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Generative AI for Generative Programming: Automating Code Variants and Exploring the Boundaries of LLMs

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► **To cite this version:**

Mathieu Acher. Generative AI for Generative Programming: Automating Code Variants and Exploring the Boundaries of LLMs. 2024. hal-04809253

HAL Id: hal-04809253

<https://hal.science/hal-04809253v1>

Submitted on 28 Nov 2024

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Generative AI for Generative Programming:

Automating Code Variants and Exploring the Boundaries of LLMs

Mathieu Acher



28 november 2024 @ Caen, invited talk at Normastic

<https://www.normastic.fr/event/journee-de-laxe-donnees-apprentissage-connaissances-large-language-models-llms/>



Large language models (LLMs) can be used to automate software engineering tasks, with the hope of boosting developers' productivity without sacrificing reliability.

In this talk, I will briefly present two initiatives: the défi Inria LLM4Code and the CodeCommons project around SoftwareHeritage, exemplifying ongoing research efforts.

Then, I will show how LLMs can automatically generate software variants across different technological spaces (Python, Rust, JavaScript, etc.) and implement new features from simple prompts.

I will also highlight how LLMs can assist in modernizing legacy applications, such as those written in COBOL or in deprecated technologies.

I will further discuss the concept of programming without directly manipulating programs, relying almost entirely on AI to manage technical details and customize code.

For all their potential, I will also demonstrate that LLMs can dramatically fail at times, making mistakes that human developers need to carefully verify and correct.

I will conclude with an illustration of LLM prompt sensitivity in chess, showcasing how LLMs can be used both to generate variants (e.g., prompts, hypotheses, ideas) and to accelerate scientific discovery through software-based exploration and analysis.

Plan

- Overview: LLM and software engineering tasks, LLM4Code, CodeCommons
- Generating software variants across different technological spaces (Python, Rust, JavaScript, etc.) and implement new features from simple prompts.
- Programming without directly manipulating programs, relying almost entirely on AI to manage technical details and create variants of code (customization).
- How LLMs can be used both to generate variants (e.g., prompts, hypotheses, ideas) and to accelerate scientific discovery through software-based exploration and analysis.
- Conclusion

PhD at University of Nice Sophia Antipolis (MESR, 2008-2011)

Postdoc at University of Namur, Belgium (Marie Curie fellowship, 2011-2012)

Associate Professor at University of Rennes 1/ISTIC (2012-2022)

Junior research fellow at IUF "mediation" (september 2021, 5 years)

Professor at INSA Rennes since september 2022

Love chess (FIDE master, 2341 Elo)

Love football (coach of Vétérans in Saint Aubin du Cormier)

Love software

Love science

can you depict a map of France with all locations?

```
python
import folium

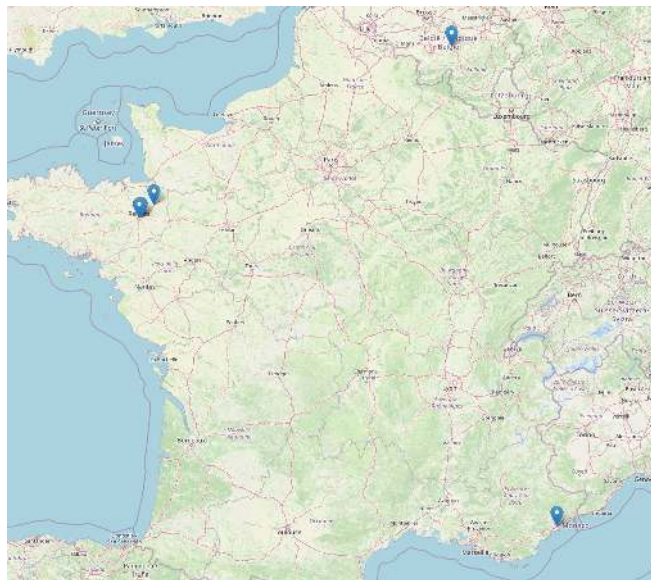
# Create a map centered around France
m = folium.Map(location=[46.603354, 1.888334], zoom_start=6)

# Add markers for each location
locations = {
    'University of Nice Sophia Antipolis': [43.6155, 7.0719],
    'University of Namur, Belgium': [50.4652, 4.8676],
    'University of Rennes 1/ISTIC': [48.1172, -1.6778],
    'INSA Rennes': [48.1215, -1.6366],
    'Saint Aubin du Cormier': [48.2972, -1.3746]
}

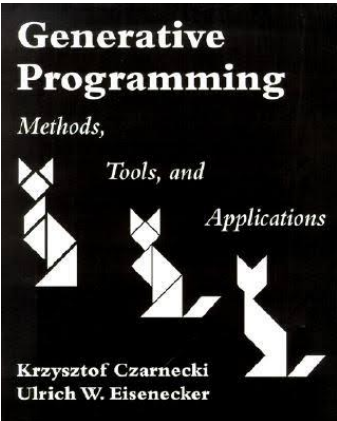
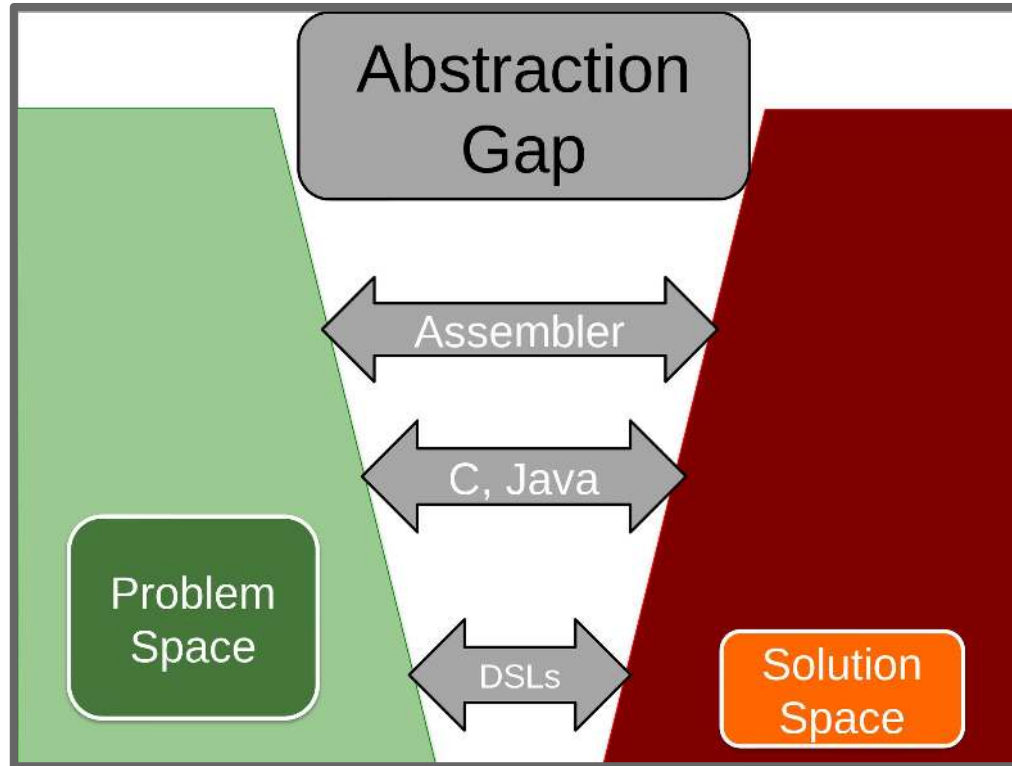
for place, coord in locations.items():
    folium.Marker(location=coord, popup=place).add_to(m)

# Save the map to an HTML file
m.save('map.html')
```

Software



Generative programming (Czarnecki and Eisenecker 2000), Software Product Line engineering: automatically generate software variants from a specification written in one or more textual or graphical domain-specific languages (DSLs)



Generative AI for Generative programming: automatically generate software variants from a specification written in one or more textual or graphical domain-specific languages (DSLs)



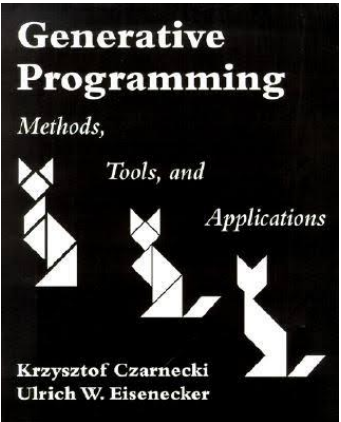
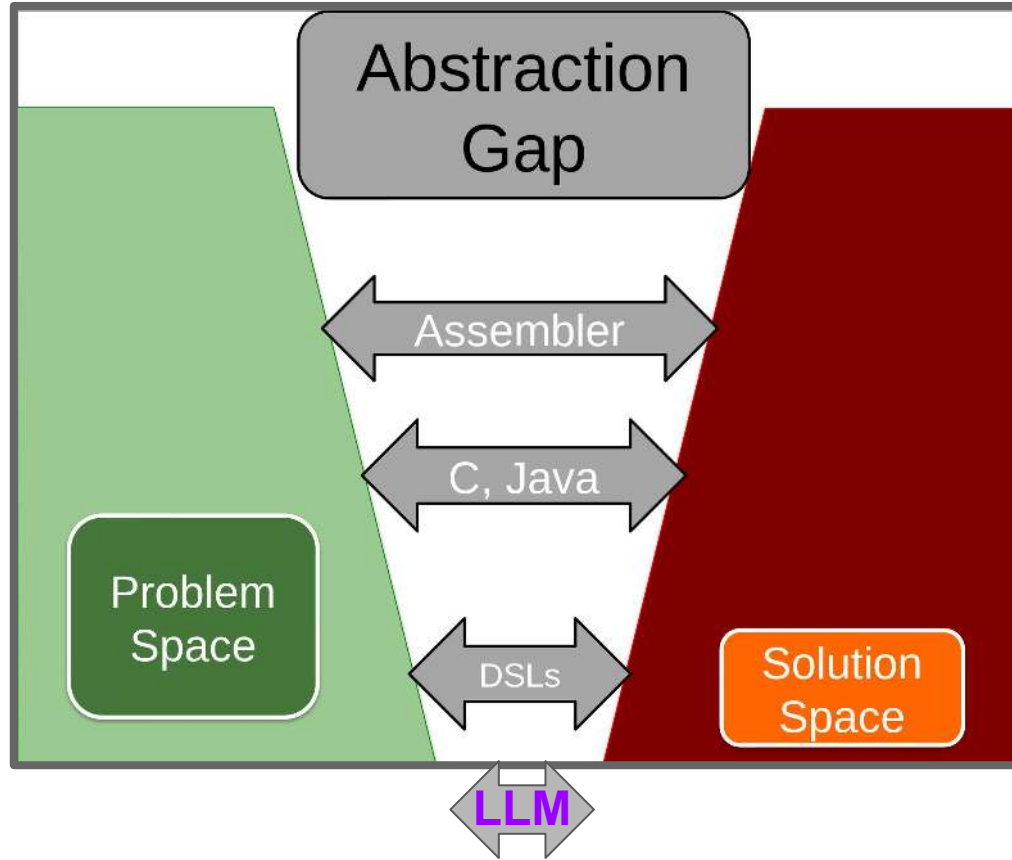
starcoder2 Public



AlphaCode

DeepSynth

GitHub Copilot



Reliable and productive code assistants based on LLMs

Main objectives:

- Generate better code: quality, diversification
- Validate the results: test, formal proof, review, integration
- Assist tedious tasks: boilerplate code, software migration

Organization: 3 cross-domain work packages

- **WP1:** Self-improving code generation
- **WP2:** Migration, maintenance and evolution of existing software
- **WP3:** Build interactive software development tools with AI-in-the-loop

LLM4Code: Reliable and Productive Code Assistants
Based on Large Language Models

Project Leads

| | | | |
|---------|--------|-------------------|--|
| DIVERSE | Rennes | Mathieu Acher | mathieu.acher@inria.fr |
| PICUBE | Paris | Guillaume Baudart | guillaume.baudart@inria.fr |

Internal Partners (EP/CRI)

| | | | |
|------------|----------|----------------------|--|
| ARGO | Paris | Marc LeLARGE | marc.lelarge@inria.fr |
| DELI-CREAM | Socha | Anthony Bordg | anthony.bordg@inria.fr |
| FVREF | Lille | Anne-Filien | anne.etien@univ-lille.fr |
| FLOWERS | Bordeaux | Pierre-Yves Oudreyer | pierre-yves.oudreyer@inria.fr |
| MYTMO5VNE | Bordeaux | Xavier Hinaut | xavier.hinaut@inria.fr |
| SPIRALS | Lille | Clément Quinton | clement.quinton@inria.fr |
| STAMP | Sophia | Cyril Cohen | cyril.cohen@inria.fr |
| SED | Nancy | Laurent Pierrou | laurent.pierrou@inria.fr |

External Partners

| | | |
|-------------------|--------------------|--|
| SOFTWARE HERITAGE | Roberto di Cosmo | roberto@dicosmo.org |
| LABRI | Nathanaël Fijalkow | nathanael.fijalkow@labri.fr |
| | Romain Robbes | romain.robbes@cnrs.fr |
| SOPRA STERIA | Yann Glorieu | yann.glorieu@sopraasteria.com |

 You


| | |
|---------|--------|
| DIVERSE | Rennes |
| PICUBE | Paris |

Internal Partners (EP/C

| | |
|-----------|----------|
| ARGO | Paris |
| DEDUCTEAM | Saclay |
| EVREF | Lille |
| FLOWERS | Bordeaux |
| MNEMOSYNE | Bordeaux |
| SPIRALS | Lille |
| STAMP | Sophia |
| SED | Nancy |

Please give me a downloadable map of France that depicts locations of these cities and teams

 ChatGPT

 Analyzing ▾

From picture to code SE task = code synthesis!

MA You

| | |
|---------|--------|
| DIVERSE | Rennes |
| PICUBE | Paris |

Internal Partners (EP/C

| | |
|-----------|----------|
| ARGO | Paris |
| DEDUCTEAM | Saclay |
| EVREF | Lille |
| FLOWERS | Bordeaux |
| MNEMOSYNE | Bordeaux |
| SPIRALS | Lille |
| STAMP | Sophia |
| SED | Nancy |

Please give me a downloadable map of France that depicts locations of these cities and teams

ChatGPT

Analyzing ▾

python  Copy code

```
import folium

# Given coordinates for the cities (these are example coord
# Normally we would obtain these through a geocoding serv
coordinates = {
    "Rennes": [48.1173, -1.6778],
    "Paris": [48.8566, 2.3522],
    "Saclay": [48.7290, 2.1912],
    "Lille": [50.6292, 3.0573],
    "Bordeaux": [44.8378, -0.5792],
    "Sophia": [43.6222, 7.0500], # This is an approximat
    "Nancy": [48.6921, 6.1844]
}

# Initialize a map centered around France
map_france = folium.Map(location=[46.603354, 1.888334], zoom=10)

# Function to add a marker for a team
def add_team_marker(map_obj, team_name, city):
    folium.Marker(
        location=coordinates[city],
        popup=f"{team_name}, {city}",
        icon=folium.Icon(color='red', icon='info-sign')
    ).add_to(map_obj)

# Add markers for each team
add_team_marker(map_france, "DIVERSE", "Rennes")
add_team_marker(map_france, "PICUBE", "Paris")
add_team_marker(map_france, "ARGO", "Paris")
add_team_marker(map_france, "DEDUCTEAM", "Saclay")
add_team_marker(map_france, "EVEREF", "Lille")
add_team_marker(map_france, "FLOWERS", "Bordeaux")
add_team_marker(map_france, "MNEMOSYNE", "Bordeaux")
add_team_marker(map_france, "SPIRALS", "Lille")
add_team_marker(map_france, "STAMP", "Sophia")
add_team_marker(map_france, "SED", "Nancy")
```

From picture to app... SE task = code synthesis!

MA You

DIVERSE Rennes
PICUBE Paris

Internal Partners (EP/C

ARGO Paris
DEDUCTEAM Saclay
EVREF Lille
FLOWERS Bordeaux
MNEMOSYNE Bordeaux
SPIRALS Lille
STAMP Sophia
SED Nancy

Please give me a downloadable map and teams



ChatGPT

Analyzing ▾

python

Copy code

```
import folium

# Given coordinates for the cities (these are example coordinates)
# Normally we would obtain these through a geocoding service
coordinates = {
    "Rennes": [48.1173, -1.6778],
    "Paris": [48.8566, 2.3522],
    "Saclay": [48.7290, 2.1912],
    "Lille": [50.6292, 3.0573],
    "Bordeaux": [44.8378, -0.5792],
    "Sophia": [43.6222, 7.0500], # This is an approximate location
    "Nancy": [48.6921, 6.1844]
}

# Initialize a map centered around France
map_france = folium.Map(location=[46.603354, 1.888334], zoom_start=6)

# Function to add a marker for a team
def add_team_marker(map_obj, team_name, city):
    folium.Marker(
        location=coordinates[city],
        popup=f"{team_name}, {city}",
        icon=folium.Icon(color='red', icon='info-sign')
    ).add_to(map_obj)

# Add markers for each team
add_team_marker(map_france, "DIVERSE", "Rennes")
add_team_marker(map_france, "PICUBE", "Paris")
add_team_marker(map_france, "ARGO", "Paris")
add_team_marker(map_france, "DEDUCTEAM", "Saclay")
add_team_marker(map_france, "EVREF", "Lille")
add_team_marker(map_france, "FLOWERS", "Bordeaux")
add_team_marker(map_france, "MNEMOSYNE", "Bordeaux")
add_team_marker(map_france, "SPIRALS", "Lille")
add_team_marker(map_france, "STAMP", "Sophia")
add_team_marker(map_france, "SED", "Nancy")
```

Code synthesis: polyglot?

MA

You

I have the following Python code:

```
import folium
```

```
# Given coordinates for the cities (these are example coordinates and may not be accurate)
```

```
# Normally we would obtain these through a geocoding service
```

```
coordinates = {
```

```
    "Rennes": [48.1173, -1.6778],
```

```
    "Paris": [48.8566, 2.3522],
```

```
    "Saclay": [48.7290, 2.1912],
```

```
    "Lille": [50.6292, 3.0573],
```

```
    "Bordeaux": [44.8378, -0.5792],
```

```
    "Sophia": [43.6222, 7.0500], # This is an approximation for Sophia Antipolis
```

```
    "Nancy": [48.6921, 6.1844]
```

```
}
```

```
# Initialize a map centered around France
```

```
map_france = folium.Map(location=[46.603354, 1.888334], zoom_start=6)
```

```
# Add markers for each team
```

```
add_team_marker(map_france, "DIVERSE", "Rennes")
```

```
add_team_marker(map_france, "PICUBE", "Paris")
```

```
add_team_marker(map_france, "ARGO", "Paris")
```

```
add_team_marker(map_france, "DEDUCTEAM", "Saclay")
```

```
add_team_marker(map_france, "EVEREF", "Lille")
```

```
add_team_marker(map_france, "FLOWERS", "Bordeaux")
```

```
add_team_marker(map_france, "MNEMOSYNE", "Bordeaux")
```

```
add_team_marker(map_france, "SPIRALS", "Lille")
```

```
add_team_marker(map_france, "STAMP", "Sophia")
```

```
add_team_marker(map_france, "SED", "Nancy")
```

```
# Since we cannot display the folium map directly in this environment,
```

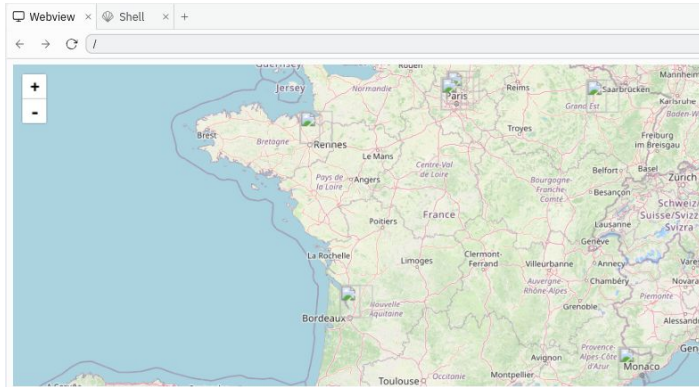
```
# we'll save it to an HTML file which you can then open in a web browser.
```

```
map_file_path = '/mnt/data/france_teams_map.html'
```

```
map_france.save(map_file_path)
```

```
map_file_path
```

Please write a JavaScript program, using Leaflet.js



ChatGPT

Creating a JavaScript program using Leaflet.js to achieve a similar functionality as your Python code with Folium is a good way to visualize geographic data on web platforms. Leaflet is a leading open-source JavaScript library for mobile-friendly interactive maps.

