FlexCoder: Practical program synthesis with flexible input lengths and expressive lambda functions

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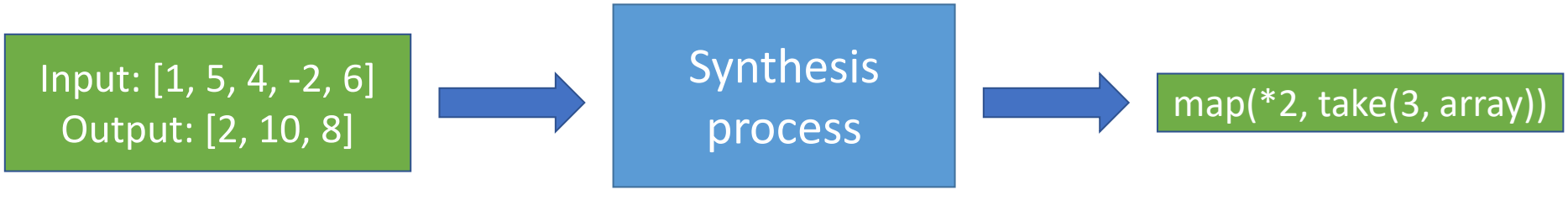
Introduction

Synthesis process



Function composition

Introduction

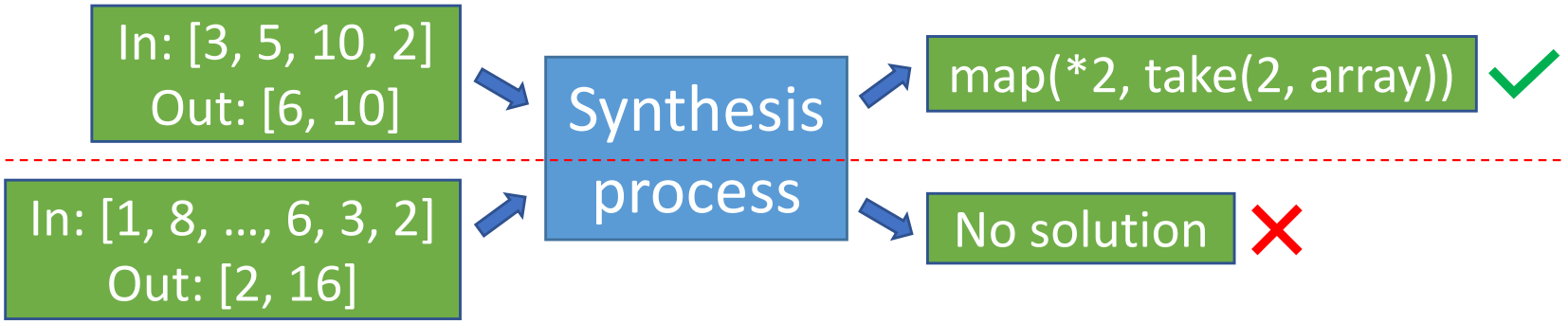
- Task
  - Synthesizing programs based on input-output pairs
- Essential parts:
  - Grammar and data generation
    - Deep learning algorithm $\Rightarrow$ data-hungry approach
  - Neural network
  - Search algorithm

Components, Limitations

How do the components work together?

Main limitations of state-of-the-art systems:

- static or upper-bounded input vector sizes



- agglutination of grammar tokens
  - map($*2$, list)
- limited parameter ranges of lambda operators
- limited integer ranges of inputs

