Synthesizing Pattern Programs from Examples

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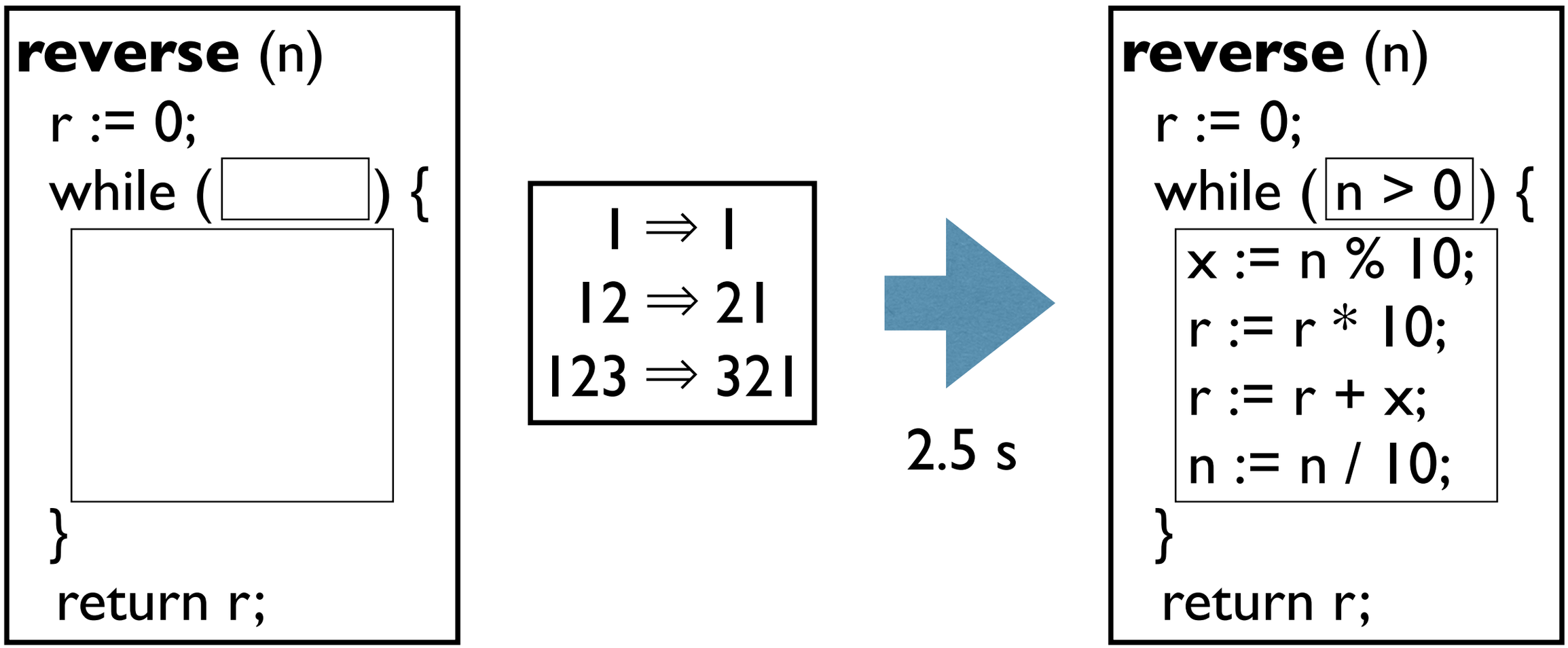
Program Synthesis

- Generate computer programs from specifications.

Imperative Program Synthesis



Synthesizing imperative programs from examples guided by static analysis,
Sunbeom So and Hakjoo Oh, SAS 2017

This Talk

Pattern Program Synthesis

★
★★★
★★★★★
★★★★★★★

0.04 s

```
for (i=0; i< N; i++)
  for (j=0; j < N - i; j++)     print ‘  ’
  for (j=0; j < 2*i - 1; j++)   print ‘★’
  print ‘\n’
```

Motivation

- Beginner students have difficulties in writing pattern programs by themselves.

mankul sachdeva • a year ago

can u give code for hollow square with a diagonal pattern

Reply • Share ›

Rishe Kundey • a year ago

Can we have W star pattern???

