61A Lecture 1

Wednesday, August 23, 2017 (or perhaps even earlier)
Welcome to CS 61A!
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You have two instructors this semester
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John DeNero
denero@berkeley.edu
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Office hours in 781 Soda
(starting next week)
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By appointment: denero.org/meet.html
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Contact both of us & heads of staff: cs61a@berkeley.edu
The 61A Community
The 61A Community

53 teaching assistants (TAs), formally known at Berkeley as UGSIs:
The 61A Community

53 teaching assistants (TAs), formally known at Berkeley as UGSIs:
• Teach lab & discussion sections
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- Lots of other stuff: develop assignments, grade exams, etc.
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50+ tutors & mentors:
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200+ lab assistants help answer individual questions & check your progress
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1,900+ fellow students make CS 61A unique
Parts of the Course
Parts of the Course

**Lecture:** Videos posted to cs61a.org before each live lecture
Parts of the Course

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**Lab section:** The most important part of this course (next week)
Parts of the Course

**Lecture:** Videos posted to cs61a.org before each live lecture

**Lab section:** The most important part of this course *(next week)*

**Discussion section:** The most important part of this course *(this week)*
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**Online textbook:** http://composingprograms.com
Parts of the Course

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Weekly homework assignments, three exams, & four programming projects
Parts of the Course

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**Lab section:** The most important part of this course (*next week*)

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**Online textbook:** [http://composingprograms.com](http://composingprograms.com)

Weekly homework assignments, three exams, & four programming projects

Lots of optional special events to help you complete all this work
An Introduction to Computer Science
What is Computer Science?
What is Computer Science?

The study of
What is Computer Science?

The study of what problems can be solved using computation,
What is Computer Science?

The study of

What problems can be solved using computation,

How to solve those problems, and
What is Computer Science?

The study of

- What problems can be solved using computation,
- How to solve those problems, and
- What techniques lead to effective solutions
What is Computer Science?

The study of

What problems can be solved using computation,
How to solve those problems, and
What techniques lead to effective solutions

Systems
What is Computer Science?

The study of systems, artificial intelligence, and the problems that can be solved using computation, how to solve those problems, and what techniques lead to effective solutions.
What is Computer Science?

- What problems can be solved using computation,
- How to solve those problems, and
- What techniques lead to effective solutions

The study of

Systems

Artificial Intelligence

Graphics
What is Computer Science?

The study of

What problems can be solved using computation,
How to solve those problems, and
What techniques lead to effective solutions

Systems
Artificial Intelligence
Graphics
Security
What is Computer Science?

The study of

What problems can be solved using computation,
How to solve those problems, and
What techniques lead to effective solutions

Systems
Artificial Intelligence
Graphics
Security
Networking
Programming Languages
Theory
Scientific Computing
...

What is Computer Science?

The study of

What problems can be solved using computation,
How to solve those problems, and
What techniques lead to effective solutions

Systems
Artificial Intelligence
Graphics
Security
Networking
Programming Languages
Theory
Scientific Computing
...
What is Computer Science?

The study of

- What problems can be solved using computation,
- How to solve those problems, and
- What techniques lead to effective solutions

Systems

Artificial Intelligence

Decision Making

Graphics

Security

Networking

Programming Languages

Theory

Scientific Computing

...
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The study of

What problems can be solved using computation,
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Systems
Artificial Intelligence
Graphics
Security
Networking
Programming Languages
Theory
Scientific Computing

Decision Making

Robotics
What is Computer Science?

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What problems can be solved using computation,
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Systems
Artificial Intelligence
Graphics
Security
Networking
Programming Languages
Theory
Scientific Computing

Decision Making
Robotics
Natural Language Processing
What is Computer Science?

The study of

- What problems can be solved using computation,
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Systems

Artificial Intelligence

- Decision Making

Graphics

- Robotics

Security

Natural Language Processing

Networking

Programming Languages

- ...

Theory

Scientific Computing

...
What is Computer Science?

What problems can be solved using computation,
How to solve those problems, and
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The study of

Systems
Artificial Intelligence
Decision Making
Graphics
Robotics
Security
Natural Language Processing
Networking
...
Programming Languages
...
Theory
Scientific Computing
...
What is Computer Science?