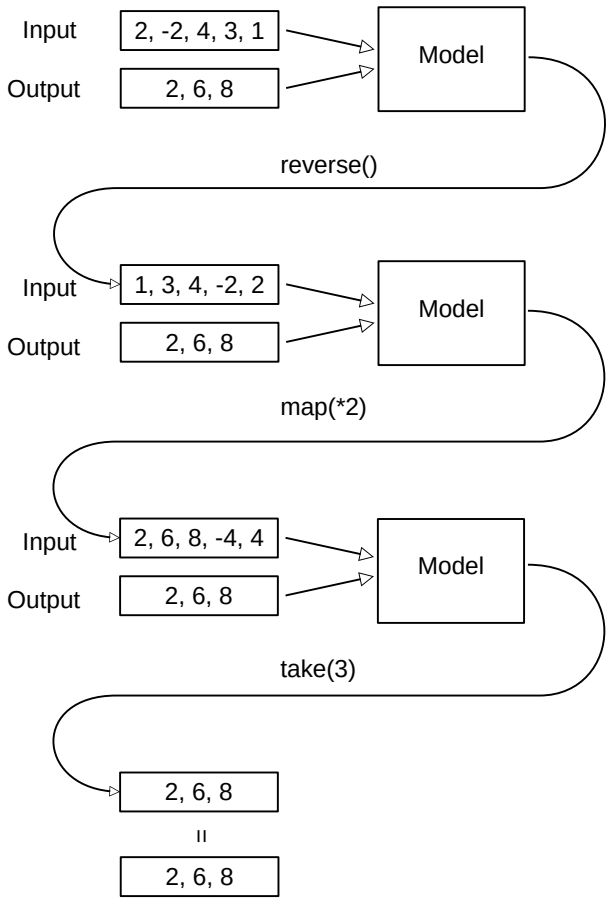
Grammar

A simplified version of the grammar

$$
\begin{aligned}
S &\to ARRAY\_FUNCTION \mid NUMERIC\_FUNCTION \\
ARRAY\_FUNCTION &\to take(NUM,\ ARRAY) \mid drop(NUM,\ ARRAY) \\
ARRAY\_FUNCTION &\to map(LAMBDA\_FUNCTION,\ ARRAY) \\
ARRAY\_FUNCTION &\to filter(LAMBDA\_FUNCTION,\ ARRAY) \mid \dots \\
NUMERIC\_FUNCTION &\to max(ARRAY) \mid min(ARRAY) \\
NUMERIC\_FUNCTION &\to sum(ARRAY) \mid count(ARRAY) \mid \dots \\
NUM &\to -8 \mid \dots \mid 8 \\
LAMBDA\_FUNCTION &\to OPERATOR\ NUM \\
OPERATOR &\to * \mid / \mid + \mid \% \mid > \mid == \mid \dots \\
ARRAY &\to list \mid ARRAY\_FUNCTION
\end{aligned}
$$

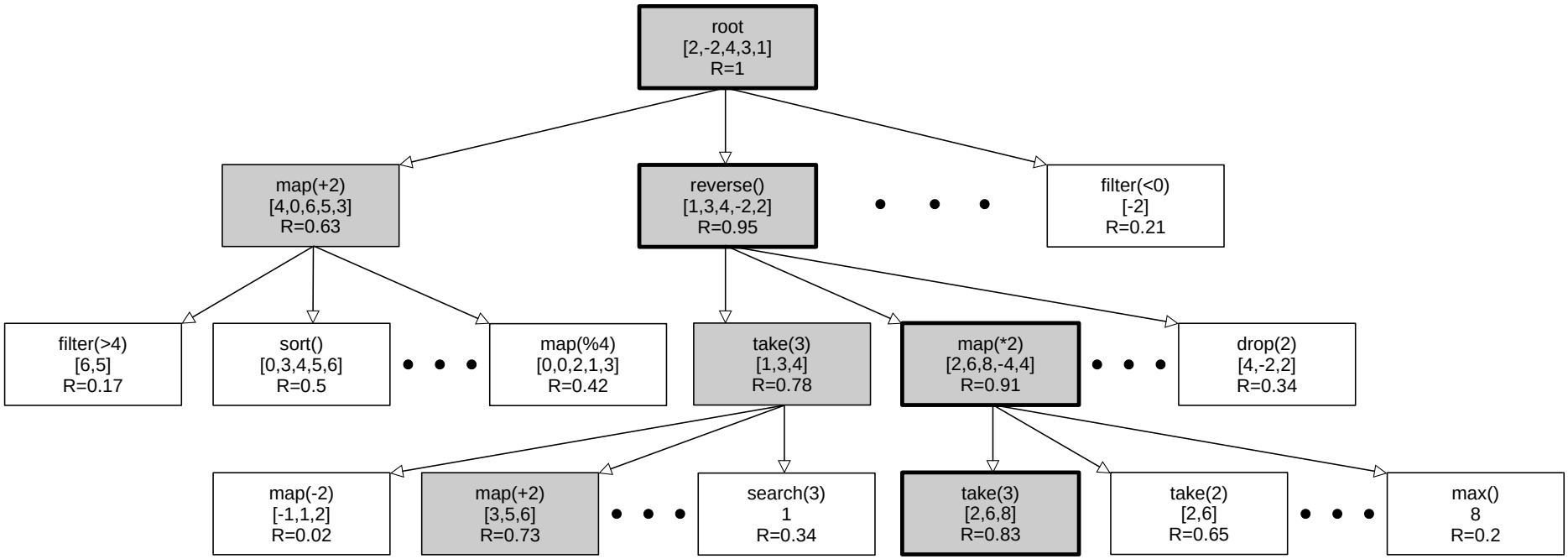
$$
\begin{aligned}
S &\to NUMERIC\_FUNCTION \to max(ARRAY) \to max(ARRAY\_FUNCTION) \\
&\to max(map(LAMBDA\_FUNCTION, ARRAY)) \to max(map(*2, list))
\end{aligned}
$$

