



CPSC 103

# Introduction to Systematic Program Design 2021S

Lecture: Module 3 - How to Design Data

Ashish Chopra


18 May, 2021

1



designed by freepik

# Announcements

1. No Communication through Canvas.
2. “Midterm Accommodation Request” survey posted on Piazza.
3. Project Module Released on Canvas.
  1. Project Proposal due on May 31, 10 pm PDT
  2. Project TA mentors will be assigned. ✓
  3. Late Policy is applied to Milestone and Final Submission only.
4. Syllabus Quiz due on Fri. May 21 10pm PDT.
5. Module 5 and Module 6 open for pre-class readings, due May 24<sup>th</sup> 10 pm.
  1. Module 5 has 2 readings, 2 Pre-lecture Assignments;
  2. Module 6 has 1 reading and 1 Pre-lecture Assignment;A handwritten blue bracket groups the two items in the list, with a large blue number '3' to its right, indicating a total of 3 pre-lecture assignments.

# Recap

## 1. Primitive Data Types

1. int (1, -4, 98)
2. float (0.123, 1.8863, -9.73)
3. str ("British Columbia", "CPSC103")
4. bool (True, False)
5. None (None)
6. Image \*

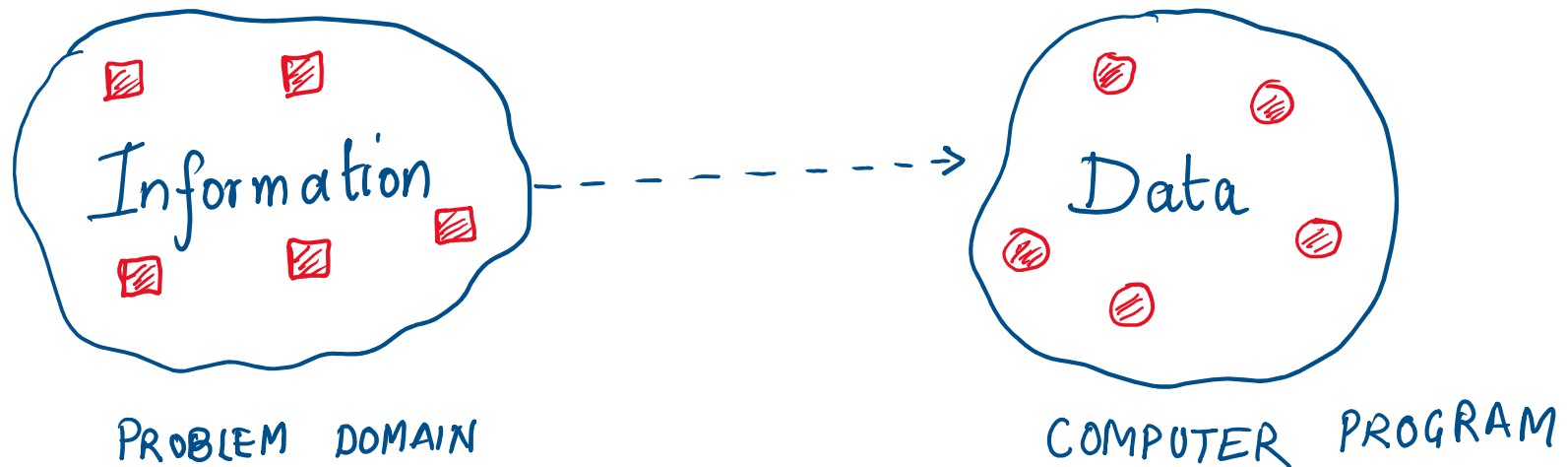
## 2. How to Design functions which operate on primitive data types, using HtDF recipe

# Learning Goals

1. What are non-primitive (or User-defined) data types
  1. Identify Problem Domain Information that should be represented as simple atomic data, intervals, enumerations, and optionals.
2. How to represent these types using HtDD recipe in your program.
  1. Use How to Design Data Definitions (HtDD) recipe to design Data Definitions.
  2. Use Data Driven Template recipe to generate templates for functions operating on data of a user-defined type.
3. Use HtDF recipe to design functions operating on data of user-defined types.  
*primitive*

# Information to Data Representation

When we try to solve a problem using computing, we first identify the information in the problem domain as represent it as data in our programs.