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Graphics

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Artificial Intelligence
Graphics
Security
Networking
Programming Languages
Theory
Scientific Computing

Decision Making
Robotics
Natural Language Processing
Answering Questions
Translation

...
What is Computer Science?

The study of

- What problems can be solved using computation,
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- Systems
- Artificial Intelligence
- Graphics
- Security
- Networking
- Programming Languages
- Theory
- Scientific Computing

- Decision Making
- Robotics
- Natural Language Processing
- Answering Questions
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- ...
What is This Course About?
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A course about managing complexity
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A course about managing complexity

Mastering abstraction
What is This Course About?

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Programming paradigms
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- Mastering abstraction
- Programming paradigms

An introduction to programming
What is This Course About?

A course about managing complexity

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Programming paradigms

An introduction to programming

Full understanding of Python fundamentals
What is This Course About?

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Combining multiple ideas in large projects
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How computers interpret programming languages
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How computers interpret programming languages

Different types of languages: Scheme & SQL
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Mastering abstraction

Programming paradigms

An introduction to programming

Full understanding of Python fundamentals

Combining multiple ideas in large projects

How computers interpret programming languages

Different types of languages: Scheme & SQL

A challenging course that will demand a lot of you
Alternatives to CS 61A
CS 10: The Beauty and Joy of Computing
CS 10: The Beauty and Joy of Computing

Designed for students without prior experience
CS 10: The Beauty and Joy of Computing

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A programming environment created by Berkeley, now used in courses around the world and online
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An introduction to fundamentals (and Python) that sets students up for success in CS 61A
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50 seats available as of Tuesday 8/22 (but these will likely fill up)
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More info: http://cs10.org/fa17/
Data Science 8: Foundations of Data Science

Fundamentals of computing, statistical inference, & machine learning applied to real-world data sets
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More statistics than computer science
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Great programming practice for CS 61A
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More info: http://data8.org/fa17
Course Policies
Learning
Course Policies

Learning Community
Course Policies

Learning

Community

Course Staff

Details...

http://cs61a.org/articles/about.html
Collaboration
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Asking questions is highly encouraged
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- Discuss everything with each other; learn from your fellow students!
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• Projects 3 & 4 can be completed with a partner
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The limits of collaboration
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**The limits of collaboration**
- One simple rule: Don’t share your code, except with your project partner
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Build good habits now
Expressions
Types of expressions
Types of expressions

An expression describes a computation and evaluates to a value
Types of expressions

An expression describes a computation and evaluates to a value

18 + 69
Types of expressions

An expression describes a computation and evaluates to a value

\[ 18 + 69 = \frac{6}{23} \]
Types of expressions

An expression describes a computation and evaluates to a value

\[
18 + 69 = \frac{6}{23} = \sqrt{3493161}
\]
Types of expressions

An expression describes a computation and evaluates to a value

\[ 18 + 69 \]

\[ \sin \pi \]

\[ \frac{6}{23} \]

\[ \sqrt{3493161} \]
Types of expressions

An expression describes a computation and evaluates to a value

\[
\begin{align*}
18 + 69 & \quad \frac{6}{23} & \sin \pi \\
\sqrt{3493161} & \quad | - 1869 |
\end{align*}
\]
Types of expressions

An expression describes a computation and evaluates to a value

\[ 18 + 69 \]
\[ \frac{6}{23} \]
\[ \sin \pi \]
\[ \sqrt{3493161} \]
\[ \sum_{i=1}^{100} i \]
\[ | - 1869| \]
Types of expressions

An expression describes a computation and evaluates to a value

\[ 18 + 69 \quad \frac{6}{23} \quad \sin \pi \quad \sqrt{3493161} \]

\[ \sum_{i=1}^{100} i \quad (69) \quad (18) \]

\[ | - 1869| \]
Types of expressions

An expression describes a computation and evaluates to a value

\[ f(x) \]

\[ \sqrt{3493161} \]

\[ 18 + 69 \]

\[ \frac{6}{23} \]

\[ \sin \pi \]

\[ \sum_{i=1}^{100} i \]

\[ | -1869| \]

\[ \begin{pmatrix} 69 \\ 18 \end{pmatrix} \]
Types of expressions

An expression describes a computation and evaluates to a value

\[ 18 + 69 \]
\[ \frac{6}{23} \]
\[ \sin \pi \]
\[ 2^{100} \]
\[ f(x) \]
\[ \frac{\sqrt{3493161}}{100} \]
\[ \sum_{i=1}^{100} i \]
\[ | - 1869| \]
\[ (69) \]
\[ 18 \]
Types of expressions

