Welcome to CS106B!

Who's Here Today?

- Aero/Astro
- African/Afro-American Studies
- Anthropology
- Applied Physics
- Bioengineering
- Biology
- Business
- CME
- Cancer Biology
- Chemistry
- Chinese
- CEE
- Computer Science
- Economics
- EE
- Energy Resources Engineering
- Engineering
- Environmental Systems Engineering
- Film and Media Studies
- Geophysics
- Human Biology
- International Policy
- IR
- Law
- MCS
- MS&E
- Materials Science and Engineering
- Mathematics
- MechE
- Medicine
- Music
- Philosophy
- Public Policy
- STS
- Sociology
- Statistics
- Structural Biology
- Symbolic Systems
- ***Undeclared!***
- Urban Studies

Course Staff

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The CS106B Section Leaders

Prerequisites

CS106A

(or equivalent)
*(check out our **course placement page** if you're unsure!)*

Course Website

https://cs106b.stanford.edu

We also have a course Canvas site, which is mostly there for lecture videos and to link you to other resources.

Live Q&A

- Visit our EdStem page. It's linked through the course Canvas and also available here:

  https://edstem.org/us/courses/32194/

- Next, find the pinned thread at the top entitled

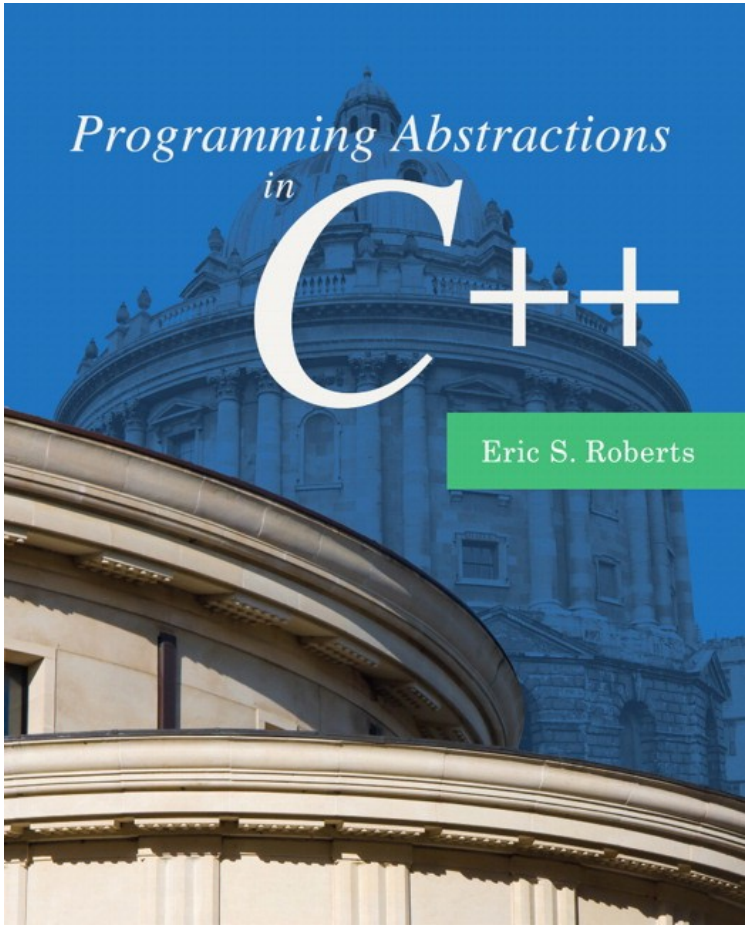
  L00: Introduction

- Once you've found that thread, give it a ❤ to let us know you've found it.
- Feel free to post questions here during lecture – we can then answer asynchronously.
- You're always welcome to raise your hand if you have any questions!

60-Minute Lectures

- We have an 80-minute time slot for lectures this quarter, but we'll only use 60 of those minutes (1:30PM – 2:30PM Pacific).
- Compared with a traditional 50-minute lecture, those extra ten minutes give us time to
  - answer your questions,
  - explore and tinker with code,
  - go at a more leisurely pace, and
  - let you play around with the material.
- I'll stick around for the remaining 20 minutes of our time block to chat with folks one-on-one about whatever it is that you're interested in.

Our Textbook



- Our course textbook is ***Programming Abstractions in C++*** by the legendary Eric Roberts.
  - There's a ***draft version*** available online.
- We've assigned readings for each lecture. You can either do them before or after the lectures – your choice.

Discussion Sections

- Starting next week, we'll be holding weekly discussion sections.
- We have our own section signup system that is independent of the one run by Axess.
- Sign up between Thursday, January 12th at 5:00PM Pacific and Sunday, January 15th at 5:00PM Pacific by visiting

  https://cs198.stanford.edu/cs198/auth/default.aspx
- 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.

Optional Add-Ons

- There are three one-unit courses you can optionally add on to CS106B.
- These are *in addition to* rather than *in place of* a regular discussion section.
  - CS100B offers additional practice and support with the material from CS106B in a small group setting. The application is ***available online here***.
  - CS106L provides a deep dive into the C++ programming language beyond what we'll cover in CS106B.
  - CS106S explores applications of the CS106B material to social good.
- Feel free to chat with us about these courses after class if you want to learn more!

