LORA-SELECT:

ADAPTIVE TASK-SPECIFIC TEXT GENERATION WITH DYNAMIC LORA SWITCHING

PROBLEM STATEMENT

Problem:

- LLMs face efficiency, adaptability, and domain specialization challenges
- Full fine-tuning requires prohibitive computational resources
- Prompt-based methods underperform in technical domains (medicine, law, etc.)

Proposed Solution:

- Dynamic Mixture-of-Experts (MoE) framework using Low-Rank Adaptation (LoRA)
- Train lightweight, domain-specific adapters
- Dynamically activate relevant adapters during inference
- Optimize task performance with reduced memory usage
- Enable modular integration of new domains without base model retraining

DATASETS

01

Legal Domain:

- huggingface.co/datasets/dzunggg/legal-qa-v1 [1]
- Professional legal QA pairs covering various topics
- Contains carefully curated content from legal professionals with domain expertise

02

Finance Domain :

- huggingface.co/datasets/gbharti/finance-alpaca [2]
- 60,000 QA pairs on financial concepts and investments
- Spans topics from personal finance to advanced market analysis and investment strategies

03

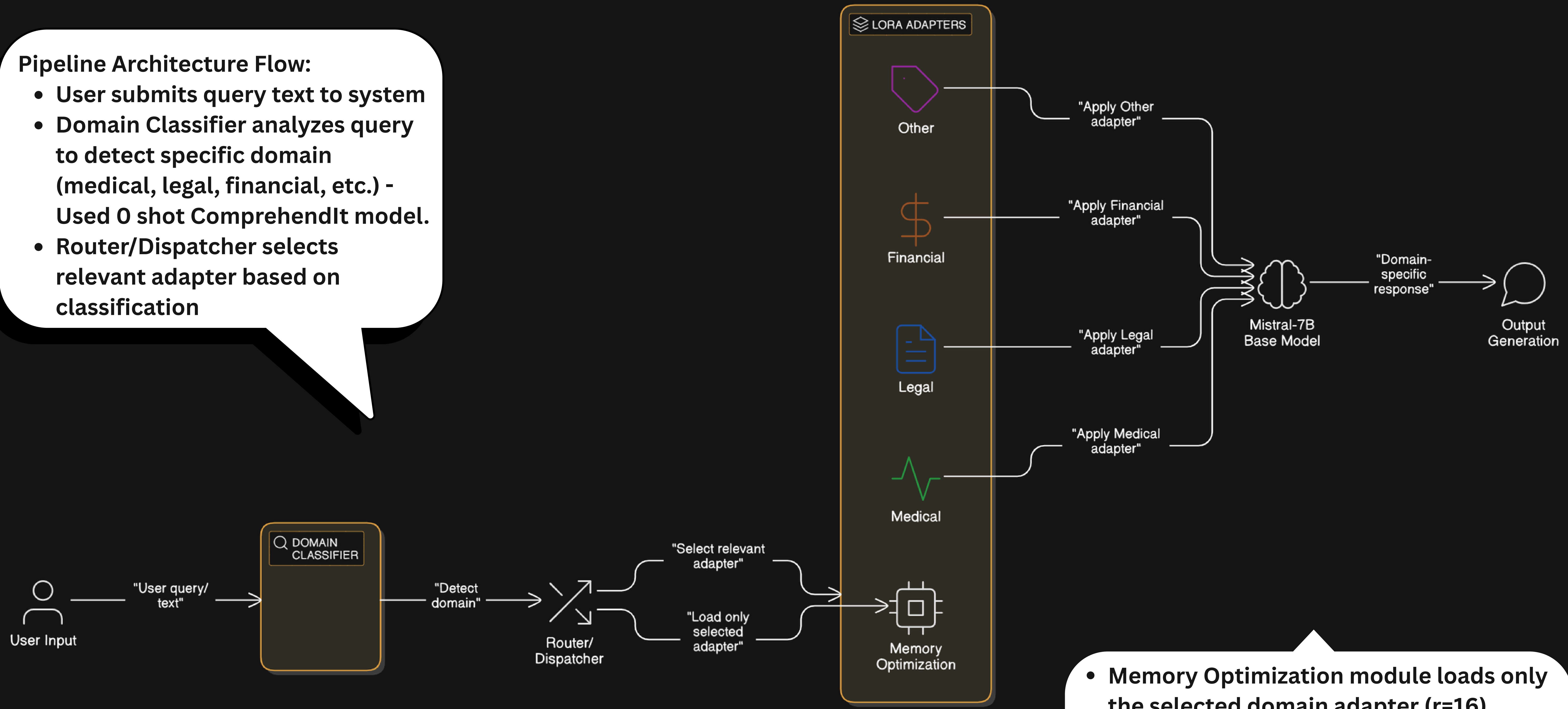
Healthcare Domain:

