LLM-Supported Natural Language to Bash Translation (NL2SH)

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Motivation

Bash commands are complex and difficult to memorize. Incorrect commands can cause system failures. Large Language Models (LLMs) are unreliable for translating natural language to Bash (NL2SH). Improving NL2SH requires (1) clean data, (2) reliable benchmarks, and (3) accurate translation methods.

Dataset

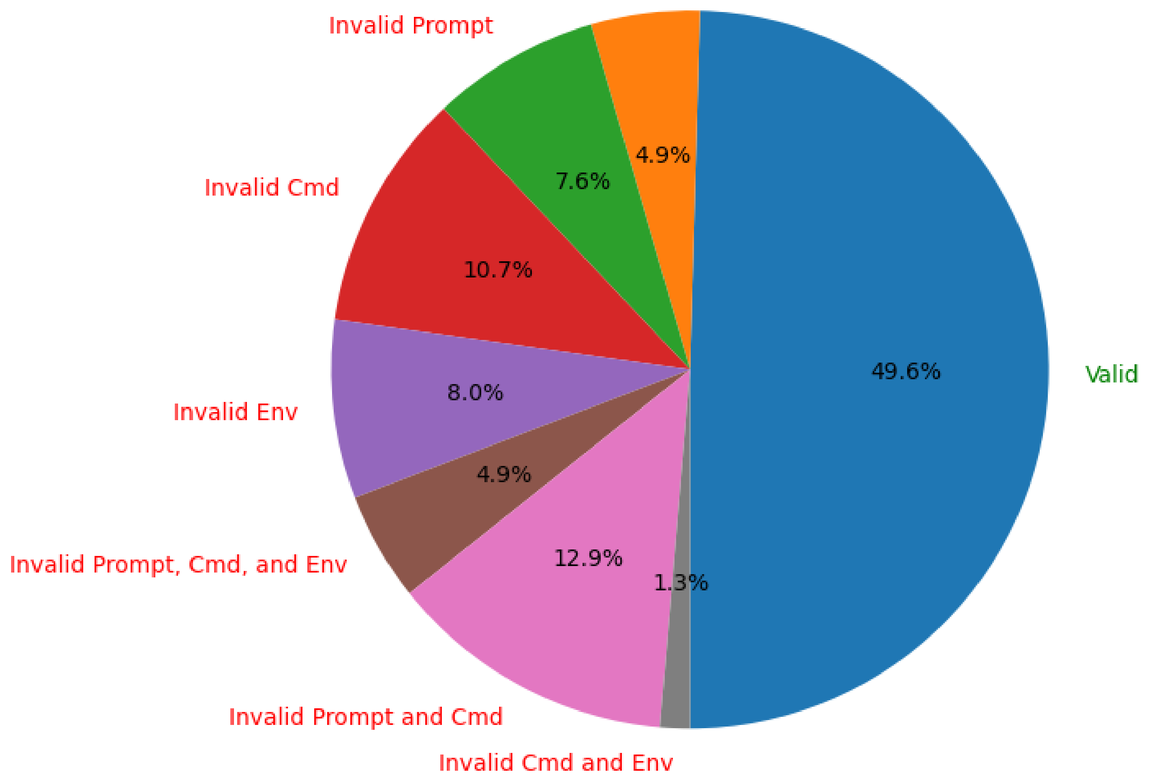
Goal:

Given		Determine
Natural Language	Bash	Correct
print the system disk usage	`df -h`	True
remove a directory named foo	`rm foo`	False
print the current user's id	`id -u`	True

Challenge: Datasets contain invalid translations.

Research Question: How can we validate NL2SH datasets to ensure models are evaluated using accurate assessments?

Result: Manual verification of test data improves benchmark reliability. Cleaning and increasing training data improves in-weight learning.



