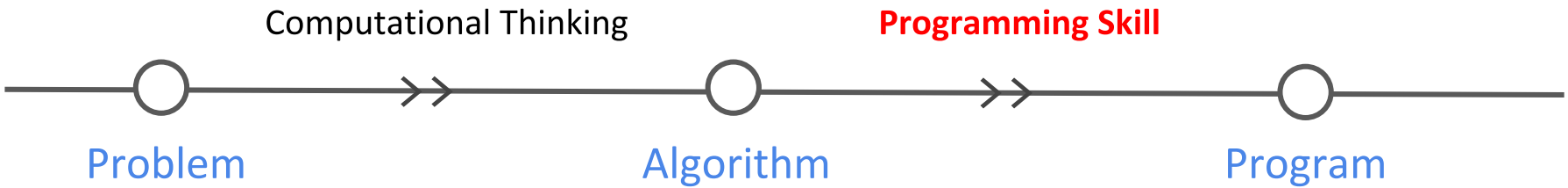
Automated Instructor for CS101 Newbs

AutomaTA

Changyoon Lee, Donghoon Han, Hyoungwook Jin
with Alice Oh

Last time...



Fill a list with Fibonacci numbers less than N.

fibonacci (*N*)
Case1: *N* is 1
output [0]
Case2: *N* is 0
output [ ]
Case3: other
Append the sum of the last two numbers to the list until sum > N

```
def fibonacci(upper_bound):¬
    list1 = [0,1]¬
    count = 1¬
    i = 1¬
    if upper_bound == 1:¬
        return [0]¬
    elif upper_bound == 0:¬
        return []¬
    ¬
    else:¬
        while sum(list1[-2:]) < upper_bound:¬
            i = list1[count-1] + list1[count]¬
            list1.append(i)¬
            count += 1¬
        return list1¬
```

Problem Statement

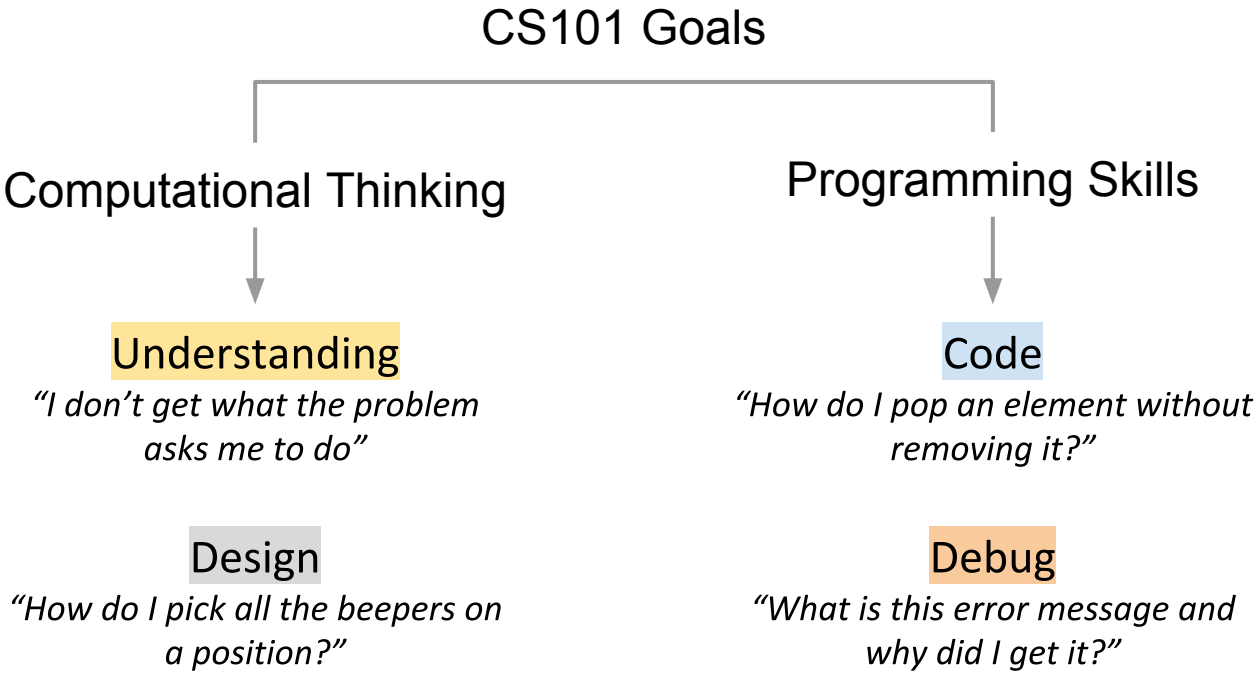
CS101 beginners ask many questions related to programming skills.