An expression describes a computation and evaluates to a value

\[ 18 + 69 \quad \frac{6}{23} \quad \sin \pi \quad \log_2 1024 \]

\[ 2^{100} \]

\[ f(x) \quad \sum_{i=1}^{100} i \]

\[ \sqrt{3493161} \]

\[ | - 1869| \]

\[ \binom{69}{18} \]
Types of expressions

An expression describes a computation and evaluates to a value

\[
18 + 69 \\
\frac{6}{23} \\
\sin \pi \\
\log_2 1024 \\
2^{100} \\
f(x) \\
7 \mod 2 \\
\left| -1869 \right| \\
\sum_{i=1}^{100} i \\
\sqrt{3493161} \\
\begin{pmatrix} 69 \end{pmatrix} \\
\begin{pmatrix} 18 \end{pmatrix}
\]
Types of expressions

An expression describes a computation and evaluates to a value

\[
\begin{align*}
18 + 69 & \quad \frac{6}{23} & \quad \sin \pi & \quad \log_2 1024 \\
2^{100} & \quad f(x) & \quad \sqrt{3493161} & \quad \lim_{x \to \infty} \frac{1}{x} \\
7 \mod 2 & \quad \sum_{i=1}^{100} i & \quad (69) & \quad (18) \\
| -1869| & \\
\end{align*}
\]
An expression describes a computation and evaluates to a value

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18 + 69 & \quad \frac{6}{23} & \quad \sin \pi & \quad \log_2 1024 \\
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7 \mod 2 & \quad \sum_{i=1}^{100} i & \quad (69) & \quad (18) \\
| - 1869| & \quad & & \\
\end{align*}
\]
Call Expressions in Python

All expressions can use function call notation

(Demo)
Anatomy of a Call Expression
Anatomy of a Call Expression

add ( 2, 3 )
Anatomy of a Call Expression

\[
\text{add} \ ( \ 2 \ , \ 3 \ )
\]
Anatomy of a Call Expression

\[ \text{add} (2, 3) \]

Operator
Anatomy of a Call Expression

```
add      (      2       ,      3       )
Operator   Operand   Operand
```
Anatomy of a Call Expression

Operators and operands are also expressions
Anatomy of a Call Expression

Operators and operands are also expressions

So they evaluate to values
Anatomy of a Call Expression

Operators and operands are also expressions

So they evaluate to values

Evaluation procedure for call expressions:
Anatomy of a Call Expression

Operators and operands are also expressions
So they evaluate to values

Evaluation procedure for call expressions:

1. Evaluate the operator and then the operand subexpressions
Anatomy of a Call Expression

Operators and operands are also expressions

So they evaluate to values

Evaluation procedure for call expressions:

1. Evaluate the operator and then the operand subexpressions

2. Apply the function that is the value of the operator subexpression to the arguments that are the values of the operand subexpression
Evaluating Nested Expressions

\[ \text{mul}(\text{add}(4, \text{mul}(4, 6)), \text{add}(3, 5)) \]
Evaluating Nested Expressions

\[ \text{mul}(\text{add}(4, \text{mul}(4, 6)), \text{add}(3, 5)) \]
Evaluating Nested Expressions

\[ \text{mul}(\text{add}(4, \text{mul}(4, 6)), \text{add}(3, 5)) \]
Evaluating Nested Expressions

\[ \text{mul}(\text{add}(4, \text{mul}(4, 6)), \text{add}(3, 5)) \]
Evaluating Nested Expressions