Here's a basic example of how you could write such a program:

```
script.js > f addCityMarker > X popupText
1 var map = L.map('map').setView([46.603354, 1.888334], 6);
2
3 // Add OpenStreetMap tiles:
4 L.tileLayer('https://{s}.tile.openstreetmap.org/{z}/{x}/{y}.png', {
5   maxZoom: 19,
6   attribution: '© OpenStreetMap contributors'
7 }).addTo(map);
8
9 // Teams and their respective cities
10 var teams = [
11   { city: "Rennes", team: "DIVERSE" },
12   { city: "Paris", team: "PICUBE" },
13   { city: "Paris", team: "ARGO" },
14   { city: "Saclay", team: "DEDUCTEAM" },
15   { city: "Lille", team: "EVEREF" },
16   { city: "Bordeaux", team: "FLOWERS" },
17   { city: "Bordeaux", team: "MNEMOSYNE" },
18   { city: "Lille", team: "SPIRALS" },
19
20   index.html < * script.js < +
21
22 1 <!DOCTYPE html>
23 2 <html>
24 3
25 4 <head>
26 5 <title>Team Locations in France</title>
27 6 <link rel="stylesheet" href="https://unpkg.com/leaflet@1.0.0/dist/leaflet.css" />
28 7 <script src="https://unpkg.com/leaflet@1.0.0/dist/leaflet.js"></script>
29 8 <style>
30 9 #map {
31 10   height: 400px;
32 11 }
33 12 </style>
34 13 </head>
35 14
36 15 <body>
37 16 <div id="map"></div>
38 17 <script src="script.js"></script>
39 18 </body>
40 19
41 20 </html>
42
43 // Helper function to get coordinates of a city
44 function getCoordinates(city) {
45   var coordinates = {
46     "Rennes": [48.1173, -1.6778],
47     "Paris": [48.8566, 2.3522],
48     "Saclay": [48.7290, 2.1912],
49     "Lille": [50.6292, 3.0573],
50     "Bordeaux": [44.8378, -0.5792],
51     "Sophia": [43.6222, 7.0500],
52     "Nancy": [48.6921, 6.1844]
53   };
54   return coordinates[city];
55 }
56
57 // Add markers for each city
58 object.keys(teamsByCity).forEach(function(city) {
59   addCityMarker(city, teamsByCity[city]);
60 });
61
62 }
```

SE task: modernization/migration



You

I have the following Python code:

```
import folium
```

```
# Given coordinates for the cities (these are example coordinates and may not be accurate)
```

```
# Normally we would obtain these through a geocoding service
```

```
coordinates = {
```

```
    "Rennes": [48.1173, -1.6778],
```

```
    "Paris": [48.8566, 2.3522],
```

```
    "Saclay": [48.7290, 2.1912],
```

```
    "Lille": [50.6292, 3.0573],
```

```
    "Bordeaux": [44.8378, -0.5792],
```

```
    "Sophia": [43.6222, 7.0500], # This is an approximation for Sophia Antipolis
```

```
    "Nancy": [48.6921, 6.1844]
```

```
}
```

```
# Initialize a map centered around France
```

```
map_france = folium.Map(location=[46.603354, 1.888334], zoom_start=6)
```

```
# Add markers for each team
```

```
add_team_marker(map_france, "DIVERSE", "Rennes")
```

```
add_team_marker(map_france, "PICUBE", "Paris")
```

```
add_team_marker(map_france, "ARGO", "Paris")
```

```
add_team_marker(map_france, "DEDUCTEAM", "Saclay")
```

```
add_team_marker(map_france, "EVEREF", "Lille")
```

```
add_team_marker(map_france, "FLOWERS", "Bordeaux")
```

```
add_team_marker(map_france, "MNEMOSYNE", "Bordeaux")
```

```
add_team_marker(map_france, "SPIRALS", "Lille")
```

```
add_team_marker(map_france, "STAMP", "Sophia")
```

```
add_team_marker(map_france, "SED", "Nancy")
```

```
# Since we cannot display the folium map directly in this environment,
```

```
# we'll save it to an HTML file which you can then open in a web browser.
```

```
map_file_path = '/mnt/data/france_teams_map.html'
```

```
map_france.save(map_file_path)
```

```
map_file_path
```

Please write a JavaScript program, using Leaflet.js

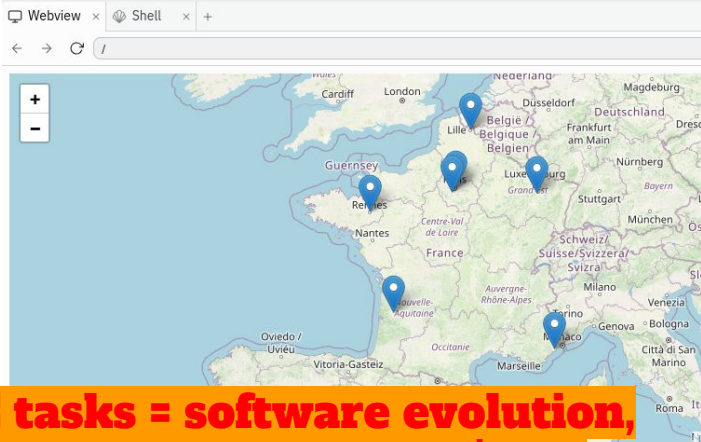


ChatGPT

Creating a JavaScript program using Leaflet.js to achieve a similar functionality as your Python code with Folium is a good way to visualize geographic data on web platforms. Leaflet is a leading open-source JavaScript library for mobile-friendly interactive maps.

Here's a basic example of how you could write such a program:

Software evolves...



SE tasks = software evolution, maintenance, upgrade | bug fixing | program understanding

```

index.html x  script.js x  +
script.js > f addCityMarker > X popupText
1  var map = L.map('map').setView([46.603354, 1.888334], 6);
2
index.html x  script.js x  +
index.html
1  <!DOCTYPE html>
2  <html>
3
4  <head>
5  <title>Team Locations in France</title>
6  <link rel="stylesheet" href="https://unpkg.com/leaflet@1.1.0/dist/leaflet.css" />
7  <script src="https://unpkg.com/leaflet@1.1.0/dist/leaflet.js"></script>
8  </head>
9  <style>
10     #map {
11         height: 400px;
12     }
13 </style>
14
15 <body>
16 <div id="map"></div>
17 <script src="script.js"></script>
18 </body>
19
20
21
22
23
24
25
26
27
28
29     height: 400px;
30 }
31 </style>
32 </head>
33 / /
34 <div id="map"></div>
35 <script src="script.js"></script>
36 </body>
37 </html>
38 }
39
40 // Helper function to get coordinates of a city
41 function getCoordinates(city) {
42     var coordinates = {
43         "Rennes": [48.1173, -1.6778],
44         "Paris": [48.8566, 2.3522],
45         "Saclay": [48.7290, 2.1912],
46         "Lille": [50.6292, 3.0573],
47         "Bordeaux": [44.8378, -0.5792],
48         "Sophia": [43.6222, 7.0500],
49         "Nancy": [48.6921, 6.1844]
50     };
51     return coordinates[city];
52 }
53
54 // Add markers for each city
55 Object.keys(teamsByCity).forEach(function(city) {
56     addCityMarker(city, teamsByCity[city]);
57 });
58

```

<https://arxiv.org/abs/2210.14699>

Piloting Copilot and Codex: Hot Temperature, Cold Prompts, or Black Magic?

```
def choose_num(x, y):  
    """  
    This function takes two positive  
    numbers x and y and returns the  
    biggest even integer number that  
    is in the range [x, y] inclusive.  
    If there's no such number, then  
    the function should return -1.  
  
    For example:  
    choose_num(12, 15) = 14  
    choose_num(13, 12) = -1  
    """  
    if x % 2 != 0:  
        x += 1  
    if y % 2 != 0:  
        y -= 1  
    if x > y:  
        return -1  
    if x % 2 == 0:  
        x += 1  
    while x <= y:  
        if x % 2 == 0:  
            return x  
        x += 2  
    return -1
```

(a) Original prompt

```
def choose_num(x, y):  
    """  
    This function takes two positive  
    numbers x and y and returns the  
    biggest even integer number that  
    is in the range [x, y] inclusive.  
    If there's no such number, then  
    the function should return -1.  
  
    For example:  
    choose_num(12, 15) = 14  
    choose_num(13, 12) = -1  
  
    Write a quick algorithm to  
    solve this problem.  
    """  
    if x % 2 == 0:  
        x = x  
    else:  
        x = x + 1  
    if y % 2 == 0:  
        y = y  
    else:  
        y = y - 1  
    if x > y:  
        return -1  
    else:  
        return max(x, y)
```

(b) Modified prompt 1

```
def choose_num(x, y):  
    """  
    This function takes two positive  
    numbers x and y and returns the  
    biggest even integer number that  
    is in the range [x, y] inclusive.  
    If there's no such number, then  
    the function should return -1.  
    """  
    if x % 2 == 1:  
        x += 1  
    if y % 2 == 0:  
        y -= 1  
    for i in range(x, y + 1, 2):  
        if x <= i <= y:  
            return i  
    return -1
```

(c) Modified prompt 2

Jean-Baptiste Döderlein
ENS Rennes
Rennes, France
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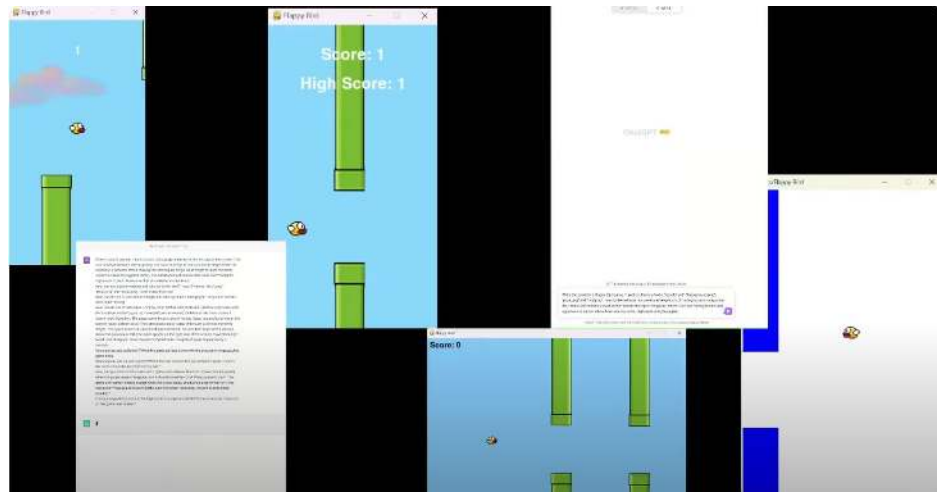
Djamel Eddine Khelladi
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djamel-eddine.khelladi@irisa.fr

Mathieu Acher
Univ Rennes, IUF, CNRS, Inria, IRISA
Rennes, France
mathieu.acher@irisa.fr

Benoit Combemale
Univ Rennes, CNRS, Inria, IRISA
Rennes, France
benoit.combemale@irisa.fr



Prompt 1: “Write a Flappy Bird game in python.”



Prompt 42: “Create a Flappy Bird game using Pygame. The game window should have a width of 288 and a height of 512, with the caption “Flappy Bird”. The game should include the following elements:

1. Load the game assets: a background image (“assets/background.png”), a bird image (“assets/bird.png”), a pipe image (“assets/pipe.png”), and a cloud image (“assets/cloud.png”).

....

10. Quit the game and close the Pygame window when the game loop is exited. Make sure to use the provided images and code structure to create a functional Flappy Bird game.”

https://www.youtube.com/watch?v=nmx1pg_DHzw

https://dev.to/diverse_research/end-user-programming-of-flappy-bird-with-chatgpt-a-reality-check-18lk

here: SE ~ end-user software engineering

Reliable and productive code assistants based on LLMs

Main objectives:

- Generate better code: quality, diversification
- Validate the results: test, formal proof, review, integration
- Assist tedious tasks: boilerplate code, software migration

Organization: 3 cross-domain work packages

- **WP1:** Self-improving code generation
- **WP2:** Migration, maintenance and evolution of existing software
- **WP3:** Build interactive software development tools with AI-in-the-loop

<https://project.inria.fr/llm4code/>

LLM4Code: Reliable and Productive Code Assistants
Based on Large Language Models

Project Leads

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| FUTUR | Lille | Anne-Françoise | anne.stien@univ-lille.fr |
| FLOWERS | Bordeaux | Pierre-Yves Oudeyer | pierre-yves.oudeyer@inria.fr |
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| SOPRA STERIA | Yann Glorieu | yann.glorieu@sopraasteria.com |

Software/code: huge data....

Key to the “success” of code LLMs: training over such data (caveats: private/ad-hoc data; lack of traceability; many legal and ethical issues; quality matters)

Cultural Heritage

Industry

Research

Public Administration



Source files

16,786,947,392



Commits

3,555,307,942



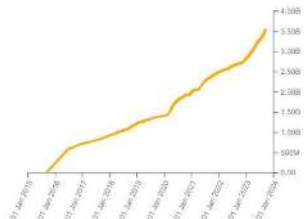
Projects

262,077,475



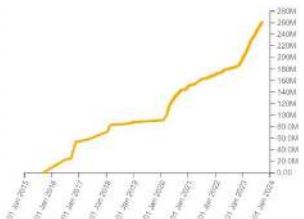
Directories

13,486,743,792



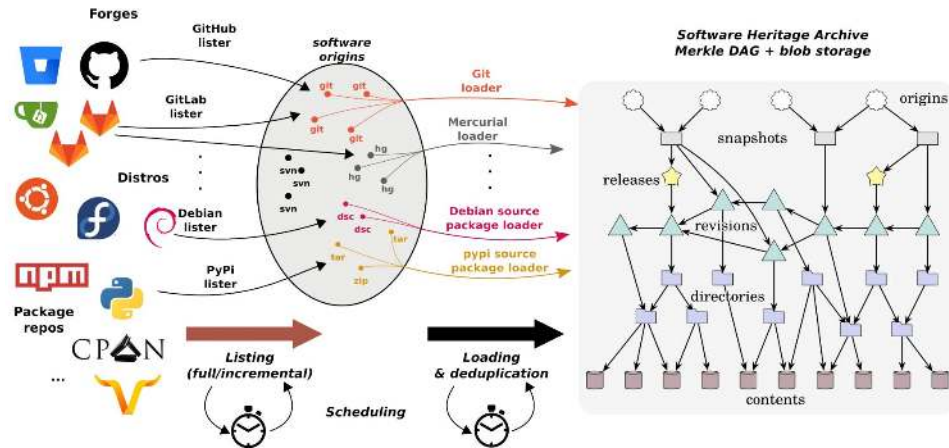
Authors

63,835,635



Releases

74,477,682

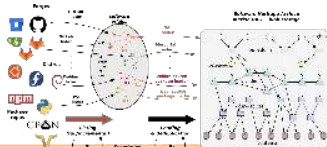




CODE COMMONS: “LE” BIEN COMMUN FOR SOURCE CODE IN FRANCE!



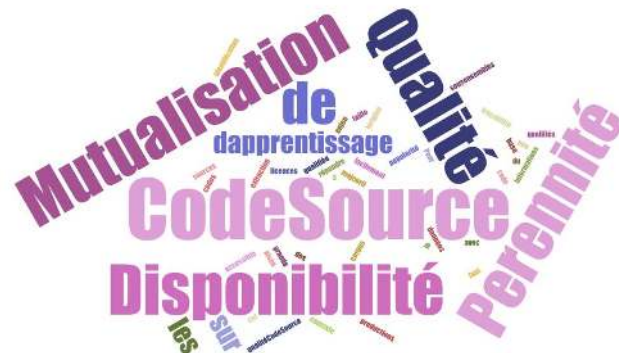
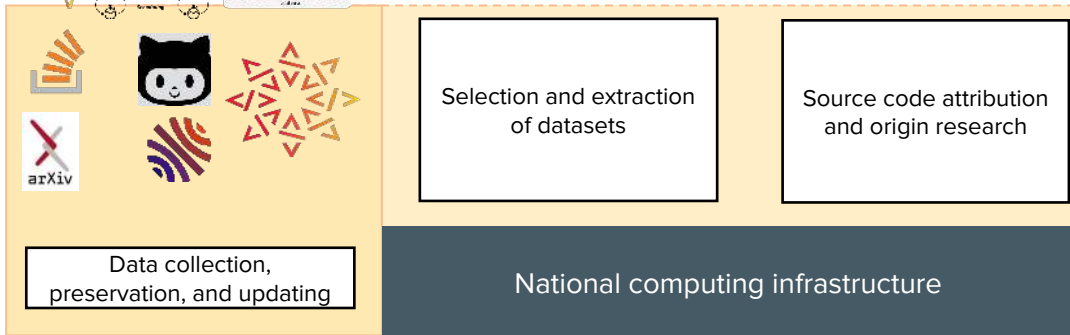
.....



Generative AI models



User group



For new generation AI!



starcoder2

Public

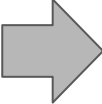
Generating software variants across different technological spaces (Python, Rust, JavaScript, etc.) and implement new features from simple prompts.



16 variants of Rust programs

Write a configurable **Rust** program that implements four features and their selections, namely, Hello, Beautiful, Wonderful, and World... If the feature is selected, then we print the name of the feature. For instance, we could well print "Hello Beautiful World", "Hello World", "Hello", "World" etc. The four features should be implemented as compile-time features.

(LLM) [...] you can use the 'cfg' attribute to enable or disable the features at compile-time [...] in your 'Cargo.toml' file [...].



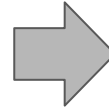
```
fn main() {  
    #[cfg(feature = "hello")]  
    print!("Hello ");  
    #[cfg(feature = "beautiful")]  
    print!("Beautiful ");  
    #[cfg(feature = "wonderful")]  
    print!("Wonderful ");  
    #[cfg(feature = "world")]  
    print!("World");  
    println!();  
}
```

https://github.com/acherm/progvary-withgpt/blob/main/conditioncompilation-helloworld/ChatGPT-Rust_Configurable_Feature_Program.md

16 variants of Java programs

Write a configurable Java program that implements [...] The four features should be implemented as compile-time features. As there is no preprocessor and built-in support for conditional compilation in Java, it is needed to leverage a templating engine for customization, acting as a preprocessor for Java. You can use Jinja (Python)

(LLM) To create a configurable Java program that implements the four features as compile-time features using Jinja (Python) templating engine, you need to follow these steps: ... Create a Jinja template (main_template.java.j2) for your Java program [...] ... Create a Python script (generate_java.py) that will generate the Java source file based on the provided features:...