However, their questions contain not enough context
so they cannot get satisfactory answers from existing solutions.

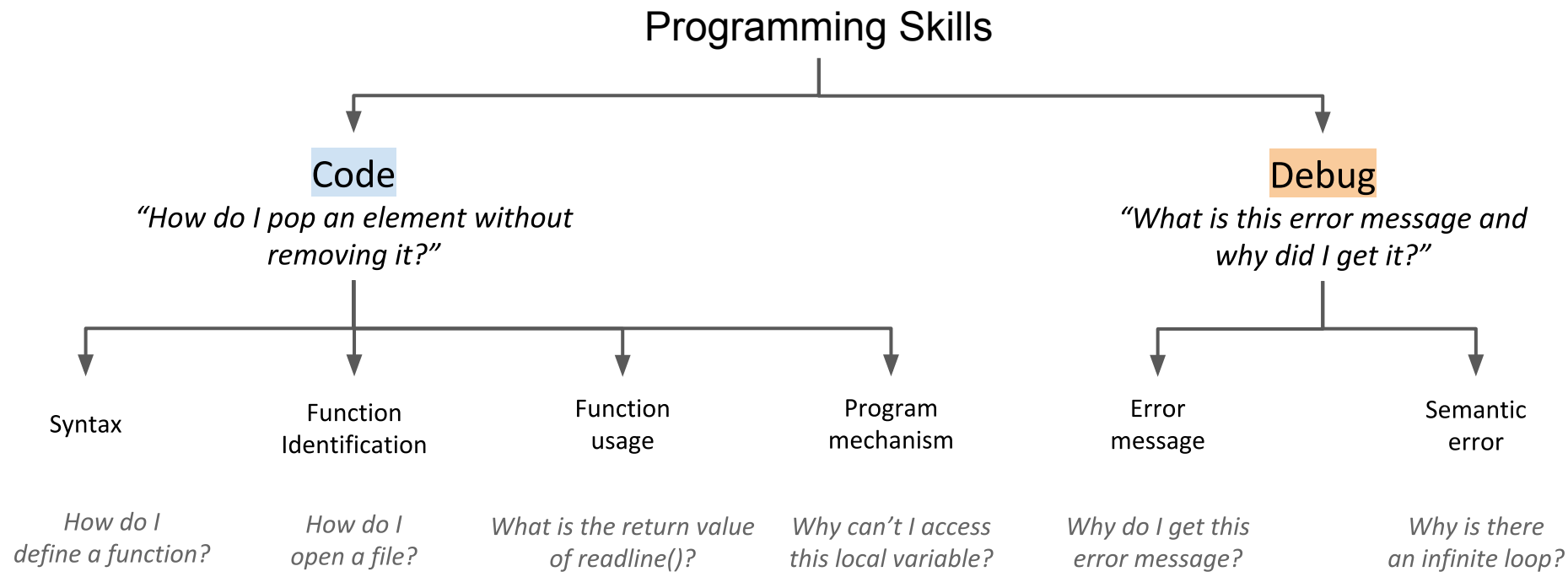
Formative Study

Purpose	To get an idea on what types of questions programming beginners ask
Setting	Sept. 20, 9pm to 11pm, N1 102
Participants	6 programming beginners, recruited with advertisement on ara
Process	1. Take a 10 minute lecture on Hubo and basic Python syntax 2. Solve programming tasks with us as the TA
Data collected	● Code revision history ● Voice recording of questions asked and answers
Analysis	Query contextualization with code, Question categorization