Grading Policies

Grading Policies

40% Assignments

Eight Coding Assignments

Plus an intro assignment that goes out today and is due Friday.

Grading Policies

Midterm Exam

Monday, February 13th
7PM – 10PM

Grading Policies

- 40% Assignments
- 20% Midterm Exam
- 30% Final Exam

Final Exam

Monday, March 20th
8:30AM – 11:30AM

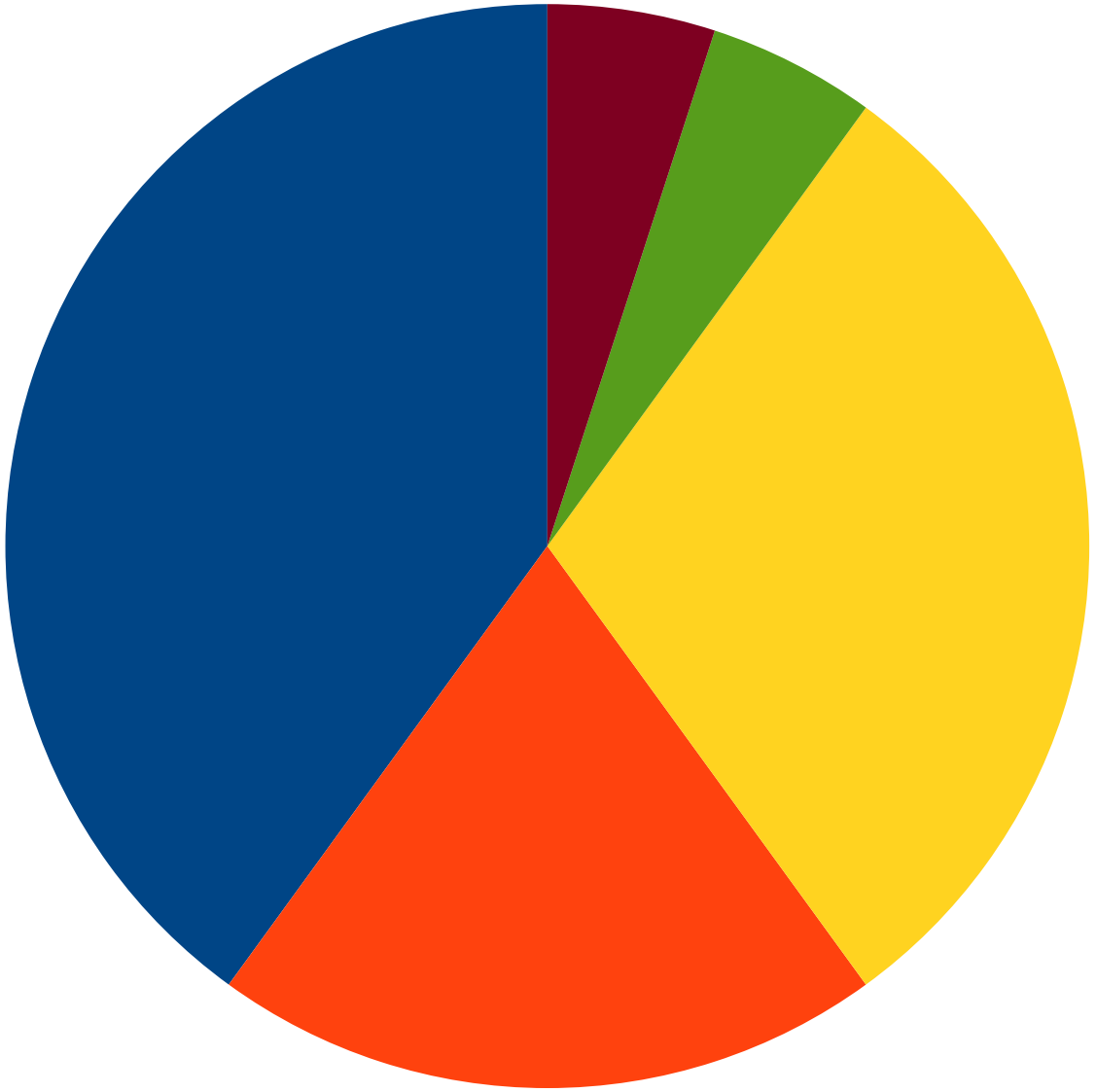
Grading Policies

- 40% Assignments
- 20% Midterm Exam
- 30% Final Exam
- 5% Section Participation

Discussion Sections

Our world-famous discussion sections!

Grading Policies



- 40% Assignments
- 20% Midterm Exam
- 30% Final Exam
- 5% Section Participation
- 5% Lecture Participation

Lecture Participation

Starts next week. We'll discuss details later this week.

