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Doctor of Engineering Praxis

Structure and Guidelines Review

Jeffrey C. Yu, D.Eng.
Professorial Lecturer
School of Engineering and Applied Science

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Topics

- Review of Overall Praxis Objectives and Research Approach
- Review of Praxis Structure and Best Practices Guidelines
- Resources
- Appendix

This session is a NOT a substitute for SEAS Online Programs Guidance or the Praxis Development/Proposal Course

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What is a Praxis?

"The D.Eng. Praxis is … a report on the novel **practical resolution** of an actual, **real-world problem in** engineering. [I]t is a description of the problem and how existing tools or techniques can fruitfully be **applied to its resolution**."

SEAS Online Engineering Programs Office, *student Guidelines: Doctor of Engineering Degree*, August 11, 2024
https://online.engineering.gwu.edu/sites/g/files/zaxdzs5816/files/2024-08/deng-student-guidelines8_11_24.pdf

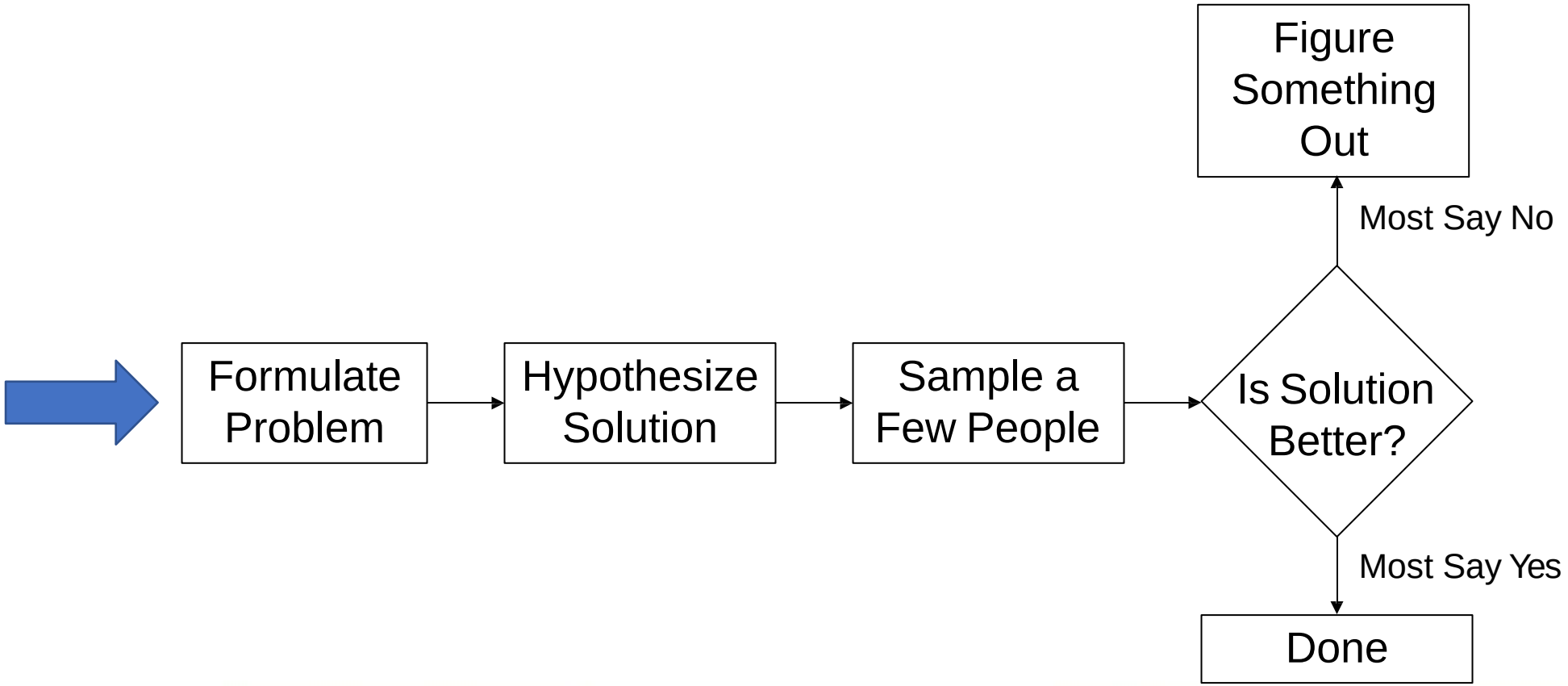
Praxis Roadmap

Praxis Development/Proposal Course

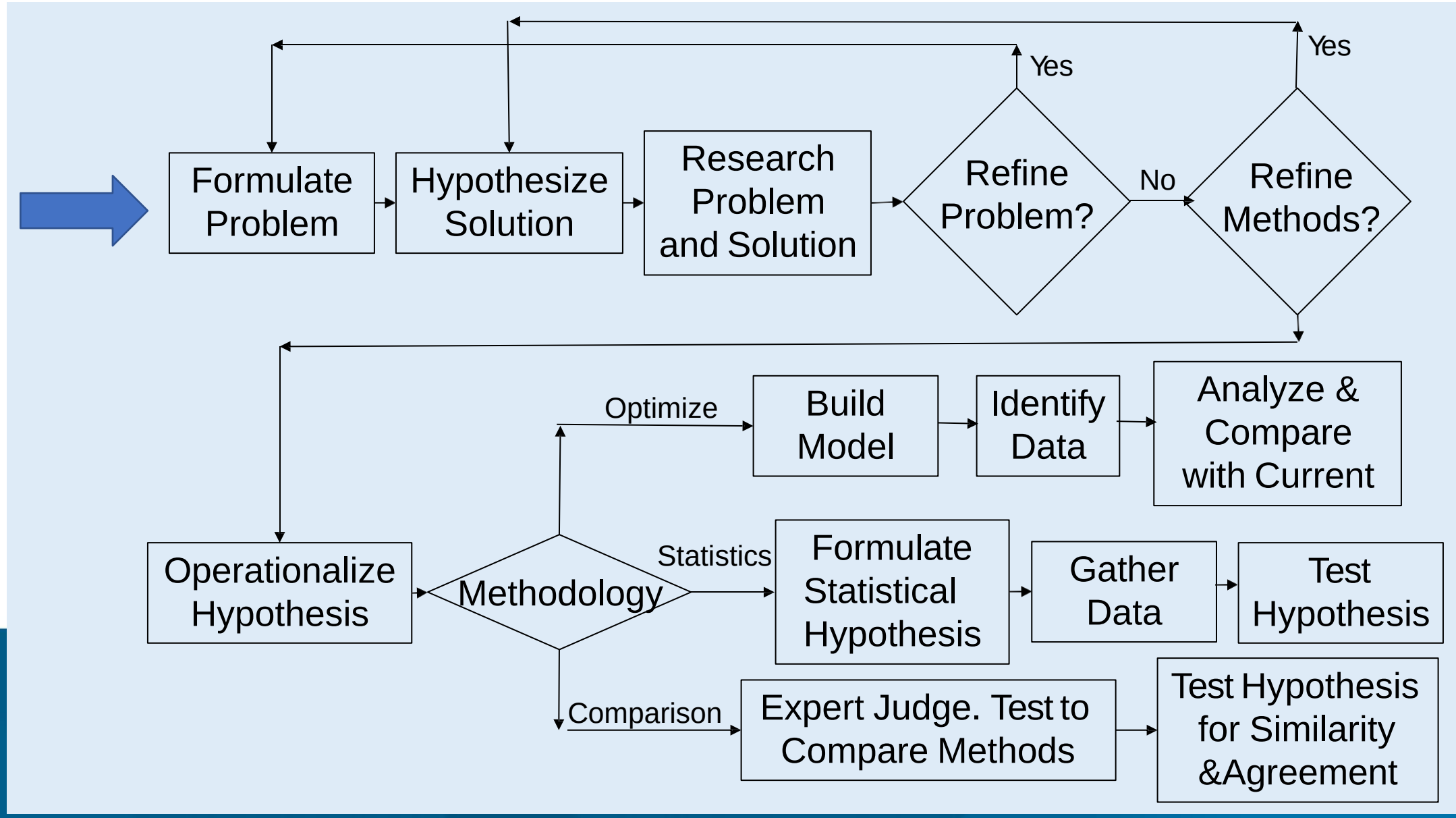
Praxis *Experimentation*, Analysis, and Writing

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 Review – What A Praxis Is NOT



Praxis Review – What A Praxis Could Be



Praxis Structure

- Front Matter
- Chapter 1—Introduction
- Chapter 2—Literature Review
- Chapter 3—Methodology
- Chapter 4—Results
- Chapter 5—Discussion and Conclusions
- References
- Appendices

Best Practice
12-20 pages

Praxis Structure

Front Matter

- Title, Approval, Copyright
- Dedication, Acknowledgments
- **Abstract**
- Table of Contents, List of Figures, List of Tables
- List of Equations, List of Symbols (if needed)
- List of Key Abbreviations and Acronyms
- Glossary of Terms

Praxis Guidance

Abstract

- Single most important part of your praxis that captures the essence of your work
- Describes your praxis without having to read the entire document
- Most readers decide to read or pass the praxis based on what is in the abstract
- 200 to 350 words long (1 page)
- It includes:
  - Your problem statement
  - The significance of your research
  - Your Thesis Statement
  - Your methodology
  - Your major findings and conclusions
- Does **NOT** include citations

Praxis Structure

Best Practice
5-7 pages

Chapter 1—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.