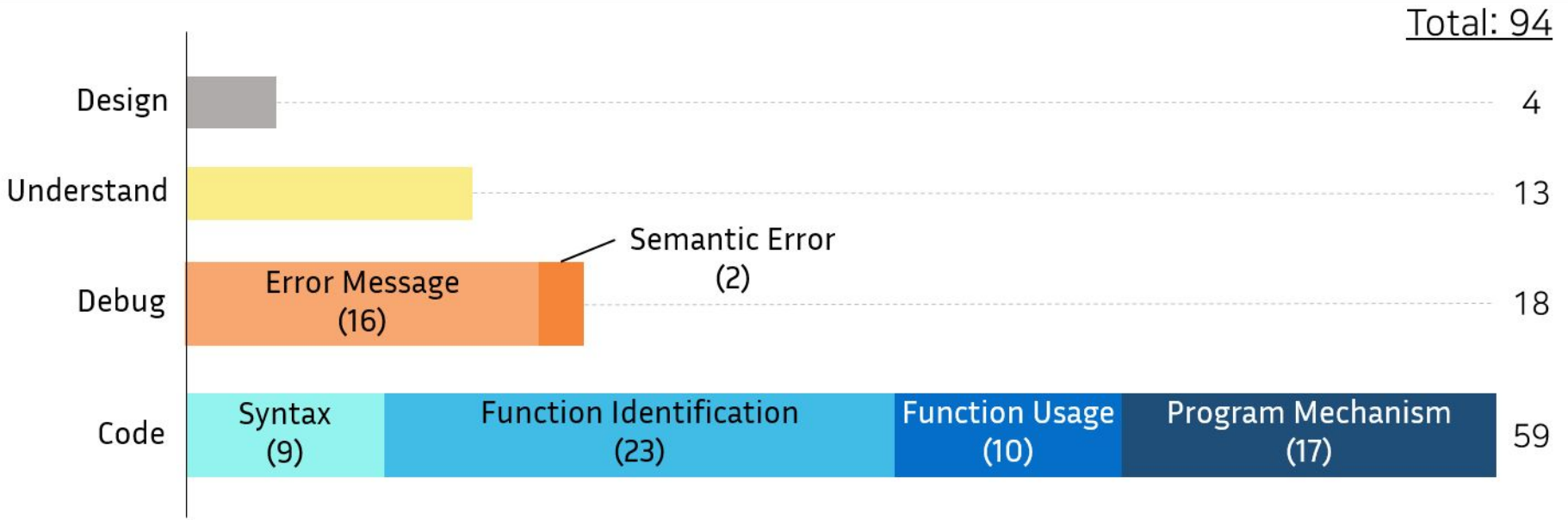
Categories


CS101 Goals
Computational Thinking
Programming Skills
Understanding
"I don't get what the problem asks me to do"
Code
"How do I pop an element without removing it?"
Design
"How do I pick all the beepers on a position?"
Debug
"What is this error message and why did I get it?"

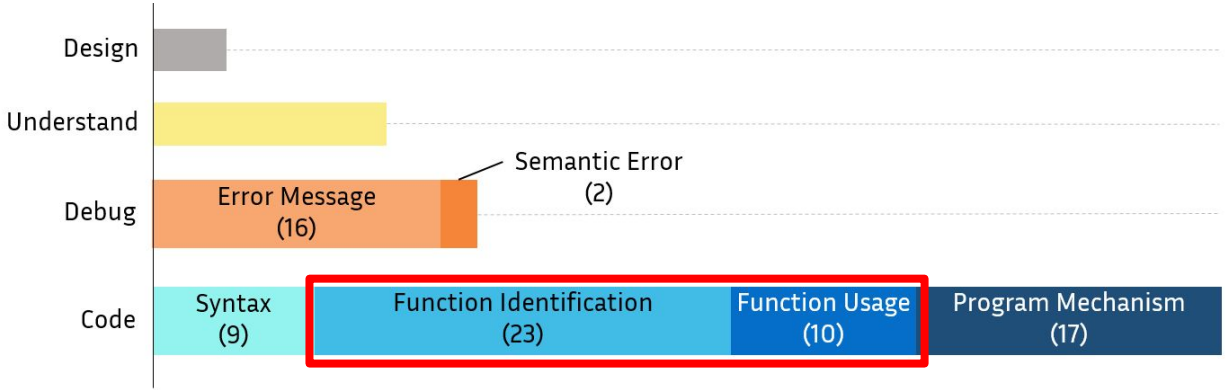
Subcategories



Question Data Analysis



Scoping Our Interest



- Problems from other categories are well addressed
- Students ask many questions regarding functions
- Project feasibility
  - Very difficult to solve for **all** functions in python
  - CS101 tasks use limited range of functions