mul(add(4, mul(4, 6)), add(3, 5))
Evaluating Nested Expressions

mul(add(4, mul(4, 6)), add(3, 5))
Evaluating Nested Expressions

\[ \text{mul}(\text{add}(4, \text{mul}(4, 6)), \text{add}(3, 5)) \]
Evaluating Nested Expressions

\[ \text{mul}(\text{add}(4, \text{mul}(4, 6)), \text{add}(3, 5)) \]
Evaluating Nested Expressions

mul(add(4, mul(4, 6)), add(3, 5))

mul

add(4, mul(4, 6))

add 4

mul(4, 6)

mul 4 6
Evaluating Nested Expressions

\[ \text{mul}(\text{add}(4, \text{mul}(4, 6)), \text{add}(3, 5)) \]

Diagram:
- \( \text{mul} \)
- \( \text{add}(4, \text{mul}(4, 6)) \)
  - \( \text{add} \)
    - \( 4 \)
    - \( \text{mul}(4, 6) \)
      - \( \text{mul} \)
        - \( 4 \)
        - \( 6 \)
  - \( \text{mul}(4, 6) \)
    - 24
Evaluating Nested Expressions

\[ \text{mul(add}(4, \text{mul}(4, 6)), \text{add}(3, 5)) \]
Evaluating Nested Expressions

\[ \text{mul} (\text{add}(4, \text{mul}(4, 6)), \text{add}(3, 5)) \]
Evaluating Nested Expressions

\[ \text{mul}(\text{add}(4, \text{mul}(4, 6)), \text{add}(3, 5)) \]
Evaluating Nested Expressions
Evaluating Nested Expressions
Evaluating Nested Expressions

mul(add(4, mul(4, 6)), add(3, 5))
Evaluating Nested Expressions

mul(add(4, mul(4, 6)), add(3, 5))

mul(4, 6)
mul(4, mul(4, 6))
add(4, mul(4, 6))
add(3, 5)
add(3, 5)
add(4, 3)
add(4, 5)
add(3, 5)
add(3, 5)
Evaluating Nested Expressions

```
mul(add(4, mul(4, 6)), add(3, 5))
```

```
mul 
mul(4, 6) 
mul 4 6
```

```
add 
add(4, mul(4, 6)) 
add 4 mul(4, 6)
```

```
add 
add(3, 5) 
add 3 5
```

```
mul 
mul(4, 6) 
mul 4 6
```

Result: 224
Evaluating Nested Expressions

\[ \text{mul}(\text{add}(4, \text{mul}(4, 6)), \text{add}(3, 5)) \]
Evaluating Nested Expressions

Expression tree

\[ \text{mul} \left( \text{add}(4, \text{mul}(4, 6)), \text{add}(3, 5) \right) \]

\[ \text{mul}(28, 8) \]

\[ \text{mul}(4, 24) \]

\[ \text{add}(4, 24) \]

\[ \text{mul}(4, 6) \]

\[ \text{add}(3, 5) \]
Evaluating Nested Expressions
Evaluating Nested Expressions

Expression tree

Operand subexpression

Value of subexpression

mul(\text{add}(4, \text{mul}(4, 6)), \text{add}(3, 5))

224

mul

28

add(4, \text{mul}(4, 6))

mul

4

24

mul(4, 6)

mul

4

6

add

4

mul

4

6

add

3

5

add(3, 5)

8

Expression tree
Evaluating Nested Expressions

Expression tree:

```
mul(add(4, mul(4, 6)), add(3, 5))
```

Operand subexpression:

- mul
- add

Value of subexpression:

- mul
- add

1st argument to mul:

- 28
- 8

Value of subexpression:

- 24
- 5

Expression tree:

```
mul(add(4, mul(4, 6)), add(3, 5))
```

Value of subexpression:

- mul
- add

Operand subexpression:

- mul
- add

1st argument to mul:

- 28
- 8

Value of subexpression:

- 24
- 5
Evaluating Nested Expressions

Expression tree

Operand subexpression

Value of subexpression

1st argument to mul

Value of the whole expression

mul(add(4, mul(4, 6)), add(3, 5))

mul(4, 6)

mul

mul

add

add

add

add

add

add

add

224

28

8

24

4

6

4

6

3

5
Functions, Values, Objects, Interpreters, and Data

(Demo)