Welcome to CS106B!

- Visit the course website at

  https://cs106b.stanford.edu

  for access to materials for today:
  - Handout 00: Course Information
  - Handout 01: CS106B Calendar
  - Handout 02: Course Placement
  - Handout 03: CS106B and the Honor Code
  - Handout 04: Assignment 0

Who's Here Today?

- Aero/Astro
- African / Afro-American Studies
- Bioengineering
- Biology
- Business
- Chemical Engineering
- Chemistry
- Civil and Environmental Engineering
- Classics
- Computer Science
- Creative Writing
- Earth Systems
- Economics
- Education
- Electrical Engineering
- Energy Resource Engineering
- English
- Environmental Systems Engineering
- Environment and Resources
- Ethics in Society
- Geophysics
- Human Biology
- Immunology
- Individually-Designed
- International Policy
- International Relations
- Law
- Linguistics
- Management Science and Engineering
- Materials Science and Engineering
- Mathematical and Computational Science
- Mathematics
- Mechanical Engineering
- Music
- Physics
- Psychology
- Public Policy
- Science, Technology, and Society
- Sociology
- Symbolic Systems
- Theater and Performing Studies
- ***Undeclared!***

Course Staff

Instructor: Keith Schwarz
(htiek@cs.stanford.edu)

Head TA: Chase Davis
(cs106b-ta@cs.stanford.edu)

The CS106B Section Leaders
The CS106B Course Helpers

Asking Questions

- ***Please feel free to ask questions at our lectures!*** It’s a great way to engage with and better understand the material.
- Use the Q&A feature on Zoom to ask questions. Chase and the course staff will respond as quickly as they can.
- I’ll periodically answer some of the more popular questions with the whole group.

Course Website

https://cs106b.stanford.edu

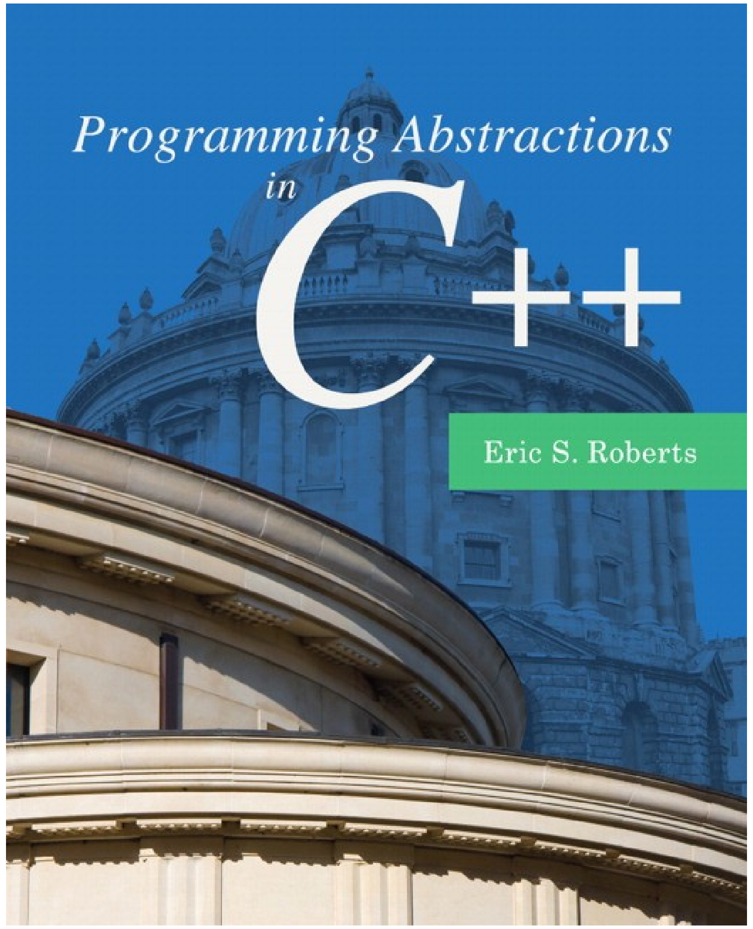
Prerequisites

CS106A

(or equivalent)

(check out our course placement handout if you're unsure!)

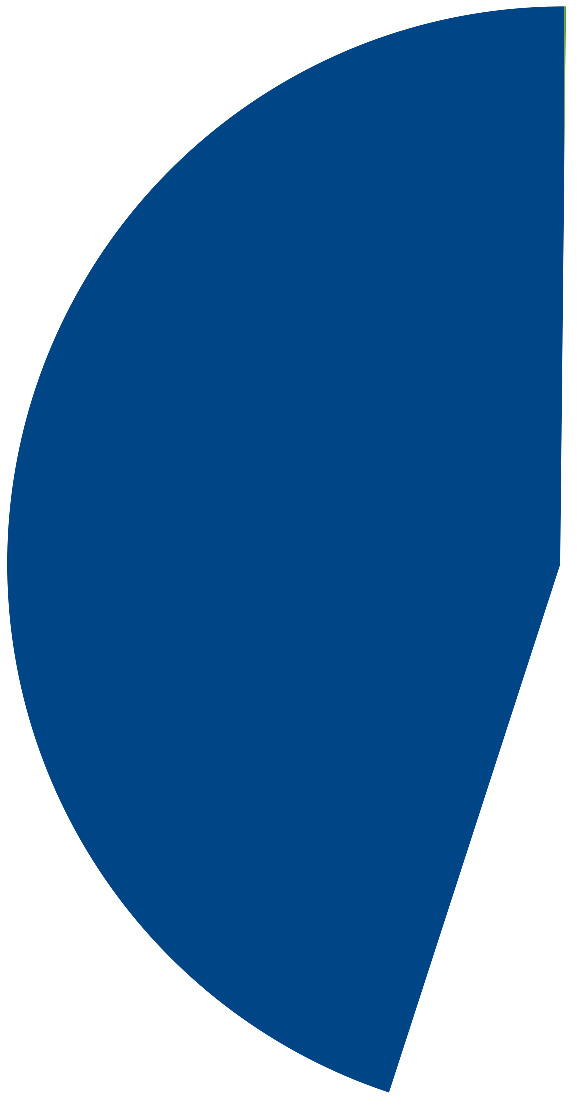
Textbook Options



- The course textbook has excellent explanations of course topics and is a great reference for C++ as we'll use it in this course.
- There's also a **draft version** available online that you can use this quarter.