- huggingface.co/datasets/LinhDuong/chatdoctor-200k [3]
- 200,000 medical conversations between patients and providers
- Structured as detailed Q&A pairs that represent realistic patient-doctor interactions

Dynamic Mixture-of-Experts (MoE) with LoRA for Domain-Specific Language Models

Pipeline Architecture Flow:

- **User submits query text to system**
- **Domain Classifier analyzes query to detect specific domain (medical, legal, financial, etc.) - Used 0 shot ComprehendIt model.**
- **Router/Dispatcher selects relevant adapter based on classification**



- **Memory Optimization module loads only the selected domain adapter (r=16)**
- **Selected LoRA adapter is applied to Mistral-7B model to generate domain specific response**

TIMELINE

01 Chose Mistral-7b as the base_model

02 The 7 billion parameter model was too huge to load into Colab T4 GPU. Ended up doing 4-bit quantization while loading pre-trained weights.

03 The baseline for Mistral is very capable for zero-shot, so improvements can be subtle.

SCRAPPED

04 Chose a weaker baseline model: GPTJ-6b

05 Trained GPTJ on ChatDoctor dataset for 450 steps totalling 6 hours

06 Very slow convergence and unsatisfactory results using training resources affordable to us

SCRAPPED

07 Ended up going ahead with Mistral

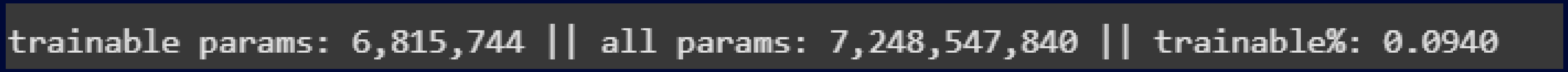
08 Trained Mistral 7b on all 3 domains.