# Examples



## Double

Design a program that returns the double of a given number.

*int / float*

## Make Circle

Design a function that makes a solid circle of given radius and color

*Image*      *float*      *str*

## CPSC 103 d-tective!

Design a function that determines if a string starts with letter d.

*str*

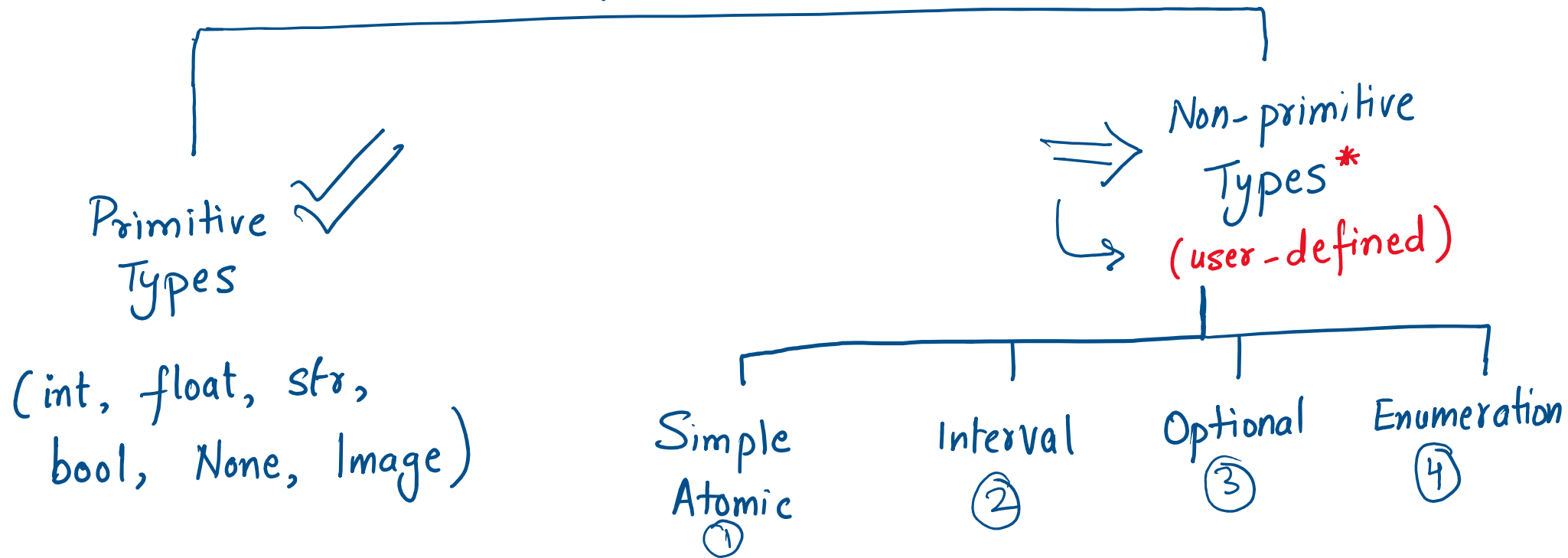
*inputs / outputs*

## Declaring Result

Design a function that returns the "Pass" or "Fail" rating based on student's score in the class.

*str* → *int / float*

# Data Types



\* Created using HTDD recipe.

Designing user-defined data types

# How to Design Data (HtDD) Recipe

HtDD recipe is about designing data definitions of user-defined types.