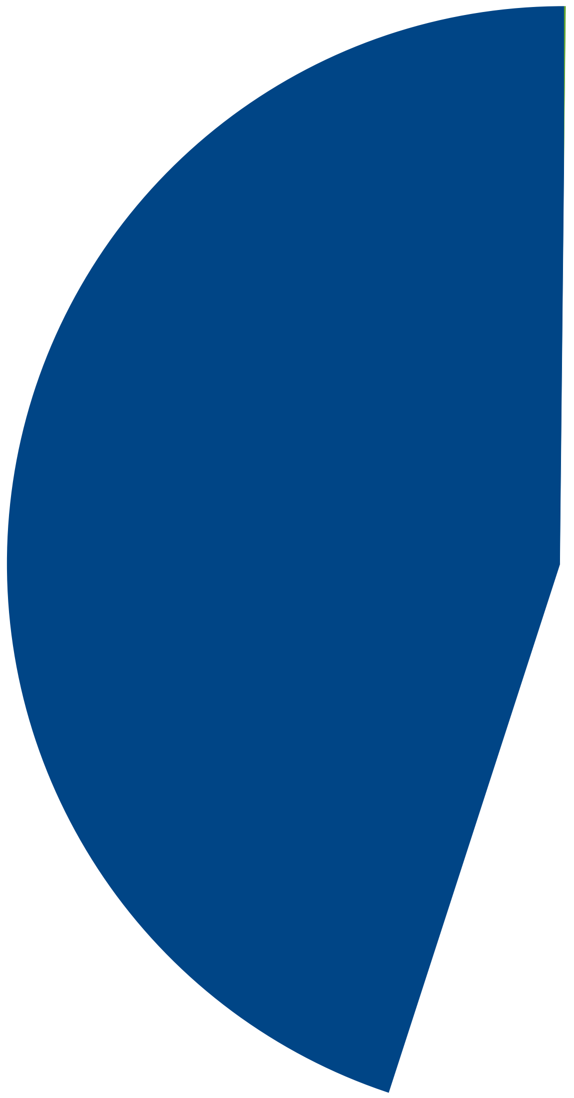
Grading Policies

Grading Policies



■ 45% Assignments

Grading Policies

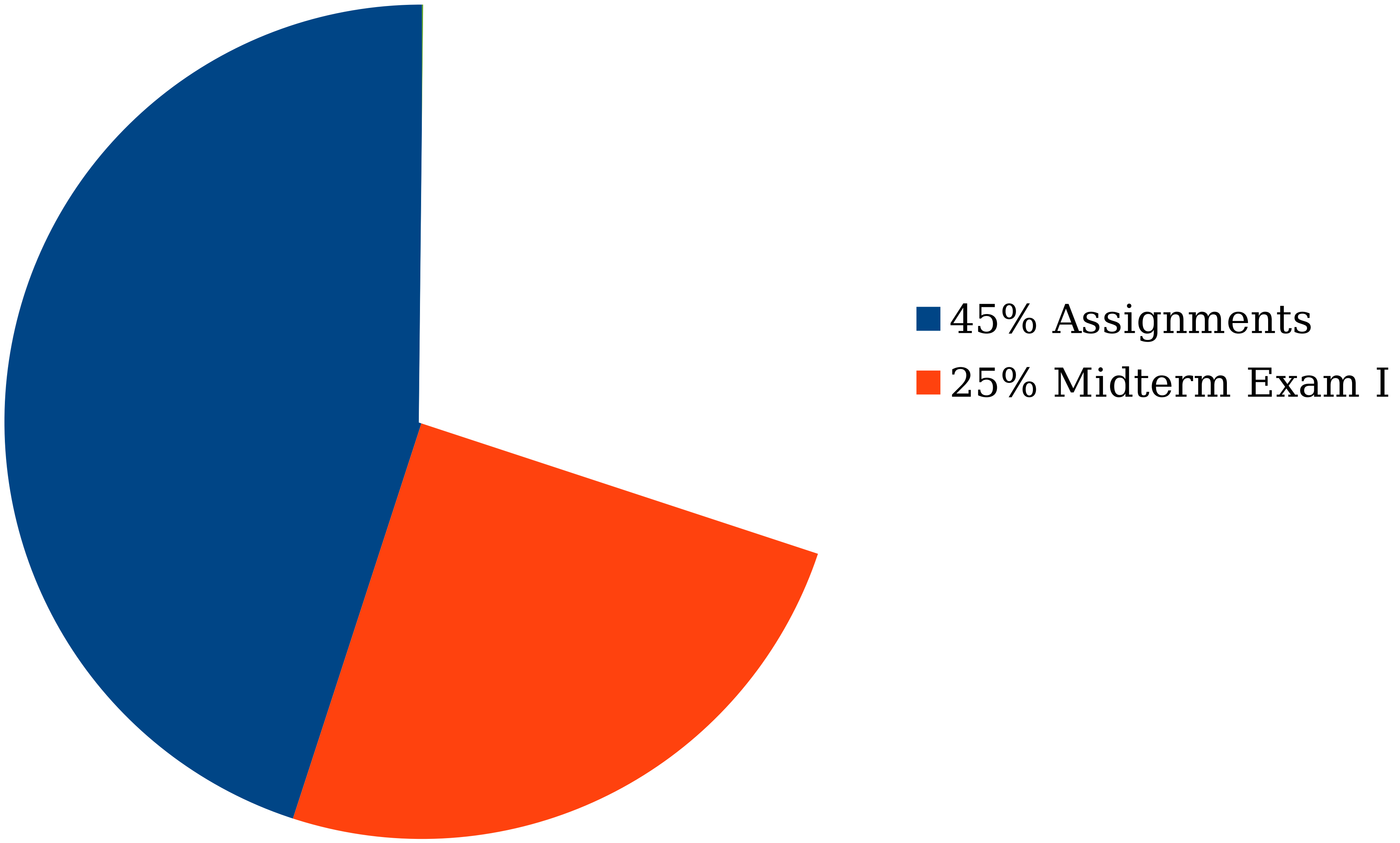


🟦 45% Assignments

Ten Assignments

(One intro assignment that goes out today, nine programming assignments)

Grading Policies



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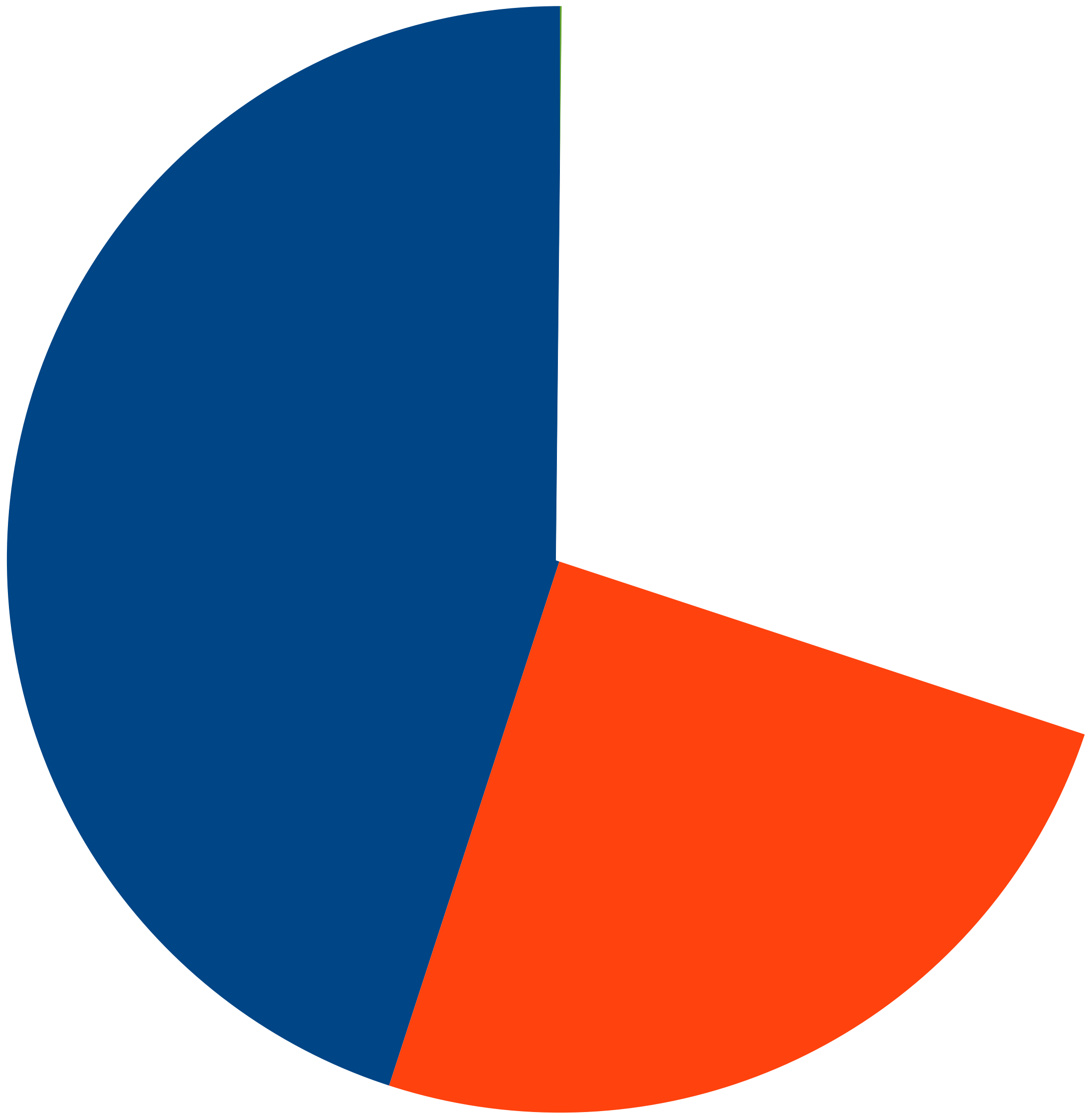