- **Background and Research Motivation**
- **Problem Statement:** provides the reason and importance of the study– ***Issue + "So what"***
- **Thesis Statement:** researcher's ***claim*** (assertion) and potential ***resolution*** (deliverable solution) to the problem statement
- **Research Objectives:** outlining the research direction and specific actions
- **Research Questions:** ***frames overall approach*** by suggesting the relationship among variables that should be ***empirically testable***
- **Research Hypotheses:** ***declarative statements*** regarding anticipated or predicted results of the research
- Research Scope and Limitations
- Praxis Organization

Should answer:
(at a high level)

What are you doing?
Why is it important?
What have others done?
What are you doing that's different or better?
What do you hope to achieve?

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Best Practice
20-30 pages

Praxis Structure

Chapter 2—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.

- Demonstrates your deep understanding of the topic and research done to date
  - Problem may have appeared in similar but not identical circumstances
  - Problem may have occurred in different industries
  - There may be many different types of solutions
- Shows that you understand the methodology you have selected and why and how it can be applied to your praxis problem
- Includes topic overview, comparison of existing techniques, and an evaluation of conclusions and gaps (in research and/or reduction to practice)
- Sourced from **peer-reviewed journal papers**, conference papers, books, reports, websites

Should be well organized and easy to follow

Should be based on 40-50+ references

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Praxis Example

Literature Review Summaries

Table 2-6. Select Literature on Insider Threat Research

Research paper	Authors	Year
Common sense guide to mitigating insider threats	Theis et al.	2019
A review of insider threat detection: Classification, machine learning techniques, datasets, open challenges, and recommendations	Al-Mhiqani, Ahmad, Abidin, Yassin, Hassan, Abdulkareem, et al.	2020
New insider threat detection method based on recurrent neural networks	Al-Mhiqani, Ahmad, Abidin, Yassin, Hassan, & Mohammad	2020
Mitigating insider threats using bio-inspired models	Nicolaou et al.	2020
Insider threat risk prediction based on Bayesian Network	Elmrabit et al.	2020

Table 2-4. Select Edge Computing and Federated Learning for IoT Literature

Key Concept	Applicability	Reference
Edge Computing	Processing at network edge for IoT scale	Shi et al., 2016
Federated Learning	Privacy-preserving distributed learning	McMahan et al., 2017; AbdulRahman et al., 2021 Mothukuri et al., 2021
Trusted Edge FL	Trustworthiness at mobile edge; IoT edge FL + blockchain for trust	AbdulRahman et al., 2021 Fotia et al, 2023; Rehman et al., 2021
FL for IoT Security	Federated architecture for IoT intrusion and anomaly detection; Centralized, federated, vs local ML & DL; Aggregation algorithm and feature selection impacts to performance	AbdulRahman et al., 2020 Ferrag et al., 2021; Sarhan et al., 2022; Mothukuri et al., 2022; Lazzarini et al., 2023
Architecture-driven Performance	Balance among objectives and performance measures for specific applications, given available resources	Khan et al., 2021; Gugueoth et al., 2023; Yaacoub et al., 2023

Mallarapu, Ravinder. 2021. Application of reinforcement learning yields more robust data breach controls for working from home. D.Eng. Praxis, The George Washington University, https://www.proquest.com/dissertations-theses/application-reinforcement-learning-yields-more/docview/2572603410/se-2

Yu, Jeffrey C. 2024. Assessing industrial internet of things security at the network edge using trust-based centralized and federated machine learning. D.Eng. Praxis, The George Washington University, https://www.proquest.com/dissertations-theses/assessing-industrial-internet-things-security-at/docview/3089141831/se-2

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Praxis Example

Literature Review Gaps & Opportunities

Key Findings from Literature	Research Gaps and Opportunities
***Edge computing and Federated Learning* (§2.4)** **Key Papers: McMahan et al., 2017**; Mothukuri et al., 2021; AbdulRahman et al., 2021; Khan et al., 2021; Ferrag et al., 2021	
• Edge processing advantageous for IoT scale and distribution • FL for IoT security distributes computation while preserving privacy • Trustworthiness at edge can drive system implementation • Edge FL with blockchain provides viable foundation for trust mgmt • Federated architectures must be tailored for IoT apps, data, resources	• Architecture guidelines for distributing security functions across cloud, fog, edge, and endpoints • Methods for tradeoff of FL security, privacy, performance • FL architecture robustness for large-scale IoT/IIoT security • Resource-aware FL implementation for IoT/IIoT security

Yu, Jeffrey C. 2024. Assessing industrial internet of things security at the network edge using trust-based centralized and federated machine learning. D.Eng. Praxis, The George Washington University, https://www.proquest.com/dissertations-theses/assessing-industrial-internet-things-security-at/docview/3089141831/se-2

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Best Practice
20-25 pages

Praxis Structure

Chapter 3—Methodology

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:

- **Data** acquisition, structure, cleaning & preprocessing, and manipulation used
- Overall **experimentation** approach
- Specific **methods, models, algorithms and tools** selected
  - Assumptions
  - Ease of use
  - Strengths and weaknesses
  - Adaptations required to address the problem in the praxis
  - *Clearly map to research questions and hypotheses*

