# Large Language Models for Code Analysis: Do LLMs Really Do Their Job?

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# Outline

- Introduction
- Experiment Settings
- Results & Findings
- Conclusion

# Introduction

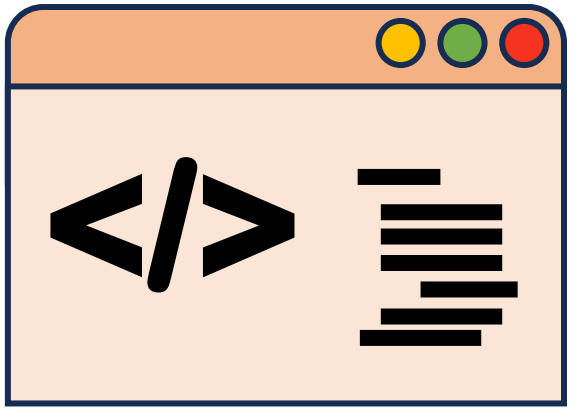
# Background

- Code Analysis
- Code Obfuscation

```
1    function hi() {
2        console.log("Hello World!");
3    }
4    hi();
```

```
1    function _0x1ec3(){var _0x3ed452=['259790KgLPlj','297688NTFutg','35ACWDkX','
         145716kEyGyf','18SFCPKB','1701952aKOEga','192jjwxUU','5LPjNwr','142417
         rtWDUq','Hello\x20World!','121610lhBPGW','2032200UghFpX','5nCOmEq','log'
         ];_0x1ec3=function(){return _0x3ed452;};return _0x1ec3();}(function(
         _0x22b342,_0x360ffb){var _0x5047be=_0xfb3c,_0x4c7c5c=_0x22b342();while
         (!![]){try{var _0x40c3be=parseInt(_0x5047be(0x90))/0x1*(-parseInt(
         _0x5047be(0x8e))/0x2)+-parseInt(_0x5047be(0x95))/0x3+parseInt(_0x5047be(0
         x97))/0x4*(parseInt(_0x5047be(0x99))/0x5)+parseInt(_0x5047be(0x8f))/0x6+
         parseInt(_0x5047be(0x94))/0x7*(parseInt(_0x5047be(0x93))/0x8)+parseInt(
         _0x5047be(0x96))/0x9*(-parseInt(_0x5047be(0x92))/0xa)+parseInt(_0x5047be
         (0x9a))/0xb*(-parseInt(_0x5047be(0x98))/0xc);if(_0x40c3be===_0x360ffb)
         break;else _0x4c7c5c['push'](_0x4c7c5c['shift']());}catch(_0x33f4b4){
         _0x4c7c5c['push'](_0x4c7c5c['shift']());}}}(_0x1ec3,0x52a68));function
         _0xfb3c(_0x257a0b,_0x17c420){var _0x1ec321=_0x1ec3();return _0xfb3c=
         function(_0xfb3ca7,_0x44b6b2){_0xfb3ca7=_0xfb3ca7-0x8d;var _0x34ca8b=
         _0x1ec321[_0xfb3ca7];return _0x34ca8b;},_0xfb3c(_0x257a0b,_0x17c420);}
         function hi(){var _0x2da467=_0xfb3c;console[_0x2da467(0x91)](_0x2da467(0
         x8d));}hi();
```

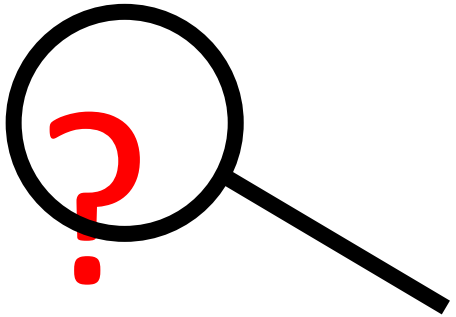
# Background

# Experiment Settings

# Research Questions

- **RQ1:** Do LLMs understand code?
- **RQ2**: Can LLMs understand obfuscated code?