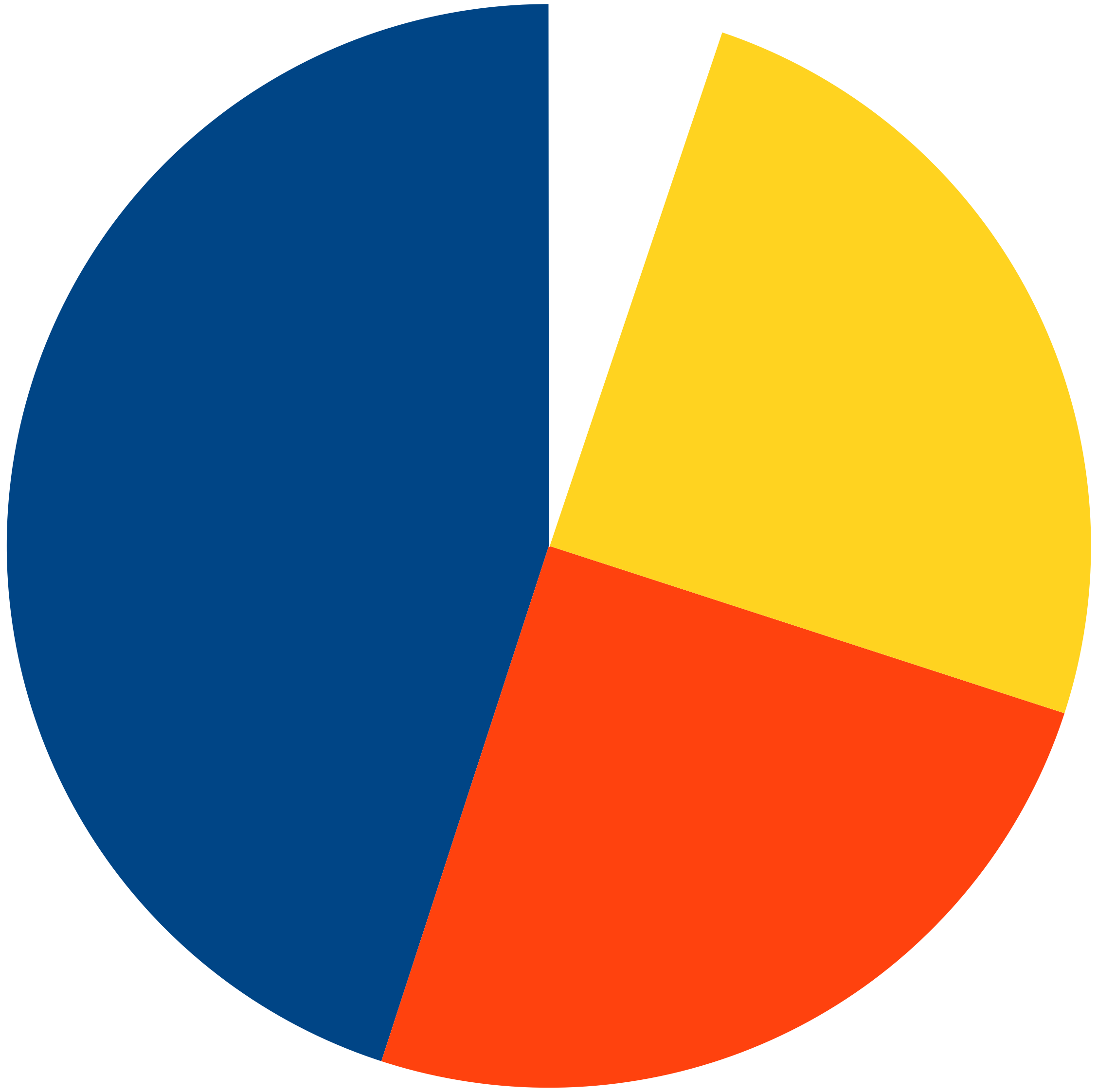
🟦 45% Assignments

🟥 25% Midterm Exam I

Midterm Exam I

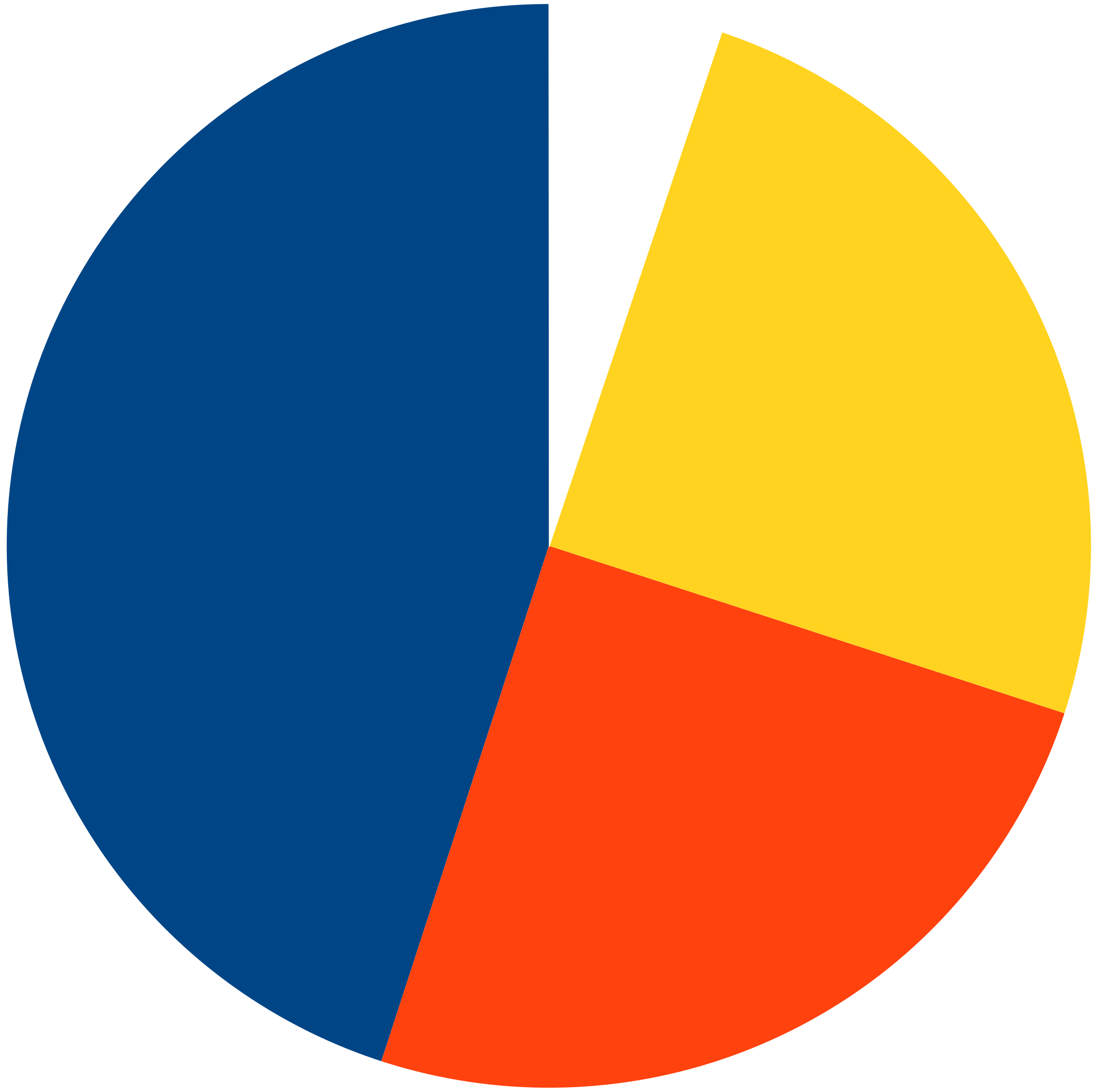
Goes out Friday, February 12th
Due Sunday, February 14th