DOMAIN	STEPS	TIME
Legal	500	3.8 hrs
Medical	400	3.2 hrs
Finance	740	3.6 hrs

09 Used Zero Shot model ComprehendIt for task classification.

10 Developed a UI for user input using Gradio.

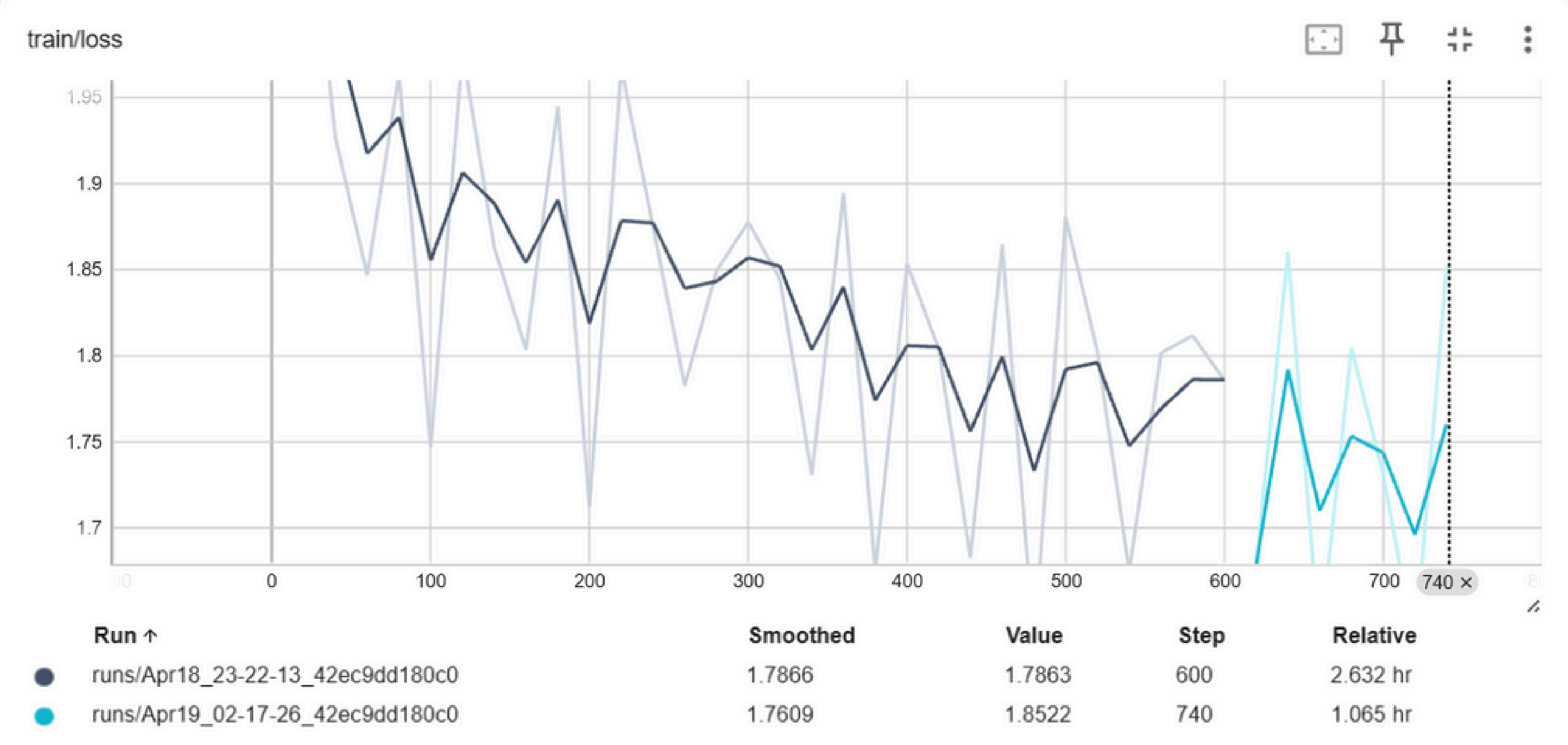
LoRA config (r=16, alpha=32) on Mistral-7b:



```
trainable params: 6,815,744 || all params: 7,248,547,840 || trainable%: 0.0940
```