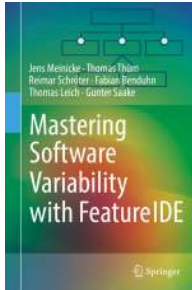
```
public class Main {
    public static void main(String[] args) {
{% if features.Hello %}
        System.out.print("Hello ");
{% endif %}
{% if features.Beautiful %}
        System.out.print("Beautiful ");
{% endif %}
{% if features.Wonderful %}
        System.out.print("Wonderful ");
{% endif %}
{% if features.World %}
        System.out.print("World");
{% endif %}
        System.out.println();
    }
}
```

```
100          P Conditional Compilation with FeatureIDE
1 public class Main {
2     public static void main(String[] args) {
3         System.out.print("Hello ");
4         System.out.print("Beautiful ");
5         System.out.print("Wonderful ");
6         System.out.print("World");
7     }
8 }
9
10 public class Main {
11     public static void main(String[] args) {
12         System.out.print("Hello ");
13         System.out.print("Beautiful ");
14         System.out.print("Wonderful ");
15         System.out.print("World");
16     }
17 }
18 }
```

Fig. 9.1 Java World example using the Jinja preprocessor. Generated source file on the left-hand side and generated file on the right

if(features.Hello), if(features.Beautiful), if(features.Wonderful), and if(features.World) as shown in the left-hand side of Fig. 9.1. These conditions establish a mapping between features and source code, specifying whether the lines between these directives will be included into the generated source file. For the Hello World example, the preprocessor can be executed as follows:

```
Usage: java -DHello -DBeautiful -DWorld Main.java targetDir
```



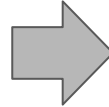
https://github.com/acherm/progvary-withgpt/blob/main/conditioncompilation-helloworld/ChatGPT-Java_program_with_Jinja.md

16 variants of Java programs and a generator

Write a configurable Java program that implements [...] The four features should be implemented as compile-time features. As there is no preprocessor and built-in support for conditional compilation in Java, it is needed to leverage a templating engine for customization, acting as a preprocessor for Java. You can use Jinja (Python)

(LLM) To create a configurable Java program that implements the four features as compile-time features using Jinja (Python) templating engine, you need to follow these steps: ... Create a Jinja template (main_template.java.j2) for your Java program [...] ... Create a Python script (generate_java.py) that will generate the Java source file based on the provided features:...

```
public class Main {
    public static void main(String[] args) {
        {% if features.Hello %}
            System.out.print("Hello ");
        {% endif %}
        {% if features.Beautiful %}
            System.out.print("Beautiful ");
        {% endif %}
        {% if features.Wonderful %}
            System.out.print("Wonderful ");
        {% endif %}
        {% if features.World %}
            System.out.print("World");
        {% endif %}
        System.out.println(
    }
}
```



```
import sys
from jinja2 import Template

def generate_java_code(features):
    with open('main_template.java.j2', 'r') as template_file:
        template = Template(template_file.read())
        java_code = template.render(features=features)
    return java_code

def write_java_code(java_code, output_file):
    with open(output_file, 'w') as java_file:
        java_file.write(java_code)

if __name__ == '__main__':
    features = {
        "Hello": True,
        "Beautiful": False,
        "Wonderful": True,
        "World": True
    }

    java_code = generate_java_code(features)
    output_file = 'Main.java'
    write_java_code(java_code, output_file)
    print(f"Java code generated in {output_file}")
```

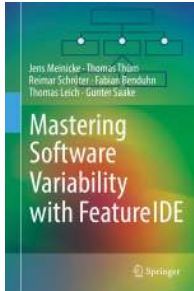
```
100 P Conditional Compilation with FeatureIDE
1 public class Main {
2     public static void main(String[]
3         args) {
4         System.out.print("Hello ");
5         System.out.print("Beautiful ");
6         System.out.print("Wonderful ");
7         System.out.print("World");
8     }
9 }
10
11 public class Main {
12     public static void main(String[]
13         args) {
14         System.out.print("Hello ");
15         System.out.print("Beautiful ");
16         System.out.print("Wonderful ");
17         System.out.print("World");
18     }
19 }
```

Fig. 9.1 Java World example using the 'Simple preprocessor' annotation scheme like on the left-hand side and generated files on the right

{% if features.Hello %}, {% if features.Beautiful %}, and {% if features.World %} as shown in the left-hand side of Fig. 9.1. These conditions establish a mapping between features and source code, specifying whether the lines between these directives will be included into the generated source file. For the Hello World example, the preprocessor can be executed as follows:

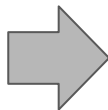
```
Usage: java -DHello -DBeautiful -DWorld Main.java targetDir
```

https://github.com/acherm/progvary-withgpt/blob/main/conditioncompilation-helloworld/ChatGPT-Java_program_with_Jinja.md



16 variants of JavaScript programs

Write a configurable JavaScript program that implements [...]
The four features should be implemented as feature toggles. I'd like to use Unleash, a feature toggle service, integrated with Gitlab



```
const { initialize } = require('unleash-client');

const unleash = initialize({
  appName: 'my-app-name',
  instanceId: 'my-instance-id',
  url: 'https://unleash.example.com/api/',
});

function printFeatures() {
  let output = '';

  if (unleash.isEnabled('hello')) {
    output += 'Hello';
  }

  if (unleash.isEnabled('beautiful')) {
    output += (output ? ' ' : '') + 'Beautiful';
  }

  if (unleash.isEnabled('wonderful')) {
    output += (output ? ' ' : '') + 'Wonderful';
  }

  if (unleash.isEnabled('world')) {
    output += (output ? ' ' : '') + 'World';
  }

  console.log(output);
}

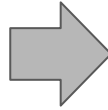
unleash.on('ready', printFeatures);
unleash.on('update', printFeatures);
```

https://github.com/acherm/progvary-withgpt/blob/main/featuretoggle-helloworld/ChatGPT-Unleash_JS_Feature_Toggles.md

16 variants of JavaScript programs at runtime

Write a configurable JavaScript program that implements [...]
The four features should be implemented as feature toggles. I'd like to use Unleash, a feature toggle service, integrated with Gitlab

“would it be possible to adapt the program as a Web application... and provide a server-side that returns the output while the client side prints it”



```
const express = require('express');
const { initialize } = require('unleash-client');
const cors = require('cors');

const app = express();
const unleash = initialize({
  appName: 'my-app-name',
  instanceId: 'my-instance-id',
  url: 'https://unleash.example.com/api/',
});

app.use(cors());

app.get('/features', (req, res) => {
  let output = '';

  if (unleash.isEnabled('hello')) {
    output += 'Hello';
  }

  if (unleash.isEnabled('beautiful')) {
    output += (output ? ' ' : '') + 'Beautiful';
  }

  if (unleash.isEnabled('wonderful')) {
    output += (output ? ' ' : '') + 'Wonderful';
  }

  if (unleash.isEnabled('world')) {
    output += (output ? ' ' : '') + 'World';
  }

  res.json({ output });
});

const PORT = process.env.
app.listen(PORT, () => {
  console.log('Server run
});

<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>Feature Toggles Web App</title>
</head>
<body>
  <h1>Enabled Features:</h1>
  <div id="output"></div>

  <script>
    async function fetchFeatures() {
      const response = await fetch('http://localhost:3000/features');
      const data = await response.json();
      document.getElementById('output').innerText = data.output;
    }

    fetchFeatures();
  </script>
</body>
</html>
```

https://github.com/acherm/progvary-withgpt/blob/main/featuretoggle-helloworld/ChatGPT-Unleash_JS_Feature_Toggles.md

3 variants of C programs

I have the following program. I'd like to create variations over this program using conditional compilation. Specifically, I'd like to create a first variation that consists in replacing the type long double by double... and another alternative variation that consists in replacing long double by float.

```
#include <stdio.h>
int main() {
    // Declare and initialize variables
    long double x = 1.0;
    long double y = 0x1p-53 + 0x1p-64;
    long double z = x + y;

    // Print the value of z
    printf("z = %a\n", z);
    return 0;
}
```



```
#include <stdio.h>

// Define the type to use as an alias
#ifdef USE_DOUBLE
    typedef double real;
#elif defined(USE_FLOAT)
    typedef float real;
#else
    typedef long double real;
#endif

int main() {
    // Declare and initialize variables
    real x = 1.0;
    real y = 0x1p-53 + 0x1p-64;
    real z = x + y;

    // Print the value of z
#ifdef USE_DOUBLE
    printf("z (using double) = %a\n", z);
#elif defined(USE_FLOAT)
    printf("z (using float) = %a\n", z);
#else
    printf("z (using long double) = %La\n", z);
#endif

    return 0;
}
```

```
#include <stdio.h>

// Define the type to use as an alias
#ifdef USE_DOUBLE
    typedef double real;
#elif defined(USE_FLOAT)
    typedef float real;
#else
    typedef long double real;
#endif

int main() {
    // Declare and initialize variables
    real x = 1.8;
    real y = 0x1p-53 + 0x1p-64;
    real z = x * y;

    // Print the value of z
#ifdef USE_DOUBLE
    printf("z (using double) = %f\n", z);
#elif defined(USE_FLOAT)
    printf("z (using float) = %f\n", z);
#else
    printf("z (using long double) = %Lf\n", z);
#endif

    return 0;
}
```

Write a Python script that compiles and executes the three variants above with and without the `-mfpmath=387` of `gcc`... Compile also with `clang`. Synthesize all results in a CSV containing the configuration (flag, with or without `-mfpmath=387`, compiler) and the different outputs. Please use `pandas` for writing the CSV... also the fieldnames should be `compiler`, `flags`, `type`, and `result`. The C file to compile is `assoc.c`

We then refine and ask:

Can you think about `gcc` flags or `clang` flags that could be combined/used and have an influence on floating point operations? Please implement them in the Python code.



```
def compile_and_run(compiler, flags):
    commands = [
        f"{compiler} {flags} -o original approx.c",
        f"{compiler} {flags} -DUSE_DOUBLE -o double_variation approx.c",
        f"{compiler} {flags} -DUSE_FLOAT -o float_variation approx.c",
    ]

    results = []
    for cmd in commands:
        subprocess.run(cmd, shell=True, check=True)

        binary = cmd.split()[-2]
        output = subprocess.check_output(f'./{binary}', shell=True).decode().strip()
        results.append(output)

    return results

def main():
    configurations = [
        ('gcc', ''),
        ('gcc', '-mfpmath=387'),
        ('gcc', '-ffast-math'),
        ('gcc', '-fno-signed-zeros'),
        ('gcc', '-fno-trapping-math'),
        ('gcc', '-fno-rounding-math'),
        ('clang', ''),
        ('clang', '-mno-sse'),
        ('clang', '-ffast-math'),
        ('clang', '-fno-signed-zeros'),
        ('clang', '-fno-trapping-math'),
        ('clang', '-fno-rounding-math'),
    ]

    data = []

    for compiler, flags in configurations:
        results = compile_and_run(compiler, flags)
        data.extend([
            {'compiler': compiler, 'flags': flags, 'type': 'original', 'result': results[0]},
            {'compiler': compiler, 'flags': flags, 'type': 'double', 'result': results[1]},
            {'compiler': compiler, 'flags': flags, 'type': 'float', 'result': results[2]},
        ])

    return data
```

Lots of variants to build programs!

```

def compile_and_run(compiler, flags):
    commands = [
        f"{compiler} {flags} -o original approx.c",
        f"{compiler} {flags} -DUSE_DOUBLE -o double_variation approx.c",
        f"{compiler} {flags} -DUSE_FLOAT -o float_variation approx.c",
    ]

    results = []
    for cmd in commands:
        subprocess.run(cmd, shell=True, check=True)

        binary = cmd.split()[-2]
        output = subprocess.check_output(f'./{binary}', shell=True).decode().strip()
        results.append(output)

    return results

def main():
    configurations = [
        ('gcc', ''),
        ('gcc', '-mfpmath=387'),
        ('gcc', '-ffast-math'),
        ('gcc', '-fno-signed-zeros'),
        ('gcc', '-fno-trapping-math'),
        ('gcc', '-fno-rounding-math'),
        ('clang', ''),
        ('clang', '-mno-sse'),
        ('clang', '-ffast-math'),
        ('clang', '-fno-signed-zeros'),
        ('clang', '-fno-trapping-math'),
        ('clang', '-fno-rounding-math'),
    ]

    data = []

    for compiler, flags in configurations:
        results = compile_and_run(compiler, flags)
        data.extend([
            {'compiler': compiler, 'flags': flags, 'type': 'original', 'result': results[0]},
            {'compiler': compiler, 'flags': flags, 'type': 'double', 'result': results[1]},
            {'compiler': compiler, 'flags': flags, 'type': 'float', 'result': results[2]},
        ])

```

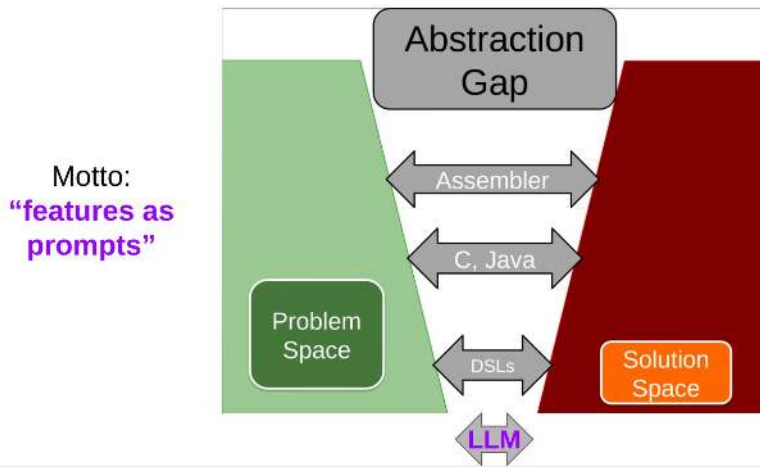
| compiler | flags | type | result |
|----------|--------------------|----------|--|
| gcc | | original | z (using long double) = 0x8.0000000000004p-3 |
| gcc | | double | z (using double) = 0x1.0000000000001p+0 |
| gcc | | float | z (using float) = 0x1p+0 |
| gcc | -mfpmath=387 | original | z (using long double) = 0x8.0000000000004p-3 |
| gcc | -mfpmath=387 | double | z (using double) = 0x1p+0 |
| gcc | -mfpmath=387 | float | z (using float) = 0x1p+0 |
| gcc | -ffast-math | original | z (using long double) = 0x8.0000000000004p-3 |
| gcc | -ffast-math | double | z (using double) = 0x1.0000000000001p+0 |
| gcc | -ffast-math | float | z (using float) = 0x1p+0 |
| gcc | -fno-signed-zeros | original | z (using long double) = 0x8.0000000000004p-3 |
| gcc | -fno-signed-zeros | double | z (using double) = 0x1.0000000000001p+0 |
| gcc | -fno-signed-zeros | float | z (using float) = 0x1p+0 |
| gcc | -fno-trapping-math | original | z (using long double) = 0x8.0000000000004p-3 |
| gcc | -fno-trapping-math | double | z (using double) = 0x1.0000000000001p+0 |
| gcc | -fno-trapping-math | float | z (using float) = 0x1p+0 |
| gcc | -fno-rounding-math | original | z (using long double) = 0x8.0000000000004p-3 |
| gcc | -fno-rounding-math | double | z (using double) = 0x1.0000000000001p+0 |
| gcc | -fno-rounding-math | float | z (using float) = 0x1p+0 |
| clang | | original | z (using long double) = 0x8.0000000000004p-3 |
| clang | | double | z (using double) = 0x1.0000000000001p+0 |

retrieve the result of S. Boldo et al.

Potential

LLMs can assist developers in implementing variability in different programming languages (C, Rust, Java, TikZ, etc.) and mechanisms (conditional compilation, feature toggles, command-line parameters, template, etc.). With "features as prompts", there is hope to raise the level of abstraction, increase automation, and bring more flexibility when synthesizing and exploring software variants.

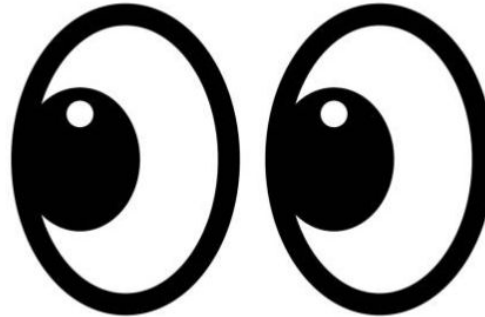
Hypothesis: **Large language models (LLMs)** act as a new variability compiler capable of transforming a high-level specification ("prompt") into variable code, features, generators, configurable systems, etc. written in a given technological space.



Programming without directly manipulating programs, relying almost entirely on AI to manage technical details and create variants of code (customization).

Here is a TikZ code:

```
\tikzset{%
something/.pic={
\tikzset{x=3cm/5,y=3cm/5,shift={(0,-1/3)}}
\useasboundingbox (-1,-1) (1,2);
\fill [BlueGrey900] (0,-2)
.. controls ++(180:3) and ++(0:5/4) .. (-2,0)
arc (270:90:1/5)
.. controls ++(0:2) and ++(180:11/4) .. (0,-2+2/5);
\foreach \i in {-1,1}
\scoped[shift={(1/2*\i,9/4)}, rotate=45*\i]{
\clip [overlay] (0, 5/9) ellipse [radius=8/9];
\clip [overlay] (0,-5/9) ellipse [radius=8/9];
\fill [BlueGrey900] ellipse [radius=1];
\clip [overlay] (0, 7/9) ellipse [radius=10/11];
\clip [overlay] (0,-7/9) ellipse [radius=10/11];
\fill [Purple100] ellipse [radius=1];
};
\fill [BlueGrey900] ellipse [x radius=3/4, y radius=2];
\fill [BlueGrey100] ellipse [x radius=1/3, y radius=1];
\fill [BlueGrey900]
(0,15/8) ellipse [x radius=1, y radius=5/6]
(0, 8/6) ellipse [x radius=1/2, y radius=1/2]
{{shift={(-1/2,-2)}, rotate= 10} ellipse [x radius=1/3, y radius=5/4]}
{{shift={( 1/2,-2)}, rotate=-10} ellipse [x radius=1/3, y radius=5/4]};
\fill [BlueGrey500]
(-1/9,11/8) ellipse [x radius=1/5, y radius=1/5]
(1/9,11/8) ellipse [x radius=1/5, y radius=1/5];
```



Here is a TikZ code:

```
\tikzset{%
something/.pic={
\tikzset{x=3cm/5,y=3cm/5,shift={(0,-1/3)}}
\useasboundingbox (-1,-1) (1,2);
\fill [BlueGrey900] (0,-2)
.. controls ++(180:3) and ++(0:5/4) .. (-2,0)
arc (270:90:1/5)
.. controls ++(0:2) and ++(180:11/4) .. (0,-2+2/5);
\foreach \i in {-1,1}
\scoped[shift={(1/2*\i,9/4)}, rotate=45*\i]{
\clip [overlay] (0, 5/9) ellipse [radius=8/9];
\clip [overlay] (0,-5/9) ellipse [radius=8/9];
\fill [BlueGrey900] ellipse [radius=1];
\clip [overlay] (0, 7/9) ellipse [radius=10/11];
\clip [overlay] (0,-7/9) ellipse [radius=10/11];
\fill [Purple100] ellipse [radius=1];
};
\fill [BlueGrey900] ellipse [x radius=3/4, y radius=2];
\fill [BlueGrey100] ellipse [x radius=1/3, y radius=1];
\fill [BlueGrey900]
(0,15/8) ellipse [x radius=1, y radius=5/6]
(0, 8/6) ellipse [x radius=1/2, y radius=1/2]
{[shift={(-1/2,-2)}, rotate= 10] ellipse [x radius=1/3, y radius=5/4]}
{[shift={( 1/2,-2)}, rotate=-10] ellipse [x radius=1/3, y radius=5/4]};
\fill [BlueGrey500]
(-1/9,11/8) ellipse [x radius=1/5, y radius=1/5]
```

**SE task = software
customization/configuration | program
understanding**

```

Here is a TikZ code:
\tikzset{%
cat/.pic={
\tikzset{x=3cm/5,y=3cm/5,shift={{(0,-1/3)}}
\useasboundingbox (-1,-1) (1,2);
\fill [BlueGrey900] (0,-2)
.. controls ++(180:3) and ++(0:5/4) .. (-2,0)
arc (270:90:1/5)
.. controls ++(0:2) and ++(180:11/4) .. (0,-2+2/5);
\foreach \i in {-1,1}
\scoped[shift={{(1/2*\i,9/4)}, rotate=45*\i}{
\clip [overlay] (0, 5/9) ellipse [radius=8/9];
\clip [overlay] (0,-5/9) ellipse [radius=8/9];
\fill [BlueGrey900] ellipse [radius=1];
\clip [overlay] (0, 7/9) ellipse [radius=10/11];
\clip [overlay] (0,-7/9) ellipse [radius=10/11];
\fill [Purple100] ellipse [radius=1];
};
\fill [BlueGrey900] ellipse [x radius=3/4, y radius=2];
\fill [BlueGrey100] ellipse [x radius=1/3, y radius=1];
\fill [BlueGrey900]
(0,15/8) ellipse [x radius=1, y radius=5/6]
(0, 8/6) ellipse [x radius=1/2, y radius=1/2]
{{shift={{(-1/2,-2)}, rotate= 10} ellipse [x radius=1/3, y radius=5/4]}
{{shift={{ 1/2,-2)}, rotate=-10} ellipse [x radius=1/3, y radius=5/4]};
\fill [BlueGrey500]
(-1/9,11/8) ellipse [x radius=1/5, y radius=1/5]
( 1/9,11/8) ellipse [x radius=1/5, y radius=1/5];
\fill [Purple100]
(0,12/8) ellipse [x radius=1/10, y radius=1/5]
(0,12/8+1/9) ellipse [x radius=1/5, y radius=1/10];
\foreach \i in {-1,1}
\scoped[shift={{(1/2*\i,2)}, rotate=35*\i}{
\clip [overlay] (0, 1/7) ellipse [radius=2/7];
\clip [overlay] (0,-1/7) ellipse [radius=2/7];
\fill [Yellow50] ellipse [radius=1];
};
\scoped{
\clip (-1,-2) rectangle ++(2,1);
\fill [BlueGrey900] (0,-2) ellipse [radius=1/2];
\fill [Grey100]
(-1/2,-2) ellipse [x radius=1/3, y radius=1/4]
( 1/2,-2) ellipse [x radius=1/3, y radius=1/4];
};
\foreach \i in {-1,1}
\foreach \j in {-1,0,1}
\fill [Grey100, shift={{(0,11/8)}, xscale=\i, rotate=\j*15,
shift=(0:1/2)\i}