Grading Policies



- 🟦 45% Assignments
- 🟥 25% Midterm Exam I
- 🟨 25% Midterm Exam II

Grading Policies



🟦 45% Assignments

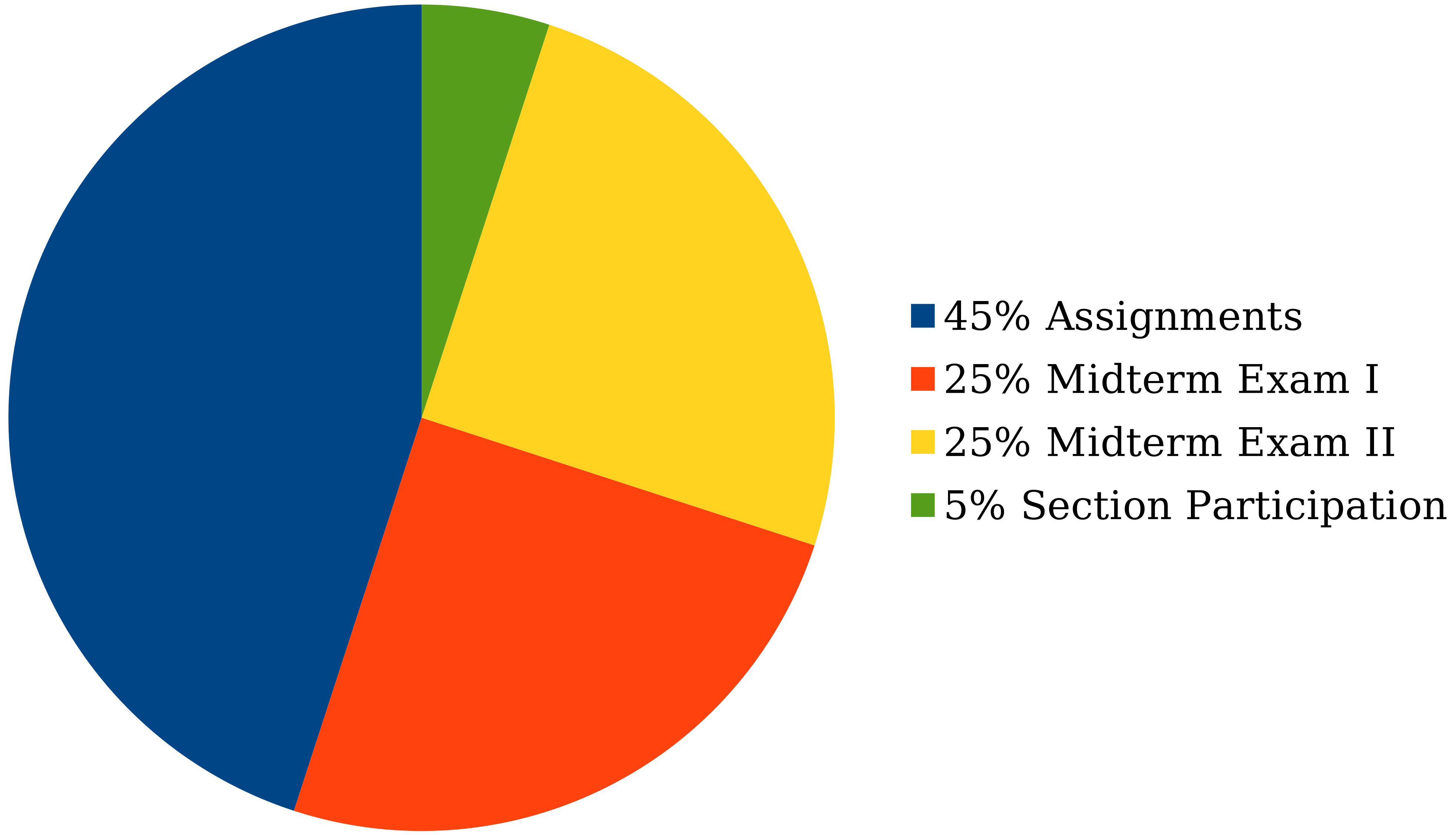
🟥 25% Midterm Exam I

🟨 25% Midterm Exam II

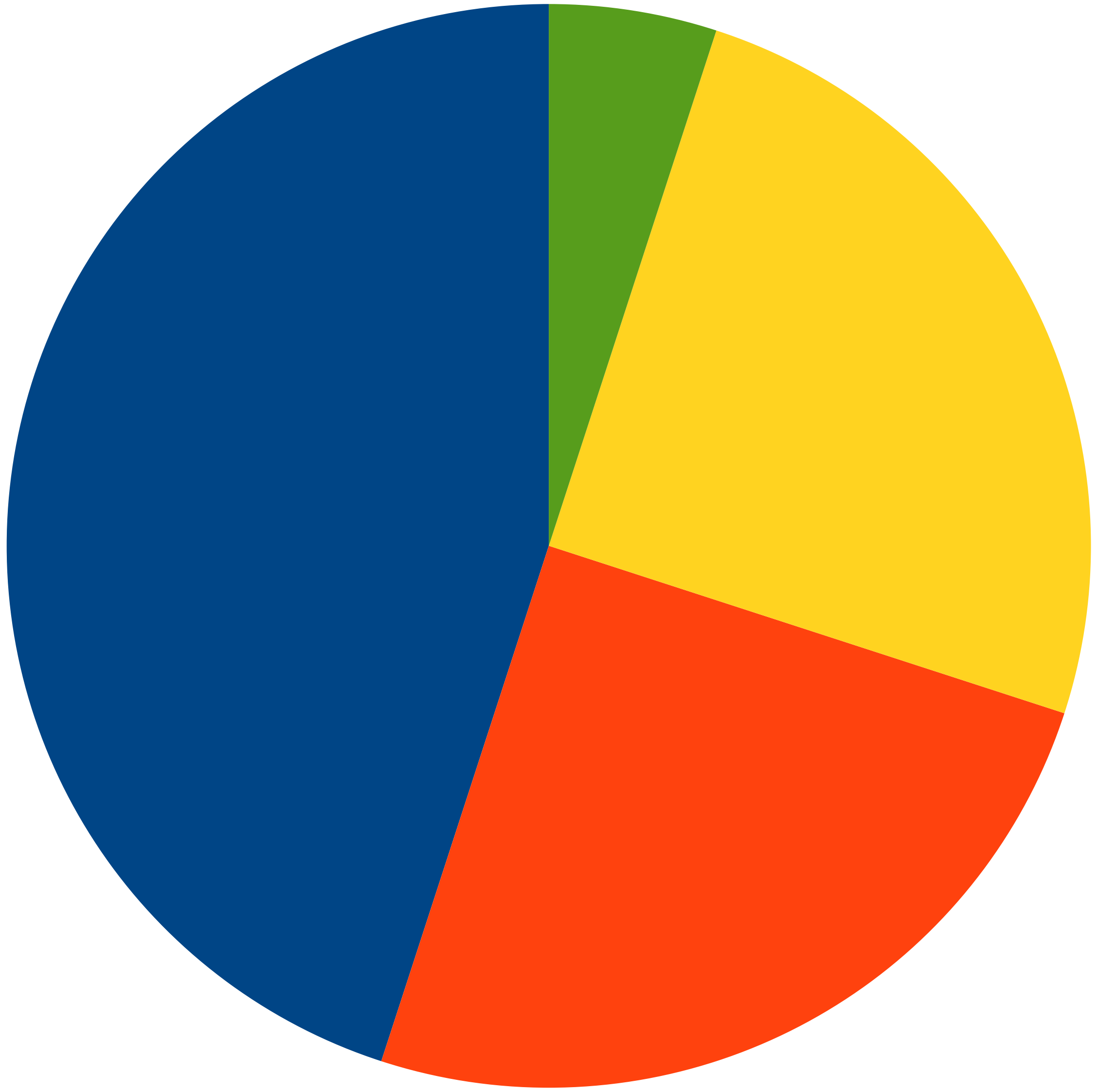
Midterm Exam II

Goes out Friday, March 12th
Due Sunday, March 14th

Grading Policies



Grading Policies



🟦 45% Assignments
🟥 25% Midterm Exam I
🟨 25% Midterm Exam II
🟩 5% Section Participation

Discussion Sections

Weekly sections.
Let’s talk about them!

Discussion Sections

- There are weekly discussion sections in CS106B. Section attendance is required.
- Sign up between Thursday, January 14th at 5:00PM Pacific and Sunday, January 17th at 5:00PM Pacific by visiting

  http://cs198.stanford.edu/section
- We don't look at Axess for section enrollments. Please make sure to sign up here even if you're already enrolled on Axess.
- Looking forward: some of the later assignments can be done in pairs. ***You must be in the same section as someone to partner with them***. You may want to start thinking about folks you'd like to partner with.

CS100B

- CS100B is an optional, one-unit add-on to CS106B that provides extra practice with the material.
  - It's run in addition to, rather than in place of, the normal CS106B weekly discussion sections.
- It's run through the School of Engineering's ACE program. The application is available online here:

  https://forms.gle/8u2AbZiPpdrdaPvL8

- Questions? Contact Betty Aynalem at **bettya@atanford.edu**.

What's Next in Computer Science?

Goals for this Course

- ***Learn how to model and solve complex problems with computers.***
- To that end:
    - Explore common abstractions for representing problems.
    - Harness recursion and understand how to think about problems recursively.
    - Quantitatively analyze different approaches for solving problems.

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Learn how to model and solve complex problems with computers.

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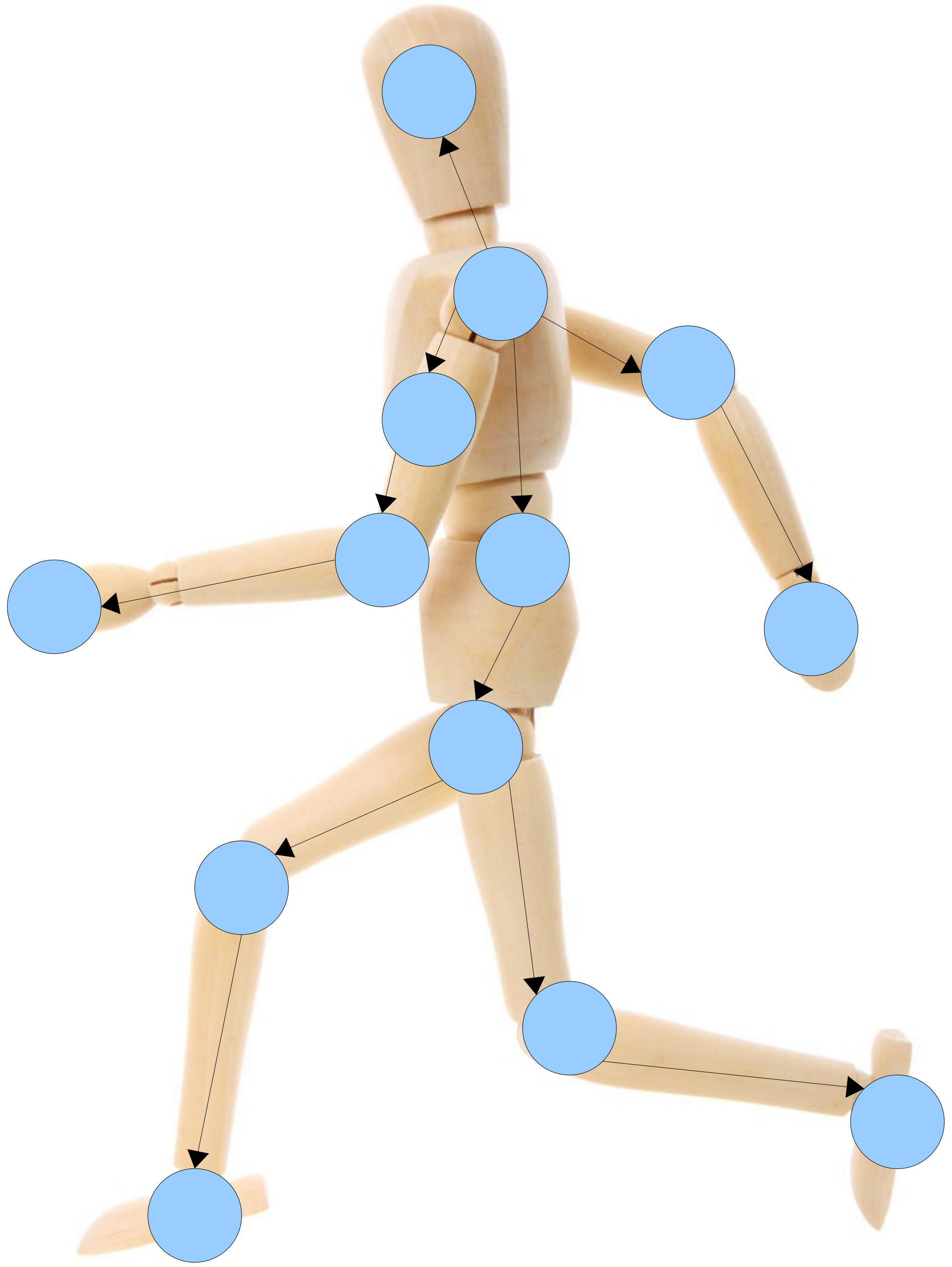