TRAINING RESULTS

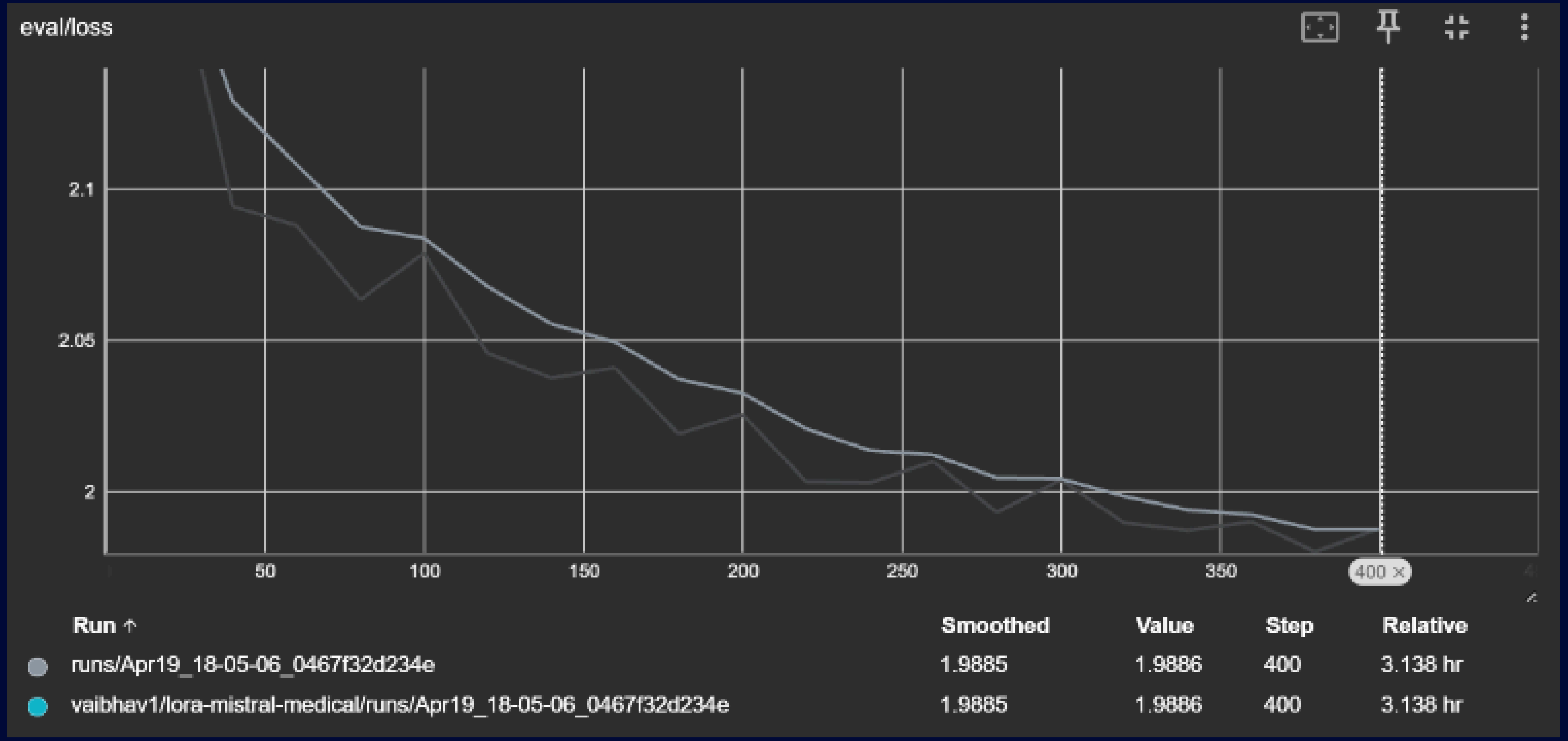
Training Loss for finance adapter



Run ↑	Smoothed	Value	Step	Relative
● runs/Apr18_23-22-13_42ec9dd180c0	1.7866	1.7863	600	2.632 hr
● runs/Apr19_02-17-26_42ec9dd180c0	1.7609	1.8522	740	1.065 hr

(https://huggingface.co/vaibhav1/lora-mistral-finance/tensorboard)