Benchmark

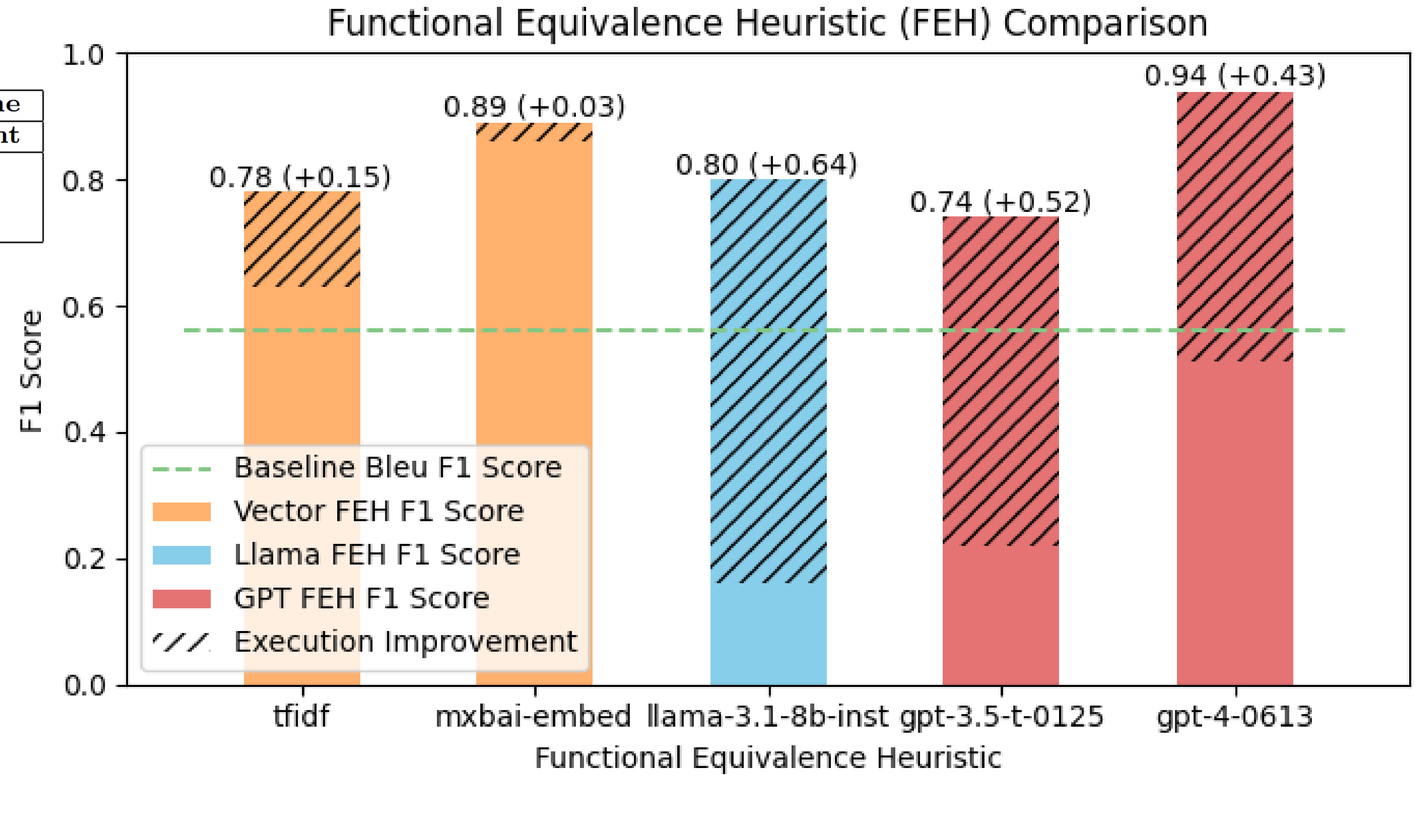
Goal:

Given			Determine
Natural Language	GT Command	Model Output	Equivalent
print the system boot time	`who -b`	`uptime -s`	True
delete bin\ in the current dir	`rm -r ./bin`	`rm -r /bin`	False
list all groups on the system	`getent group`	`cat /etc/group`	True

Challenge: Benchmarks cannot determine the functional equivalence of Bash commands.

Research Question: How can we design a functional equivalence heuristic that accurately measures the quality of model translations?

Result: Command execution with language model evaluation of command outputs outperforms previous benchmarking methods.



Translation Method

Goal:

Given	Determine
Natural Language	Bash Command

List files in /workspace accessed over an hour ago
base64 decode aGVsbG8
Sort and print only group names from /etc/group
	`find /workspace -type f -amin +60`
	`echo 'aGVsbG8=' | openssl enc -base64 -d`
	`cut -d: -f1 /etc/group | sort`

Challenge: LLMs have poor NL2SH performance.

Research Question: How can we improve the accuracy of NL2SH models as measured by a reliable benchmark?

Result: Parsing, in-context learning, in-weight learning and constrained decoding can improve NL2SH accuracy by up to 32%.