```

SE task = software customization/configuration | program understanding



Here is a TikZ code:

```
\tikzset{%
  cat/.pic={
    \tikzset{x=3cm/5,y=3cm/5,shift={{(0,-1/3)}}}
    \useasboundingbox (-1,-1) (1,2);
    \fill [BlueGrey900] (0,-2)
      .. controls ++(180:3) and ++(0:5/4) .. (-2,0)
      arc (270:90:1/5)
      .. controls ++(0:2) and ++(180:11/4) .. (0,-2+2/5);
    \foreach \i in {-1,1}
      \scoped[shift={{(1/2*\i,9/4)}}, rotate=45*\i]{
        \clip [overlay] (0, 5/9) ellipse [radius=8/9];
        \clip [overlay] (0,-5/9) ellipse [radius=8/9];
        \fill [BlueGrey900] ellipse [radius=1];
        \clip [overlay] (0, 7/9) ellipse [radius=10/11];
        \clip [overlay] (0,-7/9) ellipse [radius=10/11];
        \fill [Purple100] ellipse [radius=1];
      };
    \fill [BlueGrey900] ellipse [x radius=3/4, y radius=2];
    \fill [BlueGrey100] ellipse [x radius=1/3, y radius=1];
    \fill [BlueGrey900]
      (0,15/8) ellipse [x radius=1, y radius=5/6]
      (0, 8/6) ellipse [x radius=1/2, y radius=1/2]
      {{shift={{(-1/2,-2)}}, rotate= 10} ellipse [x radius=1/3, y radius=5/6]
      {{shift={{ 1/2,-2)}}, rotate=-10} ellipse [x radius=1/3, y radius=5/6];
    \fill [BlueGrey500]
      (-1/9,11/8) ellipse [x radius=1/5, y radius=1/5]
      ( 1/9,11/8) ellipse [x radius=1/5, y radius=1/5];
    \fill [Purple100]
      (0,12/8) ellipse [x radius=1/10, y radius=1/5]
      (0,12/8+1/9) ellipse [x radius=1/5, y radius=1/10];
    \foreach \i in {-1,1}
      \scoped[shift={{(1/2*\i,2)}}, rotate=35*\i]{
        \clip [overlay] (0, 1/7) ellipse [radius=2/7];
        \clip [overlay] (0,-1/7) ellipse [radius=2/7];
        \fill [Yellow50] ellipse [radius=1];
      };
  };
}
```

I'd like to change the color of the cat's tail



cat

SE task = software customization/configuration | program understanding

Here is a TikZ code:

```
\tikzset{%
cat/.pic={
\tikzset{x=3cm/5,y=3cm/5,shift={{(0,-1/3)}}}
\useasboundingbox (-1,-1) (1,2);
\fill [BlueGrey900] (0,-2)
.. controls ++(180:3) and ++(0:5/4) .. (-2,0)
arc (270:90:1/5)
.. controls ++(0:2) and ++(180:11/4) .. (0,-2+2/5);
\foreach \i in {-1,1}
\scoped[shift={{(1/2*\i,9/4)}}, rotate=45*\i]{
\clip [overlay] (0, 5/9) ellipse [radius=8/9];
\clip [overlay] (0,-5/9) ellipse [radius=8/9];
\fill [BlueGrey900] ellipse [radius=1];
\clip [overlay] (0, 7/9) ellipse [radius=10/11];
\clip [overlay] (0,-7/9) ellipse [radius=10/11];
\fill [Purple100] ellipse [radius=1];
};
\fill [BlueGrey900] ellipse [x radius=3/4, y radius=2];
\fill [BlueGrey100] ellipse [x radius=1/3, y radius=1];
\fill [BlueGrey900]
(0,15/8) ellipse [x radius=1, y radius=5/6]
(0, 8/6) ellipse [x radius=1/2, y radius=1/2]
{{shift={{(-1/2,-2)}}, rotate= 10} ellipse [x radius=1/3, y radius=5/4]}
{{shift={{ 1/2,-2)}}, rotate=-10} ellipse [x radius=1/3, y radius=5/4]};
\fill [BlueGrey500]
(-1/9,11/8) ellipse [x radius=1/5, y radius=1/5]
( 1/9,11/8) ellipse [x radius=1/5, y radius=1/5];
\fill [Purple100]
(0,12/8) ellipse [x radius=1/10, y radius=1/5]
(0,12/8+1/9) ellipse [x radius=1/5, y radius=1/10];
\foreach \i in {-1,1}
\scoped[shift={{(1/2*\i,2)}}, rotate=35*\i]{
\clip [overlay] (0, 1/7) ellipse [radius=2/7];
\clip [overlay] (0,-1/7) ellipse [radius=2/7];
\fill [Yellow50] ellipse [radius=1];
};
};
```

I'd like to change the color of the cat's tail

(LLM) To change the color of the tail, you need to modify the fill color specified in the first 'fill' command, which draws the tail shape. In the provided code, the tail color is set to 'BlueGrey900'. You can replace this color with any other color you'd like. Here's an example with the tail color changed to 'red':

```
\tikzset{%
cat/.pic={
\tikzset{x=3cm/5,y=3cm/5,shift={{(0,-1/3)}}}
\useasboundingbox (-1,-1) (1,2);
\fill [red] (0,-2) % Change the color here
.. controls ++(180:3) and ++(0:5/4) .. (-2,0)
arc (270:90:1/5)
.. controls ++(0:2) and ++(180:11/4) .. (0,-2+2/5);
% The rest of the code remains the same
```

added by
ChatGPT!



change as much as possible elements, applying different styles, colors, and transformations. Give me the new TikZ code and explain me the changes

Can you write a Python program that would apply the 9 proposed changes? I recommend using a templating engine in such a way the 9 changes can be applied and configured

```
cat/.pic={
  \tikzset{x=3cm/5,y=3cm/5,shift={(0,-1/3)}}
  \useasboundingbox (-1,-1) (1,2);
  \fill [<< tail_color >>] (0,-2)
    .. controls ++(180:3) and ++(0:5/4) .. (-2,0)
    arc (270:90:1/5)
    .. controls ++(0:2) and ++(180:11/4) .. (0,-2+2/5);
  ...
  \fill [<< central_body_color >>] ellipse [x radius
    =3/4, y radius=2];
  \fill [<< inner_body_color >>] ellipse [x radius=1/3,
    y radius=1];
  \fill [<< head_paws_color >>]
  ...
}
```

```
import random

def random_rgb_color():
    return f"rgb({random.randint(0, 255)},{random.randint(0, 255)},{random.randint(0, 255)})"

def random_scale(min_value=0.5, max_value=2.0):
    return random.uniform(min_value, max_value)

output = template.render(
    main_body_color=random_rgb_color(),
    head_stripe_color=random_rgb_color(),
    inner_stripe_color=random_rgb_color(),
    head_stripe_scale=random_scale(),
    head_surround_color=random_rgb_color(),
    head_inner_color=random_rgb_color(),
    nose_main_color=random_rgb_color(),
    eyes_color=random_rgb_color(),
    nose_color=random_rgb_color(),
    whisker_spots_color=random_rgb_color(),
    whisker_spots_scale=random_scale(),
    face_lower_part_color=random_rgb_color(),
    face_inner_ellipses_color=random_rgb_color(),
    whiskers_color=random_rgb_color(),
)

print(output)
```

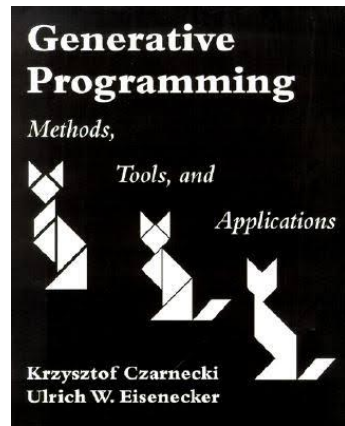
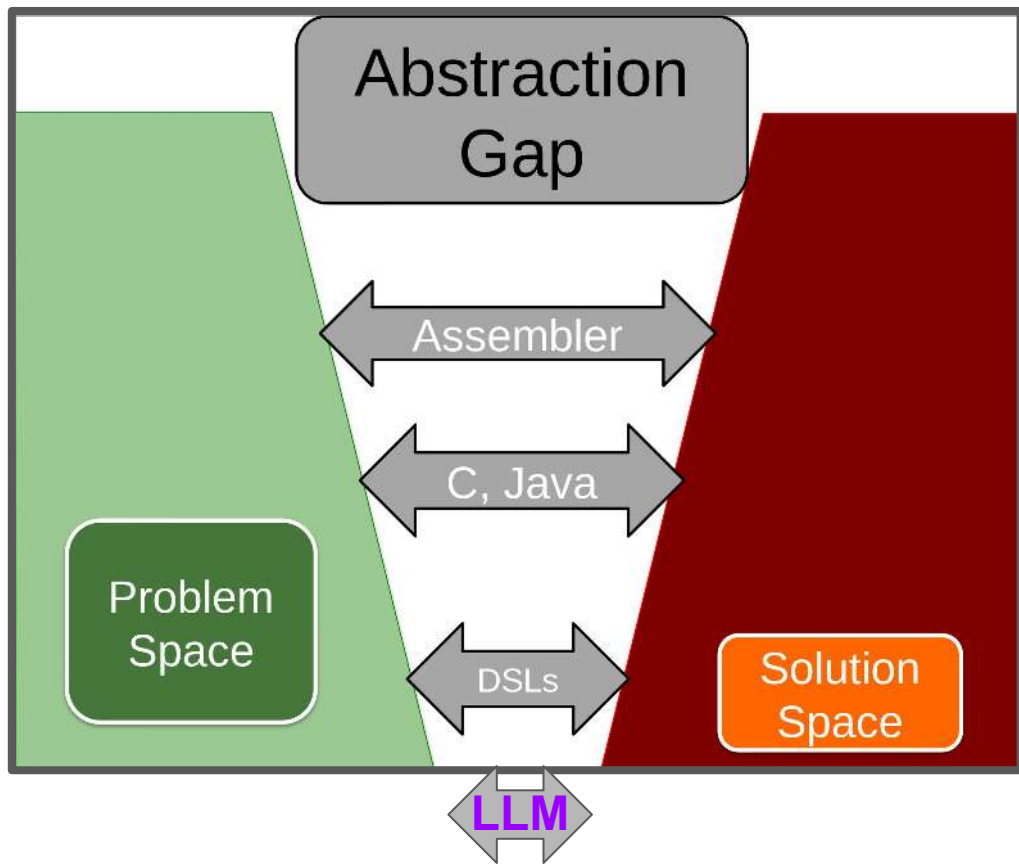


SE task = software customization/configuration | program understanding

Hypothesis: **Large language models (LLMs)** act as a new variability compiler capable of transforming a high-level specification (“prompt”) into variable code, features, generators, configurable systems, etc. written in a given technological space.

Motto:
“features as prompts”

Mathieu Acher, Jean-Marc Jézéquel, and José A. Galindo. 2023. On Programming Variability with Large Language Model-based Assistant. In SPLC 2023



LLMs can dramatically fail at times, making mistakes that human developers need to carefully verify and correct.





cat

I'd like to change the color of the cat's tail in red

Here is a TikZ code:

```
\tikzset{%
cat/.pic={
\tikzset{x=3cm/5,y=3cm/5,shift={(0,-1/3)}}
\useasboundingbox (-1,-1) (1,2);
\fill [BlueGrey900] (0,-2)
.. controls ++(180:3) and ++(0:5/4) .. (-2,0)
arc (270:90:1/5)
.. controls ++(0:2) and ++(180:11/4) .. (0,-2+2/5);
\foreach \i in {-1,1}
\scoped[shift={(1/2*\i,9/4)}, rotate=45*\i]{
\clip [overlay] (0, 5/9) ellipse [radius=8/9];
\clip [overlay] (0,-5/9) ellipse [radius=8/9];
\fill [BlueGrey900] ellipse [radius=1];
\clip [overlay] (0, 7/9) ellipse [radius=10/11];
\clip [overlay] (0,-7/9) ellipse [radius=10/11];
\fill [Purple100] ellipse [radius=1];
};
\fill [BlueGrey900] ellipse [x radius=3/4, y radius=2];
\fill [BlueGrey100] ellipse [x radius=1/3, y radius=1];
\fill [BlueGrey900]
(0,15/8) ellipse [x radius=1, y radius=5/6]
(0, 8/6) ellipse [x radius=1/2, y radius=1/2]
{shift={(-1/2,-2)}, rotate= 10} ellipse [x radius=1/3, y radius=5/4];
{shift={( 1/2,-2)}, rotate=-10} ellipse [x radius=1/3, y radius=5/4];
\fill [BlueGrey500]
(-1/9,11/8) ellipse [x radius=1/5, y radius=1/5]
( 1/9,11/8) ellipse [x radius=1/5, y radius=1/5];
\fill [Purple100]
(0,12/8) ellipse [x radius=1/10, y radius=1/5]
(0,12/8+1/9) ellipse [x radius=1/5 , y radius=1/10];
\foreach \i in {-1,1}
\scoped[shift={(1/2*\i,2)}, rotate=35*\i]{
\clip [overlay] (0, 1/7) ellipse [radius=2/7];
\clip [overlay] (0,-1/7) ellipse [radius=2/7];
\fill [Yellow50] ellipse [radius=1];
};
\scoped{
\clip (-1,-2) rectangle ++(2,1);
\fill [BlueGrey900] (0,-2) ellipse [radius=1/2];
\fill [Grey100]
(-1/2,-2) ellipse [x radius=1/3, y radius=1/4]
( 1/2,-2) ellipse [x radius=1/3, y radius=1/4];
};
\foreach \i in {-1,1}
\foreach \j in {-1,0,1}
\fill [Grey100, shift={(0,11/8)}, xscale=\i, rotate=\j*15,
shift=(0:1/2)]
ellipse [x radius=1/3, y radius=1/64];
};
}
```



cat



cat

Here is a TikZ code:

```

\tikzset{%
cat/.pic={
\tikzset{x=3cm/5,y=3cm/5,shift={(0,-1/3)}}
\useasboundingbox (-1,-1) (1,2);
\fill [BlueGrey900] (0,-2)
.. controls ++(180:3) and ++(0:5/4) .. (-2,0)
arc (270:90:1/5)
.. controls ++(0:2) and ++(180:1/4) .. (0,-2+2/5);
\foreach \i in {-1,1}
\scoped[shift={(1/2*\i,9/4)}, rotate=45*\i]{
\clip [overlay] (0, 5/9) ellipse [radius=8/9];
\clip [overlay] (0,-5/9) ellipse [radius=8/9];
\fill [BlueGrey900] ellipse [radius=1];
\clip [overlay] (0, 7/9) ellipse [radius=10/11];
\clip [overlay] (0,-7/9) ellipse [radius=10/11];
\fill [Purple100] ellipse [radius=1];
};
\fill [BlueGrey900] ellipse [x radius=3/4, y radius=2];
\fill [BlueGrey100] ellipse [x radius=1/3, y radius=1];
\fill [BlueGrey900]
(0,15/8) ellipse [x radius=1, y radius=5/6]
(0, 8/6) ellipse [x radius=1/2, y radius=1/2]
{shift={(-1/2,-2)}, rotate= 10} ellipse [x radius=1/3, y radius=5/4];
{shift={( 1/2,-2)}, rotate=-10} ellipse [x radius=1/3, y radius=5/4];
\fill [BlueGrey500]
(-1/9,11/8) ellipse [x radius=1/5, y radius=1/5]
( 1/9,11/8) ellipse [x radius=1/5, y radius=1/5];
\fill [Purple100]
(0,12/8) ellipse [x radius=1/10, y radius=1/5]
(0,12/8+1/9) ellipse [x radius=1/5, y radius=1/10];
\foreach \i in {-1,1}
\scoped[shift={(1/2*\i,2)}, rotate=35*\i]{
\clip [overlay] (0, 1/7) ellipse [radius=2/7];
\clip [overlay] (0,-1/7) ellipse [radius=2/7];
\fill [Yellow50] ellipse [radius=1];
};
\scoped{
\clip (-1,-2) rectangle ++(2,1);
\fill [BlueGrey900] (0,-2) ellipse [radius=1/2];
\fill [Grey100]
(-1/2,-2) ellipse [x radius=1/3, y radius=1/4]
( 1/2,-2) ellipse [x radius=1/3, y radius=1/4];
};
\foreach \i in {-1,1}
\foreach \j in {-1,0,1}
\fill [Grey100, shift={(0,11/8)}, xscale=\i, rotate=\j*15,
shift=(0:1/2)]
ellipse [x radius=1/3, y radius=1/64];
}

```



I'd like to change the color of the cat's tail in red

MA You



cat

visual abilities to implement a "testing oracle"

what is the color of the cat's tail? is it red?

MA ChatGPT

The cat's tail is black, not red. The only red part on the cat is its nose.

MA You

what are eyes colors?

MA ChatGPT

The cat's eyes are red.



cat

```

Here is a TikZ code:
\tikzset{%
cat/.pic={
\tikzset{x=3cm/5,y=3cm/5,shift={(0,-1/3)}}
\useasboundingbox (-1,-1) (1,2);
\fill [BlueGrey900] (0,-2)
.. controls ++(180:3) and ++(0:5/4) .. (-2,0)
arc (270:90:1/5)
.. controls ++(0:2) and ++(180:11/4) .. (0,-2+2/5);
\foreach \i in {-1,1}
\scoped[shift={(1/2*\i,9/4)}, rotate=45*\i]{
\clip [overlay] (0, 5/9) ellipse [radius=8/9];
\clip [overlay] (0,-5/9) ellipse [radius=8/9];
\fill [BlueGrey900] ellipse [radius=1];
\clip [overlay] (0, 7/9) ellipse [radius=10/11];
\clip [overlay] (0,-7/9) ellipse [radius=10/11];
\fill [Purple100] ellipse [radius=1];
};
\fill [BlueGrey900] ellipse [x radius=3/4, y radius=2];
\fill [BlueGrey100] ellipse [x radius=1/3, y radius=1];
\fill [BlueGrey900]
(0,15/8) ellipse [x radius=1, y radius=5/6]
(0, 8/6) ellipse [x radius=1/2, y radius=1/2]
{shift={(-1/2,-2)}, rotate= 10} ellipse [x radius=1/3, y radius=5/4];
{shift={( 1/2,-2)}, rotate=-10} ellipse [x radius=1/3, y radius=5/4];
\fill [BlueGrey500]
(-1/9,11/8) ellipse [x radius=1/5, y radius=1/5]
( 1/9,11/8) ellipse [x radius=1/5, y radius=1/5];
\fill [Purple100]
(0,12/8) ellipse [x radius=1/10, y radius=1/5]
(0,12/8+1/9) ellipse [x radius=1/5, y radius=1/10];
\foreach \i in {-1,1}
\scoped[shift={(1/2*\i,2)}, rotate=35*\i]{
\clip [overlay] (0, 1/7) ellipse [radius=2/7];
\clip [overlay] (0,-1/7) ellipse [radius=2/7];
\fill [Yellow50] ellipse [radius=1];
};
\scoped{
\clip (-1,-2) rectangle ++(2,1);
\fill [BlueGrey900] (0,-2) ellipse [radius=1/2];
\fill [Grey100]
(-1/2,-2) ellipse [x radius=1/3, y radius=1/4]
( 1/2,-2) ellipse [x radius=1/3, y radius=1/4];
};
\foreach \i in {-1,1}
\foreach \j in {-1,0,1}
\fill [Grey100, shift={(0,11/8)}, xscale=\i, rotate=\j*15,
shift=(0:1/2)]
ellipse [x radius=1/3, y radius=1/64];
};

```



“I’d like to have a better red, more dark...” (kids)

Customization

Ears, tail, and whisker

| | |
|-------------|--|
| tail : | <input type="text" value="red"/> |
| outer ear : | <input type="text" value="BlueGrey900"/> |
| inner ear : | <input type="text" value="Purple100"/> |
| whiskers : | <input type="text" value="Grey100"/> |

Beautify the cat!



cat

<https://www.youtube.com/watch?v=kSdLSqwZK7Q>

(plenty of experiments with LLMs, programming languages, students... I'll blog about it soon!)



My banker suggested this investment:

you give me $e \approx 2.71828...$ €,

the following year, I take €1 in fees and multiply by 1,

the following year, I take 1€ in fees and multiply by 2,

the following year, I take a €1 charge and multiply by 3,

...

after n years, I take a €1 fee and multiply by n .

To get my money back, there's a €1 fee.

In 50 years, when I retire, how much money will I have?