Limitation of Existing Solutions

Google

stackoverflow

Teaching Assistant

Needs extra effort to filter irrelevant answers

Huge transfer cost between user code and example code

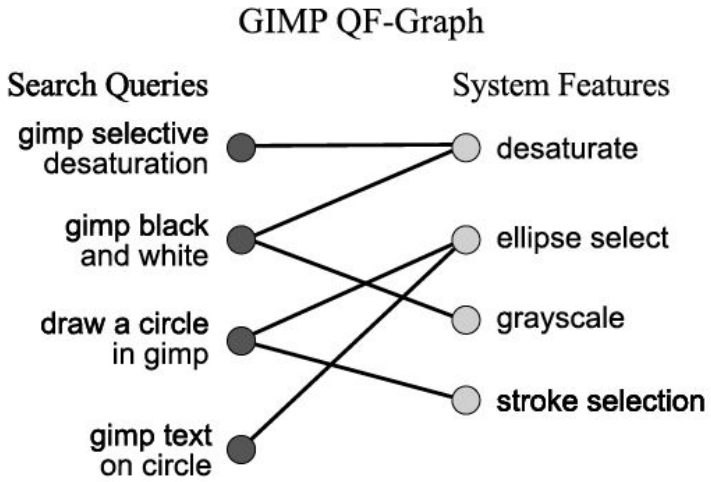
Not always present when needed

Solution

To build a programming platform
which can immediately answer questions on functions by
interpreting the context of those questions.

