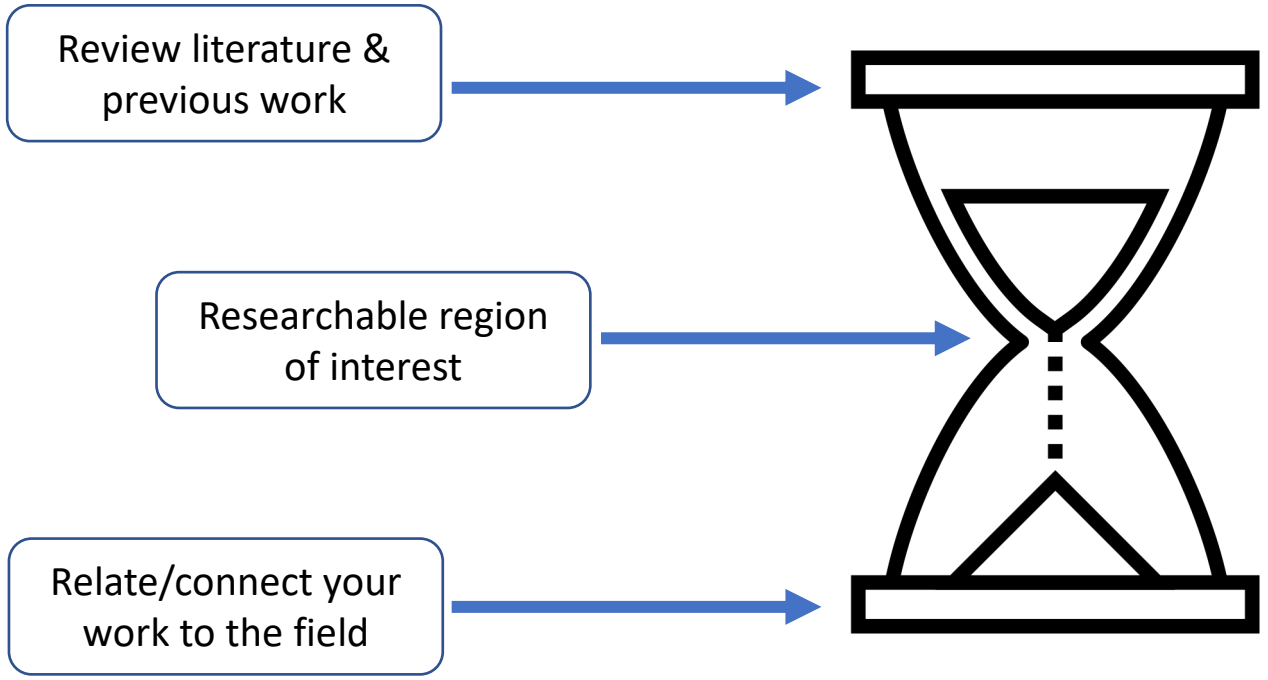
Scope of Work (SOW) Definition

- Detecting Insider Threats in Financial Institutions in Australia: Developing and implementing a **machine learning**-based **anomaly detection model** to **identify and mitigate insider threats in the financial sector in Australia** using a **dataset of banking insider threat incidents captured between 2014 and 2018**.

    - Specific sector, cyberattack type, timeframe, region, and methodology.
    - Clear objectives, methodologies, and deliverables
    - Clear boundaries.
    - Can it be accomplished within a year of research by a single researcher?