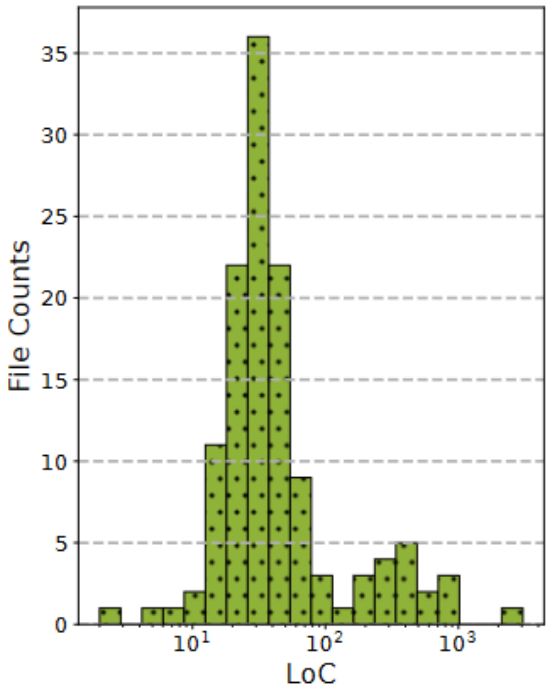
# LLM Selection

- GPT-3.5-turbo
- GPT-4
- LLaMA-2-13B
- Code-LLaMA-2-13B-Instruct
- StarChat-Beta

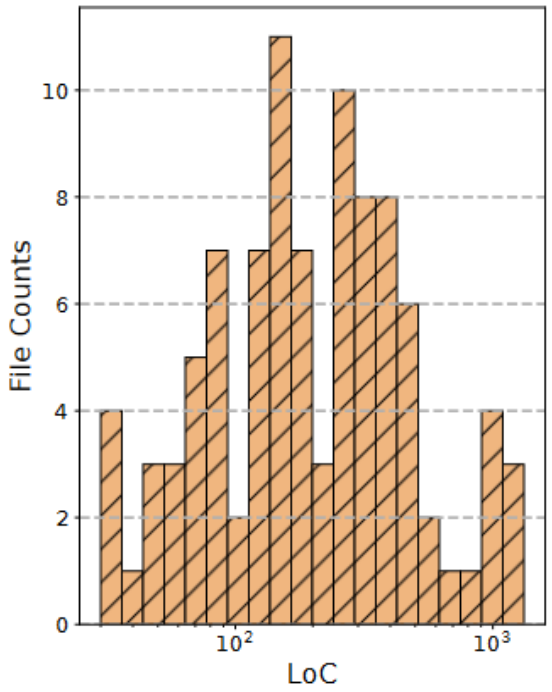
# Datasets

- Non-Obfuscated Code Dataset
  - C
    - Popular benchmarks
    - POJ-104
  - JavaScript
    - Octane 2.0
    - A list of practical JavaScript applications
  - Python
    - CodeSearchNet