No qualitative research methods (survey, grounded theory, etc.)
No method that requires the Institutional Review Board (IRB) review

Nail down your dataset(s) ASAP
Set up your experimentation platform(s) and tools early
Explore and consider paid subscription versions for course of your praxis

Best Practice
25-30 pages

Praxis Structure

Chapter 4—Results

Highlights the results accomplished after each step of the methodology followed in the praxis. Using the results from the methodology, lead the reader through the proof of the research hypotheses. This chapter includes, but is not limited to, the following:

- Descriptive Statistics
  - Covers the findings and insights from the EDA step
  - Mean, standard deviation, minimum, maximum values, and distributions for each numerical feature in the dataset
- Summary of key findings
  - Compare results of various methods examined, final performance metrics of models
  - Purposefully use tables and figures to illustrate findings
- Provide interpretations in the context of your praxis research that tell a narrative leading to conclusions of the next chapter

Best Practice
3-5 pages

Chapter 5—Discussion and Conclusions

Discusses 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 Findings:** discusses whether the results of the praxis 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 (research and/or practice)
- **Recommendations for future research:** cover items outside the scope of the praxis that could be worked on in future research
  - Refer to scope and limitations from Chapter 1 and Chapter 3
  - Refer to key literature gaps from Chapter 2
  - Address shortfalls, extensions, and new ideas based on results from Chapter 4

Praxis Structure

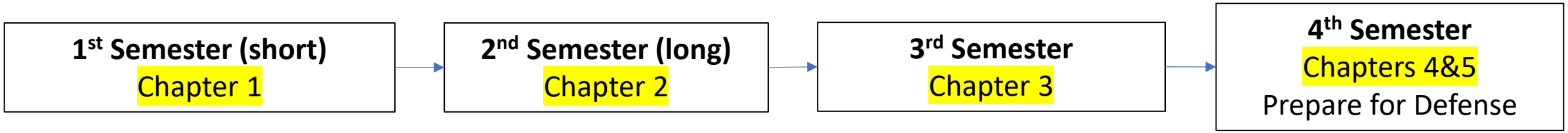
References and Appendix

- References (5-10 pages)
  - Include all 40-50+ references cited in the main text
  - APA 7th edition style guide
  - Strongly recommended: Use citation tool
- Appendices (0-20 pages)
  - Optional: should supplemental materials that augments main text
  - Can include code snippets, data details
  - Praxis main narrative should stand alone from Appendix

Preparing the Praxis Chapters

Chapters

1. Introduction
2. Review of Literature
3. Methodology
4. Results
5. Conclusion and Future Research



Failure to meet any of these deadline is grounds for giving a grade of orange for the semester and will be reported to the office

Praxis Guidance

Overall Writing Guidance and Tips

- Praxis text should be 85 to 125 (*150 maximum*) pages in length and flow smoothly from paragraph to paragraph and chapter to chapter
- Watch out for:
    - Writing in first person, unclear specification of the purpose of the praxis research (Chapter 1)
    - Too many things in quotes from other sources or single paragraphs about each reference (Chapter 2)
    - Not testing assumptions for the methodology being used, poor equation formatting (Chapter 3)
    - A smattering of tables and graphs with no explanation, tables and graphs copied as pictures from other sources, AI generated material (Chapter 4)
    - Unsubstantiated or overreaching claims in the conclusion (Chapter 5)