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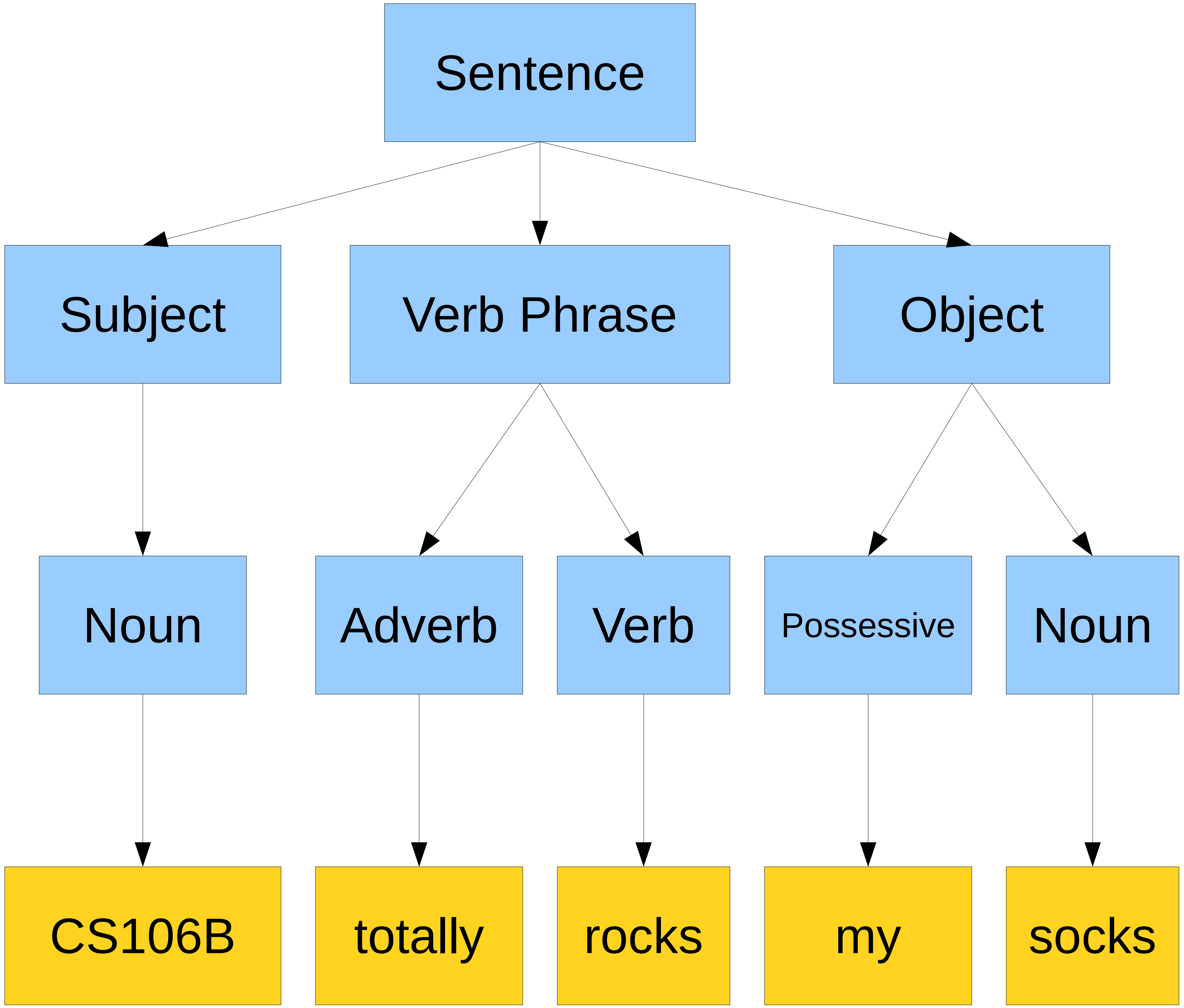
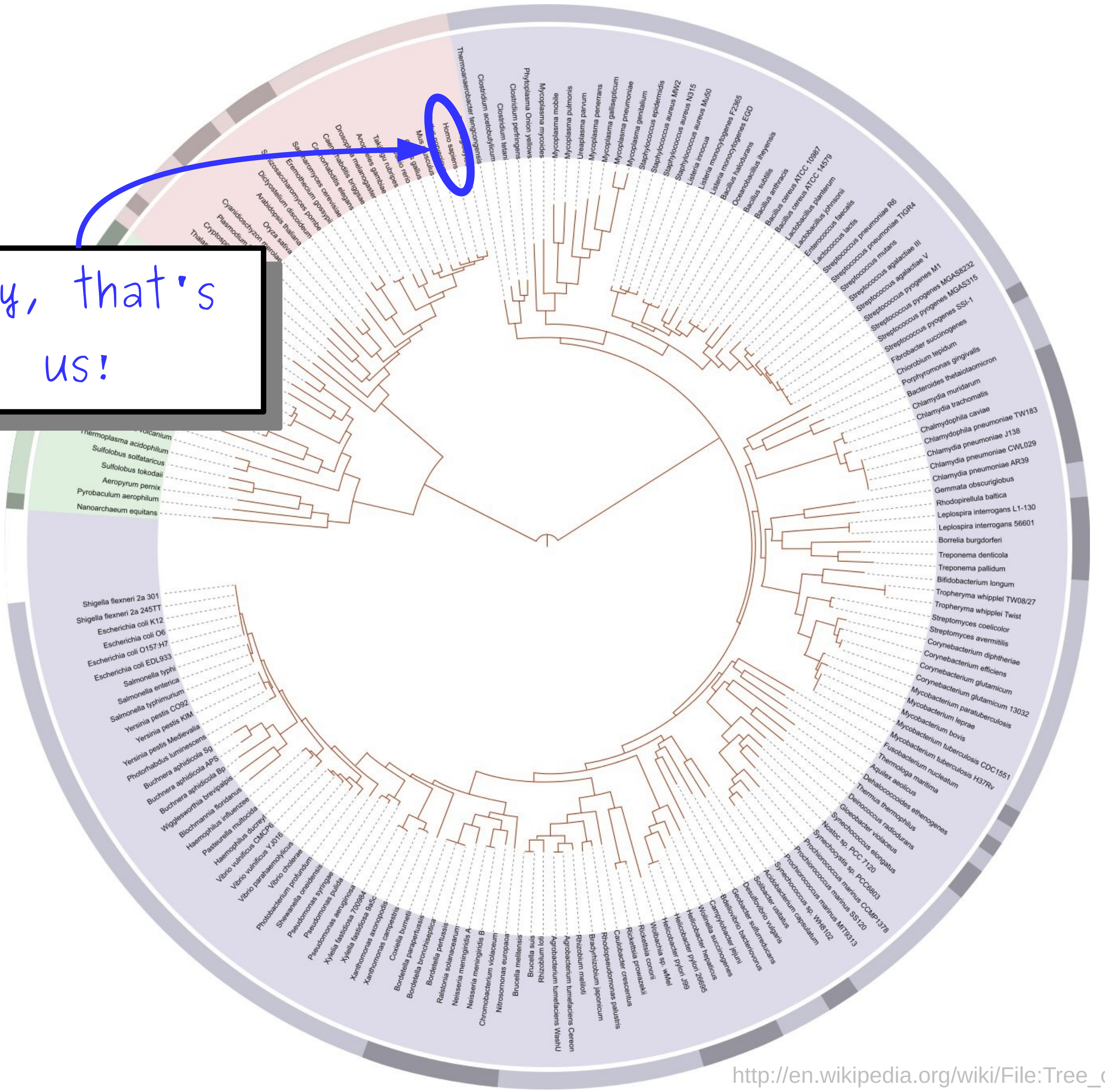
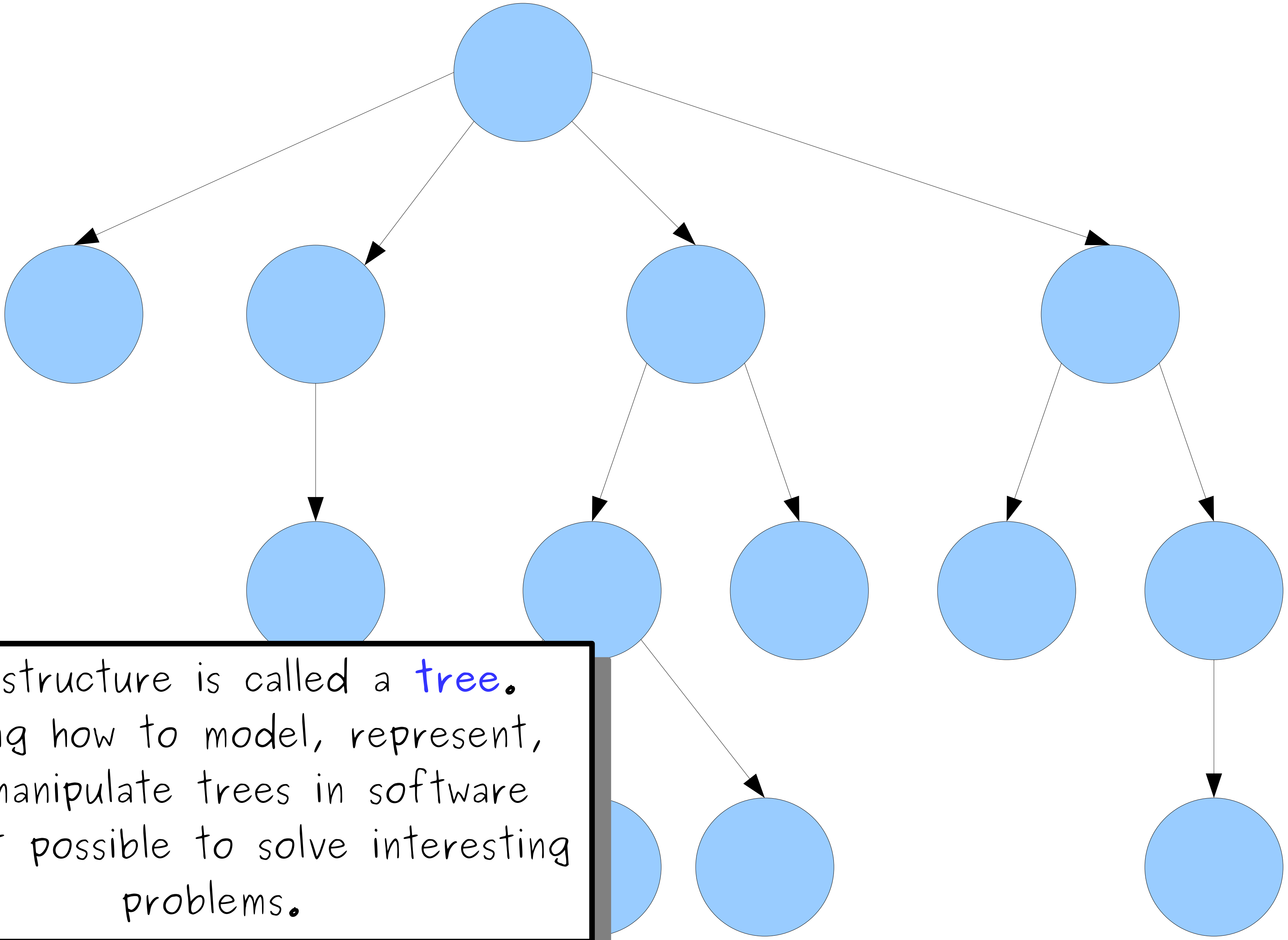