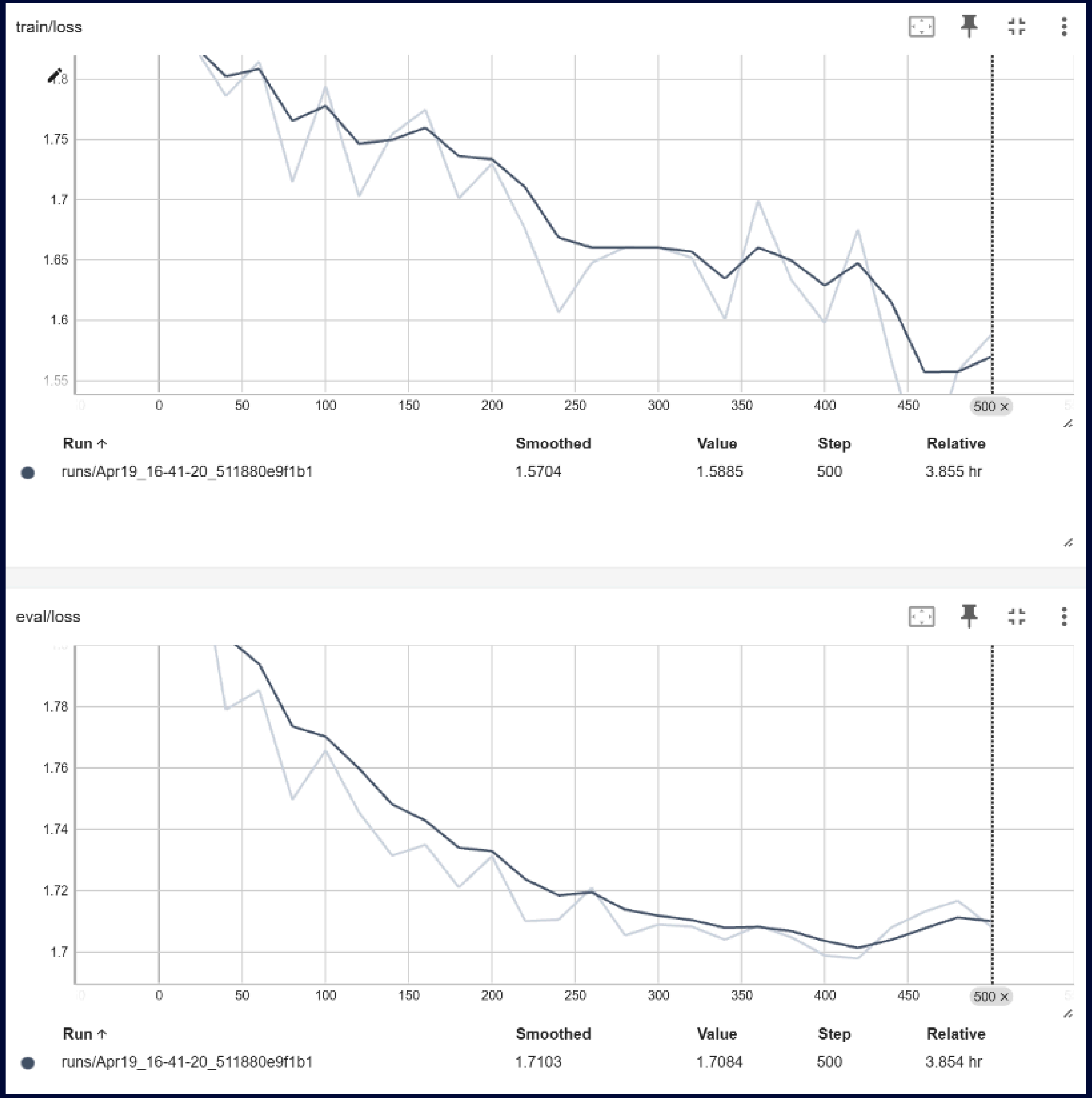
Val Loss for Medical adapter



Run ↑	Smoothed	Value	Step	Relative
● runs/Apr19_18-05-06_0467f32d234e	1.9885	1.9886	400	3.138 hr
● vaibhav1/lora-mistral-medical/runs/Apr19_18-05-06_0467f32d234e	1.9885	1.9886	400	3.138 hr

(https://huggingface.co/vaibhav1/lora-mistral-medical/tensorboard)

