ACES: generating diverse programming puzzles with autotelic language models and semantic descriptors

Julien Pourcel, Cédric Colas, Pierre-Yves Oudeyer, Laetitia Teodorescu

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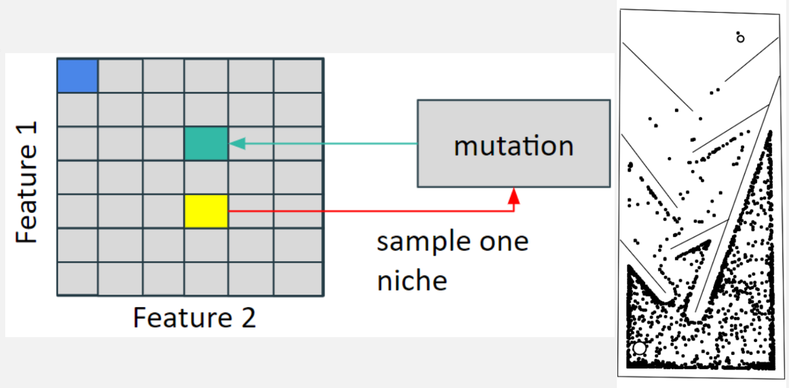
Background

- Generative models usually aim to replicate a reference distribution.
- They generally do not focus on enhancing diversity.
- Methods that do target diversity are limited to narrow or uninterpretable space (embedding space).

Diversity algorithm:

- Define a meaningful features space
- Try to maximize coverage of that space



Python Programming Puzzles (P3)

```
def f(x: float, a=1020) -> bool:
    """Find a number that when squared is close to a."""

    return abs(x ** 2 - a) < 10 ** -3
```

Problem to solve and test function (test units) return True/False
True: correct solution,
False: incorrect solution

```
def g(a=1020) -> float:
    return a ** 0.5
```

Solution function return a solution

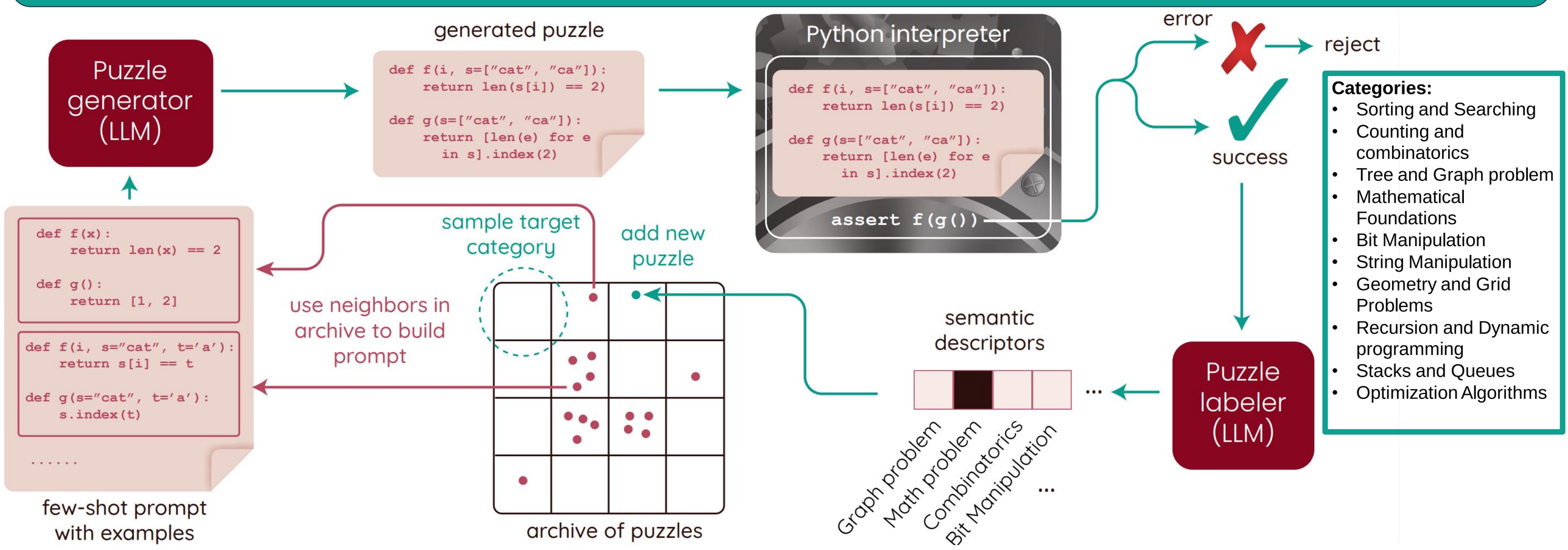
```
assert f(g()) == True
```

Check syntax of the puzzle and **correctness**

- What Behavioral Characterization space can we use for P3 ?
- How to maximize diversity given limited resources ?