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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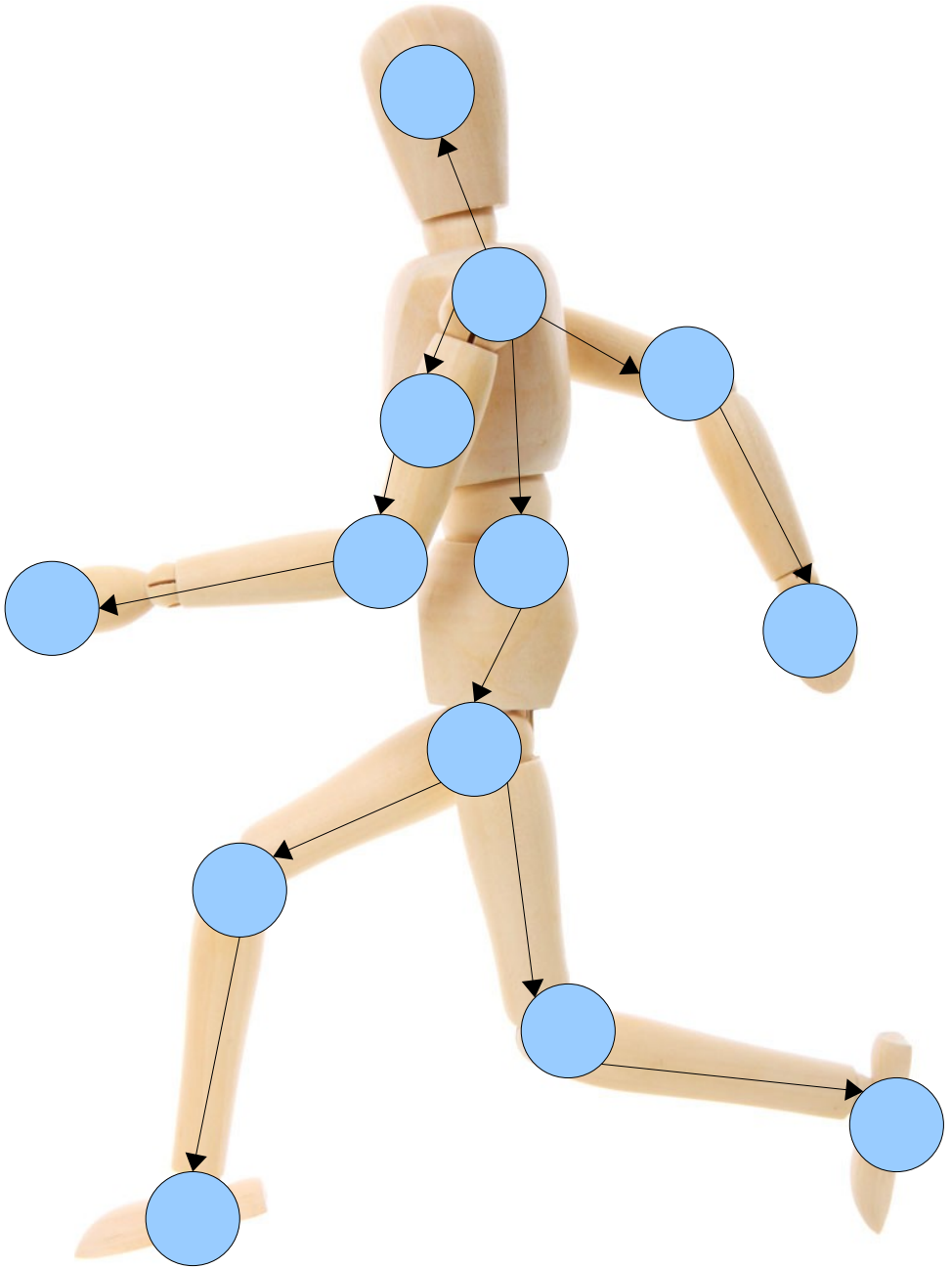