Reply • Share ›

https://codeforwin.org

Hollow Square with Diagonals

mankul sachdeva · a year ago

can u give code for hollow square with a diagonal pattern

Reply · Share ›

khyathi · 10 months ago

can we have a sqaure star pattern with diagonal in it like

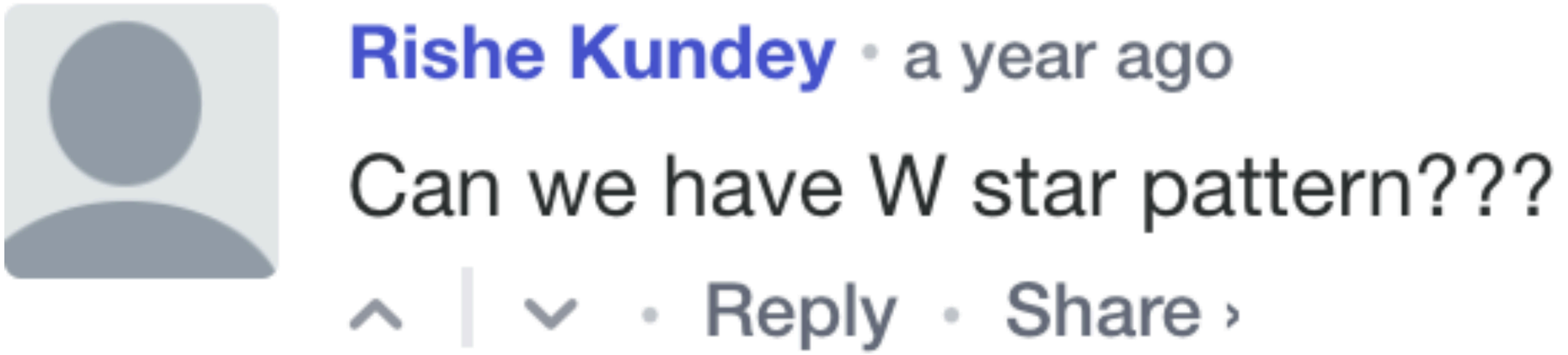
```
* * * * *
* *   * *
*   *   *
* *   * *
* * * * *
```

Hollow Square with Diagonals

5.2 s

```
for (i=0; i< N; i++)
  for (j=0; j<N - i; j++) {
    if (i=1 || i=N || j=1 || j=i || j=N-i+1 || j=N)
      print '★'
    else print '  '
  }
print '\n'
```

W pattern


Rishe Kundey · a year ago
Can we have W star pattern???
Reply · Share ›

W pattern

4.2 s

```
for (i=0; i< N; i++)
  for (j=0; j<4*N - i - 2; j++) {
    if (j = 2*N - i || j = 2*N + i - 2 ||
        j = 4*N - i -2 || j = i)
      print ‘★’
    else print ‘  ’
}
print ‘\n’
```

Hollow Parallelogram + Hollow Right Triangle

24.8 s

```
for (i=0; i< N; i++)
  for (j=0; j < N-i; j++) print ‘  ’
for (j = 0; j< N+i-1; j++) {
  if (i=1 || i=N || j=1 || j=N || j=N+i-1)
    print ‘★’
  else print ‘  ’
}
print ‘\n’
```