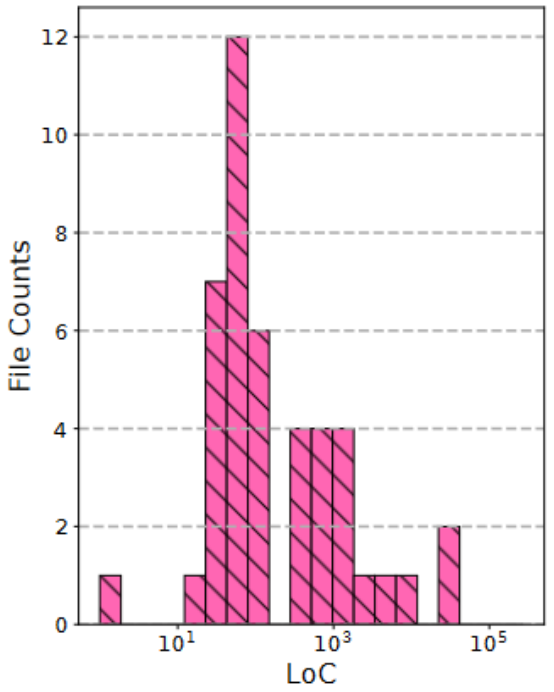
# Datasets



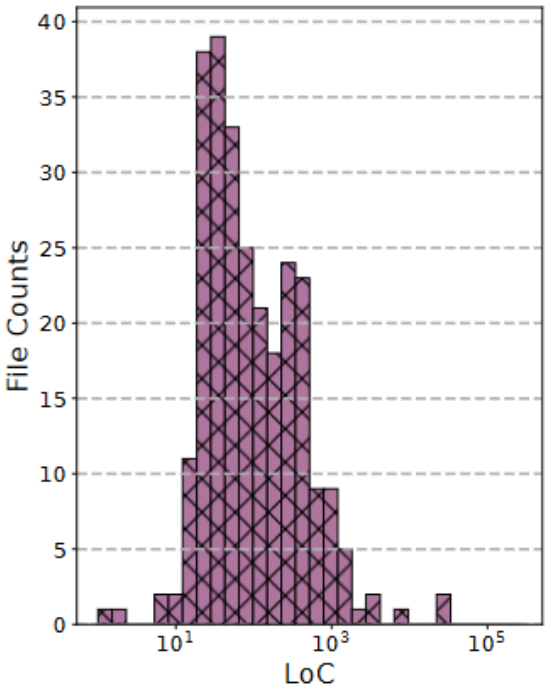

(a) C.




(b) Python.




(c) JavaScript.




(d) Overall.

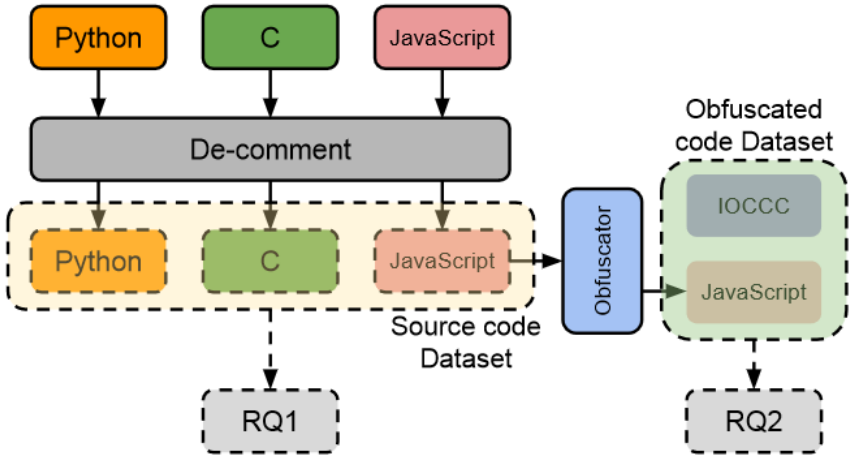
# Datasets

- Non-Obfuscated Code Dataset
  - C
    - Popular benchmarks
    - POJ-104
  - JavaScript
    - Octane 2.0
    - A list of practical JavaScript applications
  - Python
    - CodeSearchNet

- Obfuscated Code Dataset
  - Based on JavaScript Non-Obf Code
    - Default (DE)
    - Dead Code Injection (DCI)
    - Control Flow Flattening (CFF)
    - Split String (SS)
    - Wobfuscator (WSM) [1]
  - International Obfuscated C Code Contest (IOCCC)

[1] Alan Romano, Daniel Lehmann, Michael Pradel, and Weihang Wang. Wobfuscator: Obfuscating javascript malware via opportunistic translation to webassembly. In 2022 IEEE Symposium on Security and Privacy (SP), pages 1574–1589. IEEE, 2022