Sentence
Subject
Verb Phrase
Object
Noun
Adverb
Verb
Possessive
Noun
CS106B
totally
rocks
my
socks

Hey, that's us!



http://en.wikipedia.org/wiki/File:Tree_of_life_SVG.svg



This structure is called a **tree**. Knowing how to model, represent, and manipulate trees in software makes it possible to solve interesting problems.

Building a vocabulary of ***abstractions*** makes it possible to represent and solve a wider class of problems.

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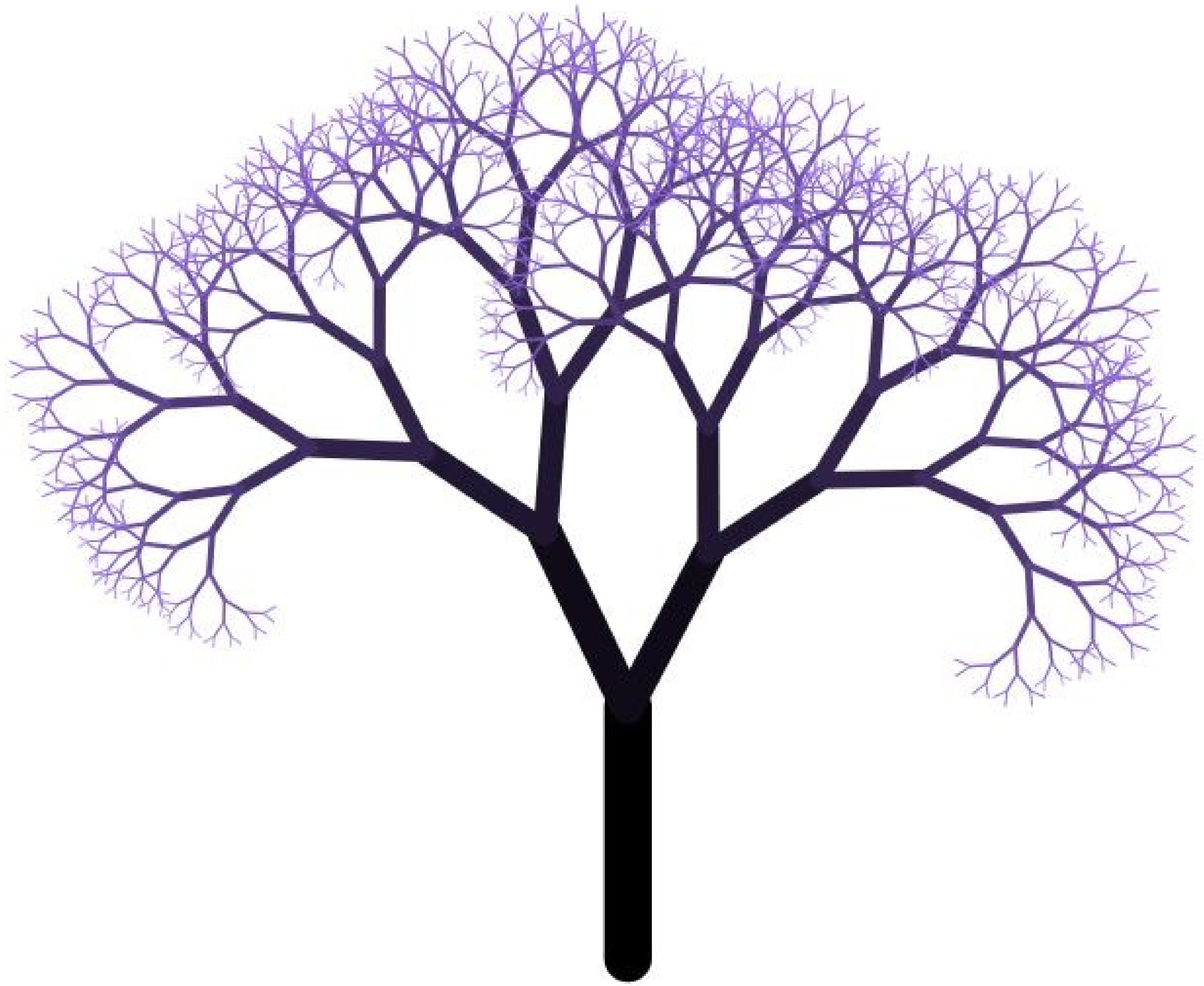