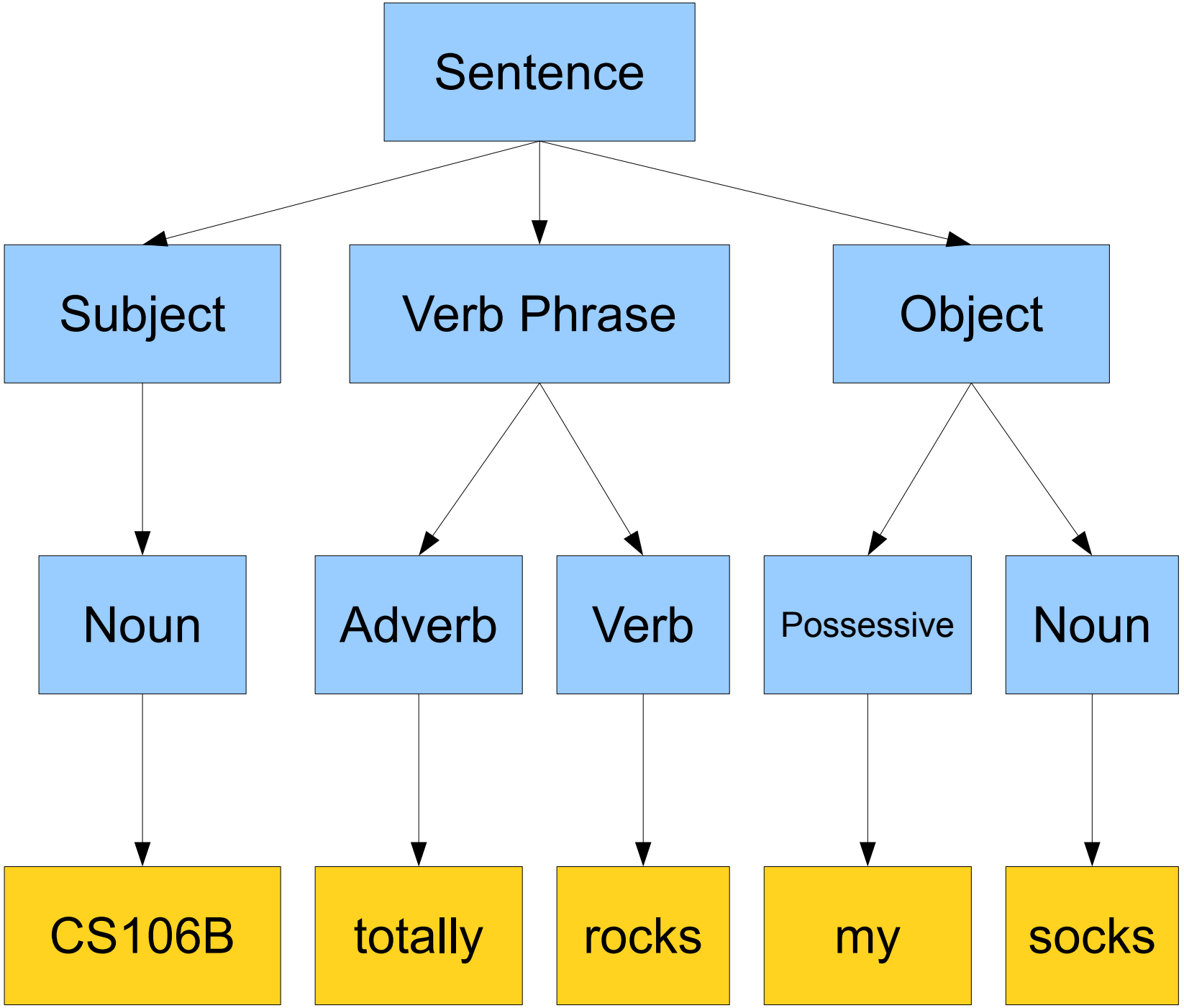
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Subject
Verb Phrase
Object
Noun
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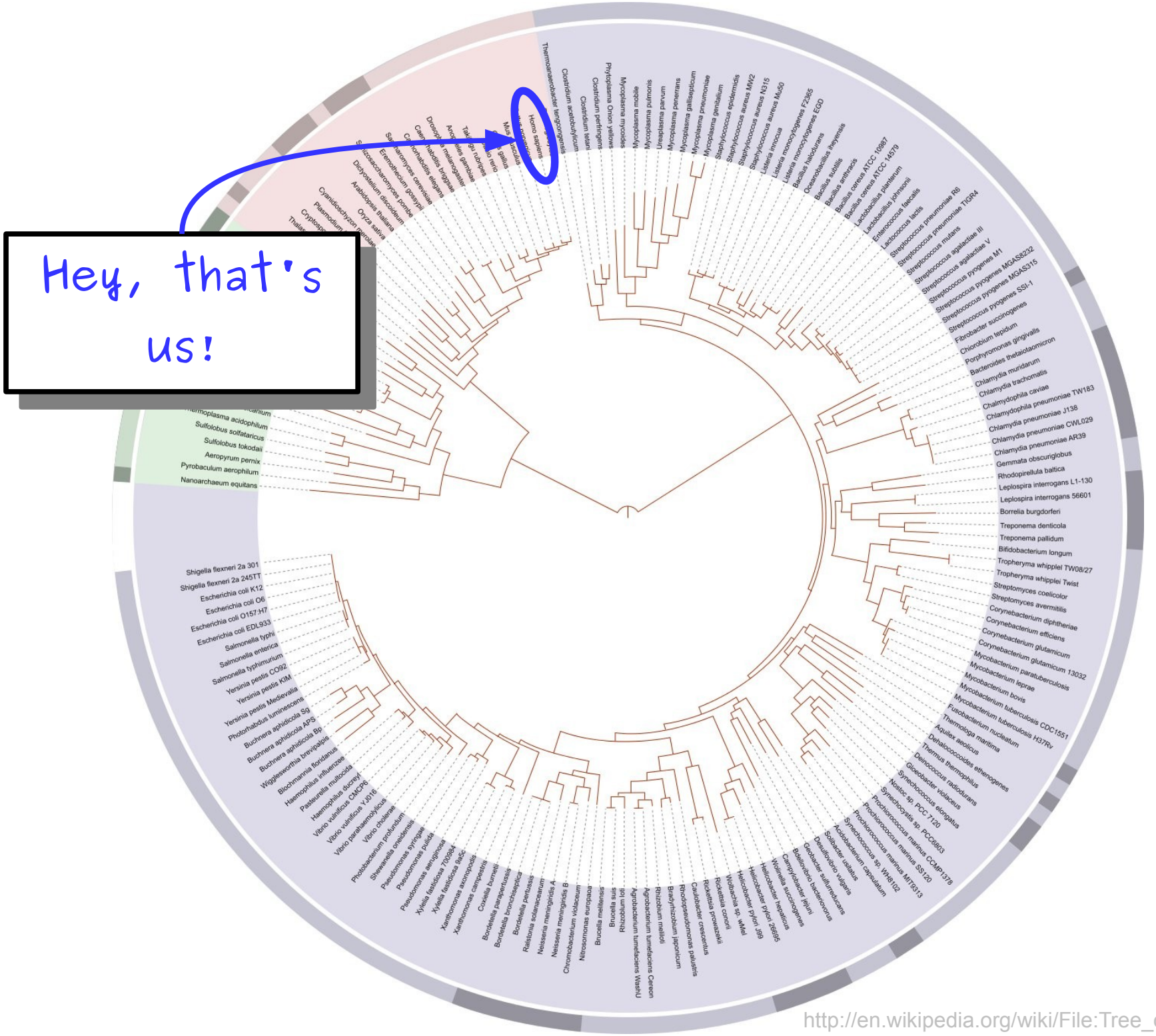
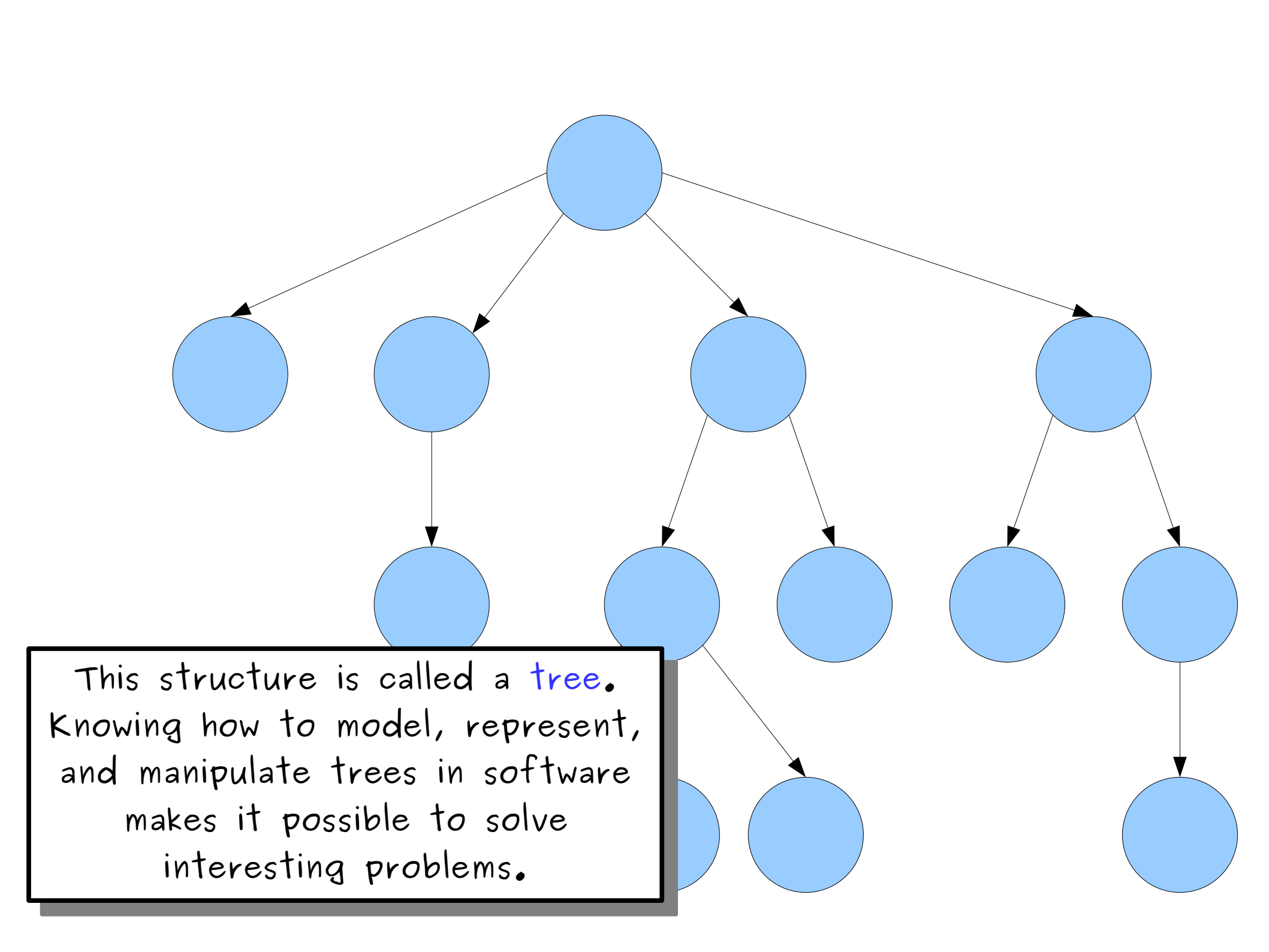
Possessive
Noun
CS106B
totally
rocks
my
socks




