L1: Introduction; Elements of Programming

CS1101S: Programming Methodology

Martin Henz

August 11, 2021



- 1 What is CS1101S?
- 2 Module management
- 3 Elements of programming

What is CS1101S? Module management Elements of programming

- 1 What is CS1101S?
- 2 Module management
- 3 Elements of programming

 Understand the structure and interpretation of computer programs

- Understand the structure and interpretation of computer programs
- Learn how to program

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- Learn how to program
- Get glimpses into the subject areas of computer science

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- Learn how to program
- Get glimpses into the subject areas of computer science
- Get a feeling for how computer science "ticks"
- Fall in love with computer science

- 1 What is CS1101S?
- 2 Module management
 - Weekly flow
 - People
 - Module overview
 - Resources
- 3 Elements of programming

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• Wednesday 2-h Lecture: introduces new concepts

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- Wednesday Path: online post-lecture quiz in Source Academy

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- Friday 1-h Brief: special topics
- Friday Path: online post-brief quiz in Source Academy
- Monday/Tuesday 2-h Studio session: Master the concepts!

- Wednesday 2-h Lecture: introduces new concepts
- Wednesday Path: online post-lecture quiz in Source Academy
- Thursday 1-h Reflection: reflects on lecture material
- Friday 1-h Brief: special topics
- Friday Path: online post-brief quiz in Source Academy
- Monday/Tuesday 2-h Studio session: Master the concepts!
- Missions, Quests, Contests: Show your mastery!

Throughout the semester, we will have...

Throughout the semester, we will have...

• 15 Paths

Throughout the semester, we will have...

- 15 Paths
- 20 Missions

Throughout the semester, we will have...

- 15 Paths
- 20 Missions
- 13 Quests

Throughout the semester, we will have...

- 15 Paths
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- 13 Quests

(some adjustment possible)



What is CS1101S? Module management Elements of programming Weekly flow People Module overview Resources

• today 2-h Lecture L1: Elements of Programming

- today 2-h Lecture L1: Elements of Programming
- today Path P1A on Elements of Programming

- today 2-h Lecture L1: Elements of Programming
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- tomorrow 1-h Reflection R1: choose between 10am and 2pm sessions

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- today Path P1A on Elements of Programming
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- Friday 1-h Mission Brief B1: Runology
- Friday Path P1B on Runology

- today 2-h Lecture L1: Elements of Programming
- today Path P1A on Elements of Programming
- tomorrow 1-h Reflection R1: choose between 10am and 2pm sessions
- Friday 1-h Mission Brief B1: Runology
- Friday Path P1B on Runology
- Friday Mission "Rune Introduction" comes out, due on Tuesday, 17/8

- today 2-h Lecture L1: Elements of Programming
- today Path P1A on Elements of Programming
- tomorrow 1-h Reflection R1: choose between 10am and 2pm sessions
- Friday 1-h Mission Brief B1: Runology
- Friday Path P1B on Runology
- Friday Mission "Rune Introduction" comes out, due on Tuesday, 17/8
- Monday/Tuesday 2-h Studio session S2 on Elements of Programming



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Lecturers

Lecturers

Their roles

Conduct **lectures** on Wednesdays and **briefs** on Fridays, coordinate the module

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Martin Henz

Low Kok Lim

Boyd Anderson

Tutors

Their role

Facilitate weekly **Reflection** sessions

Tutors

Their role

Facilitate weekly **Reflection** sessions

Eldric Liew, Kelvin Koa,

Ghozali Suhariyanto Hadi, Hou Ruomu, Liow Jia Chan, Aiden Low,

Martin Henz, Low Kok Lim, Boyd Anderson

Source Academy Team

Their roles

Design, develop, deploy, maintain the **Source Academy**, our learning environment for CS1101S

Avengers

Their role

- facilitating weekly 2-h Studio sessions,
- guiding you in the fine art of programming,
- discussing your missions and quests with you and grading them

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Module Overview

- Unit 1—Functions (textbook Chapter 1)
 - Getting acquainted with the elements of programming, using functional abstraction
 - Learning to read programs, and using the substitution model
 - Example applications: Runes, curves
- Unit 2—Data (textbook Chapter 2)
 - Getting familiar with data: pairs, lists, trees
 - Searching in lists and trees, sorting of lists
 - Example application: sound processing

Module Overview, continued

- Unit 3—State (parts of textbook Chapter 3)
 - Programming with stateful abstractions
 - Arrays, loops, searching in and sorting of arrays
 - Reading programs using the environment model
 - Example applications: robotics, video processing
- Unit 4—Beyond (parts of textbook Chapters 3 and 4)
 - Streams
 - Metalinguistic abstraction
 - Computing with Register Machines / Logic Programming / Concurrency

• Reading Assessment RA1 on Friday Week 4: 3/9 (Unit 1)