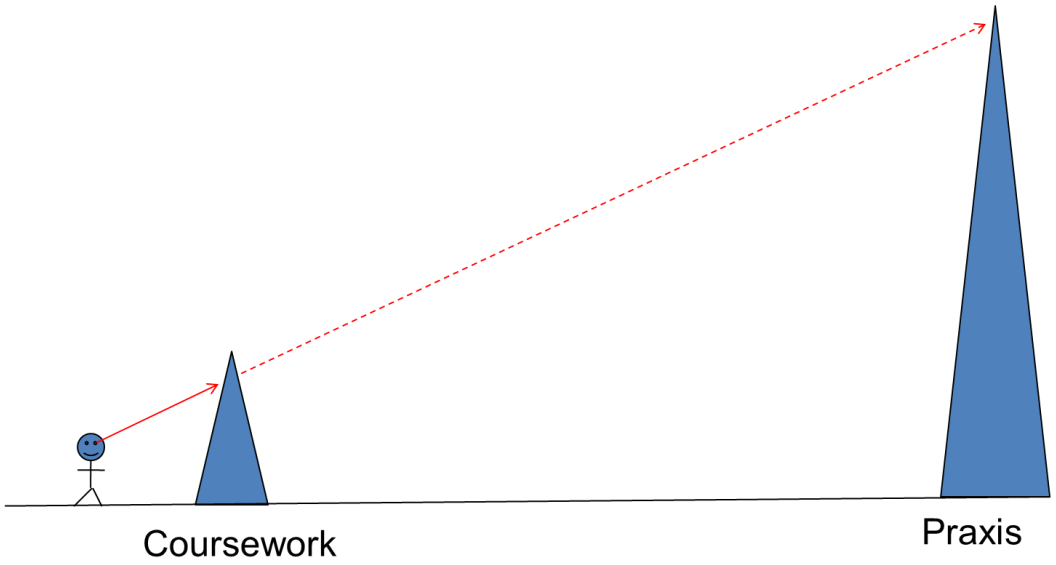
Resources

- SEAS D.Eng. Student Guidelines https://online.engineering.gwu.edu/sites/g/files/zaxdzs5816/files/2024-08/deng-student-guidelines8_11_24.pdf
- SEAS Sample Praxis: https://gradpostdoc.gwu.edu/seas-etds
- D.Eng. Praxis Template
- GWU Theses & Dissertations
  - GWU Scholarspace: https://scholarspace.library.gwu.edu/
  - ProQuest: https://www.proquest.com/pqdtlocal1006561/advanced?accountid=11243
- "Other Praxis Tips and Expectations" document
- Peer Review*

- Gelman Library: https://library.gwu.edu (e.g., Web of Science, Engineering Village)
- Google Scholar: https://scholar.google.com/, IEEE Xplore: https://ieeexplore.ieee.org/Xplore/home.jsp [use GWU proxy for paper access]
- Citations: https://libguides.gwu.edu/citing
  - APA citation style, 7th edition: APA. APA - APA Citation Style, 7th edition: https://guides.himmelfarb.gwu.edu/APA
  - RefWorks: https://libguides.gwu.edu/c.php?g=258781&p=1728365
  - Zotero: https://libguides.gwu.edu/c.php?g=258781&p=1728369

*Praxis experimentation, writing and products must be a result of individual research and effort

Praxis Commitment



- How much time are you putting in now?
- If you do not match this going forward
  YOU WILL FAIL
- This is INDIVIDUAL RESEARCH

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Appendix

FAQ

What happens after the Praxis Development/Proposal class?

- After this class, the research phase of the program will begin. You will be assigned your advisors and you will fully be engaged with your research.

- **How does the hand-off happen?**
  - This will be managed by the EMSEOCP office.

Realistically, how many months is needed to complete the praxis

- Depends! We have allotted about a year time; extension will be granted on case-by-case basis.

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FAQ

When will my academic advisors be assigned?

- After this course, everyone will be assigned two academic advisor by the department.

Can I select my academic advisors?

- No. Your advisors will be assigned by EMSEOCP office.

Can Praxis work be leveraged towards a Ph.D.?

- No. PhD and DNG have different course works and they are two separate tracks. Even if you publish your Praxis, you will continue to be in DNG program.

FAQ

Will I be required to travel to DC for defending my praxis?

- No. The defense will happen on-line.

Where is our praxis published?

- Praxis are published in university microfilms in library as a whole.

Can we utilize interviews from our peers on feedback for our model?

- Feedback to the develop the model is ok. But not as validation.

FAQ

Can we tweak our problem statement and/or Thesis statement early in the research after we complete this class or are we stuck with the proposal we develop in this this class?

- Nature of research is that it is not really done until it is done.
- You can/should continue to tweak it. This is somewhat expected.

How do we deal with company confidential information?

- You need to get stated clearance from your company before you proceed. Sometimes that means sanitizing data.
- We do not do secret praxes. It has to be in public domain.

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FAQ

Can I use historical project related data from a different companies?

