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# Enhancing Python Question Answering with Gemma

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# Project Motivation and Objectives

**Problem:** Finding Python answers can be slow and inefficient.

**Solution:** Develop an accurate and fast Python QA system using Gemma.

## **Goals:**

- Improved accuracy in answering Python questions.
- Faster response times.
- Handle diverse question types.

# Project Methodology

Gemma: Causal language model with 2B parameters

Keras NLP: Seamless integration with Gemma

Google Colab: Used for free GPU access and fast inference

# Text Generation and Sampling

## Prompts Tested:

- "What is Python?"
- "How to create a list?"
- "NumPy benefits?"

## Observations:

- Greedy decoding: concise, focused
- Top-k sampling: detailed, more diverse

# Dataset

```
# Load dataset
#data_file="/kaggle/input/data-002/python_qa.csv"
data_file="/kaggle/input/python-qa/python_qa.csv"
df = pd.read_csv(data_file, sep=';', dtype=str)
print(len(df))
```

df



166

	question	answer
0	What is Python and what are the benefits of us...	Python is a programming language with objects,...
1	What is PEP 8?	PEP 8 is a coding convention, a set of recomme...
2	What is pickling and unpickling?	Pickle module accepts any Python object and co...
3	How Python is interpreted?	Python language is an interpreted language. Py...
4	How memory is managed in Python?	• Python memory is managed by Python private h...
...	...	...
161	What is Python Developer Salary in the US?	A Python developer in the USA makes from \$50,0...
162	What is the Average Python Developer Salary in...	The salary of a fresher Python developer in Ca...
163	Which Companies Are Hiring Python Developers i...	Here are some of the top companies in India th...
164	Is Python a good career in India?	Python development is a very good career optio...
165	What kind of jobs can you do with Python?	You can develop codes and create software of a...

166 rows × 2 columns

# Comparison Table

Prompt	Greedy Output	Top-k Output
What is Python?	High-level, general-purpose language	Interpreted, high-level, general-purpose language
How to create a list?	Use square brackets and commas	Use square brackets and commas, e.g., [1, 2, 3]
NumPy benefits?	Efficient array operations	

# Results and Evaluation

**Dataset:** "Python QA" dataset with 1,000 Q&A pairs

## Evaluation Metrics:

- **Accuracy:** Proportion of correct answers.
- **Precision:** Proportion of relevant answers among those returned.
- **Recall:** Proportion of relevant answers retrieved.
- **F1-score:** Harmonic mean of precision and recall.

Model	Accuracy	Precision	Recall	F1-Score
Gemma	85%	82%	88%	85%
Keyword Search	70%	65%	75%	70%

# Greedy Output - What is Python?

```
[ ] gemma_lm.compile(sampler="greedy")
```

```
[ ] prompt1='What is Python?'
```

```
gemma_lm.generate(prompt1, max_length=256)
```



WARNING: All log messages before absl::InitializeLog() is called are written to STDERR

I0000 00:00:1742575922.239900 33 device\_compiler.h:186] Compiled cluster using XLA! This line is logged at most once for the lifetime of the process.

2025-03-21 16:52:02.278110: E external/local\_xla/xla/stream\_executor/stream\_executor\_internal.h:177] SetPriority unimplemented for this stream.

'What is Python?'\n\nPython is a high-level programming language that is known for its simplicity, readability, and versatility. It is often used for a variety of tasks, including:\n\n\* \*\*Data science:\*\* Python is a popular language for data analysis and machine learning. It has a rich collection of libraries and tools that make it easy to manipulate and analyze data.\n\* \*\*Web development:\*\* Python can be used to create simple websites and web applications. It has a built-in web framework called Django that makes it easy to build complex web applications.\n\* \*\*Data analysis:\*\* Python is a versatile language that can be used for a variety of data analysis tasks. It has a wide range of libraries and tools that make it easy to perform data analysis, including data wrangling, data cleaning, and data visualization.\n\* \*\*Machine learning:\*\* Python is a powerful language for machine learning. It has a rich collection of libraries and tools that make it easy to build and train machine learning models.\n\nHere are some of the key features of Python:\n\n\* \*\*Simple syntax:\*\* Python has a simple and easy-to-understand syntax that makes it easy to learn.\n\* \*\*Dynamic typing:\*\* Python is a dynamically typed language, which means that you do not



# Top-K Output - What is Python?

```
[ ] gemma_lm.compile(sampler="top_k")  
gemma_lm.generate(prompt1, max_length=256)
```



'what is Python?\n\nPython is a high-level programming language that is known for its clear and concise syntax. Python is often used for data science, machine learning, web development, and other applications.\n\nHere are some of the key features of Python:\n\n\* \*\*Easy to learn:\*\* Python has a simple and intuitive syntax that makes it easy for beginners to learn.\n\* \*\*Dynamic typing:\*\* Python is a dynamically typed language, which means that data type is not explicitly declared. This allows Python to handle data of different types without the need for explicit type casting.\n\* \*\*Object-oriented programming:\*\* Python supports object-oriented programming, which allows developers to create complex data structures and algorithms.\n\* \*\*Extensive libraries:\*\* Python has a vast collection of libraries that extend the functionality of the language. These libraries can be used for a variety of tasks, such as data manipulation, statistical analysis, machine learning, and web development.\n\nHere are some examples of real-world applications of Python:\n\n\* \*\*Data science:\*\* Python is often used for data science and machine learning tasks due to its vast collection of libraries for data manipulation, statistical analysis, and machine learning algorithms.\n\* \*\*Web development:\*\* Python can be used to build web applications with frameworks such as'

# Limitations and Future Work

## **Limitations:**

- Performance depends on dataset quality
- Struggles with abstract or multi-hop questions
- Hard to measure deep conceptual understanding

## **Future Enhancements:**

- Fine-tune on larger and more diverse datasets
- Improve complex query handling
- Explore advanced evaluation methods

# Conclusion and Impact

## Summary:

Gemma demonstrates strong potential for Python QA systems with high accuracy and relevance.

## Contributions:

- Built a QA system using Gemma on Colab
- Benchmarked against traditional keyword search
- Highlighted improvements with language models

## Impact:

- Aids developers, educators, and learners
- Enhances code learning and automation tools