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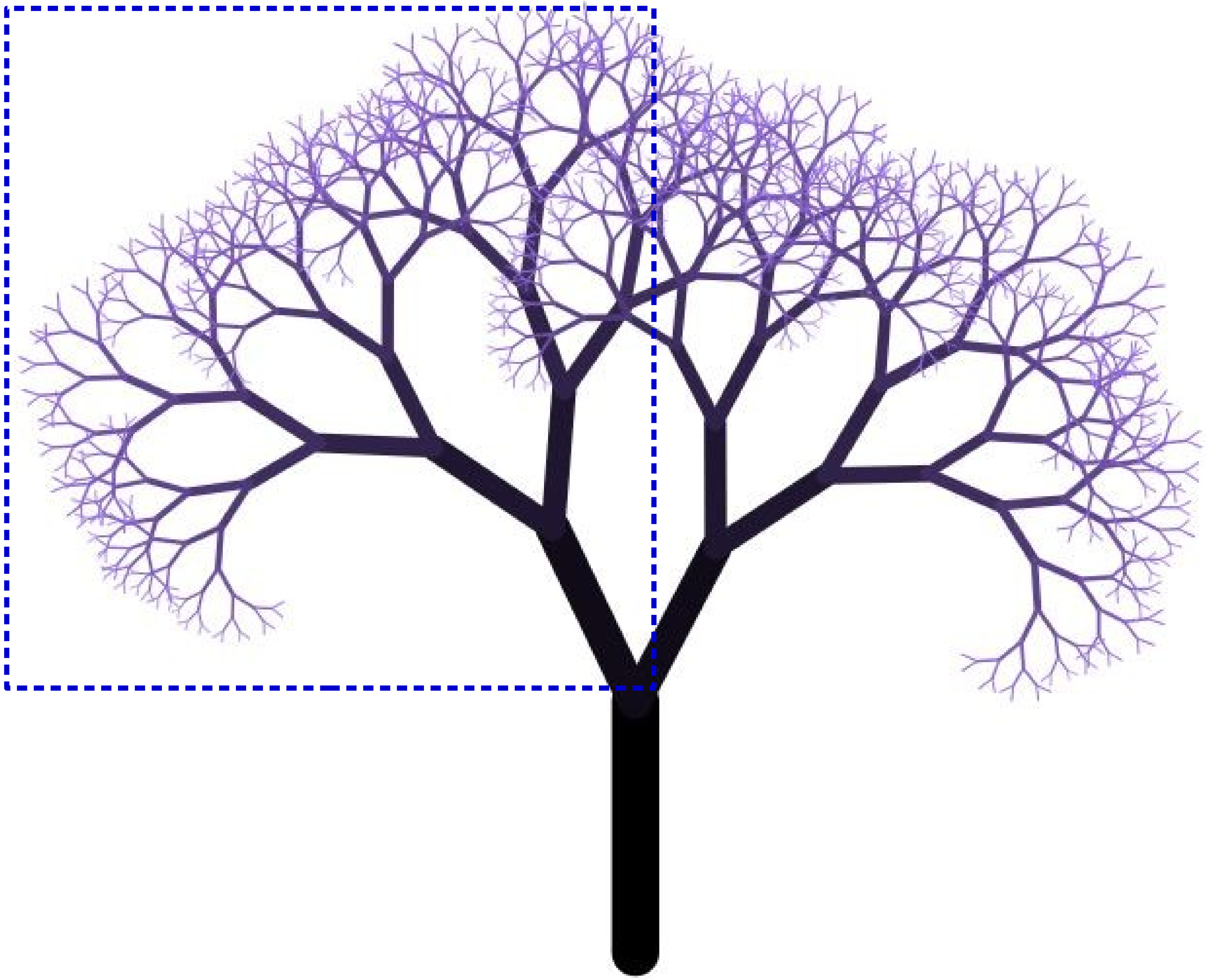
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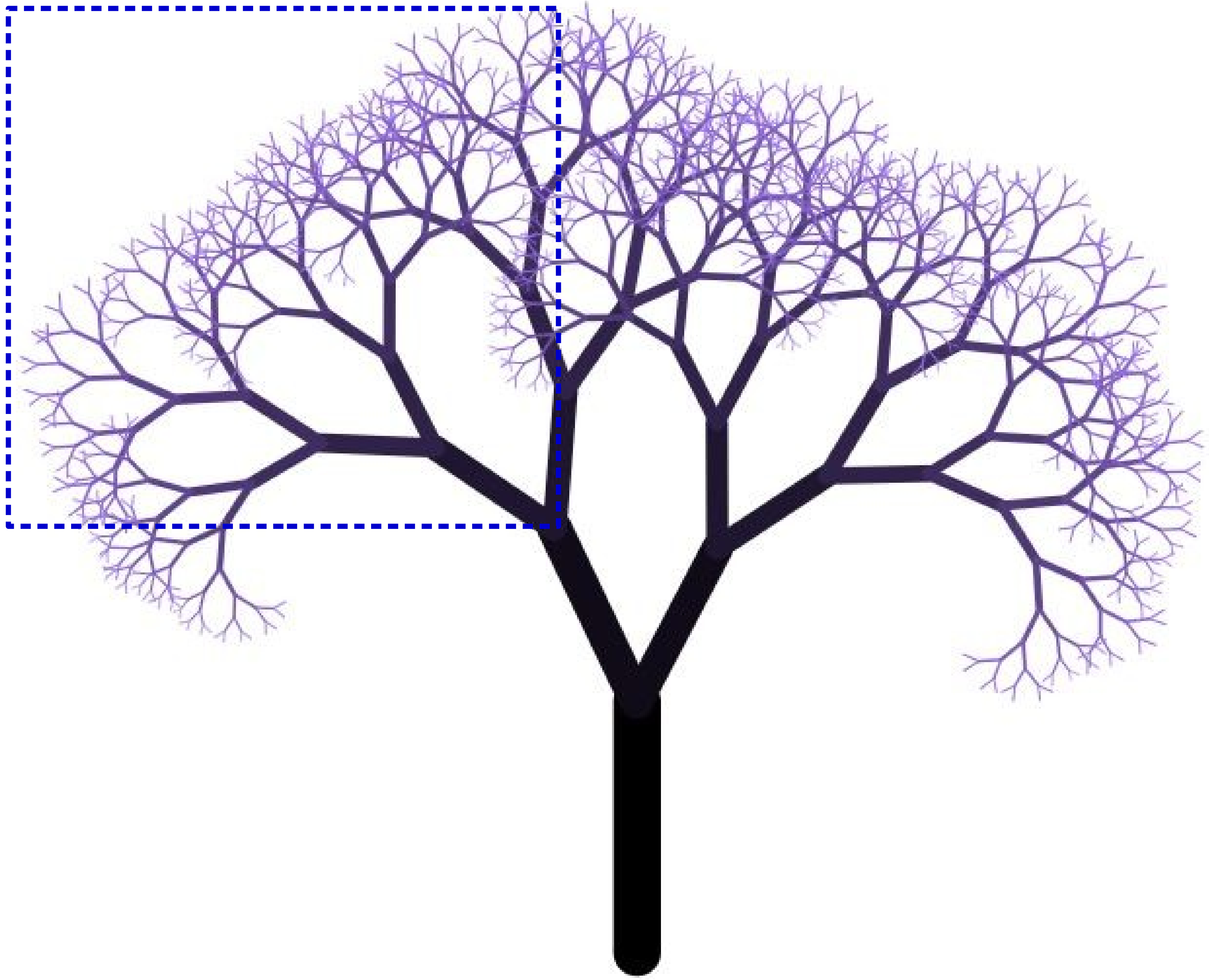
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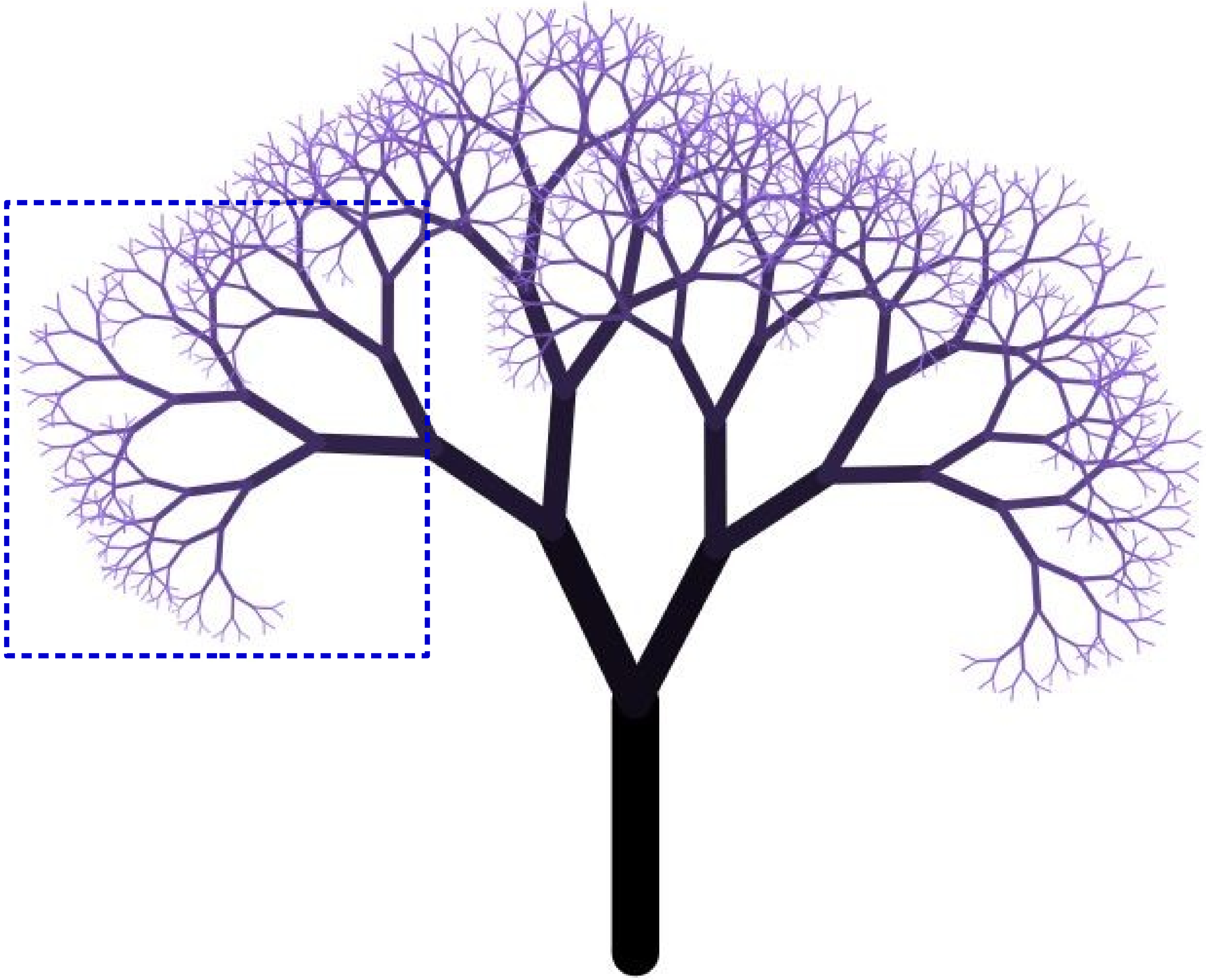

http://www.marketoracle.co.uk/images/2010/Oct/fractal-tree2.jpg

A ***recursive solution*** is a solution that is defined in terms of itself.

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Source: https://datacenterfrontier.com/year-hyperscale-facebook-growth-innovation/

There are many ways to solve the same problem. How do we ***quantitatively*** talk about how they compare?

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- Theater and Performing Studies
- ***Undeclared!***

Transitioning to C++

Transitioning to C++

- I’m assuming that the majority of you are either coming out of CS106A in Python coming from AP CS in Java.
- In this course, we’ll use the C++ programming language.
- Learning a second programming language is way easier than learning a first. You already know how to solve problems; you just need to adjust the syntax you use.