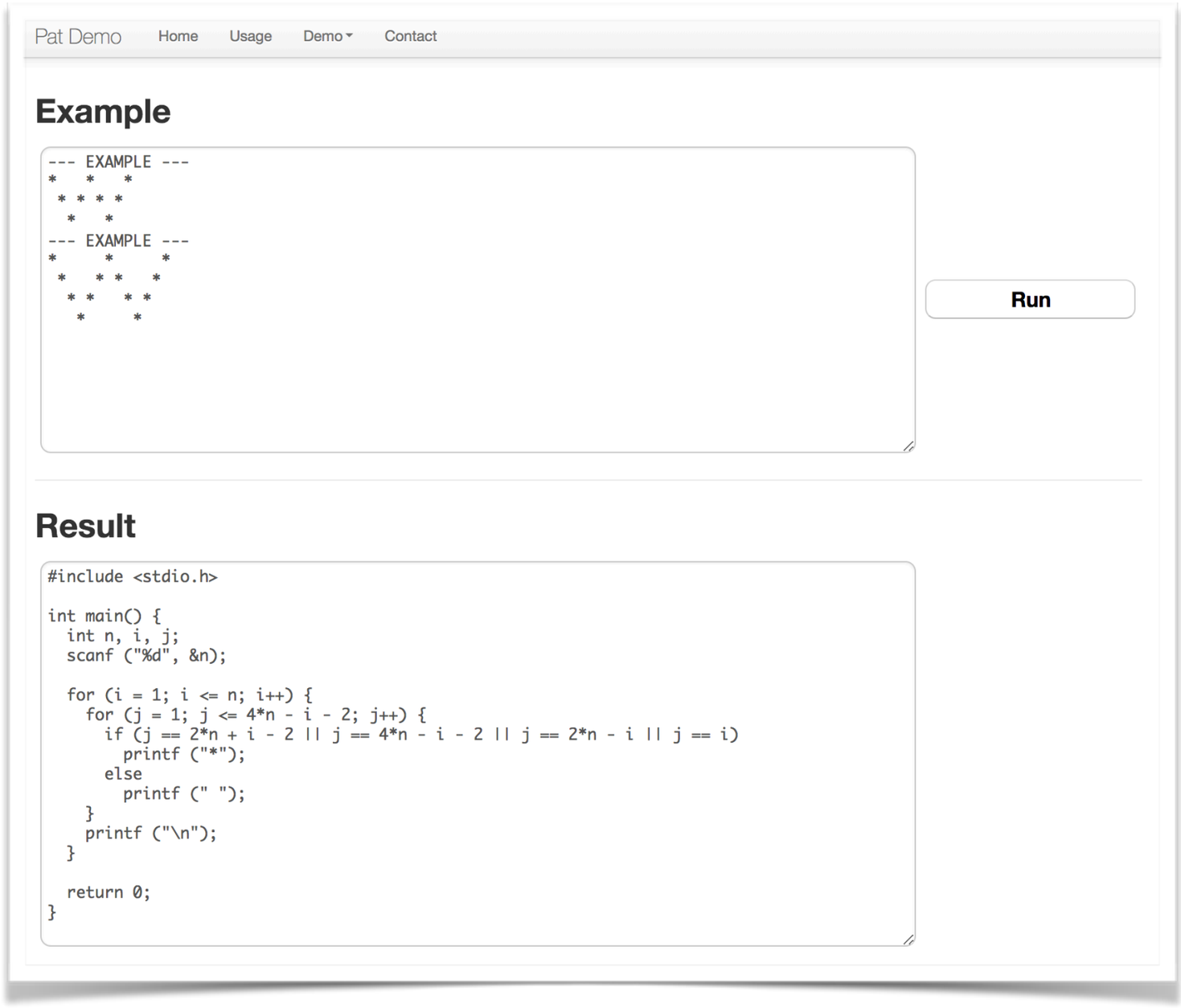
Challenge & Solution

- Big challenge in program synthesis
  - Handling huge search space
- Our solution
  - Constraint solving + static program analysis

User Study

- Conducted with 23 undergraduate students.
- Requested to solve two problems.
- Requested to freely use our tool in web demo page for one day.
  - Synthesized programs were displayed in C.

