JUMPCODER: Go Beyond Autoregressive Coder via Online Modification

Mouxiang Chen, Hao Tian, Zhongxin Liu, Xiaoxue Ren, Jianling Sun

The State Key Laboratory of Blockchain and Data Security, Zhejiang University

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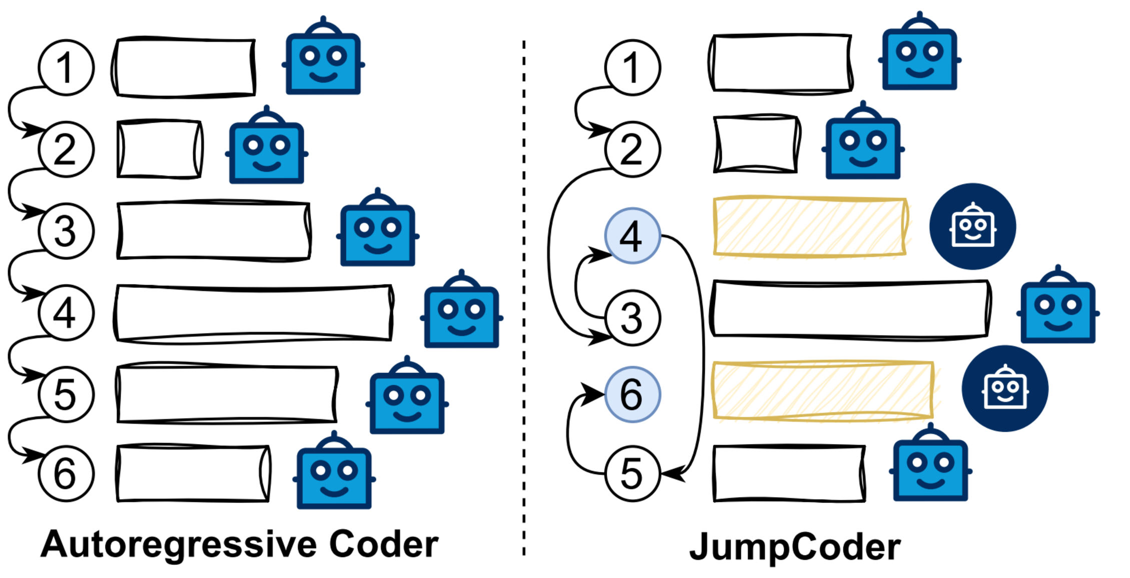
TL; DR

➤**Motivation**: Traditional code LLMs (**Autoregressive Coder**) generate code in a linear, **irreversible** sequence. This can lead to errors accumulating over time.