HtDD recipe consists of the following steps:

1. ✓ A **data type definition** with type comments where Python's types are not specific enough.
2. An **interpretation comment** that describes the correspondence between information and data.
3. One or more **examples** of the data.
4. A **template** for a one-argument function operating on data of this type.

The image shows a code snippet with handwritten annotations in blue ink. The code is as follows:

```
Temperature = float
# interp. the air temperature in degrees Celsius

T1 = 0.0
T2 = -24.5
T3 = 10.2

@typecheck
# template based on Atomic
def fn_for_temperature(t: Temperature) -> ...:
    return ...(t)
```

Handwritten annotations include:

- A box around the first two lines of code, with a circled '1' to its left. Two arrows point to the `float` type and the interpretation comment.
- A box around the three example lines of code, with a circled '2' to its left.
- A box around the function definition, with a circled '3' to its left.
- A circled '4' to the left of the function definition, indicating the template step.



# 1. Simple Atomic

When the information to be represented is itself **atomic in form**.

**Tip:** Usually these are just the primitive data with a better name and description.

CountryName  
↓  
def is\_europe(name: CountryName) → bool:  
str  
NumEmployees

The name of a country

↑  
str

Number of Employees  
in a company

↑  
int

Weight

- ① DTD
- ② Intep
- ③ Example
- ④ Template

~~DD~~

The weight of an animal in  
Zoo

↑  
float

## 2. Interval

When the information to be represented is **numbers** within a certain range.

Temperature = float # in range  $[0, 250]$

The temperature of an oven from 0 deg. Celsius to 250 deg. celcius

A student's grade in a class in percentage.

0 — 100  
Grade = float # in range  $[0, 100]$

$[0, \dots)$   
 $[0, 100] = 0, 100$  include  
 $(0, 100] = 0$  not included  
100 included

# 3. Optional

When the information to be represented is well-represented by another form of data (often simple atomic or interval) **except** for **one special case**.

GPA of a student at UBC.

Reading of a Countdown  
Timer. It is off or 10 to 0.

# 3. Enumeration

When the information to be represented consists of a  
**fixed number of distinct values**

The Book genre one of  
fiction, fantasy, drama,  
history, science.

Grades given to a student as  
one of A, B, C, D, F

The light of a traffic signal as  
one of Red, Green, Yellow.

# Rest on Jupyter Notebook at:


Module3-htdd > Lecture > Ashish > Lecture Python Notebook – Module 3 (HtDD) – Blank.ipynb

# Worksheet Activity Time!

Let's do  
Question 1 – 3

## Module 3 (HtDD): Worksheet



Upload a scanned version of your [How to Design Data worksheet](#) . (For help on how to scan, see [Creating a PDF](#).)

You can also find the Jupyter version of this worksheet on Syzygy in your [module-3-htdd/Worksheet directory](#).

If you choose to not use the Jupyter version of the worksheet, please be aware of the following:

- We reserve the right to refuse to grade non-PDF submissions.
- In order to receive marks for your worksheet submission, we must be able to see the text you have written on the page. If we cannot make out what has been written, you will receive a 0 for your worksheet.

# Rest on Jupyter Notebook at:

Module3-htdd > Lecture > Ashish > Lecture Python Notebook – Module 3 (HtDD) – Blank.ipynb

# Worksheet Activity Time!

Let's do  
Questions 4, 5, 7, 8

## Module 3 (HtDD): Worksheet



Upload a scanned version of your [How to Design Data worksheet](#) . (For help on how to scan, see [Creating a PDF](#).)

You can also find the Jupyter version of this worksheet on Syzygy in your [module-3-htdd/Worksheet directory](#).

If you choose to not use the Jupyter version of the worksheet, please be aware of the following:

- We reserve the right to refuse to grade non-PDF submissions.
- In order to receive marks for your worksheet submission, we must be able to see the text you have written on the page. If we cannot make out what has been written, you will receive a 0 for your worksheet.