Synthesize and execute a Python code to answer the question



After 50 years, your investment would be approximately -5.56×10^{58} euros, meaning the investment results in an astronomically large negative balance. This investment strategy leads to catastrophic losses. [-]



MA You
I have the following Python code:

```
import folium
```

```
# Given coordinates for the cities (these are example coordinates and may not be accurate)
```

```
# Normally we would obtain these through a geocoding service  
coordinates = {
```

```
    "Rennes": [48.1173, -1.67778],  
    "Paris": [48.8566, 2.3522],  
    "Saclay": [48.7290, 2.1912],  
    "Lille": [50.6292, 3.0573],  
    "Bordeaux": [44.8378, -0.5792],  
    "Sophia": [43.6222, 7.0500], # This is an approximation for Sophia Antipolis  
    "Nancy": [48.6921, 6.1844]  
}
```

```
# Initialize a map centered around France
```

```
map_france = folium.Map(location=[46.603354, 1.888334], zoom_start=6)
```

```
# Add markers for each team
```

```
add_team_marker(map_france, "DIVERSE", "Rennes")  
add_team_marker(map_france, "PICUBE", "Paris")  
add_team_marker(map_france, "ARGO", "Paris")  
add_team_marker(map_france, "DEDUCTEAM", "Saclay")  
add_team_marker(map_france, "EVEREF", "Lille")  
add_team_marker(map_france, "FLOWERS", "Bordeaux")  
add_team_marker(map_france, "MNEMOSYNE", "Bordeaux")  
add_team_marker(map_france, "SPIRALS", "Lille")  
add_team_marker(map_france, "STAMP", "Sophia")  
add_team_marker(map_france, "SED", "Nancy")
```

```
# Since we cannot display the folium map directly in this environment,  
# we'll save it to an HTML file which you can then open in a web browser.
```

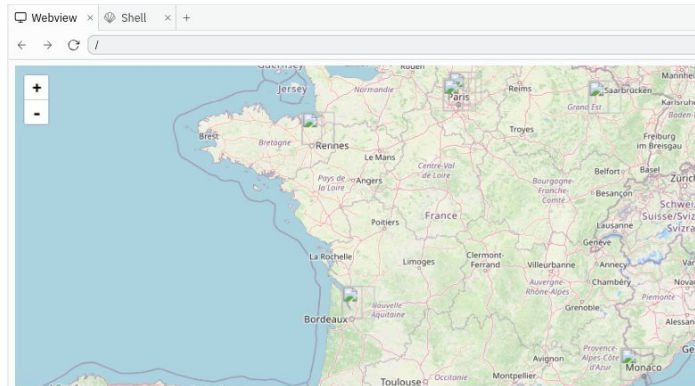
```
map_file_path = '/mnt/data/france_teams_map.html'  
map_france.save(map_file_path)  
map_file_path
```

Please write a JavaScript program, using Leaflet.js

CP ChatGPT

Creating a JavaScript program using Leaflet.js to achieve a similar functionality as your Python code with Folium is a good way to visualize geographic data on web platforms. Leaflet is a leading open-source JavaScript library for mobile-friendly interactive maps.

Here's a basic example of how you could write such a program:



SE task: modernization/migration

```
index.html | script.js | popupText  
1 var map = L.map('map').setView([46.603354, 1.888334], 6);  
2  
3 // Add OpenStreetMap tiles:  
4 L.tileLayer('https://{s}.tile.openstreetmap.org/{z}/{x}/{y}.png', {  
5   maxZoom: 19,  
6   attribution: '© OpenStreetMap contributors'  
7 }).addTo(map);  
8  
9 // Teams and their respective cities  
10 var teams = [  
11   { city: "Rennes", team: "DIVERSE" },  
12   { city: "Paris", team: "PICUBE" },  
13   { city: "Paris", team: "ARGO" },  
14   { city: "Saclay", team: "DEDUCTEAM" },  
15   { city: "Lille", team: "EVEREF" },  
16   { city: "Bordeaux", team: "FLOWERS" },  
17   { city: "Bordeaux", team: "MNEMOSYNE" },  
18   { city: "Lille", team: "SPIRALS" },  
19   { city: "Lille", team: "STAMP" },  
20   { city: "Nancy", team: "SED" }  
21 ]  
22 <!DOCTYPE html>  
23 <html>  
24 <head>  
25   <title>Team Locations in France</title>  
26   <link rel="stylesheet" href="https://unpkg.com/leaflet@1.8.0/dist/leaflet.css" />  
27   <script src="https://unpkg.com/leaflet@1.8.0/dist/leaflet.js"></script>  
28   <style>  
29     #map {  
30       height: 400px;  
31     }  
32 </style>  
33 </head>  
34 <div id="map"></div>  
35 <script src="script.js"></script>  
36 </body>  
37 </html>  
38 }  
39  
40 // Helper function to get coordinates of a city  
41 function getCoordinates(city) {  
42   var coordinates = {  
43     "Rennes": [48.1173, -1.67778],  
44     "Paris": [48.8566, 2.3522],  
45     "Saclay": [48.7290, 2.1912],  
46     "Lille": [50.6292, 3.0573],  
47     "Bordeaux": [44.8378, -0.5792],  
48     "Sophia": [43.6222, 7.0500],  
49     "Nancy": [48.6921, 6.1844]  
50   };  
51   return coordinates[city];  
52 }  
53  
54 // Add markers for each city  
55 object.keys(teamsByCity).forEach(function(city) {  
56   addCityMarker(city, teamsByCity[city]);  
57 });  
58
```

<https://arxiv.org/abs/2210.14699>

Piloting Copilot and Codex: Hot Temperature, Cold Prompts, or Black Magic?

```
def choose_num(x, y):  
    """  
    This function takes two positive  
    numbers x and y and returns the  
    biggest even integer number that  
    is in the range [x, y] inclusive.  
    If there's no such number, then  
    the function should return -1.  
  
    For example:  
    choose_num(12, 15) = 14  
    choose_num(13, 12) = -1  
    """  
    if x % 2 != 0:  
        x += 1  
    if y % 2 != 0:  
        y -= 1  
    if x > y:  
        return -1  
    if x % 2 == 0:  
        x += 1  
    while x <= y:  
        if x % 2 == 0:  
            return x  
        x += 2  
    return -1
```

(a) Original prompt

```
def choose_num(x, y):  
    """  
    This function takes two positive  
    numbers x and y and returns the  
    biggest even integer number that  
    is in the range [x, y] inclusive.  
    If there's no such number, then  
    the function should return -1.  
  
    For example:  
    choose_num(12, 15) = 14  
    choose_num(13, 12) = -1  
  
    Write a quick algorithm to  
    solve this problem.  
    """  
    if x % 2 == 0:  
        x = x  
    else:  
        x = x + 1  
    if y % 2 == 0:  
        y = y  
    else:  
        y = y - 1  
    if x > y:  
        return -1  
    else:  
        return max(x, y)
```

(b) Modified prompt 1

```
def choose_num(x, y):  
    """  
    This function takes two positive  
    numbers x and y and returns the  
    biggest even integer number that  
    is in the range [x, y] inclusive.  
    If there's no such number, then  
    the function should return -1.  
    """  
    if x % 2 == 1:  
        x += 1  
    if y % 2 == 0:  
        y -= 1  
    for i in range(x, y + 1, 2):  
        if x <= i <= y:  
            return i  
    return -1
```

(c) Modified prompt 2

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RQ₃ For both HumanEval and LeetCode, varying the temperature can significantly improve Codex performance, up to the point Codex with a configured temperature (not necessarily the best one) can strongly outperform Copilot. The optimal temperature depends on the chosen prompt variation, the number of generated codes, and to a lesser extent the targeted programming languages.

RQ₄ A proper configuration of the temperature and prompt variation can significantly improve the results of Codex. A difficulty, though, is that the best configurations differ for a given pass@k. A general recommendation is to use low temperatures (0.0, 0.2) for pass@1, and higher temperatures (0.6 to 1.0) for pass@10 and @100.

RQ₅ Tuning temperature and prompt variation per problem can provide strong performance improvements: up to 79.27% at pass@1 compared to 22.44% for the default configuration and outperforming best average configuration of RQ4 (52.67%).

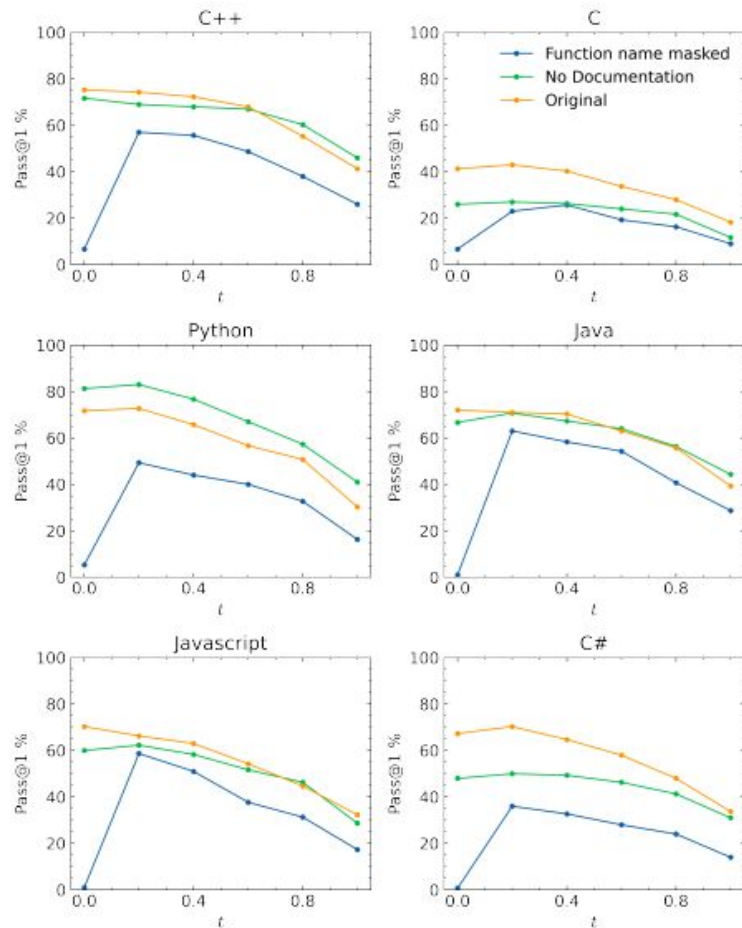


Fig. 3: Pass@1 Evaluation of Codex on Leetcode dataset; $temp \in [0.0, 0.2, 0.4, 0.6, 0.8, 1]$

Challenges

- LLMs are:
 - brittle, leading to faulty, under-optimized, or unreliable code (including tests!)
 - under-trained on “small” languages or not up-to-date with (knowledge of) new libraries or software versions
 - LLMs lack planning and reasoning capabilities
- Challenges of improving LLMs:
 - Better “language” than prompt?
 - more verification/validation tools to verify the outcome?
 - fine-tuning?
- Benchmarking (SE task specific, no data contamination, etc.)
- Open source LLMs (CodeCommons with SoftwareHeritage)



LLM4Code: Reliable and Productive Code Assistants
Based on Large Language Models

Project Leads

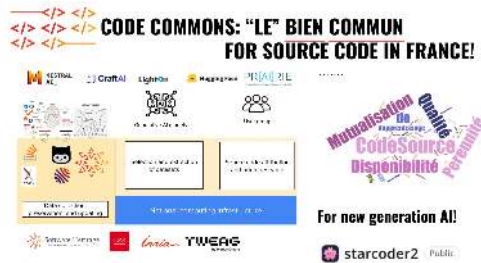
| | | | |
|---------|--------|-------------------|--|
| DIVERSE | Rennes | Mathieu Acher | mathieu.acher@inria.fr |
| PICUBE | Paris | Guillaume Baudart | guillaume.baudart@inria.fr |

Internal Partners (EP/CRI)

| | | | |
|-----------|----------|---------------------|--|
| ARGO | Paris | Marc Lelarge | marc.lelarge@inria.fr |
| DEDUCTEAM | Saclay | Anthony Bordg | anthony.bordg@inria.fr |
| EVREF | Lille | Anne Etien | anne.etien@univ-lille.fr |
| FLOWERS | Bordeaux | Pierre-Yves Oudeyer | pierre-yves.oudeyer@inria.fr |
| MNEMOSYNE | Bordeaux | Xavier Hinaut | xavier.hinaut@inria.fr |
| SPIRALS | Lille | Clément Quinton | clement.quinton@inria.fr |
| STAMP | Lille | Cyril Cohen | cyril.cohen@inria.fr |
| SED | Nancy | Laurent Pierron | laurent.pierron@inria.fr |

External Partners

| | | |
|-------------------|--------------------|--|
| SOFTWARE HERITAGE | Roberto di Cosmo | roberto@dicosmo.org |
| LABRI | Nathanaël Fijalkow | nathanael.fijalkow@labri.fr |
| | Romain Robbes | romain.robbes@cnrs.fr |
| SOPRA STERIA | Yann Gloriant | yann.gloriau@soprasteria.com |



CODE COMMONS: "LE" BIEN COMMUN
FOR SOURCE CODE IN FRANCE!

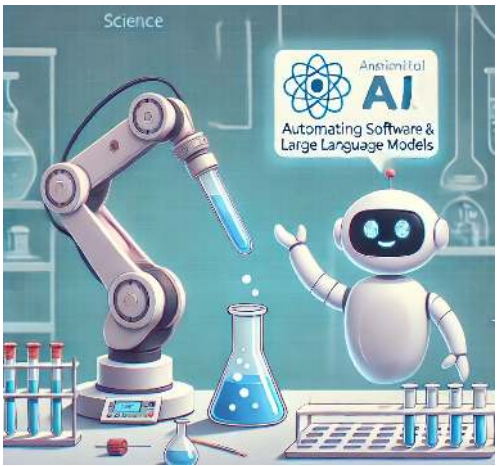
For new generation AI!

starcoder2 Public

(illustration of LLM prompt sensitivity in chess)



How LLMs can be used both to generate variants (e.g., prompts, hypotheses, ideas) and to accelerate scientific discovery through software-based exploration and analysis.



What
is your move?



What is your prompt?

[Event "FIDE World
Championship Match 2024"]
[Site "Los Angeles, USA"]
[Date "2024.12.01"]
[Round "5"]
[White "Kramnik, Vladimir"]
[Black "Nepomniachtchi,
Ian"]
[Result "1-0"]
[WhiteElo "2900"]
[BlackElo "2900"]
[TimeControl
"40/7200:20/3600:900+30"]
[UTCDate "2024.11.27"]
[UTCTime "09:01:25"]
[Variant "Standard"]



[Event "FIDE World
Championship Match 2024"]
[Site "Los Angeles, USA"]
[Date "2024.12.01"]
[Round "5"]
[White "Louapre, David"]
[Black "Giraud, Thibaut"]
[Result "0-1"]
[WhiteElo "1400"]
[BlackElo "1400"]
[TimeControl
"40/7200:20/3600:900+30"]
[UTCDate "2024.11.27"]
[UTCTime "09:01:25"]
[Variant "Standard"]



[Event
Champ
[Site "L
[Date "
[Round
[White
[Black
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[Resul
[White
[Black
[TimeC
"40/72
[UTCD
[UTCT
[Variar

[Event '
Champ
[Site "L
[Date "
[Round
[White
[Black
[Resul
[White]
[Black]
[TimeC
"40/72(
[UTCD
[UTCTI
[Variar

MrPhi
@MonsieurPhi

Petite note: j'ai remarqué que jusqu'à 1800 Elo, sa sensibilité au prompt est un peu bizarre. Par exemple avec "1-0" (Blanc gagne) il joue le coup correct g6. Mais avec "0-1" (Noir gagne) ou "1/2-1/2", il joue Nf6 (ce qui est illogique vu que Nf6 fait justement perdre les Noirs).

[Translate post](#)

Playground Complete

| | |
|--|---|
| <pre>[Event "Chess Tournament"] [Site "?"] [Date "2024.01.15"] [Round "1"] [White "Louapre, David"] [Black "Carlsen, Magnus"] [Result "1-0"] [WhiteElo "1800"] [BlackElo "1800"] 1.e4 e5 2.Bc4 Nc6 3.Qh5 g6</pre> | <pre>[Event "Chess Tournament"] [Site "?"] [Date "2024.01.15"] [Round "1"] [White "Louapre, David"] [Black "Carlsen, Magnus"] [Result "0-1"] [WhiteElo "1800"] [BlackElo "1800"] 1.e4 e5 2.Bc4 Nc6 3.Qh5 Nf6</pre> |
|--|---|

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1 7

Post your reply Reply

MrPhi @MonsieurPhi · Apr 19
Mais il n'a plus ce comportement bizarre quand le Elo dépasse 2000. Enfin bref ! Il faudrait faire d'autres tests pour déterminer à quel point cette information sur le niveau Elo influence son niveau de jeu, mais c'est déjà intéressant comme petite expérience.

2 9 441

ur prompt?



Hypothesis and Knowledge

Subject of interest/Population

Experiments (variants)

Data analysis

Interpretation/Conclusion



```

# Optional GPT calls
black_title = "[BlackTitle %04d]" if include_black_title else ""
white_title = "[WhiteTitle %04d]" if include_white_title else ""

# Construct the PROM header with the configurable options:
prom_headers = """[Event "FIDE World Championship Match 2021"]
[Site "Los Angeles, USA"]
[Date "2024.12.01"]
[Round "5"]
[White "%s"]
[Black "%s"]
[result "?"]
[WhiteElo "%d"]
[WhiteTitle "%s"]
[BlackElo "%d"]
[BlackTitle "%s"]
"""

```

```

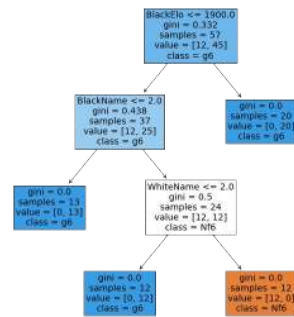
# Define possible values for each parameter
results = ["1-0", "1/2-1/2", "0-1"]
names = ["MagnusCarlsen", "Carlsen", "Carlsen", "Magnus", "Carlsen", "Magnus", "Carlsen", "Magnus"]
elos = [1900, 2400, 2700, 2800, 2900, 3000]
include_title = [True, False]
include_title = [True, False]

```

```

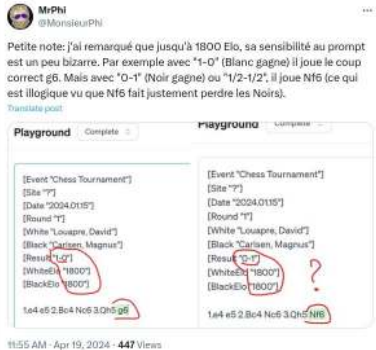
gpt_config = GPTConfig(
    model_gpt="gpt-3.5-turbo-instruct",
    temperature=0.0,
    max_tokens=5,
    chat_gpt=False,
    system_role_message=None # Since it wasn't provided in the original call
)

```



Monsieur Phi is ~right. Sensitivity of LLMs. Do LLMs have “learned” the Elo?

AI-(empowered) scientists: enormous potential to automatically explore large variants spaces (with software and AI) and discover new knowledge or confirm/refute theories.



```
# Optional GM titles
black_title = "[BlackTitle \"GM\"]" if include_black_title else ""
white_title = "[WhiteTitle \"GM\"]" if include_white_title else ""

# Construct the PGN header with the configurable options
pgn_headers = f"""[Event "FIDE World Championship Match 2024"]
[Site "Los Angeles, USA"]
[Date "2024.12.01"]
[Round "5"]
[White "{white_name}"]
[Black "{black_name}"]
[Result "{result}"]
[WhiteElo "{white_elo}"]
[BlackElo "{black_elo}"]
[black_title]
[white_title]
[TimeControl "40/7200:20/3600:900+30"]
[UTCDate "2024.11.27"]
[UTCTime "09:01:25"]
[Variant "Standard"]
"""
```

```
# Define possible values for each parameter
results = ["1-0", "1/2-1/2", "0-1"]
# results = ["1-0", "0-1"]
names = ["Nepomniachtchi, Ian", "Kramnik, Vladimir", "Giraud, Thibaut", "Louapre, David", "XXX"]
elos = [1000, 1400, 1700, 1800, 2000, 2900]
# include_title = [True, False]
include_title = [False]
```



```
gpt_config = GPTConfig(
    model_gpt="gpt-3.5-turbo-instruct",
    temperature=0.0,
    max_tokens=5,
    chat_gpt=False,
    system_role_message=None # Since it wasn't provided in the original call
)
```





MrPhi
@MonsieurPhi

Petite note: j'ai remarqué que jusqu'à 1800 Elo, sa sensibilité au prompt est un peu bizarre. Par exemple avec "1-0" (Blanc gagne) il joue le coup correct g6. Mais avec "0-1" (Noir gagne) ou "1/2-1/2", il joue Nf6 (ce qui est illogique vu que Nf6 fait justement perdre les Noirs).

[Translate post](#)

Playground Complete

[Event "Chess Tournament"]
[Site "?"]
[Date "2024.01.15"]
[Round "1"]
[White "Louapre, David"]
[Black "Carlsen, Magnus"]
[Result "1-0"]
[WhiteElo "1800"]
[BlackElo "1800"]

1.e4 e5 2.Bc4 Nc6 3.Qh5 g6

[Event "Chess Tournament"]
[Site "?"]
[Date "2024.01.15"]
[Round "1"]
[White "Louapre, David"]
[Black "Carlsen, Magnus"]
[Result "0-1"]
[WhiteElo "1800"]
[BlackElo "1800"]

1.e4 e5 2.Bc4 Nc6 3.Qh5 Nf6

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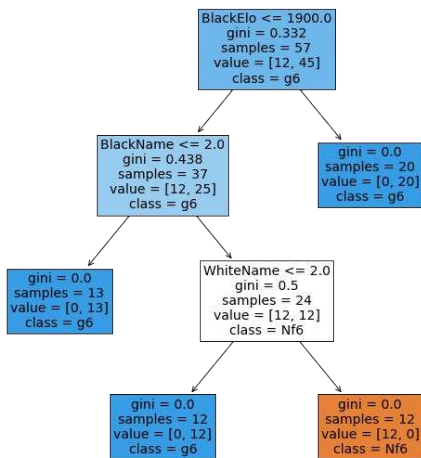


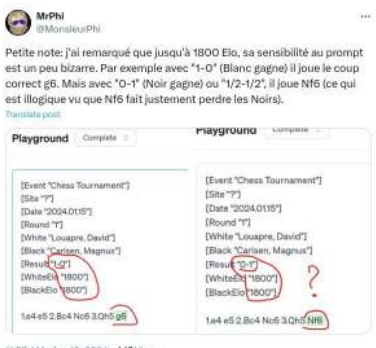
MrPhi @MonsieurPhi · Apr 19

Mais il n'a plus ce comportement bizarre quand le Elo dépasse 2000. Enfin bref ! Il faudrait faire d'autres tests pour déterminer à quel point cette information sur le niveau Elo influence son niveau de jeu, mais c'est déjà intéressant comme petite expérience.