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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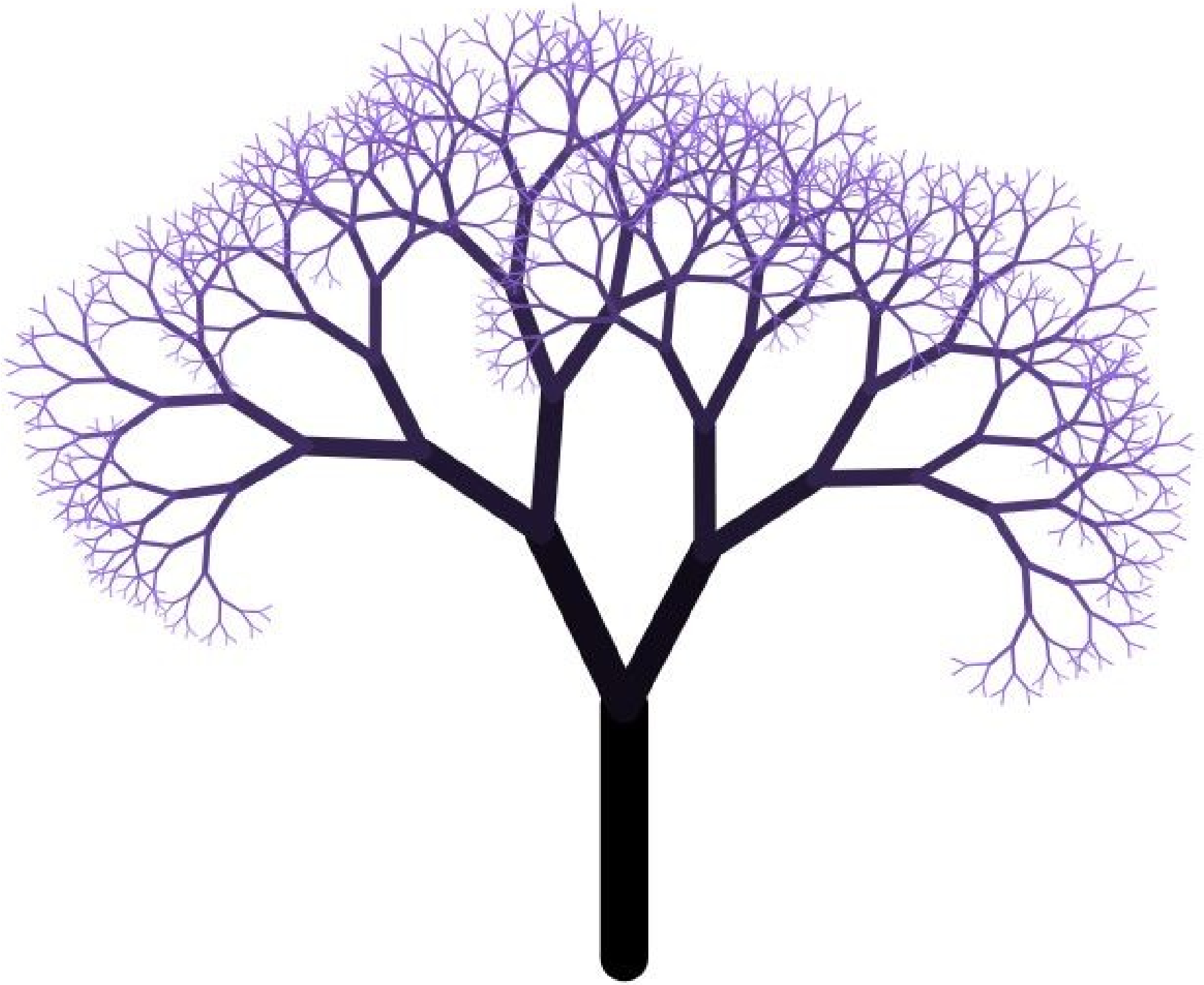

