Supplementary Material: Do you *really* code? - Designing and Evaluating Screening Questions for Online Surveys with Programmers

I. STRUCTURE

Our supplementary material is structured as follows.

1) **Section I** outlines the structure of the supplementary material.
2) In **Section II**, we provide information on our survey questions.
3) In **Section III** we give details on the demographics of our participants.
4) **Section IV** summarizes results on the effectiveness and efficiency of our tested screener questions. Additionally, this section also shows an overview of information resources our participants from the attack scenario used to answer the programming questions.
5) **Section V** reports the timing thresholds for the 4 screener questions Q2, Q3, Q4, and Q6, which we recommended to use with time limits.

II. SURVEY

The correct answers are marked with ☑. All questions were randomly shown to the participants.

Q1.1 Which of these programming languages have you worked with before?
- ☐ C#
- ☐ C
- ☐ C++
- ☐ Python
- ☐ JavaScript
- ☐ Java
- ☐ Ruby
- ☐ PHP
- ☐ Shell
- ☐ TypeScript
- ☐ Other:
- ☐ I don't program

Q1.2 Which of these lesser-known programming languages have you worked with before?
- ☐ Yod
- ☐ Lore
- ☐ Torg
- ☐ LPrime
- ☐ ThreeP
- ☐ EMH
- ☐ Holly
- ☑ SHROUD
- ☐ LTCdata
- ☐ Kryten
- ☑ None of the above

Q2 Which of these websites do you most frequently use as aid when programming?
- ☐ Wikipedia
- ☐ LinkedIn
- ☑ Stack Overflow
- ☐ MemoryAlpha
- ☐ I have not used any of the websites above for programming
- ☐ I don't program

Q3 Choose the answer that best fits the description of a compiler's function.
- ☐ Refactoring code
- ☐ Connecting to the network
- ☐ Aggregating user data
- ☐ I don't know
- ☑ Translating code into executable instructions
- ☐ Collecting user data

Q4 Choose the answer that best fits the definition of a recursive function.
- ☐ I don't know
- ☐ A function that runs for an infinite time
- ☐ A function that does not have a return value
- ☐ A function that can be called from other functions
- ☑ A function that calls itself
- ☐ A function that does not require any inputs

Q5 Choose the answer that best fits the description of an algorithm:
- ☑ A set of instructions that, when executed, create a desired result
- ☐ I don't know
- ☐ Data that is required to run a program
- ☐ A software tool for data analysis
- ☐ The inverse of an exponential function
- ☐ A program that is run in the background on websites

Q6 Which of these values would be the most fitting for a Boolean?
- ☐ Small
- ☐ I don't know
- ☐ Solid
- ☐ Quadratic
- ☐ Red
- ☑ True

Q7 Please pick all powers of 2:
- ☐ 218
- ☑ 16
- ☐ I don't know
- ☐ 86
- ☑ 512
- ☐ 100

Q8 Please translate the following binary number into a decimal number **101**:
- ☑ 5
- ☐ 9
- ☐ 7
- ☐ I don't know
- ☐ 4
- ☐ 3

Q9 Please select all even binary numbers:
- ☐ I don't know
- ☐ 100101
- ☑ 10010110
- ☐ 101101
- ☑ 11010
- ☐ 11011011

Q10 Please select all valid hexadecimal numbers:
- ☑ FACE
- ☐ HEAD
- ☑ 1234
- ☑ 99FF
- ☐ 78GH
- ☐ I don't know

Q11 When multiplying two large numbers, your program unexpectedly returns a negative number. What might have caused this?
- ☐ Backflow
- ☐ Interflow
- ☑ Overflow
- ☐ Controllflow
- ☐ I don't know
- ☐ Underflow

Q12 What is the run time of the following code?

```
for 0 to n
    for 0 to n
        foo()
```

- ☐ I don't know
- ☐ Logarithmic
- ☐ Cubic
- ☐ Linear
- ☑ Quadratic
- ☐ Constant

```
Given the following pseudocode algorithm:
1: arr = [1,4,6,7,9,2,3,5,8,0]
2: i = 1
3: j = 0
4: while i <= 9:
5:   while j <=9:
6:       if arr[j] > arr[j+1]
7:           swap(arr[j],arr[j+1])
8:       j++
9:   j = 0
10: i++
```

Q13 When running the code, you get an error message for line 6: Array index out of range.
What would you change to fix the problem?
- ☐ Line 6: if arr[j] > arr[j-1]
- ☐ Line 9: j = i
- ☐ Line 2: i = 0
- ☐ I don't know
- ☑ Line 5: while j < 9:

Q14 What is the purpose of the algorithm?
- ☑ Sorting the array
- ☐ Count the total number of items in the array
- ☐ Count the unique items in the array
- ☐ I don't know
- ☐ Selecting a number random from the array

```
main{
  print(func("hello world"))
}

String func(String in){
    int x = len(in)
    String out = ""
    for(int i = x-1; i >= 0; i--){
        out.append(in[i])
    }
    return out
}
```

Q15 What is the parameter of the function?
- ☐ String out
- ☑ String in
- ☐ I don't know
- ☐ int i = x-1; i >= 0; i–
- ☐ Outputting a String
- ☐ int x = len(in)

Q16 Please select the returned value of the pseudocode above:
- ☐ hello world
- ☐ hello world 10
- ☑ dlrow olleh
- ☐ world hello
- ☐ HELLO WORLD
- ☐ I don't know
- ☐ hello world hello world hello world hello world

1) **[Attention Check]** This is an attention check question. Please select the answer "Octal".
- ☐ Duodecimal
- ☐ I don't know
- ☑ Octal
- ☐ Binary
- ☐ Decimal
- ☐ Hexadecimal

Demographic Questions

1) How many years of programming experience do you have?

2) How experienced would you consider yourself at programming?
- ☐ Beginner
- ☐ Intermediate
- ☐ Expert
- ☐ No experience at all

3) Have you ever been paid for your work as a programmer?
- ☐ Yes
- ☐ No

4) In which country do you currently reside?

5) How old are you?

6) What is your gender?
- ☐ Male
- ☐ Female
- ☐ Prefer to self-describe:
- ☐ Prefer not to tell

7) What is your main profession?

III. Participants' Demographics

A. Country of Residence

Clickworker No Experience:: NA: (1), Finland (1), France (1), Germany (21), India (3), Italy (1), Netherlands (1), Philippines (1), Russian Federation (1), Serbia (1), South Africa (2), Spain (2), United Kingdom of Great Britain and Northern Ireland (8), United States of America (6)

Clickworker with Programming Experience:: Argentina (1), Austria (1), Egypt (2), Finland (1), Germany (22), Greece (1), India (4), Indonesia (1), Italy (4), Kenya (1), Netherlands (1), Nigeria (1), Portugal (1), Romania (1) Spain (1), Sweden (1), United Kingdom of Great Britain and Northern Ireland (5), United States of America (3)

Clickworker Attack:: Australia (1), Austria (1), Brazil (3), Colombia (1), Finland (1), France (1), Germany (16), India (1), Italy (4), Kenya (2), Malaysia (1), Mexico (1), Peru (1), Poland (2), Romania (1), Spain (4), Sweden (1), United Kingdom of Great Britain and Northern Ireland (1), United States of America (4)

B. Main Occupation

Professional Developers:: Lead Developer (3), Software Developer (22), IT Staff (2), Data scientist (1), Engineer (1), IT Release Manager (1), System architect (1), Function Developer (1), Security Consultant (1)

Clickworker without Programming Skill:: Student (4), House wife (3), Freelancer (3), Engineer (3), Merchant (2), Teacher (2),Administrator (2), Developer (2), Editor (2), Social worker (1), Self-employed (1), Manager (1), Druggist (1), Scientist (1), Project manager (1), Telephone Operator (1), Security (1), Office clerk (1), Public administration specialist (1), Bookkeeping (1), Paralegal (1), Investment analysis (1), Doctor (1), Unemployed (1), Physicist (1), Translator (1), Geologist (1), Tattoo artist (1), IT Security (1), Economist (1), Environmental Health Officer (1), Controller (1), Service staff (1), Support (1), Finance (1), NA (1)

Clickworker with Programming Skill:: Student (9), Software Developer (8), Support (7), IT (4), Self-employed (2), House wife/husband (2), Law (1), Sales (1), Spiritual life coaching (1), Nurse (1), Data scientist (1), Office employee (1), Engineer (1), System administrator (2), Scientist (4), Chemist (1), Assistant lecturer (1), Unemployed (1), Graphic designer (1), Architecture (1), Astronomer (1), Nutritionist (1)