2 441

| Result | WhiteName | BlackName | WhiteElo | BlackElo | IncludeWhiteTitle | IncludeBlackTitle | Move |
|--------|---------------------|---------------------|----------|----------|-------------------|-------------------|------|
| 0-1 | XXX | Louapre, David | 1800 | 1800 | False | False | Nf6 |
| 1-0 | Louapre, David | XXX | 2900 | 2900 | False | False | g6 |
| 0-1 | Nepomniachtchi, Ian | Louapre, David | 2900 | 2900 | False | False | g6 |
| 0-1 | Nepomniachtchi, Ian | Louapre, David | 2000 | 2000 | False | False | g6 |
| 0-1 | Louapre, David | XXX | 1400 | 1400 | False | False | Nf6 |
| 1-0 | XXX | Nepomniachtchi, Ian | 1800 | 1800 | False | False | g6 |
| 1-0 | Nepomniachtchi, Ian | Louapre, David | 2900 | 2900 | False | False | g6 |
| 1-0 | Louapre, David | Nepomniachtchi, Ian | 1800 | 1800 | False | False | g6 |
| 0-1 | Louapre, David | Nepomniachtchi, Ian | 1000 | 1000 | False | False | g6 |
| 1-0 | Nepomniachtchi, Ian | XXX | 2000 | 2000 | False | False | g6 |
| 0-1 | XXX | Nepomniachtchi, Ian | 2000 | 2000 | False | False | g6 |
| 0-1 | Nepomniachtchi, Ian | XXX | 1700 | 1700 | False | False | g6 |
| 1-0 | Louapre, David | XXX | 1700 | 1700 | False | False | Nf6 |





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Post your reply

MPH @MonsieurPH · Apr 19
 Mais il n'a plus ce comportement bizarre quand le Elo dépasse 2000. Enfin bref !! Il faudrait faire d'autres tests pour déterminer à quel point cette information sur le niveau Elo influence son niveau de jeu, mais c'est 0/6/3 intéressant comme petite expérience.

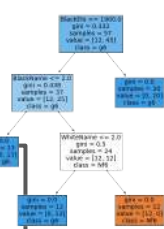
Strategic exploration with modelling and learning (assisted by LLM)

```
onal GM titles
:title = "[BlackTitle \"GM\"]" if include_black_title else ""
:title = "[WhiteTitle \"GM\"]" if include_white_title else ""
```

```
# Construct the PGN header with the configurable options
pgn_headers = f"""[Event "FIDE World Championship Match 2024"]
[Site "Los Angeles, USA"]
[Date "2024.12.01"]
[Round "5"]
[White "{white_name}"]
[Black "{black_name}"]
```

```
gpt_config = GPTConfig
model_gpt="gpt-3.5
temperature=0.0,
max_tokens=5,
chat_gpt=False,
system_role_message=None # Since it wasn't provided in the original call
```

```
# Define possible values for each parameter
results = ["1-0", "1/2-1/2", "0-1"]
# results = ["1-0", "0-1"]
names = ["Nepomniachtchi, Ian", "Kramnik, Vladimir", "Giraud, Thibaut", "Louapre, David", "XXX"]
elos = [1000, 1400, 1700, 1800, 2000, 2900]
# include_title = [True, False]
include_title = [False]
```



| Result | WhiteName | BlackName | WhiteElo | BlackElo | IncludeWhiteTitle | IncludeBlackTitle | Move |
|--------|---------------------|---------------------|----------|----------|-------------------|-------------------|------|
| 0-1 | XXX | Louapre, David | 1800 | 1800 | False | False | Nf6 |
| 1-0 | Louapre, David | XXX | 2900 | 2900 | False | False | g6 |
| 0-1 | Nepomniachtchi, Ian | Louapre, David | 2900 | 2900 | False | False | g6 |
| 0-1 | Nepomniachtchi, Ian | Louapre, David | 2000 | 2000 | False | False | g6 |
| 0-1 | Louapre, David | XXX | 1400 | 1400 | False | False | Nf6 |
| 1-0 | XXX | Nepomniachtchi, Ian | 1800 | 1800 | False | False | g6 |
| 1-0 | Nepomniachtchi, Ian | Louapre, David | 2900 | 2900 | False | False | g6 |
| 1-0 | Louapre, David | Nepomniachtchi, Ian | 1800 | 1800 | False | False | g6 |
| 0-1 | Louapre, David | Nepomniachtchi, Ian | 1000 | 1000 | False | False | g6 |
| 1-0 | Nepomniachtchi, Ian | XXX | 2000 | 2000 | False | False | g6 |
| 0-1 | XXX | Nepomniachtchi, Ian | 2000 | 2000 | False | False | g6 |
| 0-1 | Nepomniachtchi, Ian | XXX | 1700 | 1700 | False | False | g8 |
| 1-0 | Louapre, David | XXX | 1700 | 1700 | False | False | Nf6 |



Hypothesis and Knowledge

Subject of interest/Population

Experiments (variants)

Data analysis

Interpretation/Conclusion



```
# Optional GPT titles
black_title = "[BlackTitle %04d]" if include_black_title else ""
white_title = "[WhiteTitle %04d]" if include_white_title else ""

# Construct the PGN header with the configurable options
pgn_headers = """[Event "FIDE World Championship Match 2021"]
[Site "Los Angeles, USA"]
[Date "2022.12.01"]
[Round "%d"]
[White "%s"]
[Black "%s"]
[Result "%d"]
[WhiteElo "%d"]
[WhiteTitle "%s"]
[BlackElo "%d"]
[BlackTitle "%s"]

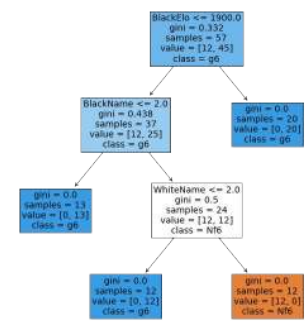
% Optional GPT titles
black_title = "[BlackTitle %04d]" if include_black_title else ""
white_title = "[WhiteTitle %04d]" if include_white_title else ""

# Construct the PGN header with the configurable options
pgn_headers = """[Event "FIDE World Championship Match 2021"]
[Site "Los Angeles, USA"]
[Date "2022.12.01"]
[Round "%d"]
[White "%s"]
[Black "%s"]
[Result "%d"]
[WhiteElo "%d"]
[WhiteTitle "%s"]
[BlackElo "%d"]
[BlackTitle "%s"]

# Define possible values for each parameter
results = ["1-0", "1/2-1/2", "0-1"]
names = ["MagnusCarlsen", "Jan", "Konerik", "Vladimir", "Sviridov", "Theodor", "Kasparov", "David", "XXX"]
elos = [1900, 3400, 1700, 3000, 2900, 2000]
include_title = [True, False]
include_title = [True, False]
```

```
# Define possible values for each parameter
results = ["1-0", "1/2-1/2", "0-1"]
names = ["MagnusCarlsen", "Jan", "Konerik", "Vladimir", "Sviridov", "Theodor", "Kasparov", "David", "XXX"]
elos = [1900, 3400, 1700, 3000, 2900, 2000]
include_title = [True, False]
include_title = [True, False]
```

```
gpt_config = GPTConfig(
    model_l_gpt="gpt-3.5-turbo-instruct",
    temperature=0.0,
    max_tokens=5,
    chat_gpt=False,
    system_role_message=None # Since it wasn't provided in the original call
)
```



Monsieur Phi is ~right. Sensitivity of LLMs. Do LLMs have “learned” the Elo?

AI-(empowered) scientists:

- this example (chess) is a bit “meta” (we’re assessing AIs)
- still: I find it representative of many scientific studies where we run variants of experiments, analyze data, and communicate insights – AI is useful to assist, but not mandatory here
- many tasks uncovered (eg literature review)

AI scientists can study AIs – no human in the loop?

Hypothesis and Knowledge

Subject of interest/Population

Experiments (variants)

Data analysis

Interpretation/Conclusion



Scientific knowledge . . .



<https://blog.mathieuacher.com/GPTsChessEloRatingLegalMoves/>

**AI(-empowered) scientists:
AI scientists can study AIs – no human in the loop?
Automated scientific discovery**

Hypothesis and Knowledge

Subject of interest/Population

Experiments (variants)

Data analysis

Interpretation/Conclusion

The image is a composite of two parts. On the left, a person in a blue shirt stands at a whiteboard in a lecture hall. On the right, a presentation slide titled "Précision intermédiaire - le cas C" is shown. The slide contains the following text:

Norme ISO 9542.2 (9)

The values of operations with floating operands and values subject to the usual arithmetic conversions and of floating constants are evaluated to a format whose range and precision may be greater than required by the type.

Exemple (Précision étendue)

variable x = 1.0;
variable y = 20.952 + 2e19.64;
variable z = x * y;

peut produire les valeurs suivantes :

- $x = 1 + 2^{-52}$ addition en binary64,
- $z = 1$ addition en binary80 puis stockage en binary64.

Arithmétique à virgule flottante : plate ou terrain de jeu ?
Séverin Belec

Scientific knowledge . . .

AI(-empowered) scientists:
AI scientists can study AIs – no human in the loop?
Automated scientific discovery

Backup slides

How LLMs can assist in modernizing legacy applications, such as those written in COBOL or in deprecated technologies.

Polyglot?

Python => JavaScript+HTML+CSS

You
I have the following Python code:

```
import folium
```

```
# Given coordinates for the cities (these are example coordinates and may not be accurate)
```

```
# Normally we would obtain these through a geocoding service  
coordinates = {
```

```
    "Rennes": [48.1173, -1.6778],  
    "Paris": [48.8566, 2.3522],  
    "Saclay": [48.7290, 2.1912],  
    "Lille": [50.6292, 3.0573],  
    "Bordeaux": [44.8378, -0.5792],  
    "Sophia": [43.6222, 7.0500], # This is an approximation for Sophia Antipolis  
    "Nancy": [48.6921, 6.1844]  
}
```

```
# Initialize a map centered around France
```

```
map_france = folium.Map(location=[46.603354, 1.888334], zoom_start=6)
```

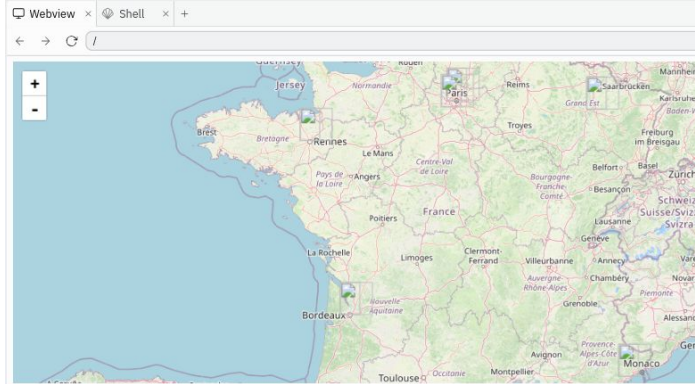
```
# Add markers for each team
```

```
add_team_marker(map_france, "DIVERSE", "Rennes")  
add_team_marker(map_france, "PICUBE", "Paris")  
add_team_marker(map_france, "ARGO", "Paris")  
add_team_marker(map_france, "DEDUCTEAM", "Saclay")  
add_team_marker(map_france, "EVEREF", "Lille")  
add_team_marker(map_france, "FLOWERS", "Bordeaux")  
add_team_marker(map_france, "MNEMOSYNE", "Bordeaux")  
add_team_marker(map_france, "SPIRALS", "Lille")  
add_team_marker(map_france, "STAMP", "Sophia")  
add_team_marker(map_france, "SED", "Nancy")
```

```
# Since we cannot display the folium map directly in this environment,  
# we'll save it to an HTML file which you can then open in a web browser.
```

```
map_file_path = '/mnt/data/france_teams_map.html'  
map_france.save(map_file_path)  
map_file_path
```

Please write a JavaScript program, using Leaflet.js



ChatGPT

Creating a JavaScript program using Leaflet.js to achieve a similar functionality as your Python code with Folium is a good way to visualize geographic data on web platforms. Leaflet is a leading open-source JavaScript library for mobile-friendly interactive maps.

Here's a basic example of how you could write such a program:

```
index.html x | scripts.js x | ...  
scripts.js > f addCityMarker > x popupText  
1 var map = L.map('map').setView([46.603354, 1.888334], 6);  
2  
3 // Add OpenStreetMap tiles:  
4 L.tileLayer('https://{s}.tile.openstreetmap.org/{z}/{x}/{y}.png', {  
5   maxZoom: 19,  
6   attribution: '© OpenStreetMap contributors'  
7 }).addTo(map);  
8  
9 // Teams and their respective cities  
10 var teams = [  
11   { city: "Rennes", team: "DIVERSE" },  
12   { city: "Paris", team: "PICUBE" },  
13   { city: "Paris", team: "ARGO" },  
14   { city: "Saclay", team: "DEDUCTEAM" },  
15   { city: "Lille", team: "EVEREF" },  
16   { city: "Bordeaux", team: "FLOWERS" },  
17   { city: "Bordeaux", team: "MNEMOSYNE" },  
18   { city: "Lille", team: "SPIRALS" },  
19  
20  
21 ]  
22 <!DOCTYPE html>  
23 <html>  
24 <head>  
25   <title>Team Locations in France</title>  
26   <link rel="stylesheet" href="https://unpkg.com/leaflet@1.0.0/dist/leaflet.css" />  
27   <script src="https://unpkg.com/leaflet@1.0.0/dist/leaflet.js"></script>  
28   <style>  
29     #map {  
30       height: 400px;  
31     }  
32 </style>  
33 </head>  
34 <div id="map"></div>  
35 <script src="scripts.js"></script>  
36 </body>  
37 </html>  
38 }  
39  
40 // Helper function to get coordinates of a city  
41 function getCoordinates(city) {  
42   var coordinates = {  
43     "Rennes": [48.1173, -1.6778],  
44     "Paris": [48.8566, 2.3522],  
45     "Saclay": [48.7290, 2.1912],  
46     "Lille": [50.6292, 3.0573],  
47     "Bordeaux": [44.8378, -0.5792],  
48     "Sophia": [43.6222, 7.0500],  
49     "Nancy": [48.6921, 6.1844]  
50   };  
51   return coordinates[city];
```

SE task: modernization/migration

```
add markers for each city  
<script>  
  Object.keys(teamsByCity).forEach(function(city) {  
    addCityMarker(city, teamsByCity[city]);  
  });  
</script>
```

MA

You

I have the following Python code:

import folium

Given coordinates for the cities (these are example coordinates and may not be accurate)

Normally we would obtain these through a geocoding service

coordinates = {

"Rennes": [48.1173, -1.6778],

"Paris": [48.8566, 2.3522],

"Saclay": [48.7290, 2.1912],

"Lille": [50.6292, 3.0573],

"Bordeaux": [44.8378, -0.5792],

"Sophia": [43.6222, 7.0500], # This is an approximation for Sophia Antipolis

"Nancy": [48.6921, 6.1844]

}

Initialize a map centered around France

map_france = folium.Map(location=[46.603354, 1.888334], zoom_start=6)

Add markers for each team

add_team_marker(map_france, "DIVERSE", "Rennes")

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add_team_marker(map_france, "ARGO", "Paris")

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add_team_marker(map_france, "EVEREF", "Lille")

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add_team_marker(map_france, "MNEMOSYNE", "Bordeaux")

add_team_marker(map_france, "SPIRALS", "Lille")

add_team_marker(map_france, "STAMP", "Sophia")

add_team_marker(map_france, "SED", "Nancy")

Since we cannot display the folium map directly in this environment,

we'll save it to an HTML file which you can then open in a web browser.

map_file_path = '/mnt/data/france_teams_map.html'

map_france.save(map_file_path)

map_file_path

Please write a JavaScript program, using Leaflet.js

AI

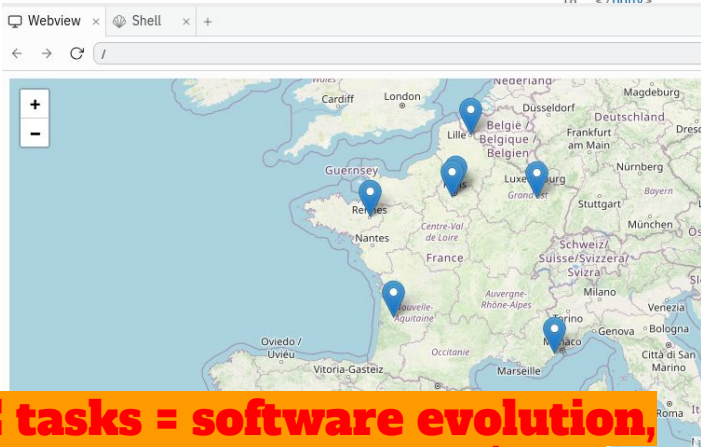
ChatGPT

Creating a JavaScript program using Leaflet.js to achieve a similar functionality as your Python code with Folium is a good way to visualize geographic data on web platforms. Leaflet is a leading open-source JavaScript library for mobile-friendly interactive maps.

Here's a basic example of how you could write such a program:

Polyglot?

- it's not a pure PL translation problem (it's also Folium => Leaflet)
- testing oracle problem
- PL and libraries evolve



SE tasks = software evolution, maintenance, upgrade | bug fixing | program understanding

```

index.html x  script.js x  +
script.js > f addCityMarker > X popupText
1 var map = L.map('map').setView([46.603354, 1.888334], 6);
2

index.html x  script.js x  +
index.html
1 <!DOCTYPE html>
2 <html>
3
4 <head>
5 <title>Team Locations in France</title>
6 <link rel="stylesheet" href="https://unpkg.com/leaflet@1.1.0/dist/leaflet.css" />
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8 </head>
9 <style>
10 #map {
11   height: 400px;
12 }
13 </style>
14
15 <body>
16 <div id="map"></div>
17 <script src="script.js"></script>
18 </body>

29 10 height: 400px;
30 11 }
31 12 </style>
32 13 </head>
33 14
34 15 <body>
35 16 <div id="map"></div>
36 17 <script src="script.js"></script>
37 18 </body>
38 19
39 20 </html>
40
41 // Helper function to get coordinates of a city
42 function getCoordinates(city) {
43   var coordinates = {
44     "Rennes": [48.1173, -1.6778],
45     "Paris": [48.8566, 2.3522],
46     "Saclay": [48.7290, 2.1912],
47     "Lille": [50.6292, 3.0573],
48     "Bordeaux": [44.8378, -0.5792],
49     "Sophia": [43.6222, 7.0500],
50     "Nancy": [48.6921, 6.1844]
51   };
52   return coordinates[city];
53 }
54
55 // Add markers for each city
56 Object.keys(teamsByCity).forEach(function(city) {
57   addCityMarker(city, teamsByCity[city]);
58 });

```

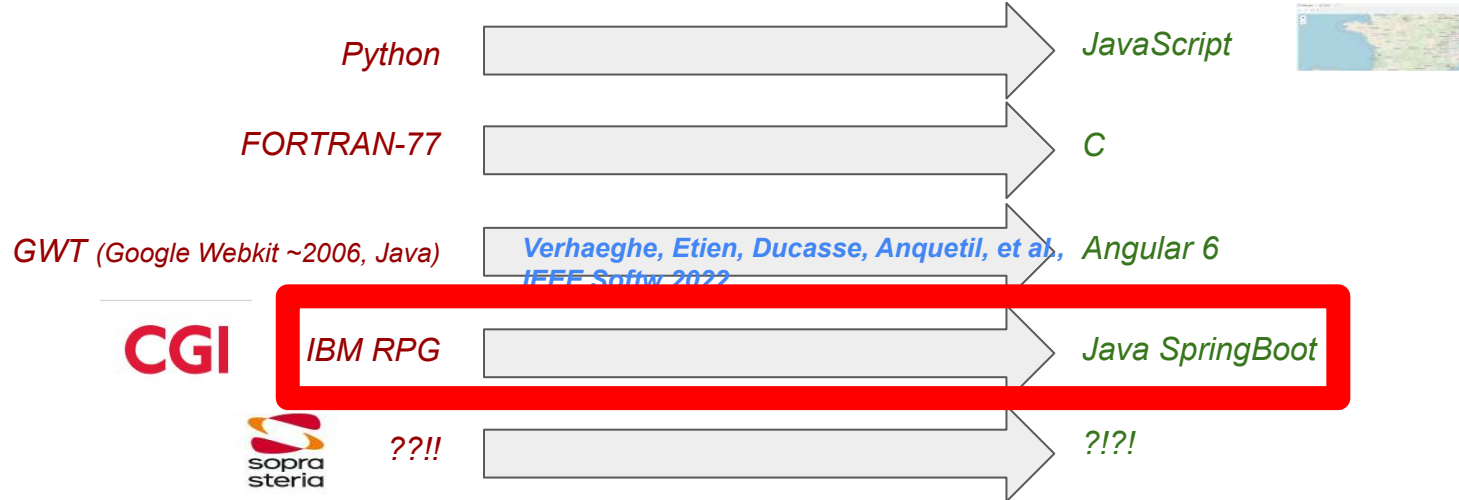
Software migration and modernization

Evref+DiverSE

Goal: LLMs to assist in migrating an existing/legacy code base to newer technologies