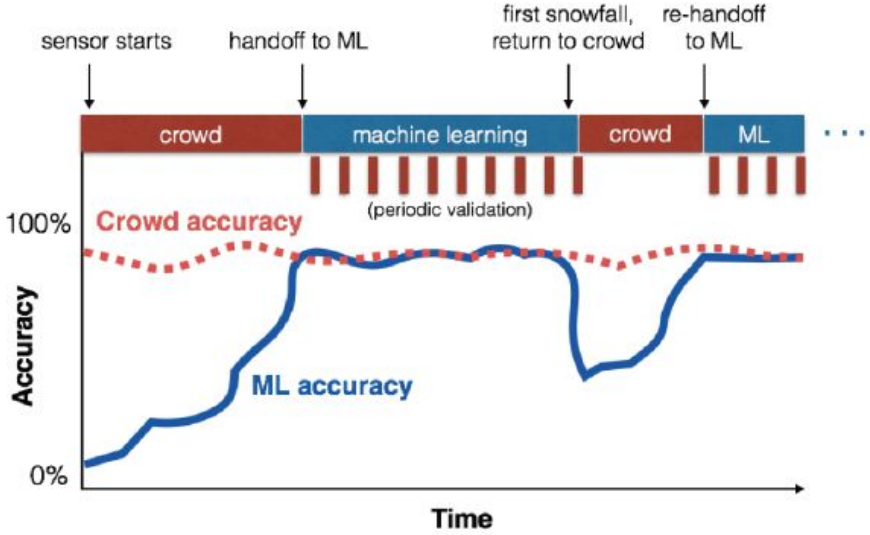
Approach

Interpret Query Context

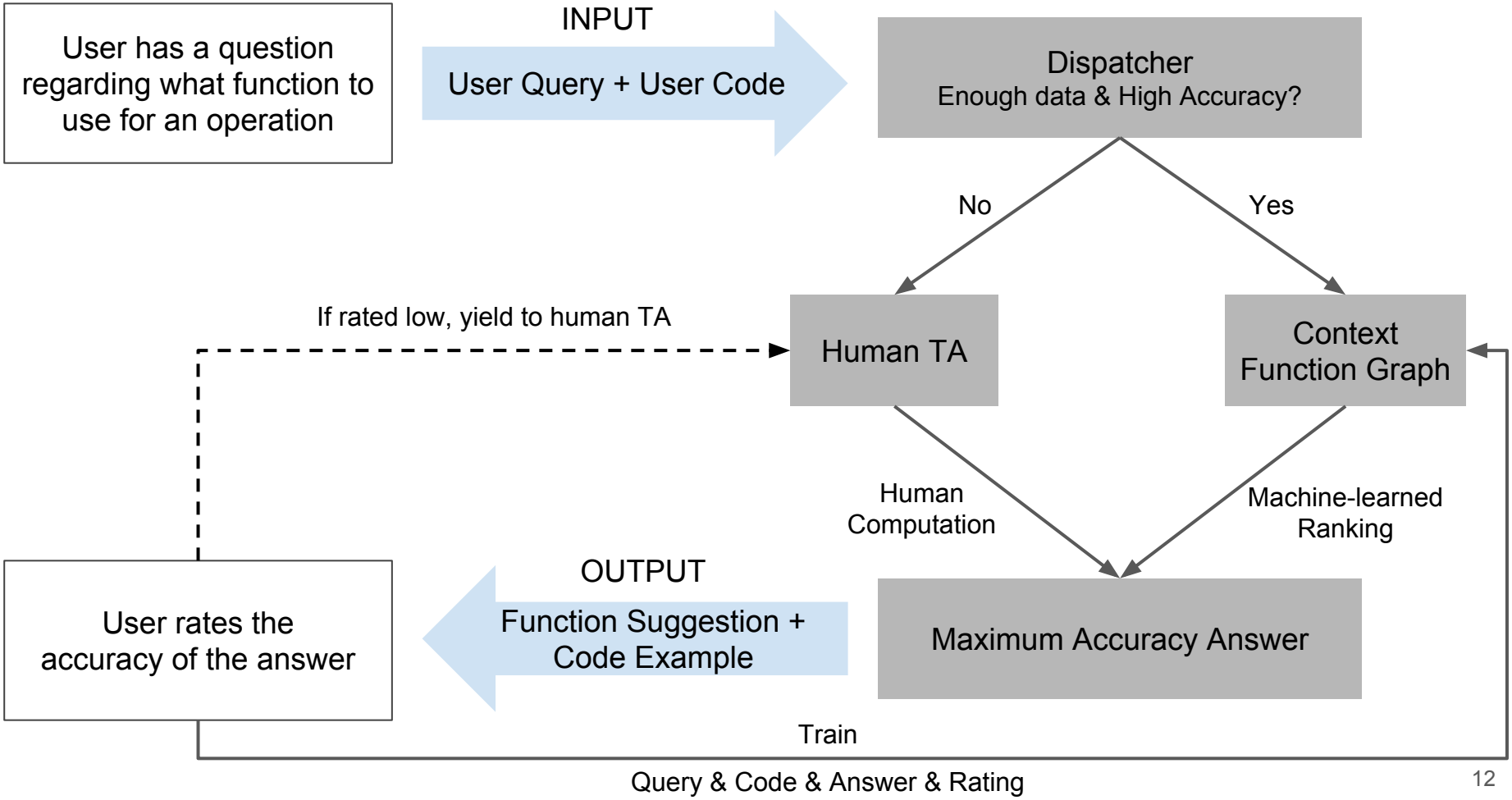


A Query-Feature graph
to handle queries more flexibly
(Fourney et al, ACM, 2011.)