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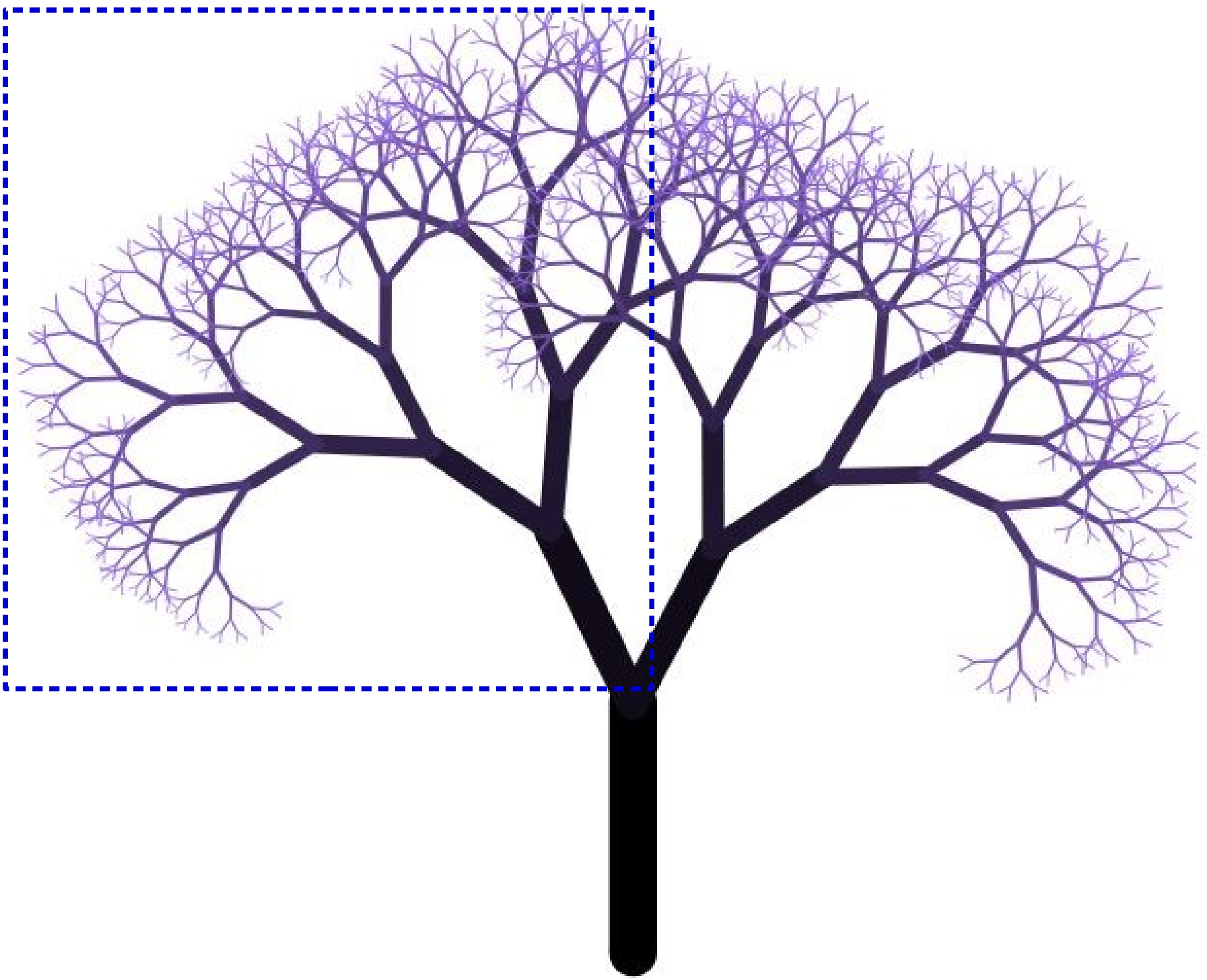