Clickworker Attack:: Student(4), Clerk (3), Sales (3), Manager (2), Teacher (2), Worker (2), Administrative (1), Architecture (1), Asacom (1), Business (1), Carrier (1), Civil engineering (1), Crowdworker (1), Data handling (1), Data scientist (1), Delivery driver (1), Developer (1), Factory technician (1), Finance (1), Freelancer (1), IT (1), Landscape architecture (1), Editor (1), Material technician (1), Mechanic (1), Medical doctor (1), Media (1), Musician (1), Online shop operator (1), Physiotherapist (1), Programming (1), Independent (1), Software developer (1), Social pedagogue (1), Student developer (1), Student assistant (1), NA (1)
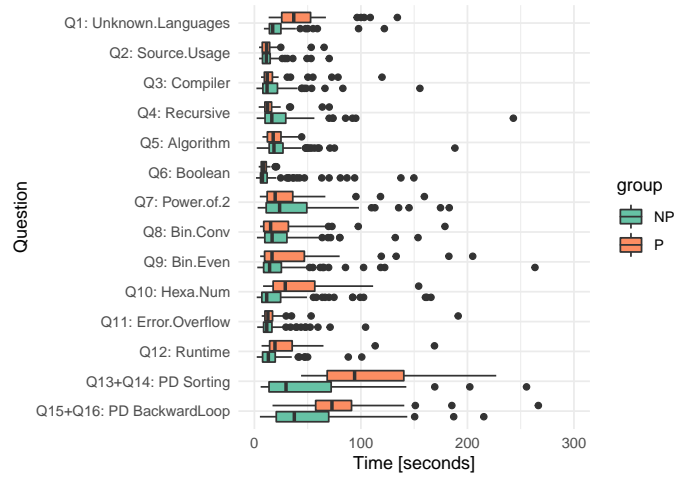

Fig. 1: Time to answer each question for the non-programmer (NP) and programmer (P) group.

IV. Results

A. Effectiveness

Table I shows an overview of the correct and incorrect answers of the programmer and non-programmer group for all the questions (Q1-Q16). Table II summarizes the related statistical analysis results. Figure 2 displays the number of correct solutions of the non-programmer group (n = 100) separated by participants who indicated to have 0 years and more than 0 years of programming experience.

B. Efficiency

We visualized the mean times for both programmer and non-programmer groups according to each task block in Figure 1.

C. Attack Scenario

Table III shows an overview of the self-reported resources used by participants for correctly answering the questions within the attack scenario (n = 47).

V. Timing thresholds

Figures 3, 4, 5, and 6, illustrate how many participants from the attacker (attack) and programmer group (progs) solved the four recommended questions Q2, Q3, Q4, and Q6 correctly and how many seconds they needed to answer. Drawing a line on a certain time threshold, it becomes visible how many attackers and programmers would be excluded from the correct group.

(a) Unknown.Languages (Q1)	✓	✗
Programmer	49	1
Non-Programmer	91	9

(b) Source.Usage (Q2)	✓	✗ (Idp)
Programmer	50	0 (0)
Non-Programmer	6	94 (60)

(c) Compiler (Q3)	✓	✗ (Idk)
Programmer	50	0 (0)
Non-Programmer	33	67 (37)

(d) Recursive (Q4)	✓	✗ (Idk)
Programmer	50	0 (0)
Non-Programmer	30	70 (33)

(e) Algorithm (Q5)	✓	✗ (Idk)
Programmer	49	1 (0)
Non-Programmer	47	53 (13)

(f) Boolean (Q6)	✓	✗ (Idk)
Programmer	50	0 (0)
Non-Programmer	25	75 (60)

(g) Power.of.2 (Q7)	✓	✗ (Idk)
Programmer	48	2 (0)
Non-Programmer	41	59 (18)

(h) Bin.Conv (Q8)	✓	✗ (Idk)
Programmer	48	2 (0)
Non-Programmer	38	62 (38)

(i) Bin.Even (Q9)	✓	✗ (Idk)
Programmer	45	5 (2)
Non-Programmer	34	66 (39)

(j) Hexa.Num (Q10)	✓	✗ (Idk)
Programmer	35	15 (0)
Non-Programmer	6	94 (51)

(k) Error.Overflow (Q11)	✓	✗ (Idk)
Programmer	47	3 (2)
Non-Programmer	21	79 (49)

(l) Runtime (Q12)	✓	✗ (Idk)
Programmer	40	10 (5)
Non-Programmer	6	94 (56)

(m) Error.OutOfBound (Q13)	✓	✗ (Idk)
Programmer	38	12 (2)
Non-Programmer	9	91 (66)

(n) Sorting.Array (Q14)	✓	✗ (Idk)
Programmer	49	1 (0)
Non-Programmer	24	76 (51)

(o) Function.Param (Q15)	✓	✗ (Idk)
Programmer	50	0 (0)
Non-Programmer	13	87 (57)