Methods

Use language model feedback to create rich human-relevant and interpretable Behavioral Characterization space

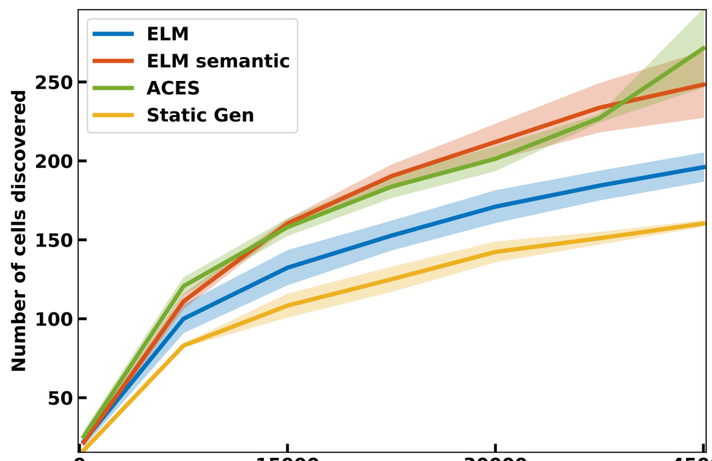


Categories:

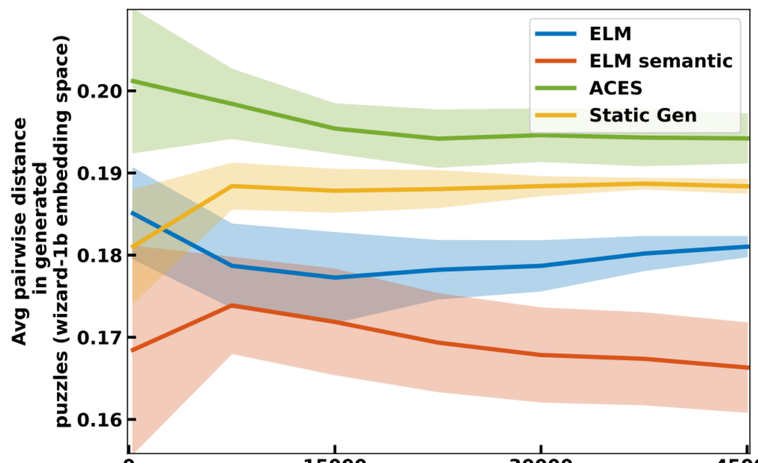
- Sorting and Searching
- Counting and combinatorics
- Tree and Graph problem
- Mathematical Foundations
- Bit Manipulation
- String Manipulation
- Geometry and Grid Problems
- Recursion and Dynamic programming
- Stacks and Queues
- Optimization Algorithms

Results

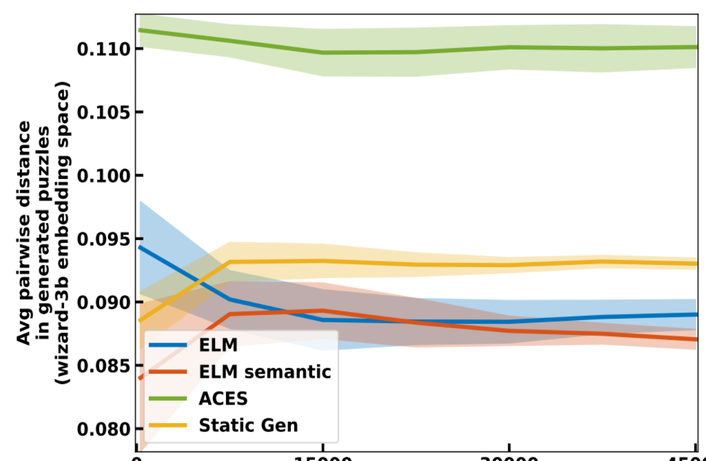
Result 1: Diversity of generated puzzles in semantic and embedding (WizardCoder-1B and 3B) space



Semantic space



Embedding space (WizardCoder-1B)

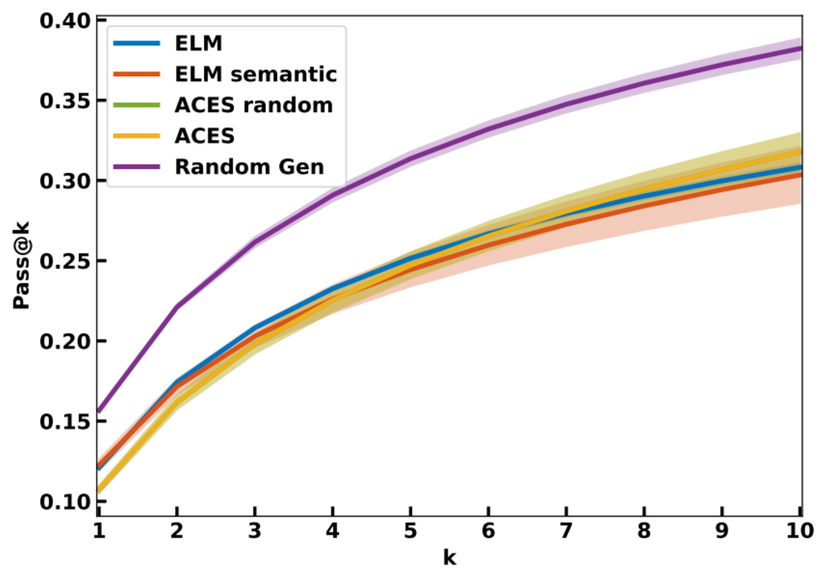


Embedding space (WizardCoder-3B)

Discussion

- Discover richer diversity on a range of metrics
- Semantic space is more interpretable
- Diversity doesn't correlate with downstream performance when fine-tuning language model
  - Quality problem? How can we define quality? (difficulty, …)
  - Imperfect skills labelling ?

Pass@k on Python Programming Puzzles (P3) test set
(number of puzzles solved for k trials)



References:

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