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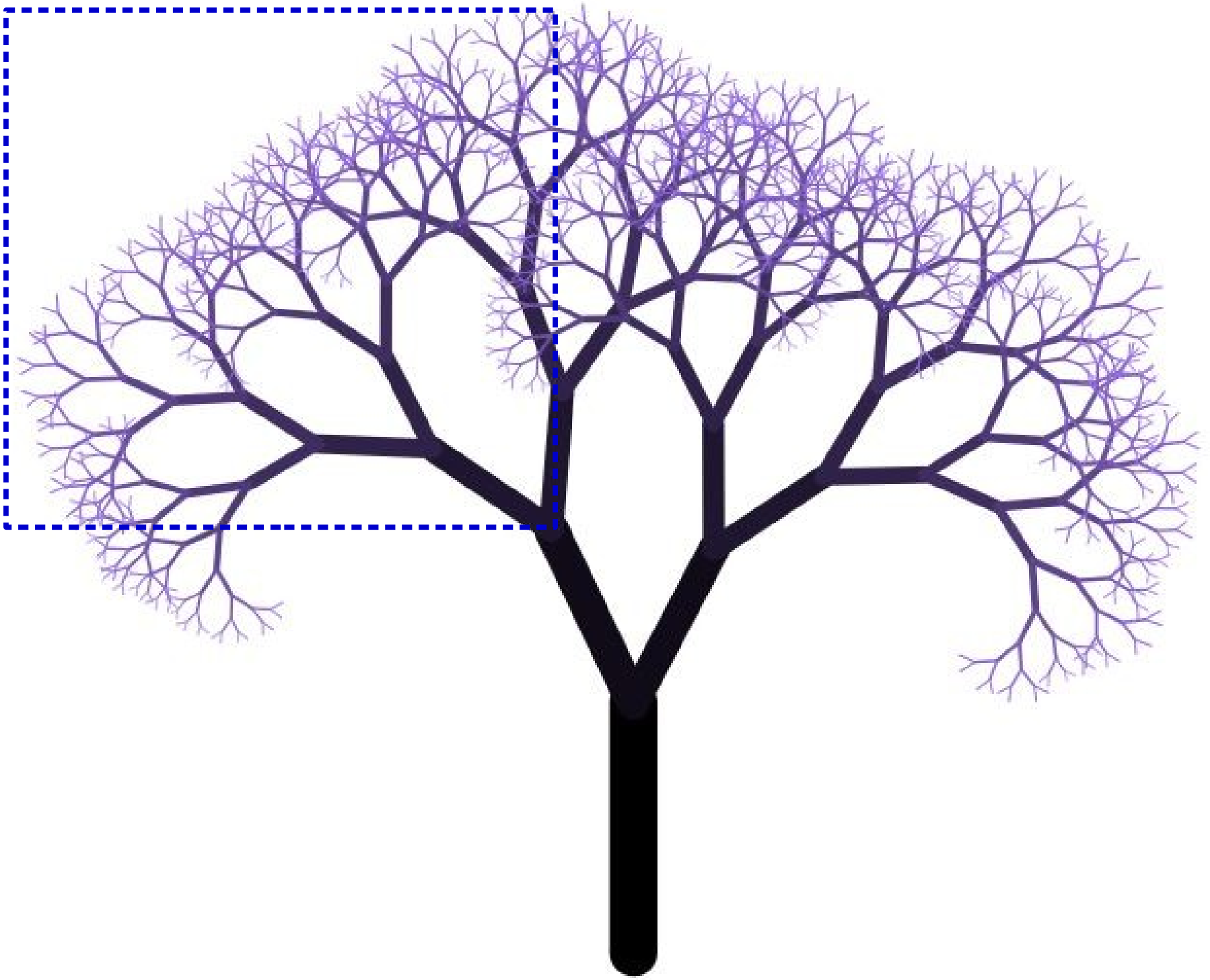