Synthesizing Process



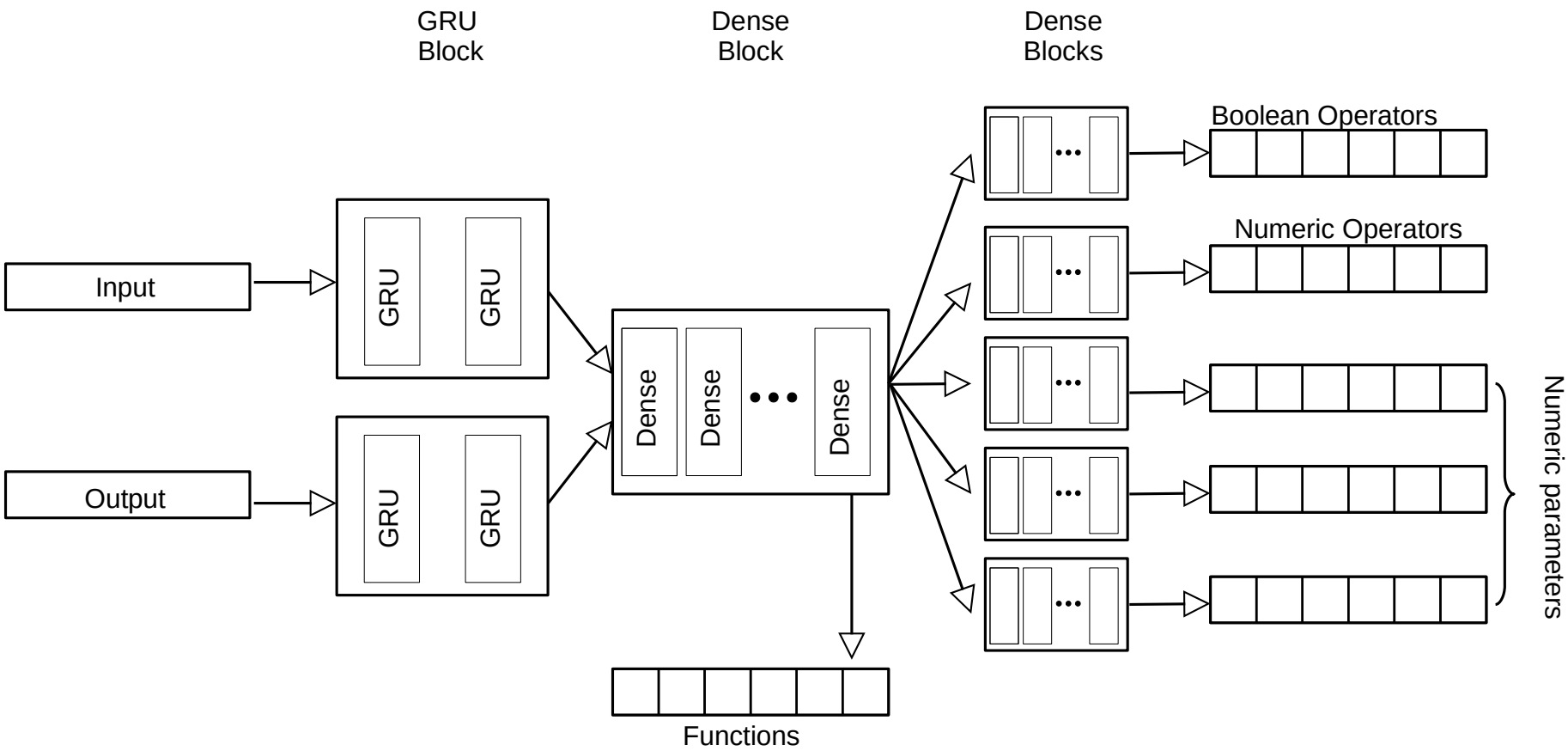
- The input(s) and corresponding output(s) are given
- The composition is built one function at a time
- The neural network guides the search as a heuristic.
- take(3,map(*2,reverse(inp)))

