Synthesizing Pattern Programs from Examples

Sunbeom So and Hakjoo Oh
Korea University

16 July 2018
IJCAI 2018 @ Stockholm, Sweden
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
Pattern Program Synthesis

```
for (i=0; i< N; i++)
    for (j=0; j < N - i; j++)
        print '   ';
    for (j=0; j < 2*i - 1; j++)
        print '★';
    print '
';
```

0.04 s
Motivation

- Beginner students have difficulties in writing pattern programs by themselves.
Hollow Square with Diagonals

mankul sachdeva • a year ago

Can u give code for hollow square with a diagonal pattern

khyathi • 10 months ago

Can we have a square star pattern with diagonal in it like

```
* * * * *
*   *   *
*   *   *
*   *   *
* * * * *
```
Hollow Square with Diagonals

```
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’
```

5.2 s
W pattern

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

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

```python
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?
- Yes: 87%
- Neutral: 9%
- No: 4%

Q2. Simpler and easier solutions, compared to yours?
- Yes: 74%
- Neutral: 13%
- No: 13%

Q3. Helpful in learning?
- Yes: 78%
- Neutral: 13%
- No: 9%

Q4. Easy to use?
- Yes: 22%
- Neutral: 29%
- No: 52%
User Study

Q1. Simple and easy solutions to understand?

Q2. Simpler and easier solutions, compared to yours?

Q3. Helpful in learning?

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 easier solutions, compared to yours?
Q3. Helpful in learning?
Q4. Easy to use?

Q1: 87% Yes, 9% Neutral, 4% No
Q2: 52% Yes, 39% Neutral, 9% No
Q3: 74% Yes, 13% Neutral, 13% No
Q4: 78% Yes, 22% Neutral

4% 9% 13% 13% 13% 74% 22% 78%
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