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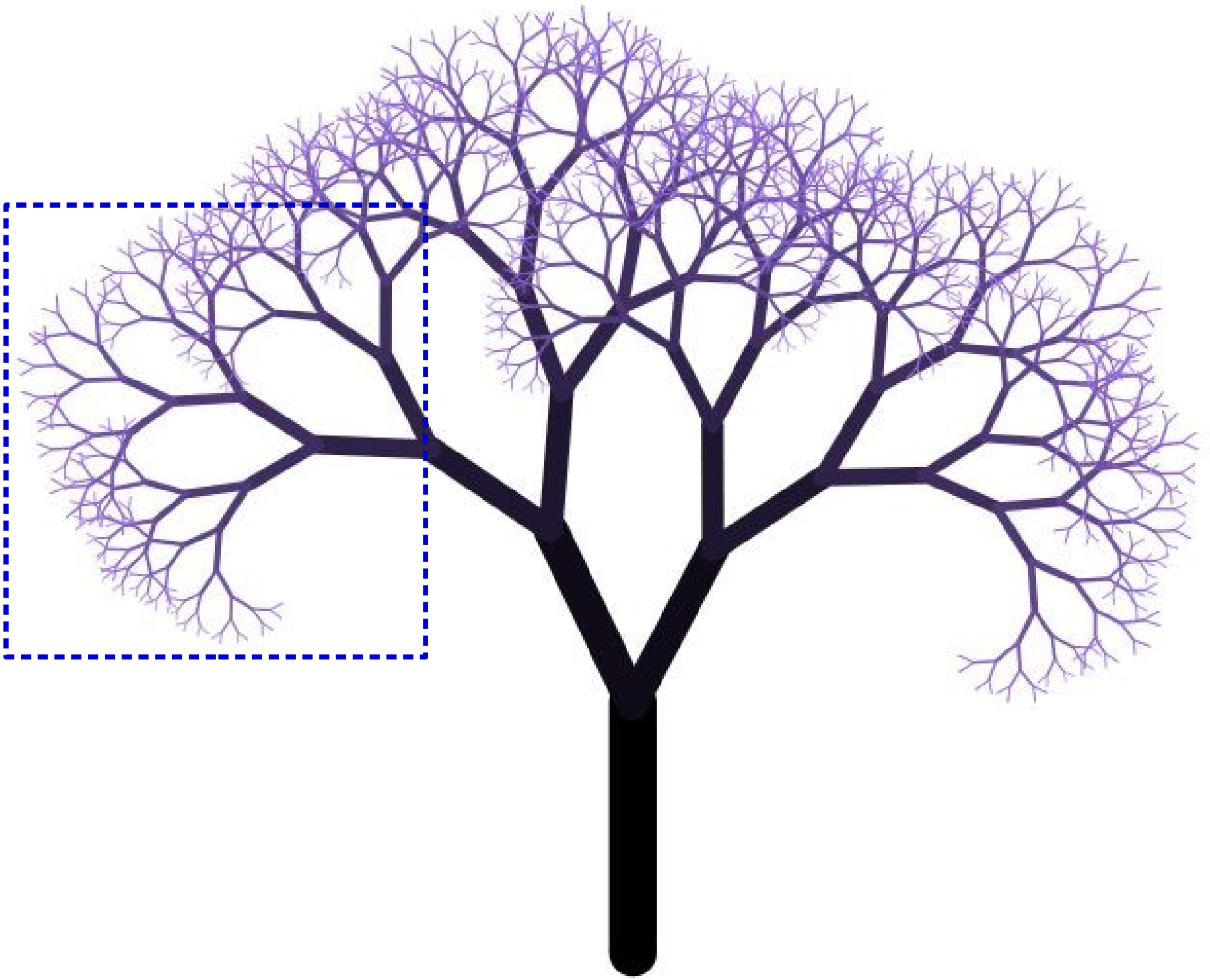

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A ***recursive solution*** is a solution that is defined in terms of itself.

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

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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 ***substantially*** easier than learning a first.
  - You already know how to solve problems; you just need to adjust the syntax you use.
- While the languages are superficially different, they have much in common.

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.

```
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
```

```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;
}
```

```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;
}
```

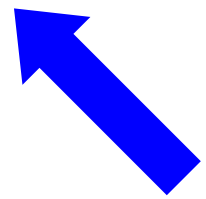
In Python, indentation alone determines nesting.

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

```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;  // H                                    nd
    int number = 1; // N

    /* Keep looking unti                                   s. */
    while (found < 4) {
        /* A number is p                                   is equal to it. */
        if (sumOfDivisors                                   {
            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.



```
total += i;
```

```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++) {
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        }
    }

    return total;
}

int main() {
    int found = 0;  // How many perfect numbers we've found
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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;
}
```

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++) {
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int main() {
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        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.

```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
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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!)

```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() {
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    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;
}
```

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++) {
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        }
    }

    return total;
}

int main() {
    int found = 0;  // How many perfect numbers we've found
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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;
}
```

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++, most 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 half an hour before the start of class (1:00PM Pacific time). The assignment and its starter files 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.
  - Basic arithmetic.
  - Writing loops.