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- Recess Week

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- Recess Week
- Midterm Assessment on Wednesday Week 7: 29/9 (Unit 2)

- Reading Assessment RA1 on Friday Week 4: 3/9 (Unit 1)
- Recess Week
- Midterm Assessment on Wednesday Week 7: 29/9 (Unit 2)
- Reading Assessment RA2: 22/10 (Unit 3)

- Reading Assessment RA1 on Friday Week 4: 3/9 (Unit 1)
- Recess Week
- Midterm Assessment on Wednesday Week 7: 29/9 (Unit 2)
- Reading Assessment RA2: 22/10 (Unit 3)
- Practical Assessment: 10/11 (Unit 4)

- Reading Assessment RA1 on Friday Week 4: 3/9 (Unit 1)
- Recess Week
- Midterm Assessment on Wednesday Week 7: 29/9 (Unit 2)
- Reading Assessment RA2: 22/10 (Unit 3)
- Practical Assessment: 10/11 (Unit 4)
- **Final** Assessment: 25/11

18%: Source Academy XP (Missions, Quests, Paths, ...): 0.5% per level, each level has 1000 XP: 36,000 XP

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5%: Studio: attendance 3%, effort 2%

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5%: Reflection attendance

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 - 5%: Studio: attendance 3%, effort 2%
 - 5%: Reflection attendance
 - 6%: Reading Assessment 1, Week 4

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- 5%: Studio: attendance 3%, effort 2%
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- 3%: Mastery Check 1, any time

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```

- 5%: Studio: attendance 3%, effort 2%
- 5%: Reflection attendance
- 6%: Reading Assessment 1, Week 4
- 3%: Mastery Check 1, any time
- 12%: Midterm Assessment, Week 7

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- 6%: Reading Assessment 1, Week 4
- 3%: Mastery Check 1, any time
- 12%: Midterm Assessment, Week 7
 - 6%: Reading Assessment 2, Week 10

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- 5%: Studio: attendance 3%, effort 2%
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- 6%: Reading Assessment 1, Week 4
- 3%: Mastery Check 1, any time
- 12%: Midterm Assessment, Week 7
 - 6%: Reading Assessment 2, Week 10
- 12%: Practical Assessment, Week 13
 - 3%: Mastery Check 2, any time
- 30%: Final Assessment



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Resources

Textbook: SICP JS

Details in LumiNUS > Module Details > SICP JS

Resources

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Weblinks: Source, Source Academy, Piazza, calendars

LumiNUS > Module Details > Weblinks

 piazza Q & A forums: piazza.com/nus.edu.sg/fall2021/cs1101s
 Many of you are signed up, already.

If you cannot sign up, please email

henz@comp.nus.edu.sg

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 Asked Questions
- Email lecturer
 - Boyd: boyd@nus.edu.sg
 - Kok Lim: lowkl@comp.nus.edu
 - Martin: henz@comp.nus.edu.sg



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 - Processes and programming
 - Primitive expressions, 1.1.1
 - Operator combinations, 1.1.1
 - Naming abstraction, 1.1.2
 - Functional abstraction, 1.1.4
 - Predicates and conditional expressions, 1.1.6

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What is CS1101S? Module management Elements of programming Processes and programming
Primitive expressions, 1.1.1
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Processes

Processes and programming
Primitive expressions, 1.1.1
Operator combinations, 1.1.1
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Processes

Definition (from Wikipedia)

A process is a set of activities that interact to produce a result. The activities unfolds according to patterns that *de*scribe or *pre*scribe the process.

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Examples

Processes are everywhere. They permeate our nature and culture:

- Galaxies and solar systems follow formation processes.
- Metabolic pathways in our bodies are biological processes.
- Political parties, legislature, courts, etc. follow processes.
- Industrial production is governed by processes.



Processes and programming
Primitive expressions, 1.1.1
Operator combinations, 1.1.1
Naming abstraction, 1.1.2
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Predicates and conditional expressions, 1.1.6

Computational processes

Definition

A *computational process* is a set of activities in a computer, designed to achieve a desired result.

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Our task

Here we are concerned about how this *design* happens.

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Our task

Here we are concerned about how this *design* happens.

Our design method

We use *programs* to prescribe how the computational process unfolds.



Processes and programming
Primitive expressions, 1.1.1
Operator combinations, 1.1.1
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What is programming?

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People in focus

As the complexity of computer systems increases, *communication* between architects, designers, programmers, operators and users becomes increasingly important.

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Programs as communication devices

Since programs prescribe the computational processes at the heart of these systems, they can play a central role in the *human* communication during their construction and operation.

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People in focus

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Our motto

Programming is communicating computational processes.



Processes and programming
Primitive expressions, 1.1.1
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Our programming environment: Source Academy

Processes and programming
Primitive expressions, 1.1.1
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Website designed for CS1101S

Processes and programming
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Has just what you need for understanding the *structure* and *interpretation* of computer programs.