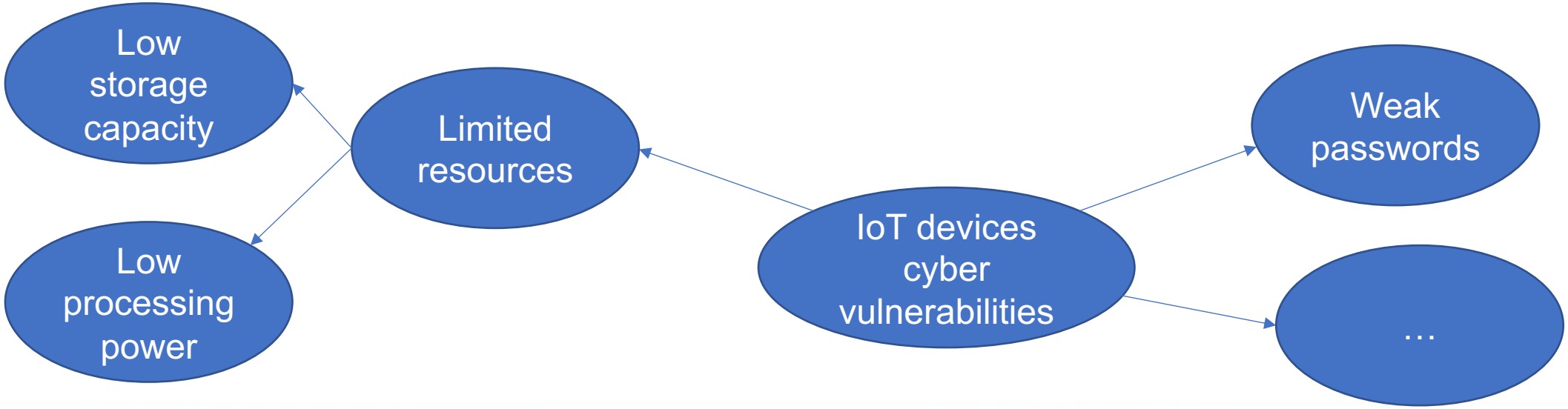
Research Topic Selection

- When working on selecting a topic of research for your praxis, start out by selecting a general broad region of interest.
- Narrow that region of interest to areas that are researchable and have not been fully covered in previous literature.
- Finally, work on linking your research to the field that it is conducted in.
- **Be sure to select a topic/dataset that can be made available publicly and published.**



Research Topic Selection

- Start out by picking a **topic of interest** that you would like to explore further and spend time working on.
- Construct a **concept map** for your topic of interest.



Research Topic Selection

- Highlight **topics and keywords** within your concept map that are of most interest to you.
- Conduct a **literature review** for research papers whose titles contain the keywords you are interested in researching.
- Review the "**Recommendations for Future Research**" section of previous research papers published on similar topics. These usually give a good idea of next steps in that field of study.
- Review **survey papers**. Survey papers summarize and analyze the most recent research publications in a certain field.

Research Topic Selection – Praxis Title

- Your praxis title should encompass the main keywords and be **clear and descriptive** of the work done in the praxis. Your praxis title should **be no longer than 20 words**, and they usually range between 5 and 15 words. When writing a praxis title, be sure to **avoid** the following:
  - Exclamation or question marks.
  - Abbreviations or slang.
  - Conclusions or findings from the praxis.
  - Words like “a study on”, “a research project on”, etc.
  - Being too brief that it does not describe the work.
  - Being too long that it loses focus on the topic.
- Praxis titles should be concise, simple, interesting, and declarative.

Sample Praxis Titles

- A Deep Learning-based Defense System for Ransomware Attacks on US Financial Institutions
- Enhancing Personalized Healthcare Recommendations for Patients with Chronic Diseases Using Machine Learning
- An Artificial Intelligence-based Infrastructure Management Tool for Smart City Traffic Optimization

Assignment Structure Overview

- HW #1 and HW #2 will be presented together during lectures 3 and 4. HW #3 will include the annotated bibliography, as well as the updates to the deliverables from HW #1 and HW #2. HW #4 (Final praxis proposal) will include the data sources, as well as the updates to the deliverables from HW #1, HW #2, and HW #3.

- You will be graded on the following:
  - Deliverables in each assignment
  - Applying feedback from previous assignments
  - Grammar and clarity of writing
  - Following the template structure and assignment requirements

HW #1

- Using the template provided on Blackboard, provide your research title and scope of work.
- Be sure to follow the guidelines provided in this lecture when writing your title and scope of work.
- Be sure to follow the template as is without making any changes to its structure or organization.
- Be sure to name your submitted assignment as follows: **lastName_firstName_HW#1_SEAS_8599_DA2.pptx**

Next Steps

- Come to office hours with any questions you may have:
  - Sundays: 5:30 pm – 6:30 pm ET
  - Wednesdays: 6:00 pm – 8:00 pm ET
- Work on your HW #1 and submit it by 11:59 pm ET on Thursday.
- Begin/continue reading up on AI research topics.
- See you next class!

Thank you!