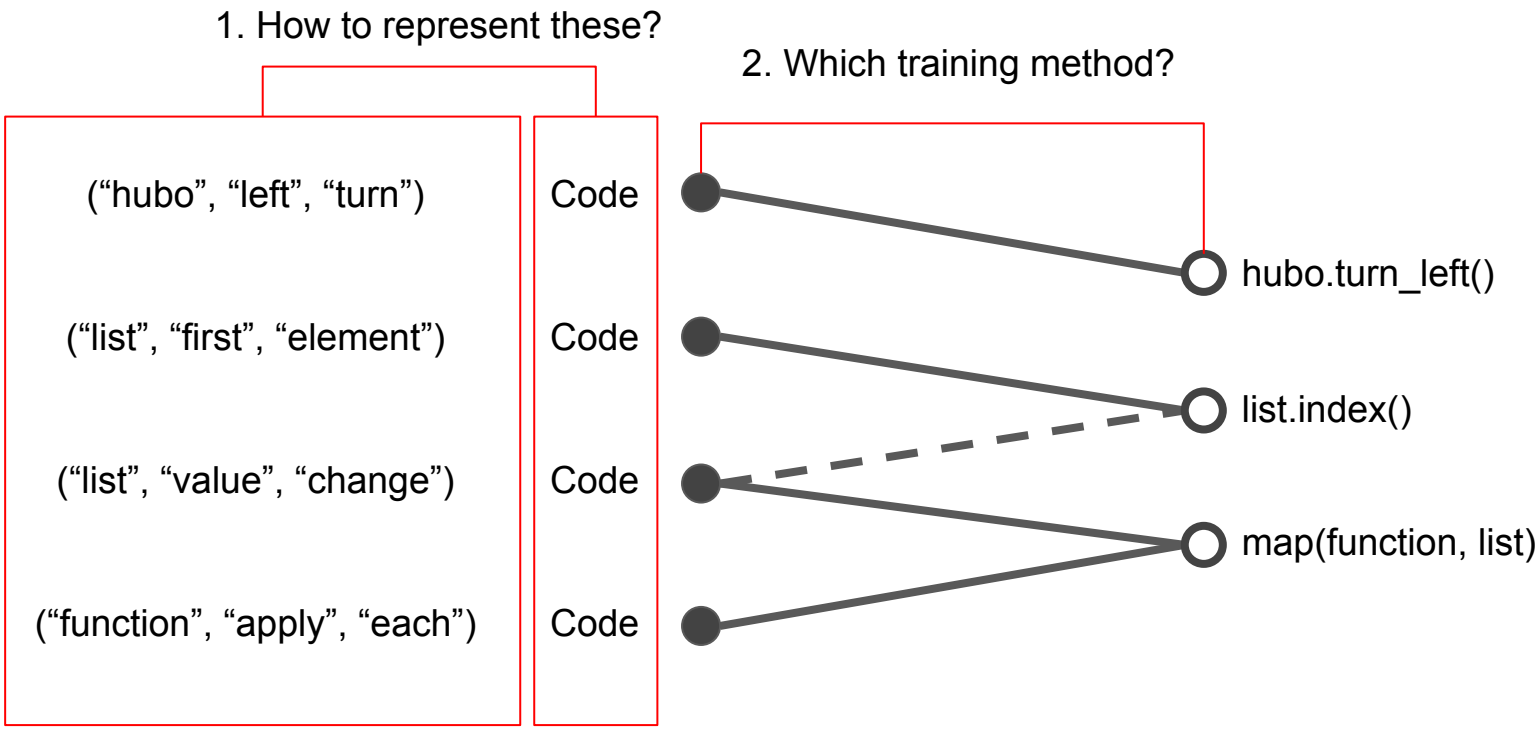
Automate QnA Process



Human-machine hybrid workflow
for a long-run automation
(Laput, Gierad, et al, ACM, 2015.)

