

# CS 1501

## Metaprogramming



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**Course Description:** Students will learn several implementations and applications of metaprogramming, starting with Python and eventually moving to other languages. Metaprogramming is the writing of programs that take in programs as input and output programs as a result. Metaprograms can sometimes even do this to themselves. Some languages, like Python, have built in features that facilitate this programming style. After this course, students will know these features, what they can accomplish, and the true power of python. More broadly, students will learn how to live DRY (don't repeat yourself).

**Prerequisites:** CS 111x and 2110, or Familiarity with Object Oriented Programming and Python  
**Credit Hours:** 1

### **Course Objectives:**

At the completion of this course, students will be able to:

1. Write object-oriented Python
2. Use functions as first-class objects
3. Use Python Inheritance
4. Write closures and decorators
5. Use and write metaclasses
6. Write dynamic classes and functions
7. Use reflection in several languages
8. Use homoiconicity
9. Develop domain specific languages

### **Grade Distribution:**

Assignments	50%
Take Home Final Exam	20%
Attendance	30%

## Course Policies:

- **Lecture**

- Lectures will be integrated lecture-lab. ie mix of instruction and workshop style coding.
- When we code in class, I will ask students to submit their code as a form of attendance for the day.
- When coding, students should have their computers out; however, I do ask that students keep computers away otherwise.
- There will be minimal need for taking notes, as I will make all lecture materials available on Collab.

- **Assignments**

- There will be an assignment for each week.
- Each assignment should take no more than 2 hours.
- Some assignments will be *explorations* designed to be creative, unique, and fun applications of course topics.
- Other assignments will be *puzzles*. These puzzles are meant to be solved with metaprogramming, but no penalty will be incurred if students can solve them without metaprogramming. So that students do not stress too much over them, a certain number will be dropped.
- Assignments will be made available as soon as possible, and students may start working as early as they wish.
- Assignments will be due at the start of lecture the week after they are officially assigned.

- **Late Policy**

- 25% off per week.

- **Final Exam**

- Take home.
- Will cover high-level concepts and overall paradigms.

## Academic Honesty Policy:

In the real world, there is no cheating as long as you cite your sources and your sources agree to being cited. Same goes with this course. Students are encouraged to work together and google things.

## Professor Sponsor

If a student has an issue with the course, grades, or instructor, he/she may contact the sponsoring professor, **Luther Tychonievich**.

## Tentative Course Outline:

The weekly coverage might change as it depends on the progress of the class.

Week	Topic	Assignment (due the following week)
1	Object-Oriented Python	Exploration: Prisoners Dilema
2	Python Inheritance	Puzzle: Dependency Injection
3	Objects as Functions	Exploration: Esoteric Print
4	Closures	Puzzle: Limited Lines
5	Decorators	Exploration: Decorating Contest
6	The Metaclass	Puzzle: Abstract Base Prisoner
7	Python Reflection	Puzzle: Restricted Function
8	Java Reflection	Puzzle: Breaking Visibility
9	Plysp	Exploration: Hello World
10	Homoiconicity	Puzzle: Plysp Macro
11	Compile-time Computation	Exploration: Esoteric Python
12	Programs Writing Programs	Exploration: PyQuine
13	Domain Specific Languages	Exploration: Esoteric Plysp
14	Review and Conclusion	Take-Home Final Exam

## Assignment Descriptions:

- Prisoners Dilema

Students will write an class that defines a strategy for the prisoner's dilemma. There will be a tournament with all on-time submissions, pitting instances of the students' classes against each other. Prizes for the best and worst strategies.

- Dependency Injection

Students will use Python's Method Resolution Order (MRO) to make a subclass that overrides a 'super' dependency higher up in the inheritance tree. Overriding this dependency will prevent the "bomb from going off."

- Esoteric Print

Students will override the built-in print function with an object that has some creative esoteric behavior. One requirement will be that print() should refuse to print the same thing 3 times in a row. Prize for the funniest print function.

- Limited Lines

I will give the students a piece of code that could benefit from the use of closures. The students will have to rewrite portions of the code with closures such that the program is smaller than the line limit.

- Decorating Contest

Write a creative decorator. Prizes for the best. Bonus points for decorating your decorators.

- Abstract Base Prisoner

Students will write a metaclass for their prisoners that will automatically add new prisoner classes to the prisoners list and will require that all prisoners implement the confess\_or\_no() method.

- Esoteric Python

Students will write an esoteric Python Interpreter. Prizes for the most creative.

- Breaking Visibility

I have a very secure Java gradebook application. Students will use reflection to change my private fields to public so that they can hack their grade to an A.

- Hello World in Plysp

Simple introductory assignment in a Python-implemented dialect of Lisp called Plysp.

- Plysp Macro

I will provide code with an 'infix' function that is meant to evaluate its parameters as an infix expression. Students will need to change this function into a macro in order for the code to work.

- Restricted Function

Students will write a restricted function that I can't call.

- PyQuine

Write a quine in Python. Prizes for the most creative.

- Esoteric Plysp

Students will analyze the source code for the Plysp interpreter and make esoteric changes.