Search

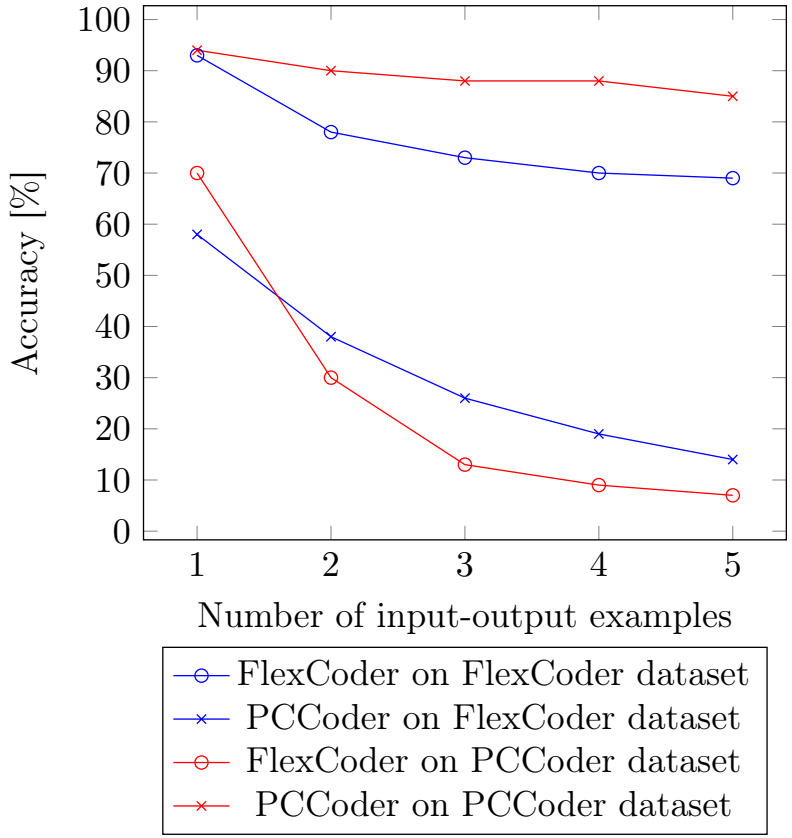


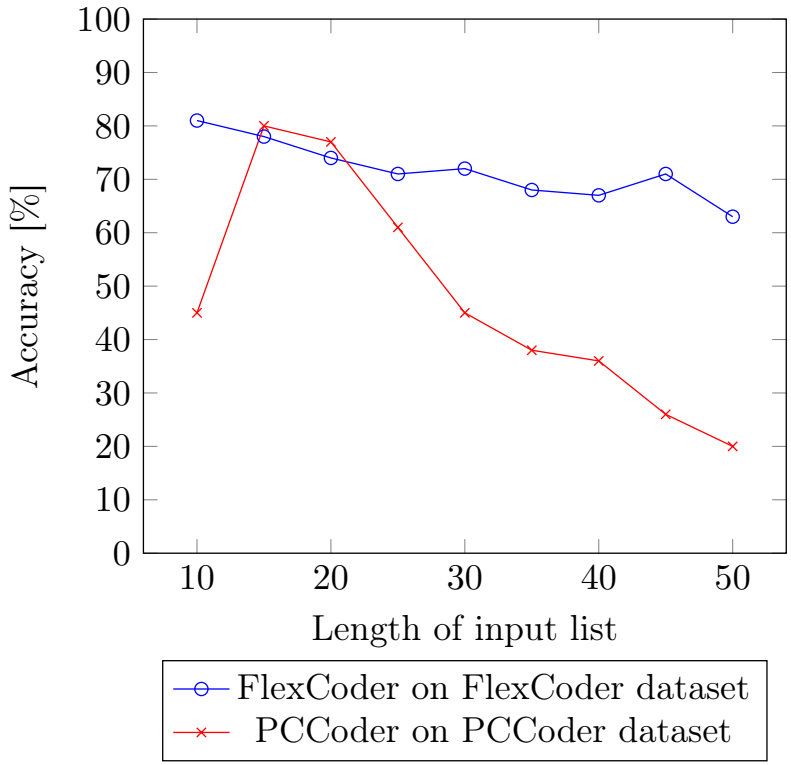
- The branch leading to success is indicated by black rectangles

Structure of Neural Network



Comparison With a State-of-the-Art System





- Our system: FlexCoder
- A Zohar, L Wolf: PCCoder

Takeaways

- We introduce a program synthesis system that generalizes well to different input lengths.
- We treat the operators in lambda functions separately from their parameters.
- We extend the range of intermediate results and outputs fourfold compared to previous works.

Thank you for your attention!

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