(p) Backward.Loop (Q16)	✓	✗ (Idk)
Programmer	47	3 (0)
Non-Programmer	7	93 (41)

TABLE I: Number of (in)correct answers of the programmers (n = 50) and non-programmers (n = 100) for Q1-Q16.
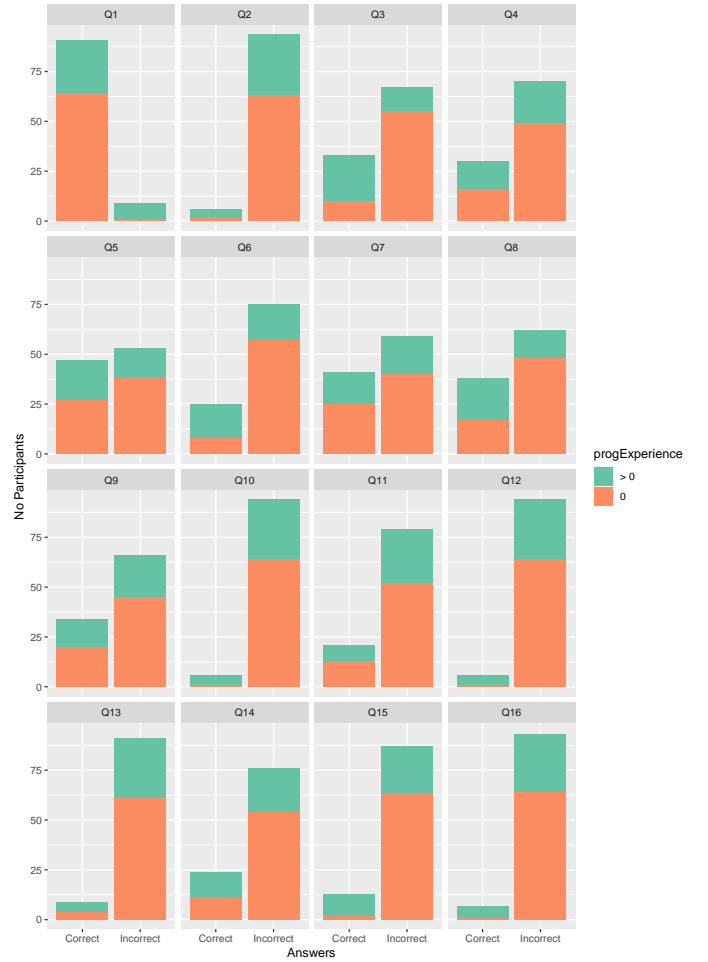Idp = I don't program; Idk = I don't know.

Fig. 2: Number of correct solutions of the non-programmer group (n = 100) separated by participants who indicated to have 0 years and more than 0 years of programming experience.

progExperience: > 0 if non-programmer participants reported to have more than 0 years of programming experience, and $= 0$ if they reported to have no programming experience at all.
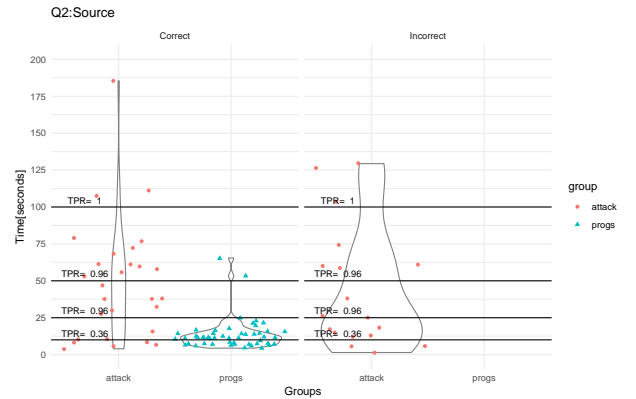

Fig. 3
The figure illustrates the true positive rate at example thresholds (10 seconds, 25 seconds, 50 seconds, 100 seconds)

Question	O.R.	CI	p-value
Q1	4.8	[0.63, 216.47]	0.17
Q2	Inf	[143.54, Inf]	< 0.001*
Q3	Inf	[23.93, Inf]	< 0.001*
Q4	Inf	[27.37, Inf]	< 0.001*
Q5	54.18	[8.56, 2240.58]	< 0.001*
Q6	Inf	[34.71, Inf]	< 0.001*
Q7	33.82	[8.09, 302.74]	< 0.001*
Q8	38.29	[9.14, 343.35]	< 0.001*
Q9	17.11	[6.05, 60.28]	< 0.001*
Q10	35.14	[12.11, 120.60]	< 0.001*
Q11	56.86	[15.96, 310.37]	< 0.001*
Q12	59.35	[19.37, 218.09]	< 0.001*
Q13	30.79	[11.45, 92.27]	< 0.001*
Q14	149.39	[23.1, 6075.50]	< 0.001*
Q15	Inf	[71.76, Inf]	< 0.001*
Q16	190.22	[45.97, 1170.64]	< 0.001*