Approach:

- LLMs for reverse engineering, assistance to devs/architects
- Validation of the migration (testing), etc.
- Fine-grained examples and data out of compilers/transpilers
- Use-cases from Industrial collaborations



The current migration is done using deterministic tools (lexer/parser + IR)

Currently, **over 70%** of the code is migrated with this process

Difficulties:

- long methods (up to 10K lines!)
- methods are not modularized (calls to decompose and refactor)
- RPG variants
- context matters:
 - hard to only translate one method (you need to take the context into account)
 - implicit semantics (eg with variable' names)
 - different RPG files (physic: table; logic: view)
- reading and code comprehension

```
C      Read      CLE001
C      Eval      MsgId = 'CLR*ALL'
C      ExSr      SndMsg
C
C      Eval      *In12 = *Off
C      Eval      *In51 = *On
C
C      Select
C
C      When      *InKc Or *InKl
C      KC        MOVE      'C'          #CDRET
C      KL        MOVE      'L'          #CDRET
C      Leave
C      When      *InKj
C      ExSr      InzSfl
C      If      SwitchF10 = *On
C      C          Eval      SwitchF10 = *Off
C      C          ExSr      SrSfl2
C
C      Else
C      C          Eval      SwitchF10 = *On
C      C          ExSr      SrSfl
C      EndIf
C
C      When      *In56
C
C      4 Chain    Sfl001
C      If      #DtApd <>0
C
C      CALL      'RHU815R'
C      PARM      '*VDATE'          ACT          8
C      PARM      *ZEROS            DEBDAT       8 0
C      PARM      *ZEROS            FINDAT       8 0
C      PARM      *ZEROS            CALCUL       6 0
C      PARM      #dtapd            DATREF       8 0
C      PARM      *ZEROS            DEFS         8 0
```

RPG source code. Src: Opera project screenshot

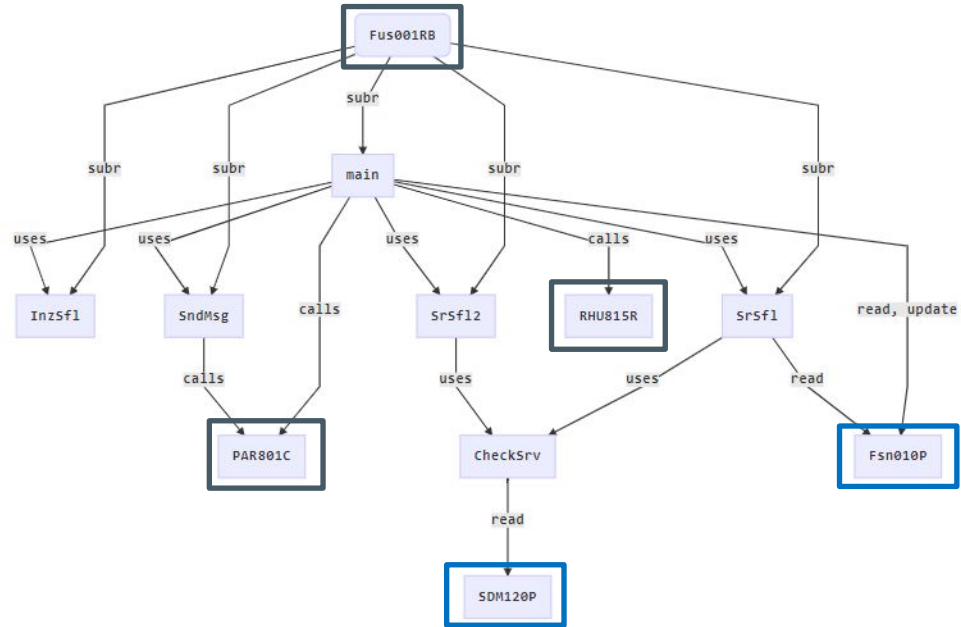
Without documentation!

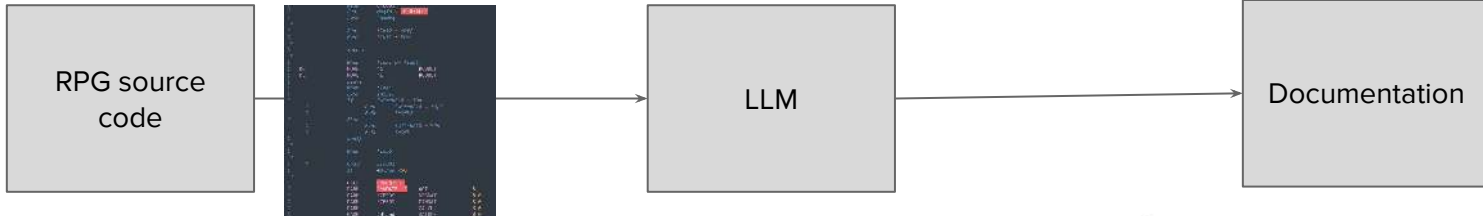
REVERSE ENGINEERING



Augmenting the context before calling LLMs

Build the program tree execution flow for retro-documentation





Evaluation of LLM pipeline wrt retro-documentation

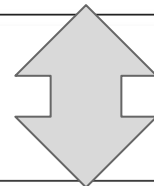
Possible approaches:

- manually review generated doc
- compare GT doc with generated doc
 - Levenshtein distance? BLEU? ROUGE?

We aim to know:

- precision
- recall
- in an automated way

This RPG method, named 'CheckSrv', is designed to verify the presence of a report named 'SPD616' in a database entity called 'Spdm121L'. The method starts by setting a flag 'FoundSpd616' to '*Off'. Then, it checks if the report exists in the database by evaluating the contents of 'Spdm121L'. If the report is found and not at the end of the database, the flag 'FoundSpd616' is set to '*On'.



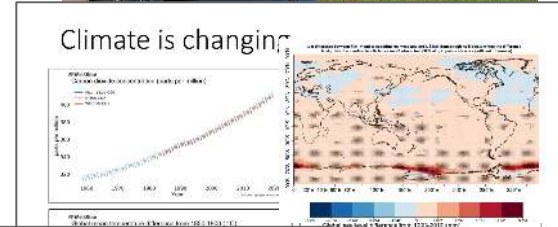
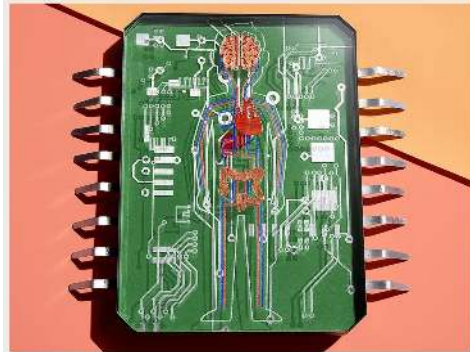
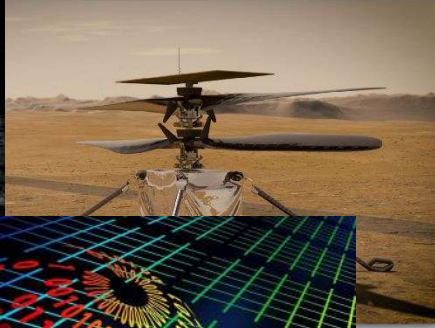
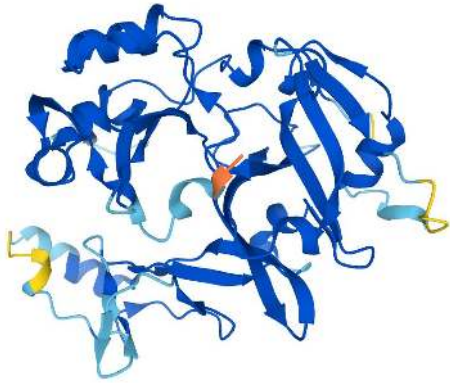
Ground truth documentation

- Reading the "Service agreement, items to be invoiced" data
 - Checks that the data is already present
 Verifies that the service agreement table (Spdm121L) contains an item associated with the company number and the service code (code = SPD616). If the searched item is present, FoundSpd616 is set to true.

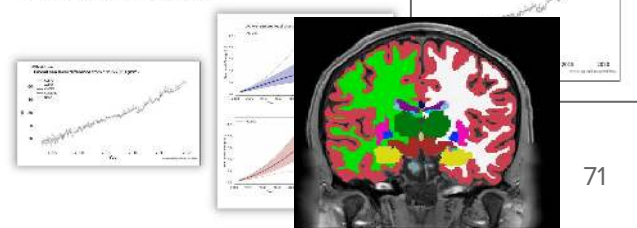
Software is eating the world!



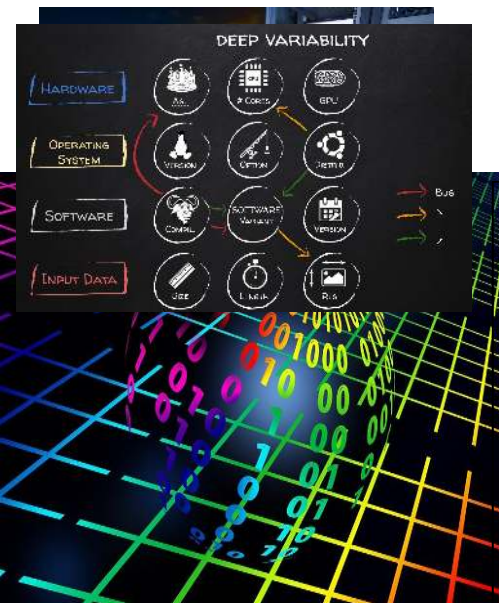
Software is eating science!



The sea level is rising

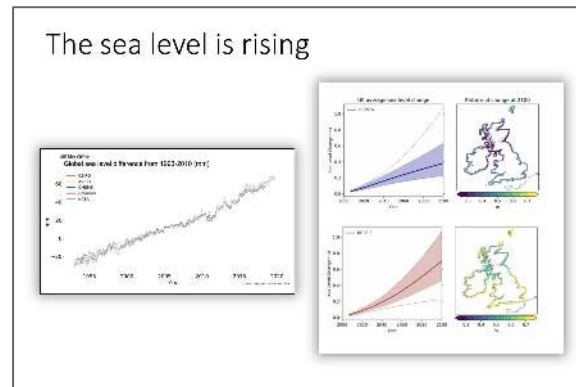
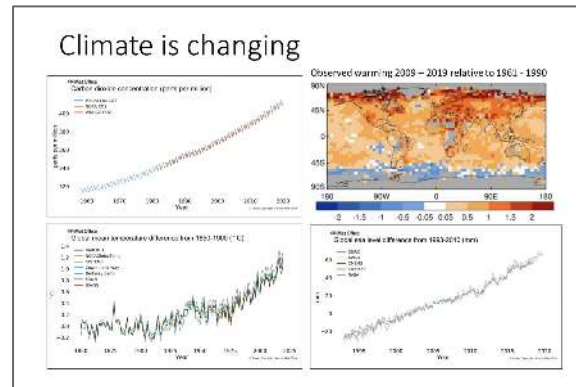


Computational science depends on software and its engineering



design of mathematical model
mining and analysis of data
executions of large simulations
problem solving
executable paper

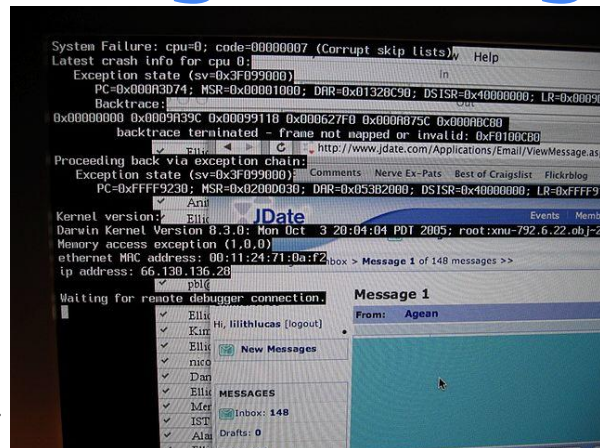
from a set of scripts to automate the deployment to... a comprehensive system containing several features that help researchers exploring various hypotheses



Computational science depends on software and its engineering



multi-million line of code base
multi-dependencies
multi-systems
multi-layer
multi-version
multi-person
multi-variant



```
In [6]: sess.run(tf.svd(tf_matrix))  
Out[6]: (array([[ 9.9998987e-01,  1.48747023e-03,  4.88133628e-06,  
  4.69811084e-06,  4.37980998e-06,  3.45290823e-06,  
  1.14868304e-06,  3.10980795e-06,  2.97525912e-06,  
  2.65099743e-06,  1.91537106e-06,  0.00000000e+00,  
  0.00000000e+00,  0.00000000e+00,  0.00000000e+00,  
  0.00000000e+00,  0.00000000e+00,  0.00000000e+00,  
  0.00000000e+00,  0.00000000e+00,  0.00000000e+00,  
  0.00000000e+00,  9.82503479e-05, -2.52892733e-06,  
  6.43756945e-07, -2.61201409e-06, -3.18651830e-06,  
  0.00000000e+00, nan, nan, nan,  
  8.60062854e-10,  1.93595340e-09,  0.00000000e+00,  
 -1.24836730e-09,  3.83645737e-09, -3.90316446e-09,  
 nan, -7.00323994e-07], dtype=float32),  
 [-7.27595761e-11,  7.15255737e-07, -2.68207733e-02,  
 -6.68754578e-01,  1.68675050e-01, -2.37232931e-02, ...])
```

Dealing with software collapse: software stops working eventually
Konrad Hinsin 2019
Configuration failures represent one of the most common types of
software failures Sayagh et al. TSE 2018

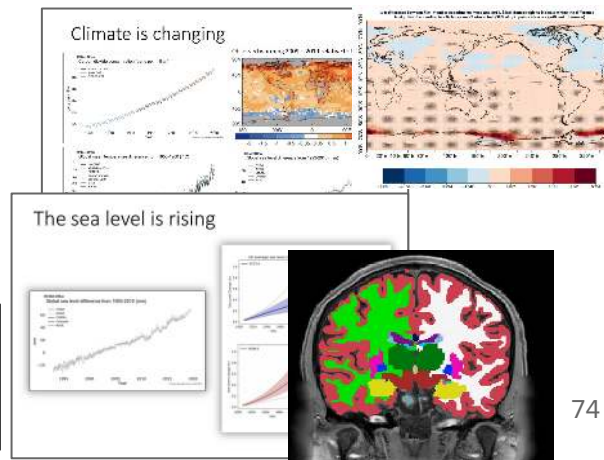
Reproducible science

“Authors provide all the necessary data and the computer codes to run the analysis again, re-creating the results.”

Despite the availability of data and code, several studies report that the same data analyzed with different software can lead to different results.



from a set of scripts to automate the deployment to... a comprehensive system containing several features that help researchers exploring various hypotheses



As **Software is key to Computational Science and Society**, numerous challenges and opportunities ahead!

- democratization of software
- reliable/trustable/resilient software
- speeding up productivity (and focusing on tough/creative challenges)
- software to explore variants' space (hypothesis, ideas, products, etc.)
- ...

We need to **invest more in software science and software engineering (SE) research**

Large Language Models (LLMs) are a transformative technology to raise the level of abstraction, automate SE tasks, and augment/assist software users/developers/scientists → **LLM for SE!?**

Generative AI and LLM for Software



starcoder2

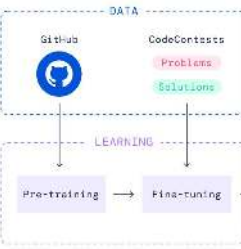
Public



GitHub Copilot

```
def f(x, y):  
    return x + y  
def g(x, y):  
    return x * y  
def h(x, y):  
    return x / y  
def i(x, y):  
    return x - y  
def j(x, y):  
    return x % y  
def k(x, y):  
    return x > y  
def l(x, y):  
    return x < y  
def m(x, y):  
    return x >= y  
def n(x, y):  
    return x <= y  
def o(x, y):  
    return x == y  
def p(x, y):  
    return x != y
```

```
def main():  
    # Create a new window  
    window = Window("Hello World", width=400, height=200)  
    # Create a label  
    label = Label("Hello World")  
    # Add the label to the window  
    window.add(label)  
    # Show the window  
    window.show()  
    # Run the event loop  
    window.run()
```



1553_D_Backspace python pass "Layer 18" [tip]

Problem Description

Solution

```
def main():  
    # Create a new window  
    window = Window("Hello World", width=400, height=200)  
    # Create a label  
    label = Label("Hello World")  
    # Add the label to the window  
    window.add(label)  
    # Show the window  
    window.show()  
    # Run the event loop  
    window.run()
```

Llama-2



DeepSynth

```
type ButtonGroupProps = {  
  plan: any;  
  onClick: (plan: any) => void;  
};  
  
const ButtonGroup = (props: ButtonGroupProps) => {  
  const {selected, setSelected} = useState(0);  
  return (  
    <div class="button-group">  
      {props.plan.map((plan, index) => (  
        <button
```

AlphaCode

Code synthesis: default strategy to answer questions...



You

what is the result of 2+3 ?



ChatGPT



Finished analyzing ▾

```
python
```

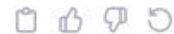
Copy code

```
# Calculating the sum of 2 and 3  
result = 2 + 3  
result
```

Result

5

The result of $2 + 3$ is 5. [↩]



Related work (code generation multi language)

MultiPL-E: A Scalable and Polyglot Approach to Benchmarking Neural Code Generation

Federico Cassano et al. TSE 2023

Piloting Copilot and Codex: Hot Temperature, Cold Prompts, or Black Magic?

Jean-Baptiste Döderlein, Mathieu Acher, Djamel Eddine Khelladi, Benoit Combemale, 2022, <https://arxiv.org/abs/2210.14699>

Evaluation on HumanEval or
**Mainly at the methods level, from a specification
Discrepancies across PL**

| Model | Size | Multi-lingual Human-Eval | | | | | |
|------------------|-------|--------------------------|-------|-------|--------------|--------------|-------|
| | | C++ | Java | PHP | TS | C# | Bash |
| CodeGen-Multi | 16B | 21.0% | 22.2% | 8.4% | 20.1% | 8.2% | 0.6% |
| CodeGeeX | 13B | 16.9% | 19.1% | 13.5% | 10.1% | 8.5% | 2.8% |
| code-cushman-001 | 12B | 30.6% | 31.9% | 28.9% | 31.3% | 22.1% | 11.7% |
| StarCoder Base | 15.5B | 30.6% | 28.5% | 26.8% | 32.2% | 20.6% | 11.0% |
| StarCoder Python | 15.5B | 31.6% | 30.2% | 26.1% | 32.3% | 21.0% | 10.5% |
| LLAMA-v2 | 7B | 6.8% | 10.8% | 9.9% | 12.6% | 6.3% | 3.2% |
| | 13B | 13.7% | 15.8% | 13.1% | 13.2% | 9.5% | 3.2% |
| | 34B | 23.6% | 22.2% | 19.9% | 21.4% | 17.1% | 3.8% |
| | 70B | 30.4% | 31.7% | 34.2% | 15.1% | 25.9% | 8.9% |
| CODE LLAMA | 7B | 28.6% | 34.2% | 24.2% | 33.3% | 25.3% | 12.0% |
| | 13B | 39.1% | 38.0% | 34.2% | 29.6% | 27.3% | 15.2% |
| | 34B | 47.8% | 45.6% | 44.1% | 33.3% | 30.4% | 17.1% |
| | 70B | 52.8% | 51.9% | 50.9% | 49.1% | 38.0% | 29.1% |

| | Copilot pass@1 | Codex pass@1 |
|---------------------------------|-------------------|-----------------|
| Original (HumanEval, Python3) | 31.1 | 22.44 |
| Original (Leetcode, Javascript) | 37.3 | 32.3 |
| Original (Leetcode, Java) | 46.3 | 39.3 |
| Original (Leetcode, C#) | 44.3 | 33.7 |
| Original (Leetcode, Python3) | 33.7 | 30.3 |
| Original (Leetcode, C) | 18.7 | 18.3 |
| Original (Leetcode, C++) | 45.3 | 41.3 |

TABLE II: Pass@1 (original prompts; default temperature) 78

Related work (code generation multi language)

Lost in Translation : A Study of Bugs Introduced by Large Language Models while Translating Code
Rangeet, Pan, et al. ICSE 2024

ICSE 2024, April 2024, Lisbon, Portugal

Pan et al.