User Study



http://prl.korea.ac.kr/patdemo

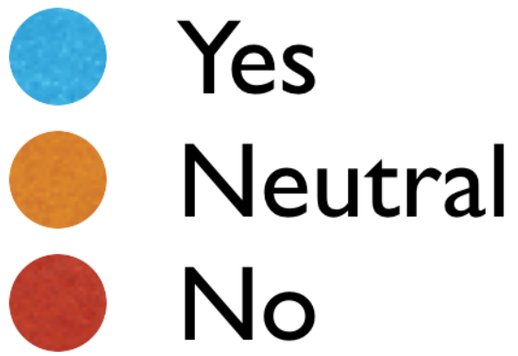
User Study

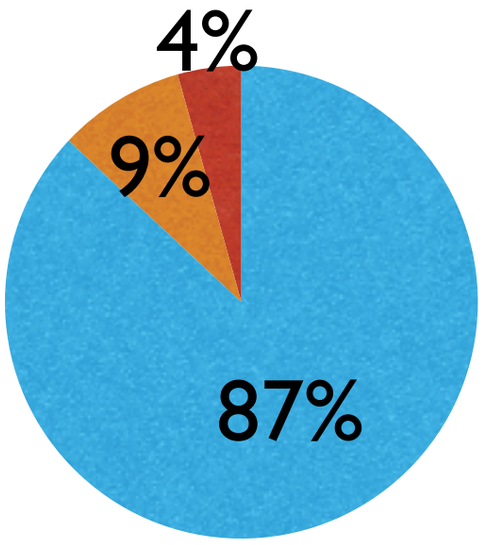
Q1. Simple and easy solutions to understand?

Q2. Simpler and and easier solutions, compared to yours?

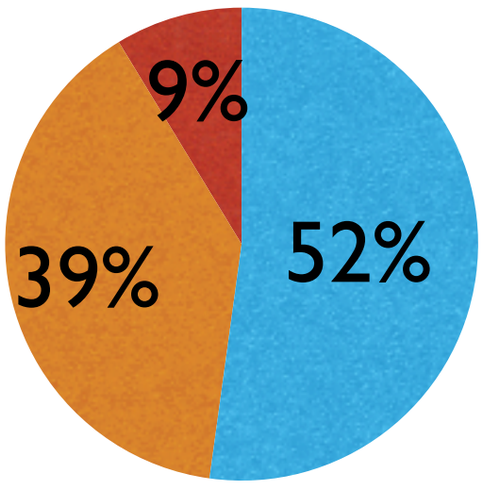
Q3. Helpful in learning?

Q4. Easy to use?