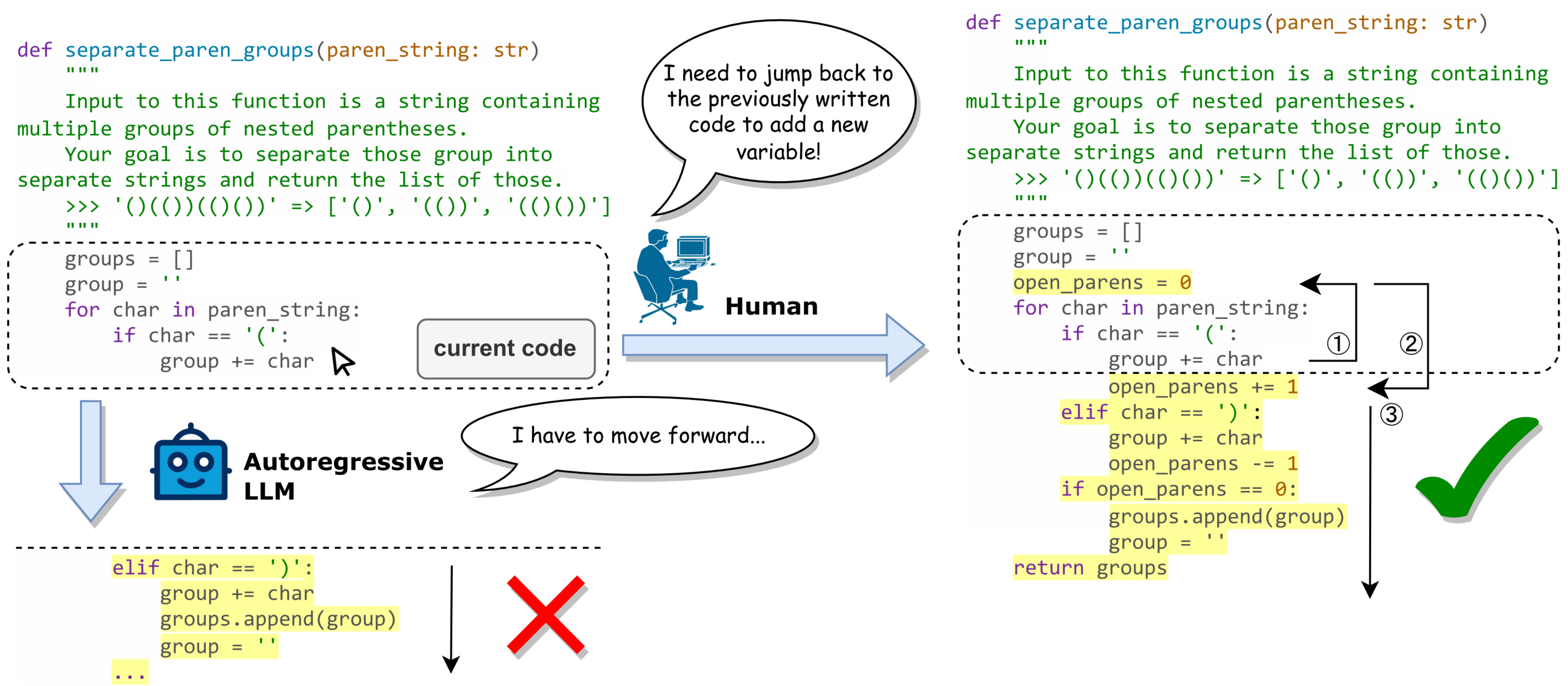
➤**Method:** We introduce **JumpCoder**, a model-agnostic code generation framework for augmenting code LLMs without retraining.

➤**How it Works**: JumpCoder can insert new code into currently generated code on-the-fly with an auxiliary **infilling model.**



◀ Schematic illustrations of traditional autoregressive coder and the proposed JumpCoder.

1. Motivation Example



◀ An illustrative example demonstrating the difference between humans and LLMs.

➤ When a new variable is required, humans can ***jump back*** to the front section to define it.