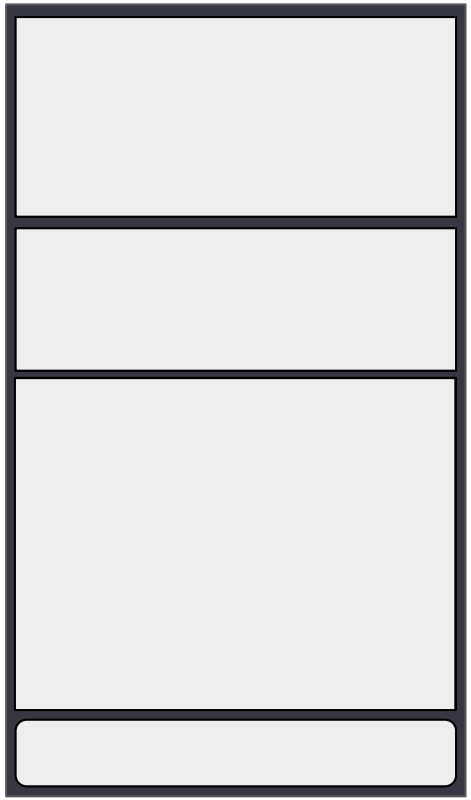

User has a question regarding what function to use for an operation
INPUT
User Query + User Code
Dispatcher
Enough data & High Accuracy?
No
Yes
If rated low, yield to human TA
Human TA
Context Function Graph
Human Computation
Machine-learned Ranking
OUTPUT
Function Suggestion + Code Example
Maximum Accuracy Answer
User rates the accuracy of the answer
Train
Query & Code & Answer & Rating

Challenge


1. How to represent these?
2. Which training method?
(“hubo”, “left”, “turn”)
Code
(“list”, “first”, “element”)
Code
(“list”, “value”, “change”)
Code
(“function”, “apply”, “each”)
Code
hubo.turn_left()
list.index()
map(function, list)

Prototype

```
1  from cs1robots import *
2
3  create_world()
4  hubo=Robot()
5
6  def hubo_right():
7        for i in range(3):
8              hubo.turn_left()
9
10 hubo_right()
11 if hubo.front_is_clear():
12       hubo.move()
13
14 print(“3”)
15
16
17
18
19
20
```



Why is our approach better?