# Measurement Methods



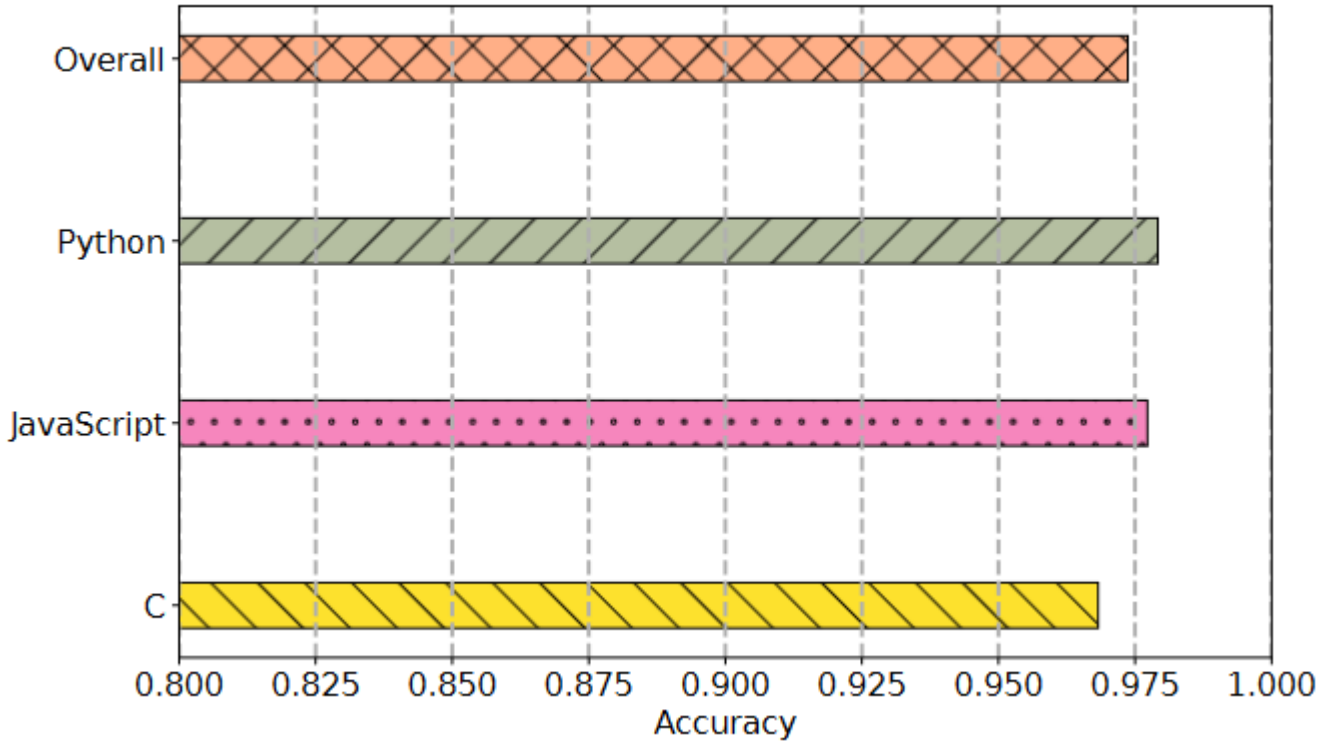

- Ground Truth

- Comparison Metrics
  - Cosine Similarity
  - Bert-Based Semantic Similarity [2]
  - ChatGPT-Based Similarity

[2] Semantic-text-similarity. https://github.com/AndriyMulyar/semantic-text-similarity