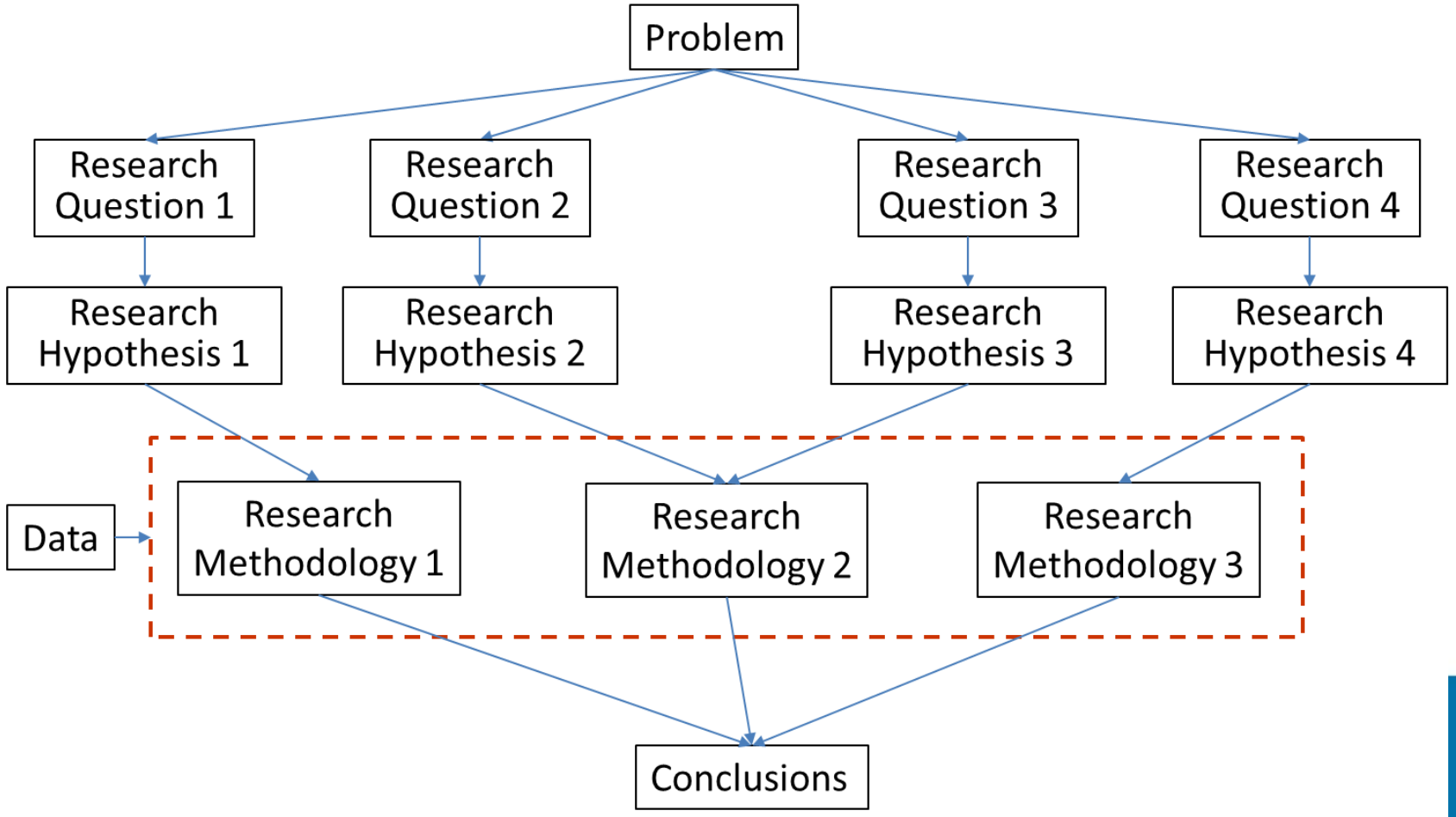
- You can combine different data sources if they have the same timelines and assumptions and can be assumed as independent sources.

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.