Only relevant answers

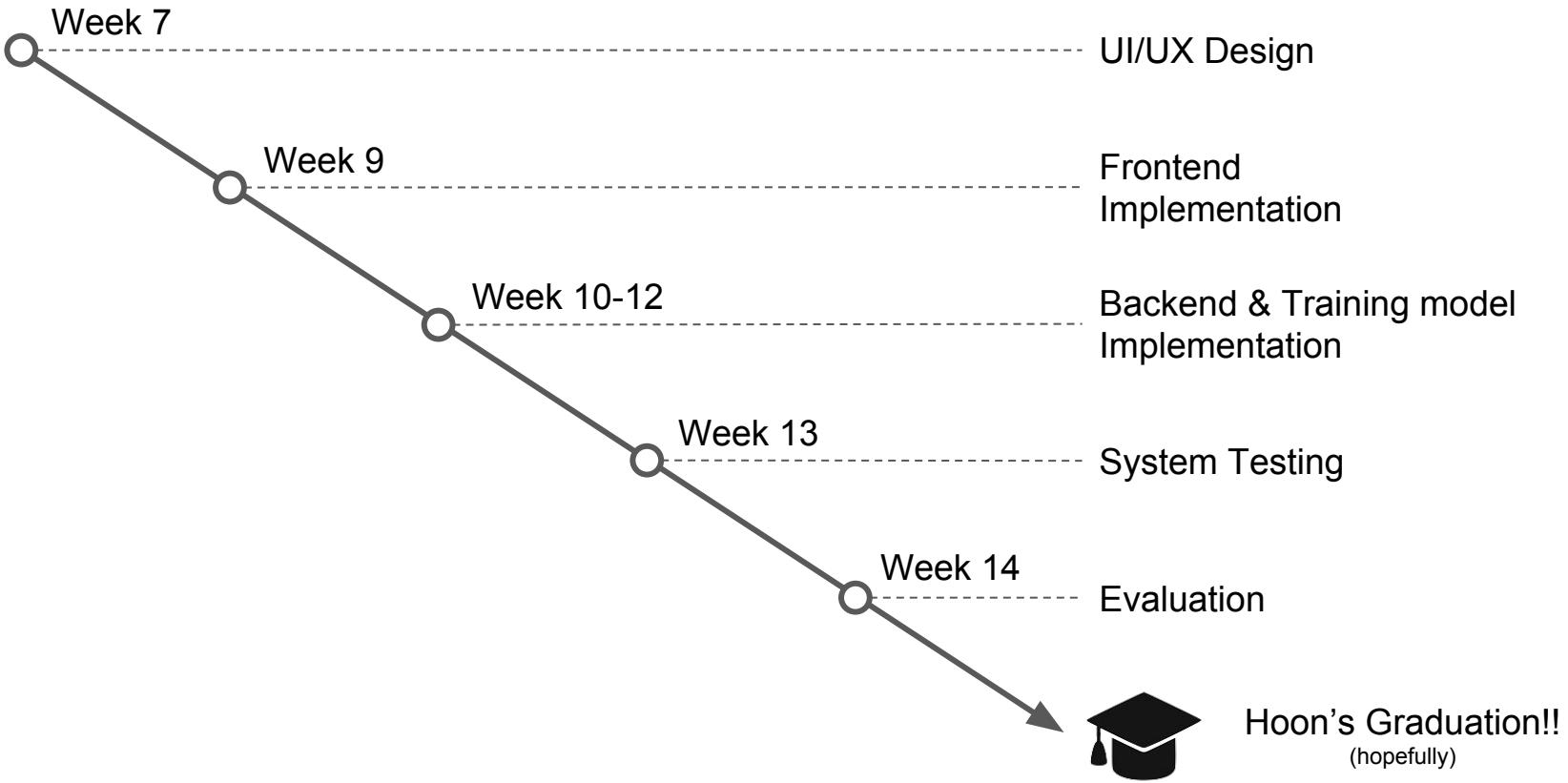
More task-relevant code example

Integrated platform

Teaching Assistant

Present whenever needed

Plan


Week 7
UI/UX Design
Week 9
Frontend Implementation
Week 10-12
Backend & Training model Implementation
Week 13
System Testing
Week 14
Evaluation
Hoon’s Graduation!!
(hopefully)

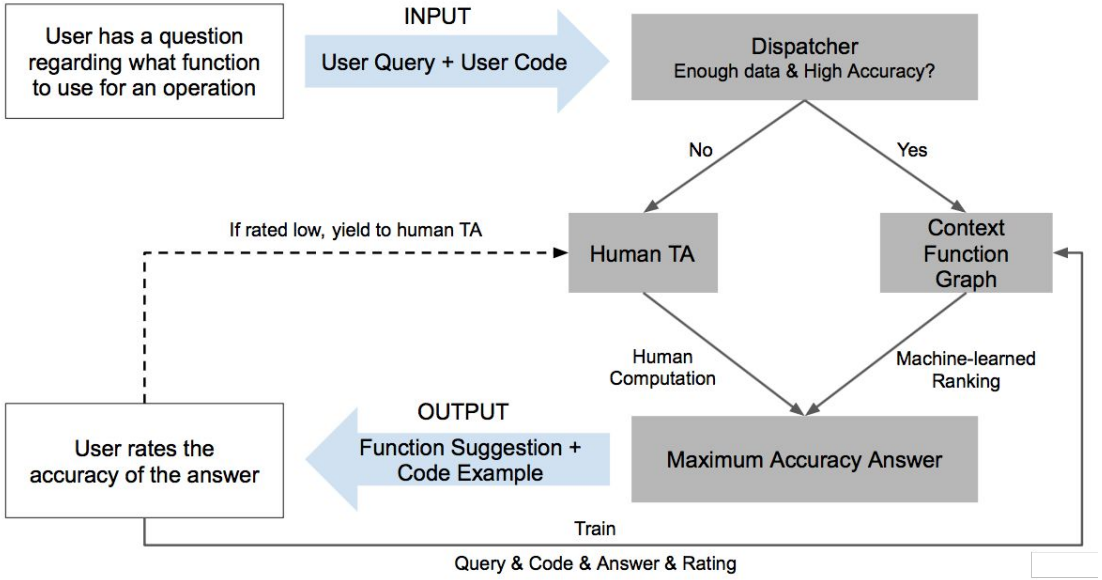
Evaluation

Metric	Answer Accuracy, User Satisfaction, Time Taken
Conditions	Google vs. AutomaTA vs. Teaching Assistant
Method	Within Subject

Any questions?

Problem Statement: CS101 beginners ask many questions related to programming skills. However, their questions contain not enough context so they cannot get satisfactory answers from existing solutions.

Pipeline



Evaluation

Metric	Answer accuracy, User satisfaction, Time taken
Conditions	Google search, AutomaTA, Human TA
Method	Within Subject