# Results & Findings

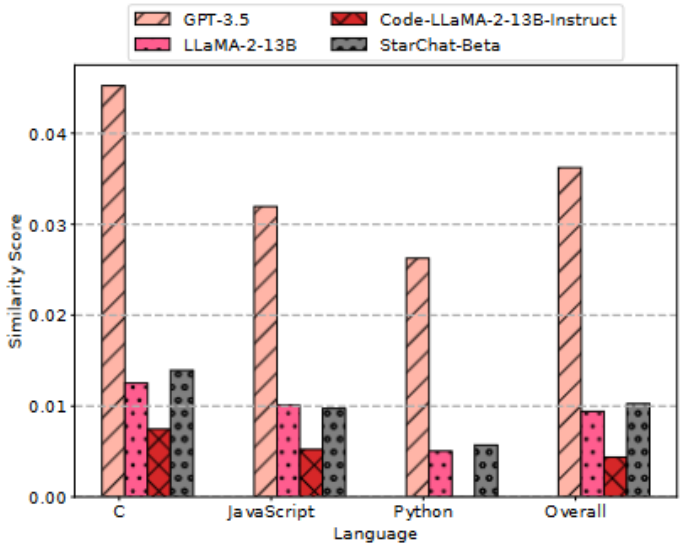
# Results: Non-Obfuscated Code Dataset



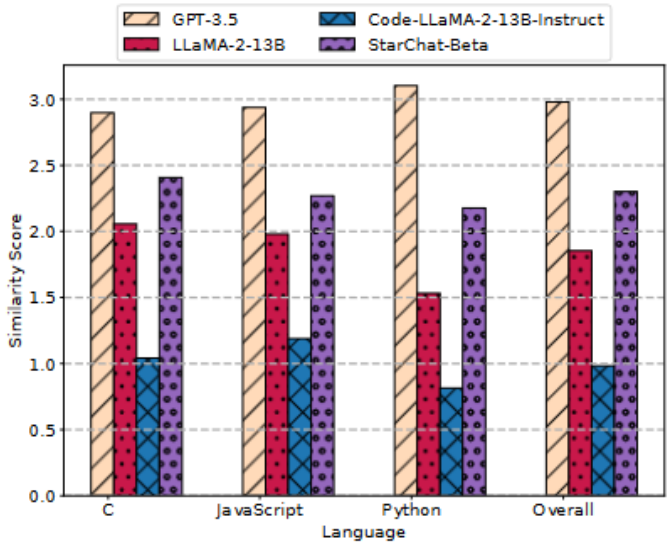

**Finding:** GPT utilizes information provided in identifier names to assist code analysis.

**Finding:** GPT-4 occasionally makes wrong associations.

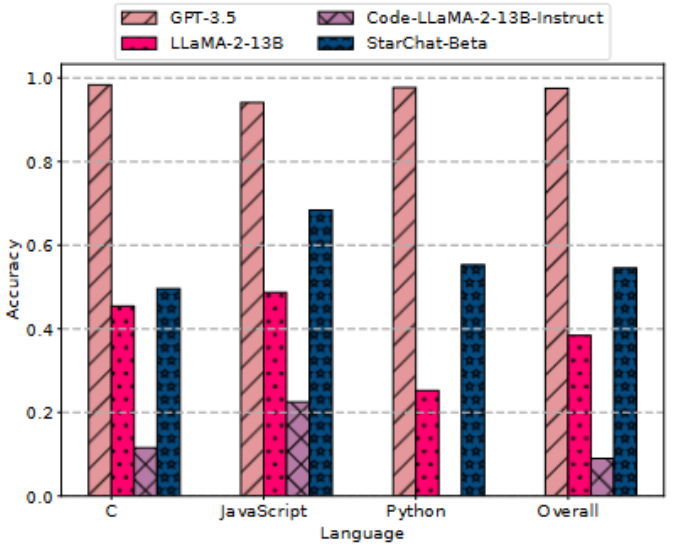
# Results: Non-Obfuscated Code Dataset




(a) Cosine similarity score.



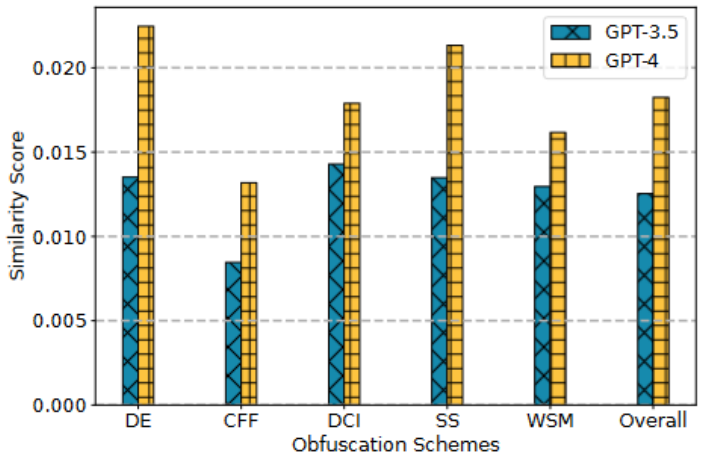

(b) Bert-based semantic similarity score.



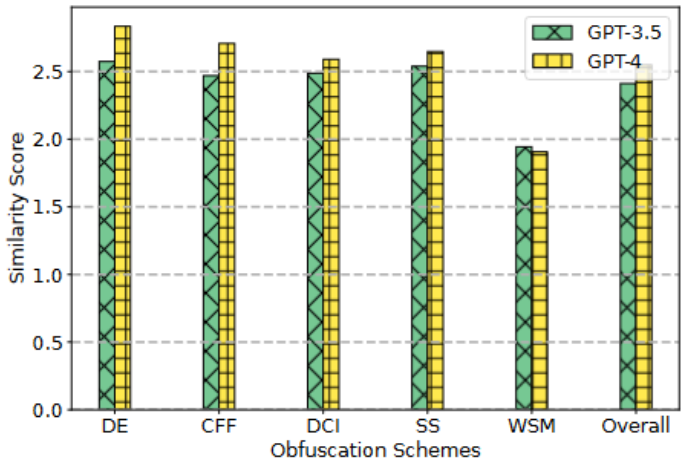

(c) ChatGPT measured accuracy results.

