# Independent Study Project Proposal

## Exploring and Experimenting Debugging/Testing Techniques in ML/DL Development

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# Problem Description

The intuition comes from the testing/debugging theory and practice in software engineering. Similar to traditional software products, ML/DL applications can also be abstracted into a machine that returns some outputs given some inputs. The same expectation here is that the machine should be **implemented correctly** and **operate normally**. This requires testing/debugging during the ML/DL development.

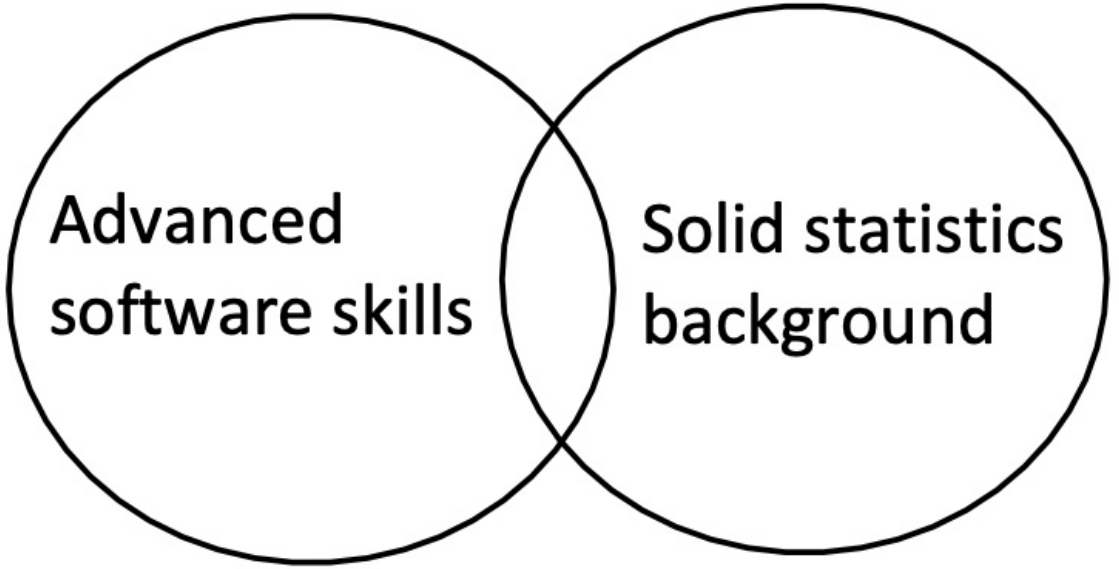
# Current Situation

The topic is not well studied in ML/DL area yet. Some observations:

- [📖] Insufficient amount of publications. Braiek and Khomh (2020) [1] reports that there are only 37 relative papers published from 2007 to 2019. After 2020, still quite silent. (link)
- [🛠️] Many mainstream ML/DL frameworks/libraries are not equipped with built-in or third-party testing/debugging modules.
- [👷] Many practitioners still debug/test ML/DL applications with some prehistoric methods or no debugging/testing at all.

# Why not enough research and tools?

We definitely need reliable ML/DL applications. Since we still write code to implement these applications, it is **inevitable** to test and debug code. Plus, these bugs can hide everywhere, including the data, model implementation (esp in DL), and model training/testing procedures, which further increases the difficulty of the challenge.



# What we can do in this independent study?

## Theory side

⏭ Collect and read reviews/surveys on this topic to gain a broad overview of the history and recent discoveries.
⏭ Try to form an end-to-end testing/debugging solution by utilizing existing methods in each part. This serves as a theoretical blue-print if later we are set to develop an all-encompassing testing/debugging tool for a commonly-used ML/DL framework (e.g., `scikit-learn`).

# What we can do in this independent study?

## Practice side

⏭ Get familiar with existing tools by knowing what they can do and how to use them in real development.
⏭ Grading is essentially testing/debugging. We can apply these tools to ECE580 assignments grading, or help students to debug.
⏭ Case studies (debugging/testing on different ML/DL algorithms) could be very handy based on assignment questions.

# Reference

[1] Braiek, H. B., & Khomh, F. (2020). On testing machine learning programs. Journal of Systems and Software, 164, 110542.