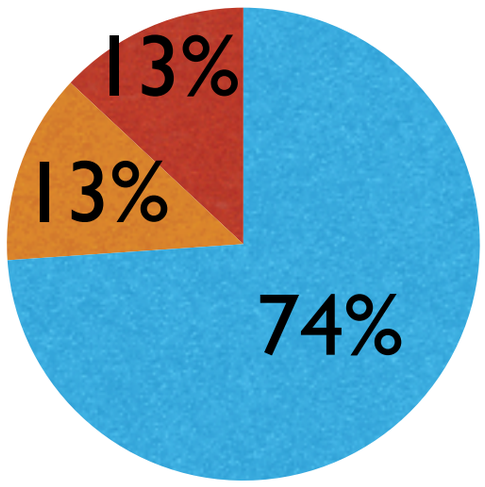




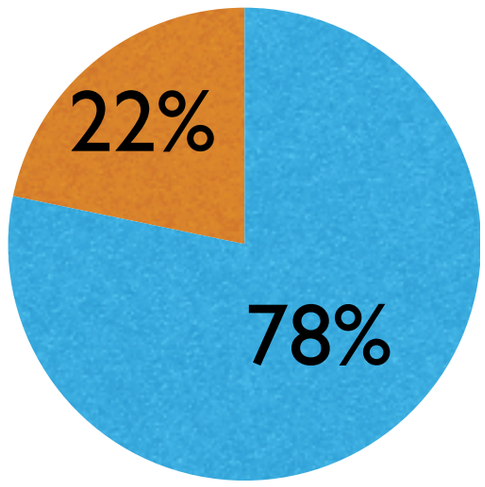
Q1



Q2



Q3



Q4

User Study

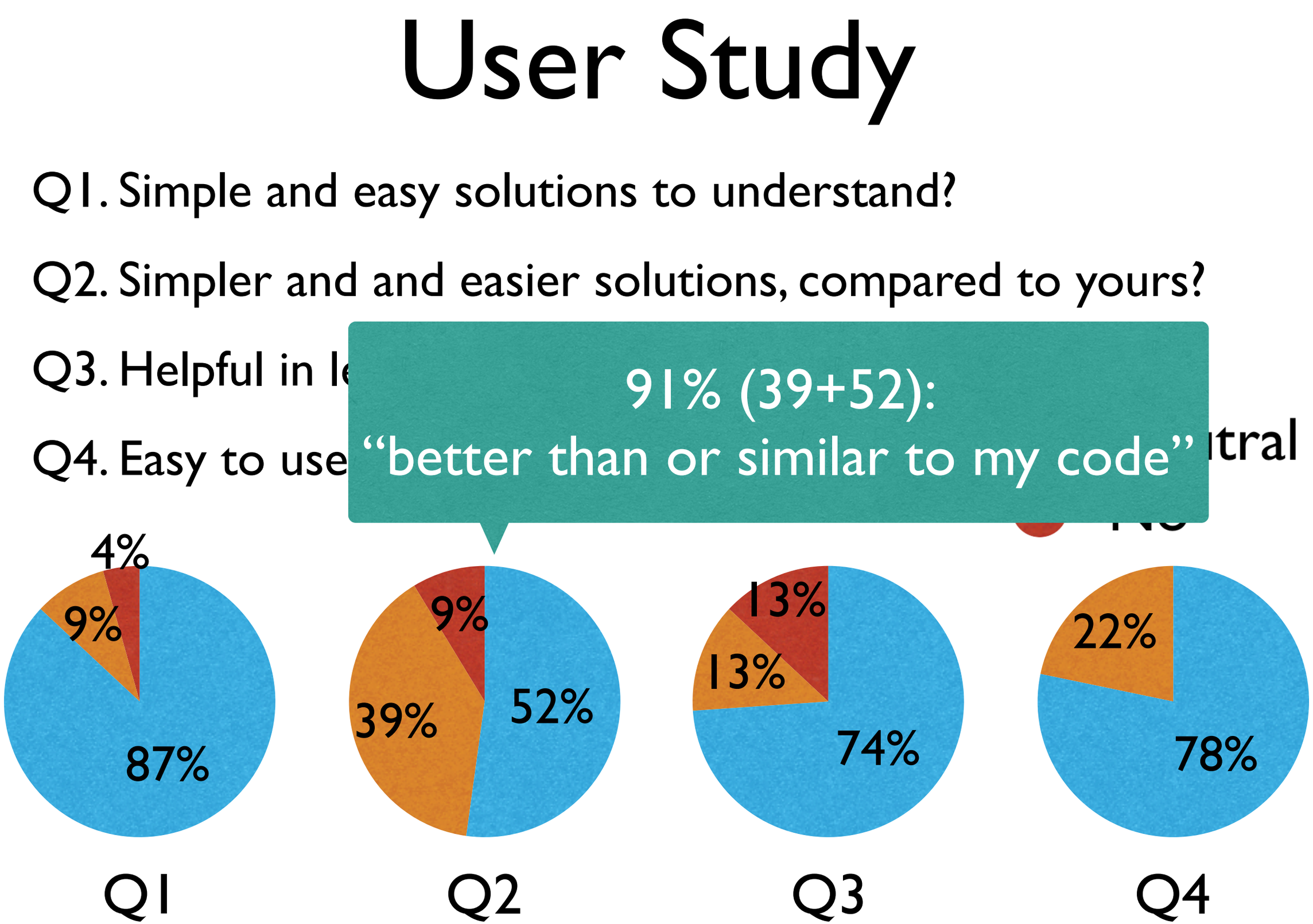
Q1. Simple and easy solutions to understand?

Q2. Simpler and and easier solutions, compared to yours?