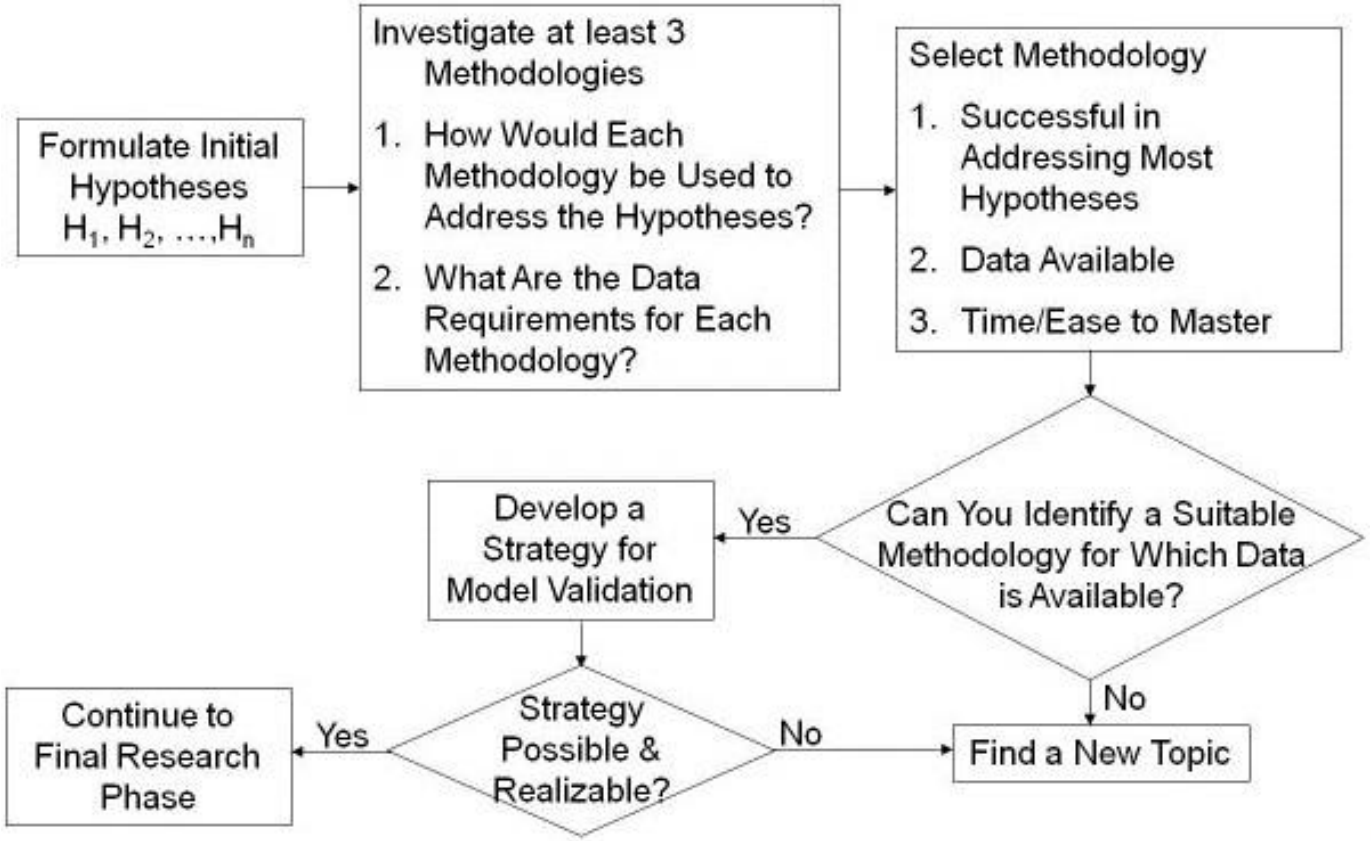
Praxis Guidance

Research Methodology Mapping to Praxis



Praxis Guidance

Research Methodology Selection



Praxis Guidance

Research Methodology Evaluation

Are Data Sources COMPLETELY Defined?

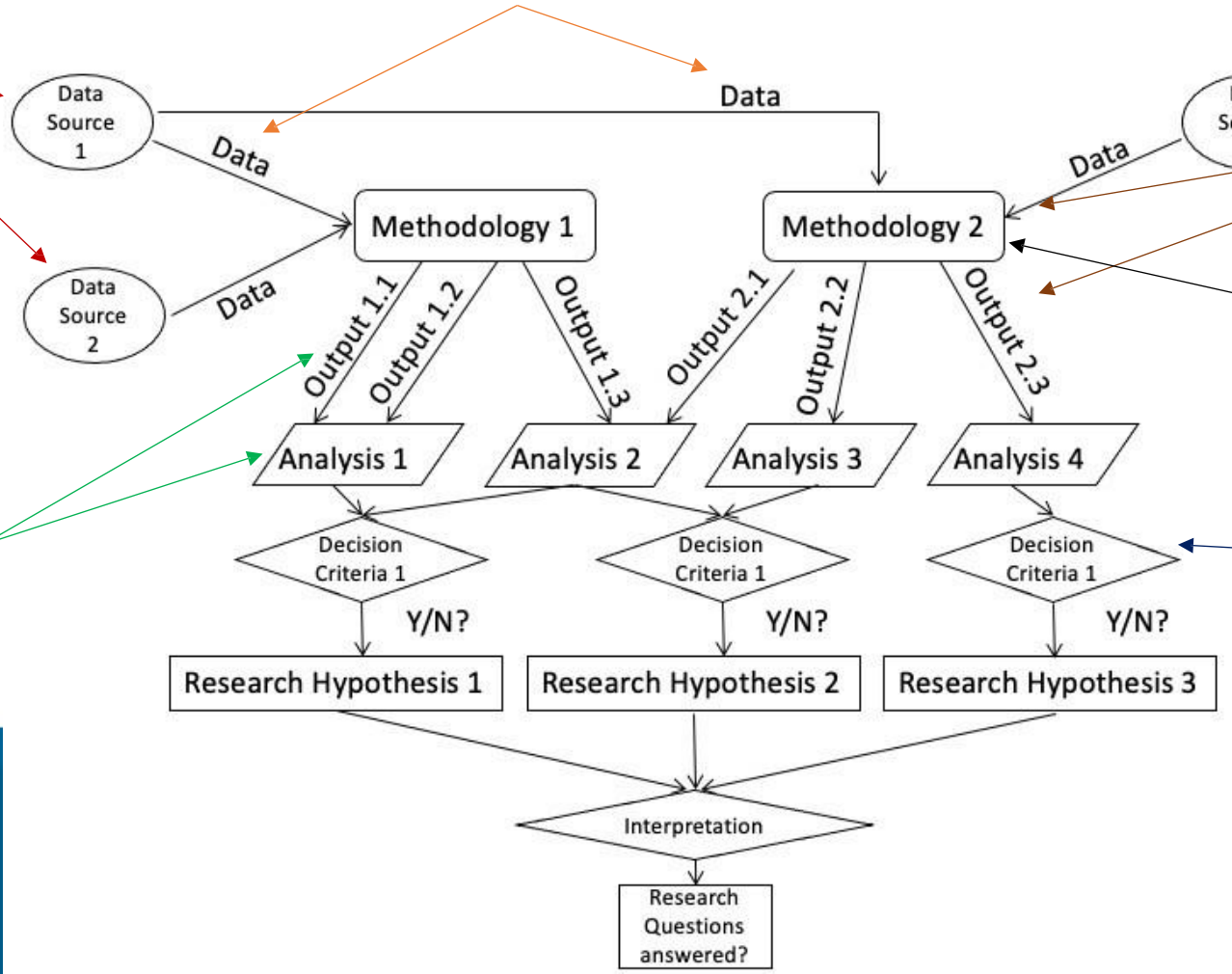
Are Data Types CLEARLY Specified?