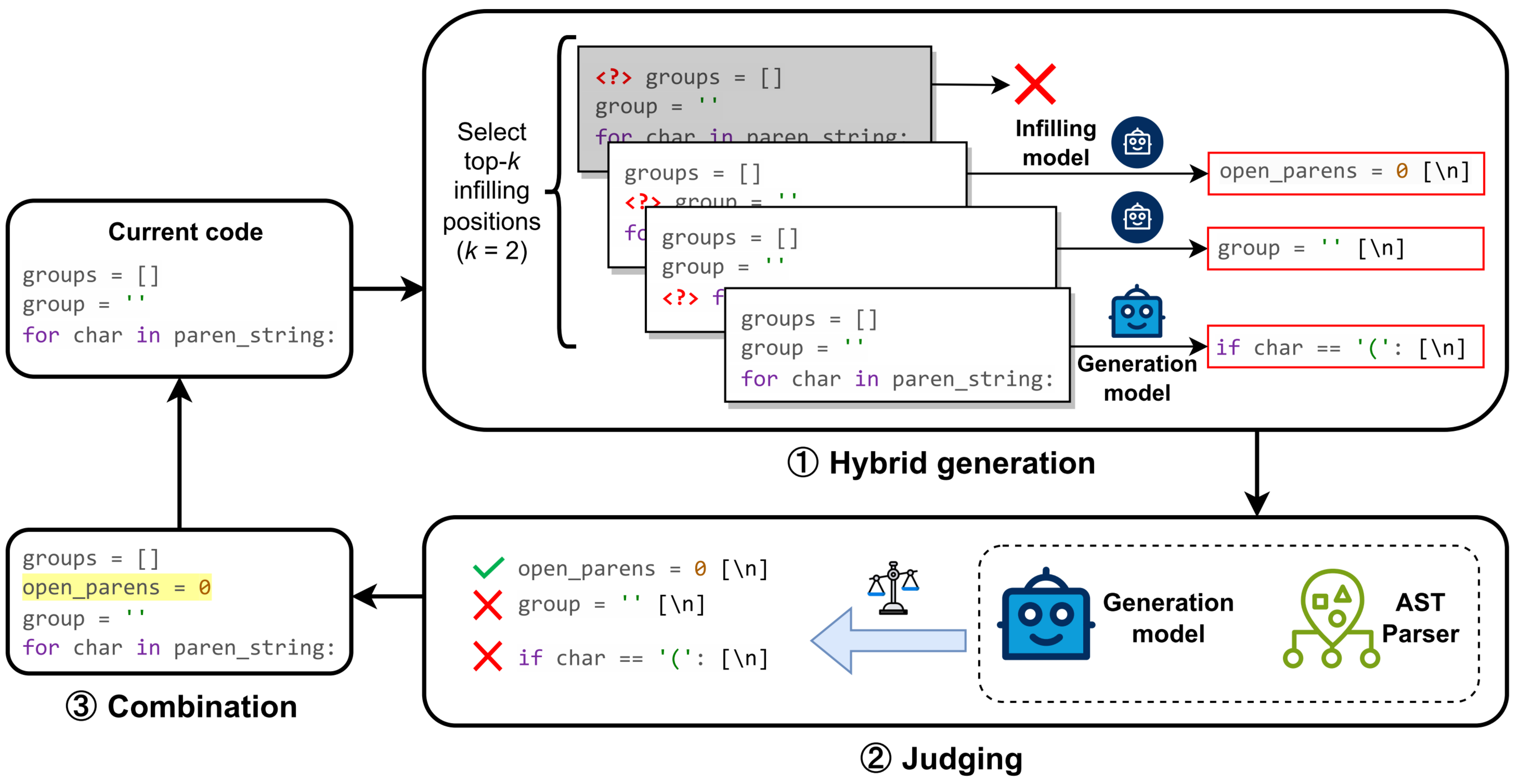
➤ But LLMs, constrained by their autoregressive nature, can ***only continue generation*** and lead to error propagation.

2. Challenges

➤ **Challenge 1:** How to infill a line?
  ➤ Use a pre-trained infilling model.
  ➤ *e.g.*, InCoder, CodeLlama-Instruct.

➤ **Challenge 2:** Whether (and where) to infill, or continue generation?
  ➤ **infill first, judge-later:** ① let infill model experiment with filling at the start of the k most critical lines; ② judge their contributions to the current generation.

3. Method



▲ JumpCoder Framework. The iterative code update process comprises three important stages: Hybrid generation, Judging and Combination. Each iteration inserts a new line of code.

① **Hybrid Generation**

➤ Generate $k+1$ lines of code: k infills, 1 line of continual generation

➤ Efficiency Optimization: Parallel generation, Speculative infilling

② **Judging**

➤ **AST Parser:** accepts the infill that adds the missing declaration.

➤ **Generation Model Scoring:** scores the code following the infill. If improved, accept the infill.

➤ **Other case:** continue generation.