Table 2: Performance of subject LLMs in translating code from different studied datasets. The best performance by general and code LLMs are highlighted in teal and violet, respectively. The final performance is computed over the average of each dataset.

| Dataset | Source Language | Source Samples | #Tests | Target Language | #Translations | % Successful Translations | | | | | | |
|-------------------------|-----------------|----------------|--------|-----------------------|---------------|---------------------------|----------|-----------|-------|---------|--------------|-----------|
| | | | | | | CodeGen | CodeGeeX | StarCoder | GPT-4 | Llama 2 | TB-Airoboros | TB-Vicuna |
| CodeNet [63] | C | 200 | 200 | C++, Go, Java, Python | 800 | 23.4% | 14.9% | 42.0% | 83.0% | 14.9% | 18.8% | 4.4% |
| | C++ | 200 | 200 | C, Go, Java, Python | 800 | 14.0% | 3.6% | 39.1% | 80.0% | 9.5% | 8.3% | 3.4% |
| | Go | 200 | 200 | C, C++, Java, Python | 800 | 14.3% | 5.9% | 42.0% | 85.5% | 16.9% | 6.6% | 0.9% |
| | Java | 200 | 200 | C, C++, Go, Python | 800 | 21.3% | 10.3% | 30.3% | 81.3% | 13.9% | 6.5% | 0.1% |
| | Python | 200 | 200 | C, C++, Go, Java | 800 | 17.5% | 7.3% | 33.3% | 79.9% | 11.0% | 6.5% | 1.0% |
| Total/Average (CodeNet) | - | 1,000 | 1,000 | - | 4,000 | 18.1% | 8.4% | 37.3% | 82.0% | 13.2% | 9.3% | 2.0% |
| AVATAR [23] | Java | 249 | 6,255 | C, C++, Go, Python | 996 | 8.1% | 1.8% | 11.9% | 70.8% | 1.8% | 5.1% | 0.0% |
| | Python | 250 | | C, C++, Go, Java | 1,000 | 3.8% | 1.6% | 14.2% | 52.2% | 4.7% | 0.9% | 0.9% |
| Total/Average (AVATAR) | - | 499 | 6,255 | - | 1,996 | 5.9% | 1.7% | 13.0% | 61.5% | 3.2% | 3.0% | 0.4% |
| EvalPlus [54] | Python | 164 | 2,682 | Java | 164 | 16.5% | 3.7% | 22.0% | 79.3% | 1.2% | 14.0% | 7.9% |
| Commons CLI [6] | Java | 22 | 310 | Python | 22 | 0.0% | 0.0% | 0.0% | 13.6% | 0.0% | 0.0% | 0.0% |
| Click [10] | Python | 15 | 611 | Java | 15 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Total/Average (All) | - | 1,700 | 10,858 | - | 6,197 | 8.1% | 2.8% | 14.5% | 47.3% | 3.5% | 5.3% | 2.1% |

Many difficulties to translate real projects from one programming language to another one

Challenges and Opportunities for Science and Society

Challenges:

- LLMs are:
 - brittle, leading to faulty, under-optimized, or unreliable code (including tests!)
 - under-trained on “small” languages or not up-to-date with (knowledge of) new libraries or software versions
 - LLMs lack planning and reasoning capabilities
- Challenges of improving LLMs:
 - Better “language” than prompt?
 - more verification/validation tools to verify the outcome?
 - fine-tuning?
- Benchmarking (SE task specific, no data contamination, etc.)
- Open source LLMs (see next slides!)



LLM4Code: Reliable and Productive Code Assistants
Based on Large Language Models

Project Leads

| | | | |
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| | | |
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Opportunities:

- democratization of software
- reliable/trustable/resilient software
- speeding up productivity (and focuses on hard/creative tasks)
- software to explore variants' space (hypothesis, ideas, products, etc.)
- ...

Software or/and ML are eating the world...



Portfolio companies @OpenAI and @replit set this off - a total paradigm shift. No surprise a marketing person just won a coding competition.

Prediction #2

There could be a billion programmers all "programming" in natural language. Many parts of the craft of coding would be commoditized & the entire field would be opened up to those without a CS degree. Democratizing computer coding is well on its way in the next 10-15 yrs.



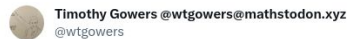
At a hackathon where a winner is a "nontechnical" PM and her work — powered by Replit + AI — is more technically impressive than teams of engineers! Was surprised at first but it struck me that PMs must be exceptional prompting, after that "is" their job.



People often ask if ML or software skills are more the bottleneck to AI progress. It's the wrong question—both are invaluable, and people with both sets of skills can have outsized impact. We find it easier, however, to teach people ML skills as needed than software engineering.



coming up with good ml research ideas is significantly easier than implementing them in a complex codebase — the returns to being an extremely good engineer are super high



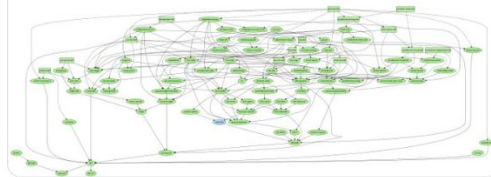
Update: it's finished now.



This is just wild!

Nov 9: @wtgowers, Green, Manners, and Tao prove the polynomial Freiman-Ruzsa conjecture in char 2. arxiv.org/abs/2311.05762

[Show more](#)



This is one of the hidden secrets of scalable research labs: creating template experimental codebases that allow fast testing of wild research ideas. You need your experiment, data, compute, and model abstractions just right 1/



Replying to @tszsl

It also follows that the returns to making simple codebases to test research ideas must be really high and also that the returns to making ai engineering tools are enormously high

Newcomers

End-users

Professional developers
(~28 millions)

Data analysts

Scientists
(physicists,
mathematicians,
historians, etc.)

As code is repetitive and predictable, there is hope to have tools that enhance reliability and productivity

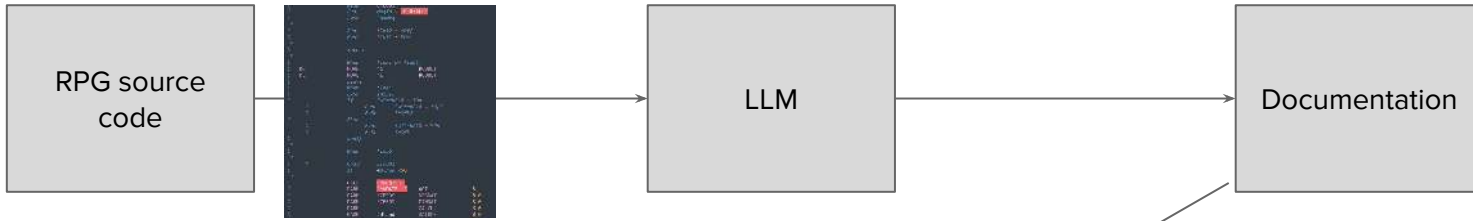
On the Naturalness of Software

Abram Hindle, Earl Barr, Mark Gabel, Zhendong Su, Prem Devanbu
devanbu@cs.ucdavis.edu

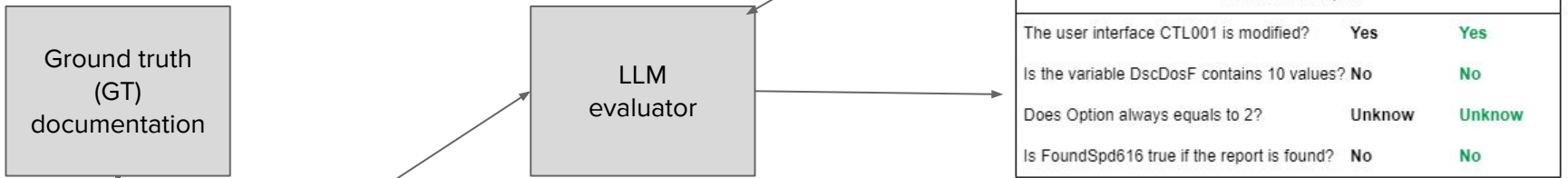
Unpublished version of ICSE 2012 paper, with expanded future work section
Enjoy! Comments Welcome.

Programming languages, in theory, are complex, flexible and powerful, but the programs that real people actually write are mostly simple and rather repetitive, and thus they have usefully predictable statistical properties that can be captured in statistical language models and leveraged for software engineering tasks.

Corpus-based n-gram model outperforms Eclipse **completion** for Java



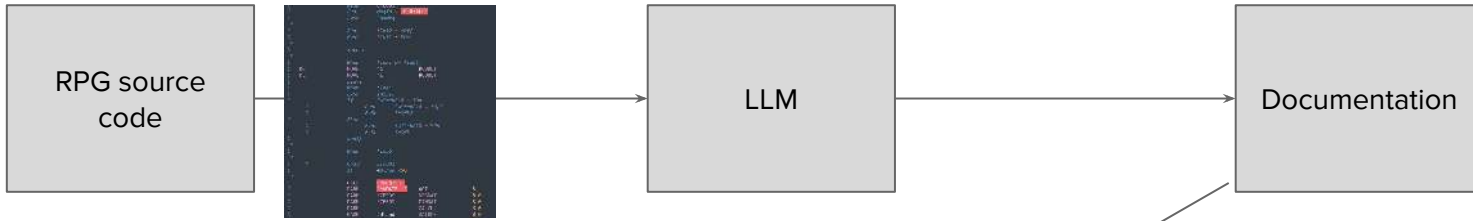
Evaluation of LLM pipeline wrt retro-documentation



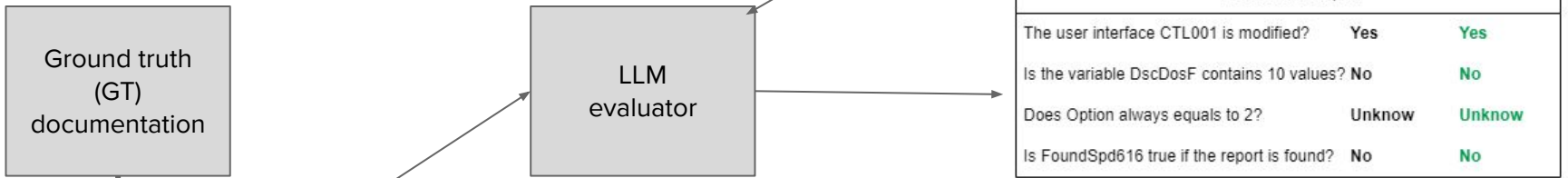
LLM evaluator answers to questions out of the generated documentation (instead of out of GT documentation)

Then we can compute precision/recall/accuracy/...

Questions with ground truth answers associated with GT documentation



Evaluation of LLM pipeline wrt retro-documentation



LLM evaluator answers to questions out of the generated documentation

Challenges:

- calibration/truth worthiness of the LLM evaluator
- documentation vs or with program comprehension
- granularity details of the doc

Questions with ground truth answers associated with GT documentation

Evaluation dataset

Our empirical evaluation is based on self-constructed dataset using previous rules to interpret

| | program | subr | category | question | exp | prov |
|----|----------|----------|----------|---|---------|--------|
| 1 | FUS001RB | InzSfl | General | The user interface CTL001 is modified ? | Yes | <null> |
| 2 | FUS001RB | InzSfl | General | Is the variable Desc_Dossier been modified base on the user language ? | Yes | <null> |
| 3 | FUS001RB | InzSfl | General | Is the variable Dsc_DosF contains many values ? | Yes | <null> |
| 4 | FUS001RB | InzSfl | General | Is the variable Dsc_DosF contains 10 values ? | No | <null> |
| 5 | FUS001RB | InzSfl | General | Is the current date set ? | No | <null> |
| 6 | FUS001RB | InzSfl | General | Is indicator IN60 on (active) before leave this subroutine ? | Yes | <null> |
| 7 | FUS001RB | InzSfl | General | Is indicator IN64 on (active) before leave this subroutine ? | No | <null> |
| 8 | FUS001RB | InzSfl | General | Do we wait the form submission to process data in the main subroutine ? | No | <null> |
| 9 | FUS001RB | InzSfl | OutOfBox | Do we read Dsc_DosF if the user language is English ? | No | <null> |
| 10 | FUS001RB | InzSfl | OutOfBox | Do we read Dsc_DosF if the user language is French ? | Yes | <null> |
| 11 | FUS001RB | *InzSr | General | Are the program input parameters defined? | Yes | <null> |
| 12 | FUS001RB | *InzSr | General | Is the current date is set ? | Yes | <null> |
| 13 | FUS001RB | *InzSr | General | Is indicator *in49 set following on variable LdaLge ? | Yes | <null> |
| 14 | FUS001RB | *InzSr | General | Does variable LdaLge equals 'A' means indicator *in49 false ? | No | <null> |
| 15 | FUS001RB | *InzSr | OutOfBox | Does Option always equals to 2 ? | Unknown | <null> |
| 16 | FUS001RB | *InzSr | OutOfBox | Is the key Key_Spdm121l used in main subroutine ? | Unknown | <null> |
| 17 | FUS001RB | *InzSr | OutOfBox | Does indicator in50 to on clear all data in Spdm121L file ? | Unknown | <null> |
| 18 | FUS001RB | CheckSrv | General | Is RH@044 a report ? | Unknown | <null> |
| 19 | FUS001RB | CheckSrv | General | Is FoundSpd616 true if the report is found? | Yes | <null> |

More than **50 questions** for the **FUS001RB** program (average of 500 LOC)

Table 11. Distribution of SE tasks over six SE activities.

| SE Activity | SE Task | Total | |
|----------------------------|---|--|-----|
| Requirements engineering | Anaphoric ambiguity treatment (3) | Requirements term identification (1) | 11 |
| | Requirements classification (3) | Coreference detection (1) | |
| | Requirement analysis and evaluation (2) | Traceability automation (1) | |
| Software design | GUI retrieval (1) | Software specification synthesis (1) | 3 |
| Software development | Rapid prototyping (1) | | 136 |
| | Code generation (62) | Agile story point estimation (1) | |
| | Code completion (16) | API documentation smell detection (1) | |
| | Code summarization (10) | API entity and relation extraction (1) | |
| | Code understanding (7) | Code optimization (1) | |
| | Code search (5) | Code example recommendation (1) | |
| | Program synthesis (5) | Control flow graph generation (1) | |
| | API recommendation (2) | Data analysis (1) | |
| | API synthesis (2) | Identifier normalization (1) | |
| | Code comment generation (2) | Instruction generation (1) | |
| | Code representation (2) | Type inference (1) | |
| | Method name generation (2) | Others (11) | |
| Software quality assurance | Test generation (8) | Bug localization (1) | 24 |
| | Vulnerability detection (7) | Failure-inducing test identification (1) | |
| | Test automation (4) | Flaky test prediction (1) | |
| | Verification (2) | | |
| Software maintenance | Program repair (23) | Duplicate bug report detection (1) | 58 |
| | Code review (6) | Decompilation (1) | |
| | Debugging (4) | Program merge conflicts repair (1) | |
| | Bug report analysis (3) | Sentiment analysis (1) | |
| | Code clone detection (3) | Tag recommendation (1) | |
| | Logging (2) | Vulnerability repair (1) | |
| | Bug prediction (1) | Commit classification (1) | |
| | Bug triage (1) | Traceability recovery (1) | |
| | Bug report replay (1) | Others (6) | |
| | | | |
| Software management | Effort estimation (1) | | 1 |

• [Papers](#)

- [Type Inference](#)
- [Code Completion](#)
- [Code Generation](#)
- [Code Summarization](#)
- [Code Embeddings/Representation](#)
- [Code Changes/Editing](#)
- [Code Comments](#)
- [Bug/Vulnerability Detection](#)
- [Source Code Modeling](#)
- [Program Repair](#)
- [Program Translation](#)
- [Program Analysis](#)
- [Software Testing](#)
- [Code Clone Detection](#)
- [Code Language Models](#)
- [Code Review](#)
- [Code Documentation](#)
- [Empirical Studies](#)
- [Surveys](#)
- [Misc](#)

SE tasks!

Empirical experimentation results

| SUBR | QUESTION | EXP | 0 | | | | | | 0,2 | | | | | | 0,4 | | | | | |
|----------|--|-----|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|
| | | | No-P | | Lo-P | | Fu-P | | No-P | | Lo-P | | Fu-P | | No-P | | Lo-P | | Fu-P | |
| | | | PROV | SCORE | PROV | SCORE | PROV | SCORE | PROV | SCORE | PROV | SCORE | PROV | SCORE | PROV | SCORE | PROV | SCORE | PROV | SCORE |
| SRSFL | Is the data recovery (CHAIN) in FND010P done on #Compt ? | No | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| | Is the CheckSrv subroutine executed on the sixth iteration? | No | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| | Is the data written to SFL001 coming from the FND010P file? | Yes | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| | Is the data written to SFL001 coming from the Spdm1211 file? | No | No | 57,14 | No | 57,14 | No | 71,43 | No | 57,14 | No | 57,14 | No | 57,14 | No | 57,14 | No | 71,43 | No | 71,43 |
| | If the CHAIN on FND010P file returns a value, is the flag 90 set to true (=1)? | Yes | No | | No | | Yes | | No | | No | | No | | No | | Yes | | Yes | |
| SRSFL2 | Is the SFL001 record written 7 times if FoundSpd616 is set on? | Yes | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| | Is the data written to SFL001 coming from the Spdm1211 file? | No | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| | Is the data recovery (CHAIN) in FND010P done on #Compt ? | No | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| | Is the CheckSrv subroutine executed on the sixth iteration? | No | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| | Is the data written to SFL001 coming from the FND010P file? | Yes | No | 60 | No | 60 | No | 60 | No | 60 | No | 60 | No | 60 | No | 60 | No | 60 | No | 60 |
| SndMsg | Is the SFL001 record written 7 times if FoundSpd616 is set on? | Yes | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| | Is the data written to SFL001 coming from the Spdm1211 file? | No | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| | Is PAR801C a program ? | Yes | No | 50 | Yes | 100 | Yes | 100 | No | 50 | Yes | 100 | Yes | 100 | No | 50 | Yes | 100 | No | 0 |
| CheckSrv | Is the PAR801C program called in this subroutine? | Yes | Yes | | Yes | | Yes | | Yes | | Yes | | Yes | | Yes | | Yes | | Yes | |
| | Is RH@044 a report ? | No | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| | Is FoundSpd616 true if the report is found? | Yes | Yes | 75 | Yes | 50 | Yes | 50 | Yes | 75 | Yes | 75 | Yes | 75 | Yes | 50 | Yes | 50 | Yes | 75 |
| | Is Spdm1211 data file read in this subroutine? | Yes | Yes | | No | | No | | Yes | | Yes | | Yes | | No | | No | | Yes | |
| | Does fields Cd@Srv always equals to 'SPD616'? | Yes | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| InzSfl | The user interface CTL001 is modified ? | Yes | No | | No | | Yes | | Yes | | No | | No | | No | | No | | No | |
| | Is the variable Desc_Dossier been modified base on the user language ? | Yes | No | | No | | Yes | | No | | No | | No | | No | | Yes | | Yes | |
| | Is the variable Desc_Dossier contains many values ? | Yes | No | | No | | Yes | | No | | No | | No | | No | | No | | Yes | |
| | Is the variable Desc_Dossier contains 10 values ? | No | No | 50 | No | 50 | No | 87,5 | No | 62,5 | No | 50 | No | 50 | No | 50 | No | 62,5 | No | 75 |
| | Is the current date is set ? | No | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| *InzSr | Do we wait the form submission to process data in the main subroutine ? | No | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| | Do we read Dsc_DosF if the user language is English ? | No | No | | No | | No | | No | | No | | No | | No | | No | | No | |
| | Do we read Dsc_DosF if the user language is French ? | Yes | No | | No | | Yes | | No | | No | | No | | No | | No | | No | |
| | Are the program input parameters defined? | Yes | Yes | | Yes | | No | | Yes | | Yes | | Yes | | No | | No | | No | |
| | Is the current date is set ? | Yes | Yes | 100 | Yes | 100 | Yes | 50 | Yes | 100 | Yes | 100 | Yes | 75 | Yes | 50 | Yes | 50 | Yes | 75 |
| FUS001RB | | | | 63,33 | | 63,33 | | 70,00 | | 66,67 | | 66,67 | | 63,33 | | 53,33 | | 63,33 | | 66,67 |

Software migration and modernization

Evref+DiverSE

Goal: LLMs to assist in migrating an existing/legacy code base to newer technologies

Approach:

- LLMs for reverse engineering, assistance to devs/architects
- Validation of the migration (testing), etc.
- Fine-grained examples and data out of compilers/transpilers
- Use-cases from Industrial collaborations

Ongoing:

- recruitment of a PhD student
- SopraSteria in the défi