TABLE II: Summary of statistical analysis for questions Q1-Q16 for the programmer and non-programmer group. Fisher's exact tests were used for analysis. The independent variable was the programmer/non-programmer group. The dependent variable was the correctness of an answer. Significant results are marked with *.

Question	No of correct responses	Used Internet search	Asked friends/colleagues	Other
Q2	29	12	4	0
Q3	36	14	4	1: "I actually knew that myself! :)"
Q4	36	19	3	0
Q6	36	16	2	1:"I knew it could have a value of true or false"
Q14	29	0	1	1:"Guessed"
Q15	13	0	0	0
Q16	12	1	2	0

TABLE III: Self-reported resources used by participants for correctly answering the questions within the attack scenario (n = 47). Multiple answers were possible.
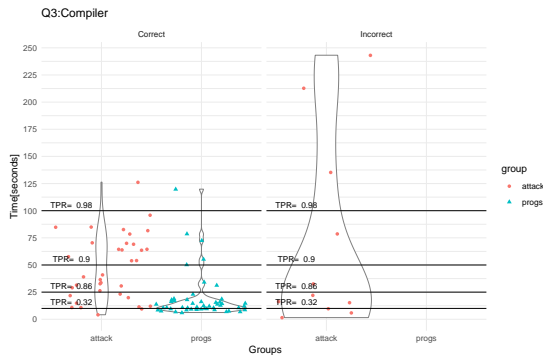

Fig. 4
The figure illustrates the true positive rate at example thresholds (10 seconds, 25 seconds, 50 seconds, 100 seconds).
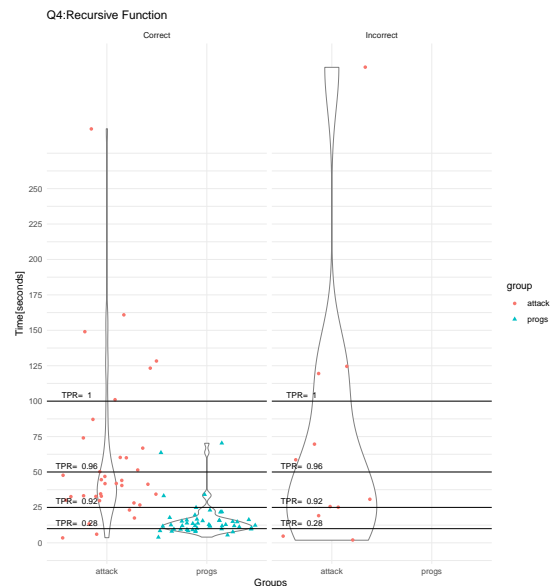

Fig. 5
The figure illustrates the true positive rate at example thresholds (10 seconds, 25 seconds, 50 seconds, 100 seconds)
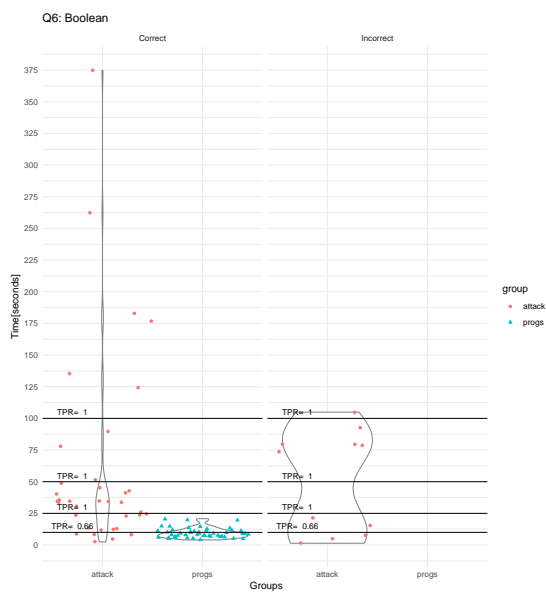
Fig. 6
The figure illustrates the true positive rate at example thresholds(10
seconds, 25 seconds, 50 seconds, 100 seconds)