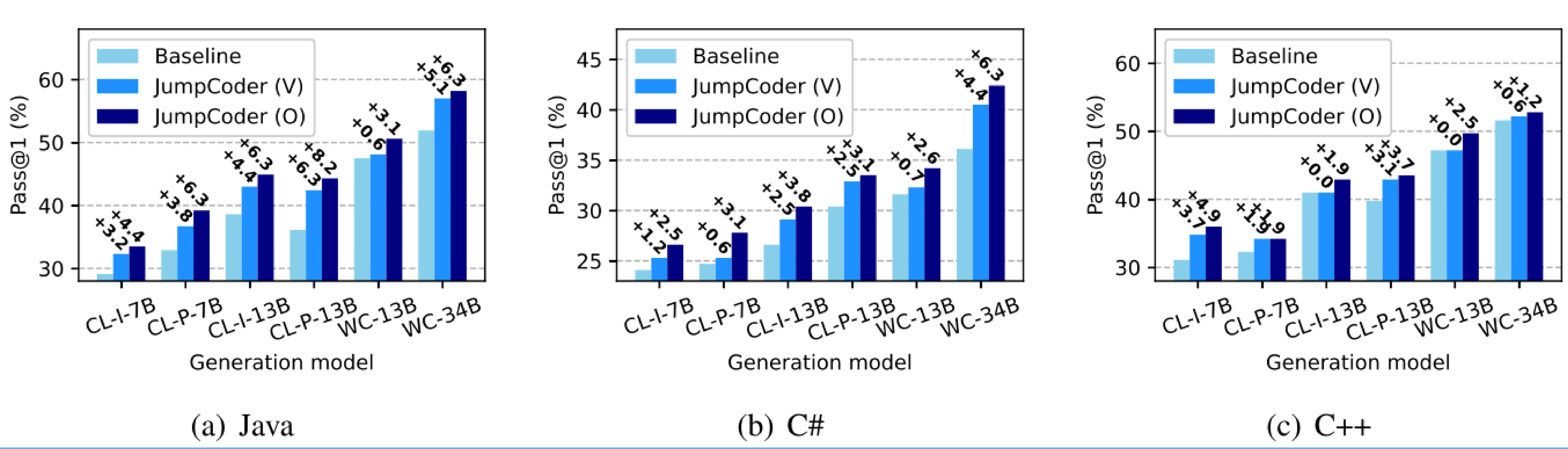
③ **Combination**

➤ Combine the line of code after judging into existing n lines of code

4. Experiments

Generation model	Method	HumanEval	MBPP
CodeLlama-Instruct (7B)	-	36.0	42.4
	+ JC (V)	37.8 (+1.8)	44.8 (+2.4)
	+ JC (F)	**39.6 (+3.6)**	**45.2 (+2.8)**
	+ JC (O)	*39.6 (+3.6)*	*45.2 (+2.8)*
CodeLlama-Python (7B)	-	38.4	43.2
	+ JC (V)	40.2 (+1.8)	45.4 (+2.2)
	+ JC (F)	**41.5 (+3.1)**	**45.6 (+2.4)**
	+ JC (O)	*41.5 (+3.1)*	*46.8 (+3.6)*
CodeLlama-Instruct (13B)	-	40.9	45.8
	+ JC (V)	**44.5 (+3.6)**	**46.8 (+1.0)**
	+ JC (F)	43.9 (+3.0)	46.6 (+0.8)
	+ JC (O)	*45.7 (+4.8)*	*48.0 (+2.2)*
CodeLlama-Python (13B)	-	43.9	50.0
	+ JC (V)	**45.7 (+1.8)**	**51.0 (+1.0)**
	+ JC (F)	**45.7 (+1.8)**	50.8 (+0.8)
	+ JC (O)	*47.0 (+3.1)*	*53.2 (+3.2)*
WizardCoder-Python (13B)	-	64.0	56.8
	+ JC (V)	64.6 (+0.6)	**57.2 (+0.4)**
	+ JC (F)	**65.2 (+1.2)**	**57.2 (+0.4)**
	+ JC (O)	*65.9 (+1.9)*	*57.2 (+0.4)*
WizardCoder-Python (34B)	-	73.8	59.2
	+ JC (V)	**74.4 (+0.6)**	59.2 (+0.0)
	+ JC (F)	**74.4 (+0.6)**	**59.6 (+0.4)**
	+ JC (O)	*75.0 (+1.2)*	*60.0 (+0.8)*

▲ **Results of Pass@1 (%) on HumanEval and MBPP using greedy generation.** JC (V): Use code from JumpCoder. JC (F): use code from JumpCoder and Autoregressive Coder based on the lower perplexity. JC (O): use code from the above two based on evaluation test cases, served as an upper bound.



(a) Java (b) C# (c) C++

◀ **Results on MultiPL-E.** On average, JumpCoder passes an additional 5.8% (Java), 3.6% (C#) and 2.7% (C++) problems.

chenmx@zju.edu.cn