Our programming environment: Source Academy

Website designed for CS1101S

Has just what you need for understanding the *structure* and *interpretation* of computer programs.

Research

Source Academy is also a *educational research tool*: We want to to study what happens when people like you learn how to program.



Processes and programming
Primitive expressions, 1.1.1
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Your first login to Source Academy

Processes and programming
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Your first login to Source Academy

Consent

You can be part of our research by letting us use your programs anonymously.

Processes and programming
Primitive expressions, 1.1.1
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Our ship

You think you are studying at NUS?

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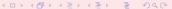
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Visit https://sourceacademy.nus.edu.sg, decide on consent and click on "Playground". (Source Academy opens after the lecture.)



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Elements of programming

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Elements of programming

Every powerful language provides...

Elements of programming

Every powerful language provides...

Primitives

Elements of programming

Every powerful language provides...

- Primitives
- Combination

Elements of programming

Every powerful language provides...

- Primitives
- Combination
- Means of abstraction

Processes and programming
Primitive expressions, 1.1.1
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Primitive expressions

Processes and programming

Primitive expressions, 1.1.1

Operator combinations, 1.1.1

Naming abstraction, 1.1.2

Functional abstraction, 1.1.4

Predicates and conditional expressions, 1.1.6

Primitive expressions

• Numerals: 0, -42, 486

Primitive expressions

- Numerals: 0, -42, 486
- Numerals use decimal notation

Primitive expressions

- Numerals: 0, -42, 486
- Numerals use decimal notation
- Our interpreter can evaluate numerals, resulting in the numbers they represent

Processes and programming
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A detail

Expressions are not programs in Source

Instead they can be turned into programs using a semicolon.

A detail

Expressions are not programs in Source

Instead they can be turned into programs using a semicolon.

Example

486; is a program.

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Means of Combination: Operators

Examples

```
5 * 99;
```

$$25 - (4 + 2) * 3;$$

Means of Combination: Operators

Examples

```
5 * 99;
25 - (4 + 2) * 3;
```

Notation as usual

operator between operands: infix notation with precedences

Evaluating Operator Combinations

But exactly how...

...do we evaluate

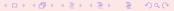
$$(2 + 4 * 6) * (3 + 12)$$

???

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Evaluation of expressions

Demonstration: Evaluation of expressions



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Means of Abstraction: Naming

```
Example
const size = 2;
5 * size;
```

Environment

Purpose

The interpreter of JavaScript keeps track of an environment (table) that associates names with values.

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The interpreter of JavaScript keeps track of an environment (table) that associates names with values.

Constant declarations

The keyword const adds a name-value entry to the table.

Pre-declared names

Pre-declared constants

Source has a few names pre-declared. For example, the name math_PI refers to the constant π .

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In addition to operators such as +, Source has pre-declared functions. For example, math_sqrt is the square root function.

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Function application expressions

Functions can be applied as usual in mathematics, for example math_sqrt (15);

applies the pre-declared square root function to 15.

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Means of Abstraction: Compound functions

```
function square(x) {
    return x * x;
}
```

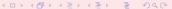
Means of Abstraction: Compound functions

Example

```
function square(x) {
    return x * x;
}
```

What does this statement mean?

Like constant declarations, this function declaration declares a name, here square. The value associated with the name is a function that takes an argument x and produces (returns) the result of multiplying x by itself.



Review: Function application

Recall from the math_sqrt example

We apply a function by supplying its arguments in parentheses.

Review: Function application

Recall from the math_sqrt example

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Example

```
function square(x) {
    return x * x;
}
square(14);
```

More examples

```
square(21);
square(2 + 5);
square(square(3));
```

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Boolean values

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The two boolean values true and false represent *answers* to yes-no questions

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Predicates

A *predicate* is a function or an expression that returns or evaluates to a boolean value.

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A *predicate* is a function or an expression that returns or evaluates to a boolean value.

Examples

```
true;
false;
x >= 1;
```

Another predicate

```
function adult(x) {
   return x >= 18;
}
```

Conditional expressions

Why?

We would like to check something, e.g. answer a yes/no question, and return a different value, depending on the answer

Conditional expressions

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Back to the example

```
adult(my_age) ? enter_club() : go_to_movie()
```

Conditional expressions

Why?

We would like to check something, e.g. answer a yes/no question, and return a different value, depending on the answer

Back to the example

```
adult(my_age) ? enter_club() : go_to_movie()
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Example: abs function

To compute the absolute value of a number, check if it is greater or equal 0. If yes, return the number unchanged, and if no, return the number negated.

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May the Source be with you!

The Source Acacdemy is open!



May the Source be with you!

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Look out for your first Path "Elements of Programming".



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Welcome on board!