**Finding:** Smaller models are unable to reliably generate consistent paragraphs of code analysis results.

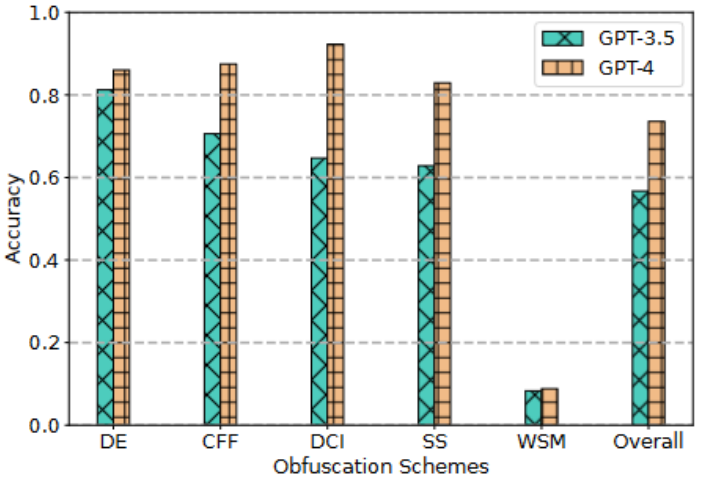
# Results: Obfuscated Code Dataset




(a) Cosine similarity score.




(b) Bert-based semantic similarity score.

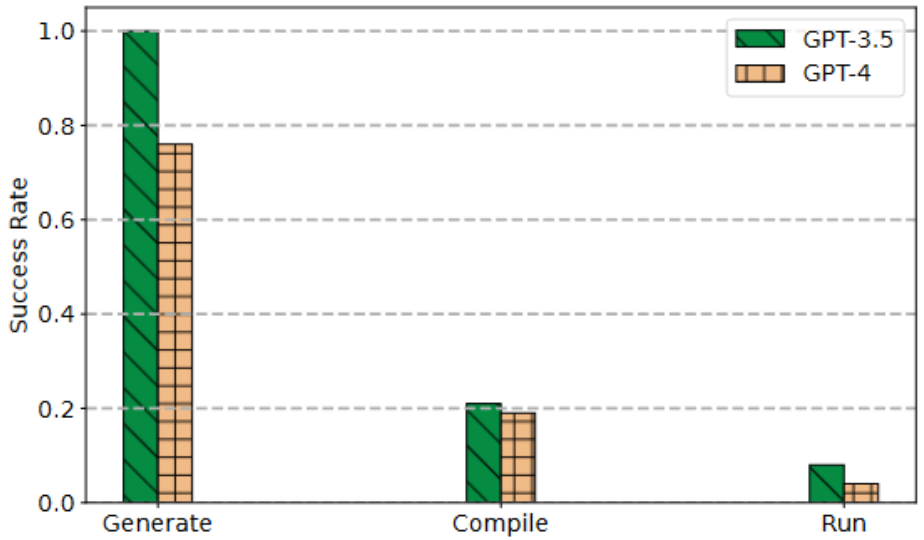



(c) ChatGPT measured accuracy results.

**Finding:** Basic obfuscation techniques only slightly influence the ability of GPT models to perform code analysis.

**Finding:** LLMs are not able to decipher obfuscated code generated by Wobfuscator.

# Results: Obfuscated Code Dataset




**Finding:** All models fall short of generating compilable and runnable de-obfuscated code.

**Finding:** GPT-4 generates code with higher readability.

# Conclusion

# Conclusion

- A thorough evaluation of code analysis capabilities of popular LLMs
- Limitations of LLM
- Online Appendix: https://github.com/aseec-lab/llms-for-code-analysis

# Q&A