Q3. Helpful in le

Q4. Easy to use

91% (39+52):
"better than or similar to my code"



User Study

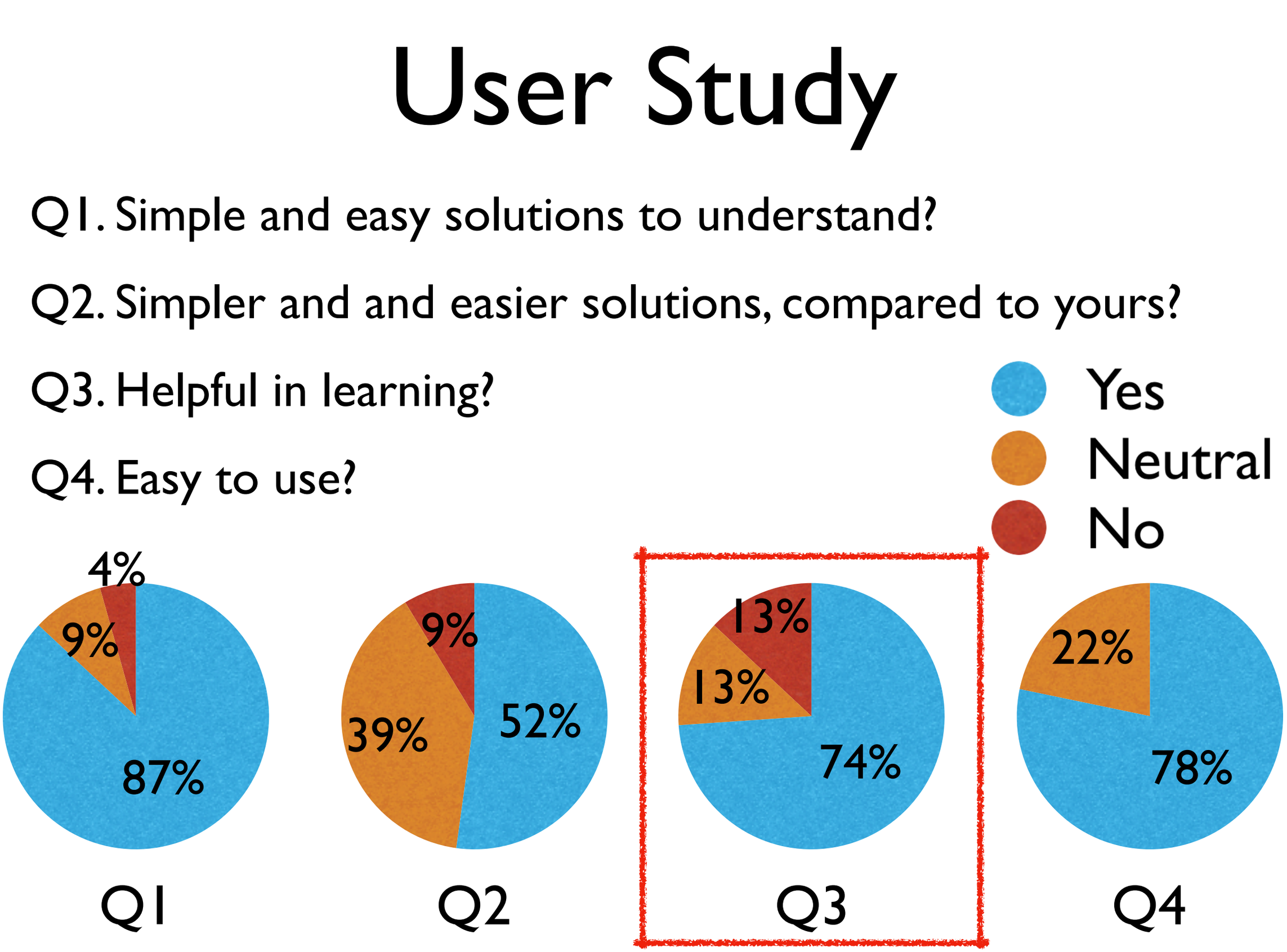
Q1. Simple and easy solutions to understand?

Q2. Simpler and and easier solutions, compared to yours?

Q3. Helpful in learning?

Q4. Easy to use?

Yes
Neutral
No



Why Helpful?

- In Q3, the students answered "our tool is helpful".
  - Improving programming skills by learning instructive code generated by the tool (71%)
  - Real-time feedback without asking to human instructors (65%)
  - Severing as an automated teacher for shy students (47%)

Summary

- We developed a new system that synthesizes pattern programs from examples.
- Students actually loved our tool!

Thank you for listening