Are All Data Flows Clear?

Is There a Good Selection of Methodologies?

Is it Clear How The Methodology Results in Answering the Research Questions?

Are the Criteria For Answering Research Questions Specified?



Praxis Guidance

Data – Common Issues

Common issues with datasets include, but are not limited to, the following:

- **Data access** – not gaining approval to use a dataset for your research or not being allowed to publish the dataset/findings as part of your praxis.
- **Data imbalance** – wide gaps in representation of different classes in the dataset leading to poor analysis results and performance.
- **Data incompleteness** – various values missing from different columns and rows making it difficult to use those features or records.
- **Data gaps** – significant parts of the data missing, which is especially problematic with datasets collected over a period of time.
- **Data inconsistency** – data pooled from different sources representing similar scenarios in materially different ways.
- **Data scale** – wide gaps in scale between different features in the dataset leading to unfair representation of larger scale features over smaller scale features.

Praxis Guidance

Academic Writing

- Academic writing is a formal type of writing that is structured and focused on an evidence-based approach. It aims to communicate the findings of researchers in a logical format.
- Academic writing provides an analysis and a critical view of other work found in the field while ensuring proper attribution to the sources used.
- The goal of academic writing is to advance the existing body of knowledge within a specific field or discipline.

Praxis Guidance

Academic Writing – Characteristics

- **Formal structure and tone** – structured into chapters or sections and avoids colloquial phrases and words
- **Objective** – focuses on evidence-based arguments rather than the author's opinions
- **Balanced and logical** – avoids biases and follows a clear structure that makes the argument easy to understand by the readers
- **Concise and focused** – uses words that help develop the argument while staying focused on the topic

Praxis Guidance

Academic Writing – Checklist

Academic writing avoids the following:

- Informal phrases and words
- The use of personal pronouns, such as “I” or “You”
- Starting a sentence with a conjunction, such as “And” or “But”
- Long run-on sentences
- Including multiple major ideas in one paragraph
- Generalizations, such as using the words “Always” or “Best”

Academic Writing – Praxis Expectations*

- Follow the provided praxis template to avoid any formatting errors.
- Practice **tight writing**. Make your topic flow from concept to concept without being wordy, while providing sufficient detail for understanding
- **Review and edit** your work **before submitting** any chapter or the completed work
  - If needed or directed, use the services of a professional editor
  - Your Advisor is not your editor, and poorly written chapters (e.g., flow, understandability, grammatical issues, etc.) may be returned without full review for your correction, which can lead to not meeting deadlines, low Semester grades, etc.

* Source: SEAS Online D.Eng., Other Praxis Tips and Expectations, 2022.

Academic Writing – Praxis Expectations*

- Ensure you provide sufficient references related to understanding the aspects of your topic, as well as convey confidence to the reader. As a rule of thumb, we would expect to see about **50 references, with >30 of those from robust peer-reviewed journal papers**.
- In addition to the acronyms list, **spell out acronyms the first time you use them in each chapter** – do not assume that the reader is familiar with your domain or require them to flip back to the acronym list, glossary, or prior chapters.

* Source: SEAS Online D.Eng., Other Praxis Tips and Expectations, 2022.

Academic Writing – Praxis Expectations*

- **Properly use quotation marks** – reserve “” for actual quotes, not emphasis. Where emphasis is needed, italics may be used, albeit sparingly.
- Plagiarism is a very serious violation. Do not use any material (text, tables, figure, equations, etc.) from other sources without properly citing that reference (and using “” if direct quotes).
- Long direct quotes (a sentence or more) should be included very sparingly. Paraphrase most of them and keep the most important ones, i.e., those from authoritative figures in the domain. Make sure you use “” if quoting directly AND cite the reference.
- **Use equation editor if including equations** or variables. **All equations must be numbered** and summarized in your list of equations in the Front Matter.
- In chapter 4, **include sufficient graphs and tables to ensure understandability** without needing to turn to the appendix.

* Source: SEAS Online D.Eng., Other Praxis Tips and Expectations, 2022.