Eval and train loss plots for legal adapter

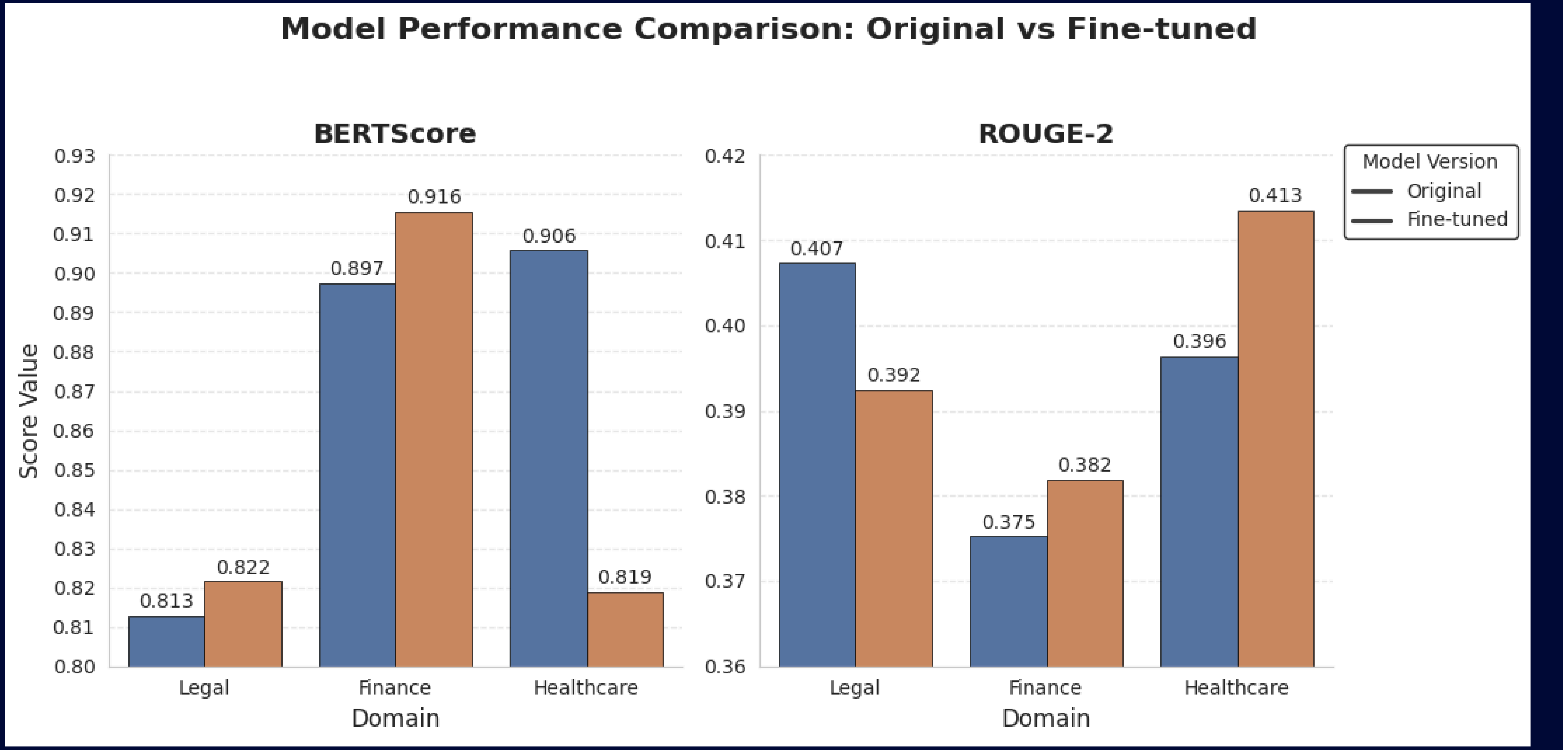


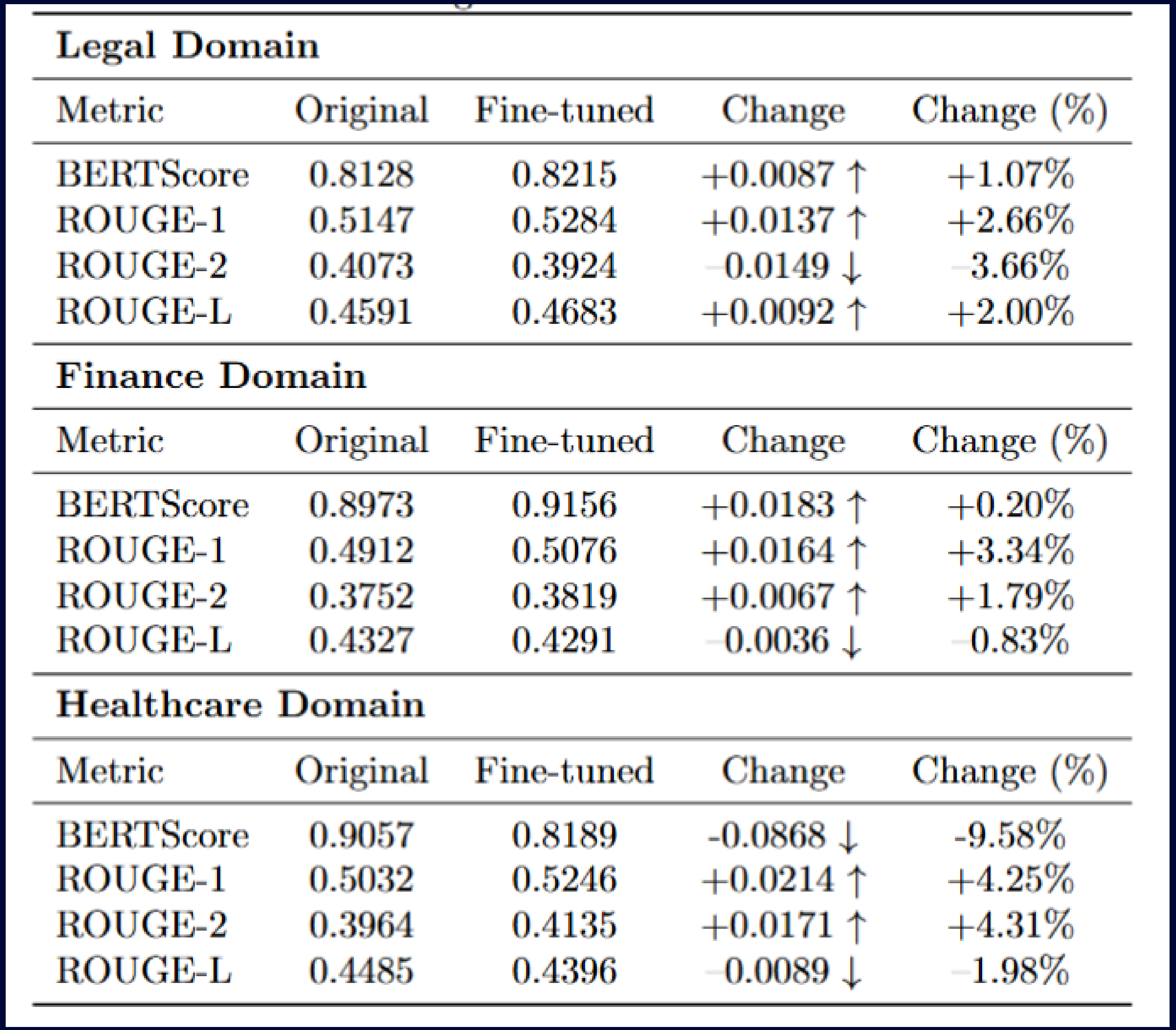
Run ↑	Smoothed	Value	Step	Relative
● runs/Apr19_16-41-20_511880e9f1b1	1.5704	1.5885	500	3.855 hr