Our First C++ Program

Perfect Numbers

- A positive integer n is called a ***perfect number*** if it's equal to the sum of its positive divisors (excluding itself).
- For example:
  - 6 is perfect since 1, 2, and 3 divide 6 and $1 + 2 + 3 = 6$.
  - 28 is perfect since 1, 2, 4, 7, and 14 divide 28 and $1 + 2 + 4 + 7 + 14 = 28$.
  - 35 isn't perfect, since 1, 5, and 7 divide 35 and $1 + 5 + 7 \neq 35$.
- Let's find the first four perfect numbers.

```python
def sumOfDivisorsOf(n):
    """Returns the sum of the positive divisors of the number n >= 0."""
    total = 0

    for i in range(1, n):
        if n % i == 0:
            total += i



    return total



found = 0   # How many perfect numbers we've found
number = 1  # Next number to test

# Keep looking until we've found four perfect numbers.
while found < 4:
    # A number is perfect if the sum of its divisors is equal to it.
    if sumOfDivisorsOf(number) == number:
        print(number)
        found += 1


    number += 1
```

```
#include <iostream>
using namespace std;

/* Returns the sum of the positive divisors of the number n >= 0. */
int sumOfDivisorsOf(int n) {
    int total = 0;

    for (int i = 1; i < n; i++) {
        if (n % i == 0) {
            total += i;
        }
    }

    return total;
}

int main() {
    int found = 0;  // How many perfect numbers we've found
    int number = 1; // Next number to test

    /* Keep looking until we've found four perfect numbers. */
    while (found < 4) {
        /* A number is perfect if the sum of its divisors is equal to it. */
        if (sumOfDivisorsOf(number) == number) {
            cout << number << endl;
            found++;
        }

        number++;
    }

    return 0;
}
```

```cpp
#include <iostream>
using namespace std;

/* Returns the sum of the positive divisors of the number n >= 0. */
int sumOfDivisorsOf(int n) {
    int total = 0;

    for (int i = 1; i < n; i++) {
        if (n % i == 0) {
            total += i;
        }
    }

    return total;
}

int main() {
    int found = 0;  // How many perfect numbers we've found
    int number = 1; // Next number to test

    /* Keep looking until we've found four perfect numbers. */
    while (found < 4) {
        /* A number is perfect if the sum of its divisors is equal to it. */
        if (sumOfDivisorsOf(number) == number) {
            cout << number << endl;
            found++;
        }

        number++;
    }

    return 0;
}
```

In Python, indentation alone determines nesting.

In C++, indentation is nice, but ***curly braces*** alone determine nesting.

```
#include <iostream>
using namespace std;

/* Returns the sum of the positive divisors of the number n >= 0. */
int sumOfDivisorsOf(int n) {
    int total = 0;

    for (int i = 1; i < n; i++) {
        if (n % i == 0) {
            total += i;
        }
    }

    return total;
}

int main() {
    int found = 0;  // How many perfect numbers we've found
    int number = 1; // Next number to test

    /* Keep looking until we've found four perfect numbers. */
    while (found < 4) {
        /* A number is perfect if the sum of its divisors is equal to it. */
        if (sumOfDivisorsOf(number) == number) {
            cout << number << endl;
            found++;
        }

        number++;
    }

    return 0;
}
```

In Python, newlines mark the end of statements.

In C++, individual statements must have a semicolon (;) after them.

```
#include <iostream>
using namespace std;

/* Returns the sum of the positive divisors of the number n >= 0. */
int sumOfDivisorsOf(int n) {
    int total = 0;

    for (int i = 1; i < n; i++) {
        if (n % i == 0) {
            total += i;
        }
    }

    return total;
}

int main() {
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        /* A number is perfect if the sum of its divisors is equal to it. */
        if (sumOfDivisorsOf(number) == number) {
            cout << number << endl;
            found++;
        }

        number++;
    }

    return 0;
}
```

In Python, you print output by using `print()`.

In C++, you use the ***stream insertion operator*** (<<) to push data to the console. (Pushing `endl` prints a newline.)

```cpp
#include <iostream>
using namespace std;

/* Returns the sum of the positive divisors of the number n >= 0. */
int sumOfDivisorsOf(int n) {
    int total = 0;

    for (int i = 1; i < n; i++) {
        if (n % i == 0) {
            total += i;
        }
    }

    return total;
}

int main() {
    int found = 0;  // How many perfect numbers we've found
    int number = 1; // Next number to test

    /* Keep looking until we've found four perfect numbers. */
    while (found < 4) {
        /* A number is perfect if the sum of its divisors is equal to it. */
        if (sumOfDivisorsOf(number) == number) {
            cout << number << endl;
            found++;
        }

        number++;
    }

    return 0;
}
```

In Python, you can optionally put parentheses around conditions in `if` statements and `while` loops.

In C++, these are mandatory.

```
#include <iostream>
using namespace std;

/* Returns the sum of the positive divisors of the number n >= 0. */
int sumOfDivisorsOf(int n) {
    int total = 0;

    for (int i = 1; i < n; i++) {
        if (n % i == 0) {
            total += i;
        }
    }

    return total;
}

int main() {
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    /* Keep looking until we've found four perfect numbers. */
    while (found < 4) {
        /* A number is perfect if the sum of its divisors is equal to it. */
        if (sumOfDivisorsOf(number) == number) {
            cout << number << endl;
            found++;
        }

        number++;
    }

    return 0;
}
```

Python and C++ each have `for` loops, but the syntax is different. (Check the textbook for more details about how this works!)

```
#include <iostream>
using namespace std;

/* Returns the sum of the positive divisors of the number n >= 0. */
int sumOfDivisorsOf(int n) {
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    for (int i = 1; i < n; i++) {
        if (n % i == 0) {
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        }
    }

    return total;
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int main() {
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    /* Keep looking until we've found four perfect numbers. */
    while (found < 4) {
        /* A number is perfect if the sum of its divisors is equal to it. */
        if (sumOfDivisorsOf(number) == number) {
            cout << number << endl;
            found++;
        }

        number++;
    }

    return 0;
}
```

C++ has an operator ++ that means “add one to this variable’s value.” Python doesn’t have this.

```cpp
#include <iostream>
using namespace std;

/* Returns the sum of the positive divisors of the number n >= 0. */
int sumOfDivisorsOf(int n) {
    int total = 0;

    for (int i = 1; i < n; i++) {
        if (n % i == 0) {
            total += i;
        }
    }

    return total;
}

int main() {
    int found = 0;  // How many perfect numbers we've found
    int number = 1; // Next number to test

    /* Keep looking until we've found four perfect numbers. */
    while (found < 4) {
        /* A number is perfect if the sum of its divisors is equal to it. */
        if (sumOfDivisorsOf(number) == number) {
            cout << number << endl;
            found++;
        }

        number++;
    }

    return 0;
}
```

In Python, comments start with # and continue to the end of the line.

In C++, there are two styles of comments. Comments that start with /* continue until */. Comments that start with // continue to the end of the line.

```cpp
#include <iostream>
using namespace std;

/* Returns the sum of the positive divisors of the number n >= 0. */
int sumOfDivisorsOf(int n) {
    int total = 0;

    for (int i = 1; i < n; i++) {
        if (n % i == 0) {
            total += i;
        }
    }

    return total;
}

int main() {
    int found = 0;  // How many perfect numbers we've found
    int number = 1; // Next number to test

    /* Keep looking until we've found four perfect numbers. */
    while (found < 4) {
        /* A number is perfect if the sum of its divisors is equal to it. */
        if (sumOfDivisorsOf(number) == number) {
            cout << number << endl;
            found++;
        }

        number++;
    }

    return 0;
}
```

In Python, each object has a type, but it isn't stated explicitly.

In C++, you *must* give a type to each variable. (The `int` type represents an integer.)

```cpp
#include <iostream>
using namespace std;

/* Returns the sum of the positive divisors of the number n >= 0. */
int sumOfDivisorsOf(int n) {
    int total = 0;

    for (int i = 1; i < n; i++) {
        if (n % i == 0) {
            total += i;
        }
    }

    return total;
}

int main() {
    int found = 0;  // How many perfect numbers we've found
    int number = 1; // Next number to test

    /* Keep looking until we've found four perfect numbers. */
    while (found < 4) {
        /* A number is perfect if the sum of its divisors is equal to it. */
        if (sumOfDivisorsOf(number) == number) {
            cout << number << endl;
            found++;
        }

        number++;
    }

    return 0;
}
```

In Python, statements can be either in a function or at the top level of the program.

In C++, all statements must be inside of a function.

Why do we have both C++ and Python?

C++ and Python

- Python is a *great* language for data processing and writing quick scripts across all disciplines.
  - It’s pretty quick to make changes to Python programs and then run them to see what’s different.
  - Python programs, generally, run more slowly than C++ programs.
- C++ is a *great* language for writing high-performance code that takes advantage of underlying hardware.
  - Compiling C++ code introduces some delays between changing the code and running the code.
  - C++ programs, generally, run much faster than Python programs.
- Knowing both languages helps you use the right tool for the right job.

Your Action Items

- ***Read Chapter 1 of the textbook.***
  - Use this as an opportunity to get comfortable with the basics of C++ programming and to read more examples of C++ code.
- ***Start Assignment 0.***
  - Assignment 0 is due this Friday at the start of class (11:30AM Pacific time). Starter files and assignment handout are up on the course website.
  - No programming involved, but you'll need to get your development environment set up.
  - There's a bunch of documentation up on the course website. Please feel free to reach out to us if there's anything we can do to help out!

Next Time

- ***Welcome to C++!***
  - Defining functions.
  - Reference parameters.
  - Introduction to recursion.