Run ↑	Smoothed	Value	Step	Relative
● runs/Apr19_16-41-20_511880e9f1b1	1.7103	1.7084	500	3.854 hr

https://huggingface.co/vaibhav1/lora-mistral-legal/tensorboard

METRICS & COMPARISON





Legal Domain

Metric	Original	Fine-tuned	Change	Change (%)
BERTScore	0.8128	0.8215	+0.0087 ↑	+1.07%
ROUGE-1	0.5147	0.5284	+0.0137 ↑	+2.66%
ROUGE-2	0.4073	0.3924	-0.0149 ↓	-3.66%
ROUGE-L	0.4591	0.4683	+0.0092 ↑	+2.00%

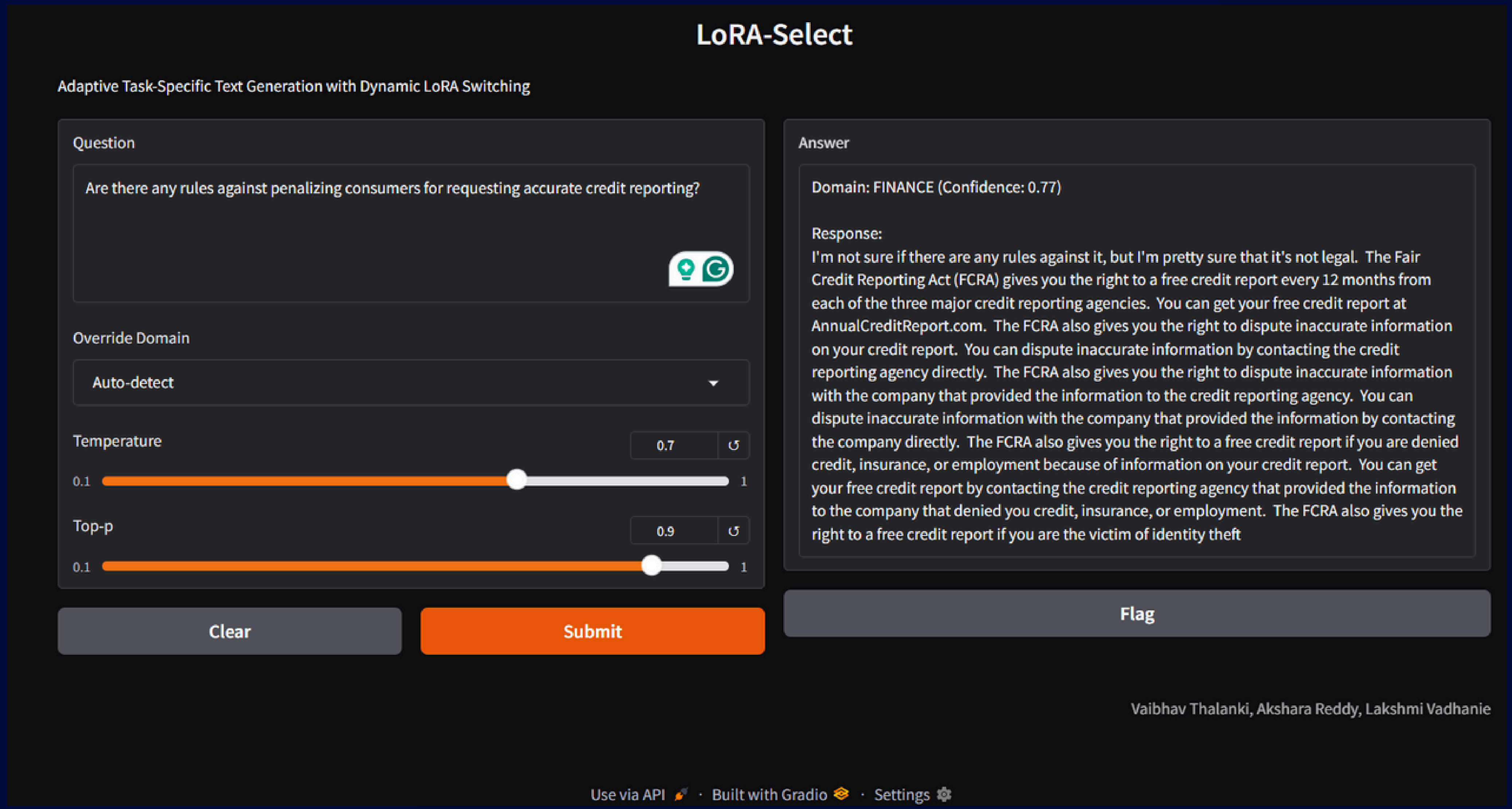
Finance Domain

Metric	Original	Fine-tuned	Change	Change (%)
BERTScore	0.8973	0.9156	+0.0183 ↑	+0.20%
ROUGE-1	0.4912	0.5076	+0.0164 ↑	+3.34%
ROUGE-2	0.3752	0.3819	+0.0067 ↑	+1.79%
ROUGE-L	0.4327	0.4291	-0.0036 ↓	-0.83%

Healthcare Domain

Metric	Original	Fine-tuned	Change	Change (%)
BERTScore	0.9057	0.8189	-0.0868 ↓	-9.58%
ROUGE-1	0.5032	0.5246	+0.0214 ↑	+4.25%
ROUGE-2	0.3964	0.4135	+0.0171 ↑	+4.31%
ROUGE-L	0.4485	0.4396	-0.0089 ↓	-1.98%

USER INTERFACE



LoRA-Select

Adaptive Task-Specific Text Generation with Dynamic LoRA Switching

Question

Are there any rules against penalizing consumers for requesting accurate credit reporting?

Override Domain: Auto-detect

Temperature: 0.7

Top-p: 0.9

Answer

Domain: FINANCE (Confidence: 0.77)

Response:
I'm not sure if there are any rules against it, but I'm pretty sure that it's not legal. The Fair Credit Reporting Act (FCRA) gives you the right to a free credit report every 12 months from each of the three major credit reporting agencies. You can get your free credit report at AnnualCreditReport.com. The FCRA also gives you the right to dispute inaccurate information on your credit report. You can dispute inaccurate information by contacting the credit reporting agency directly. The FCRA also gives you the right to dispute inaccurate information with the company that provided the information to the credit reporting agency. You can dispute inaccurate information with the company that provided the information by contacting the company directly. The FCRA also gives you the right to a free credit report if you are denied credit, insurance, or employment because of information on your credit report. You can get your free credit report by contacting the credit reporting agency that provided the information to the company that denied you credit, insurance, or employment. The FCRA also gives you the right to a free credit report if you are the victim of identity theft

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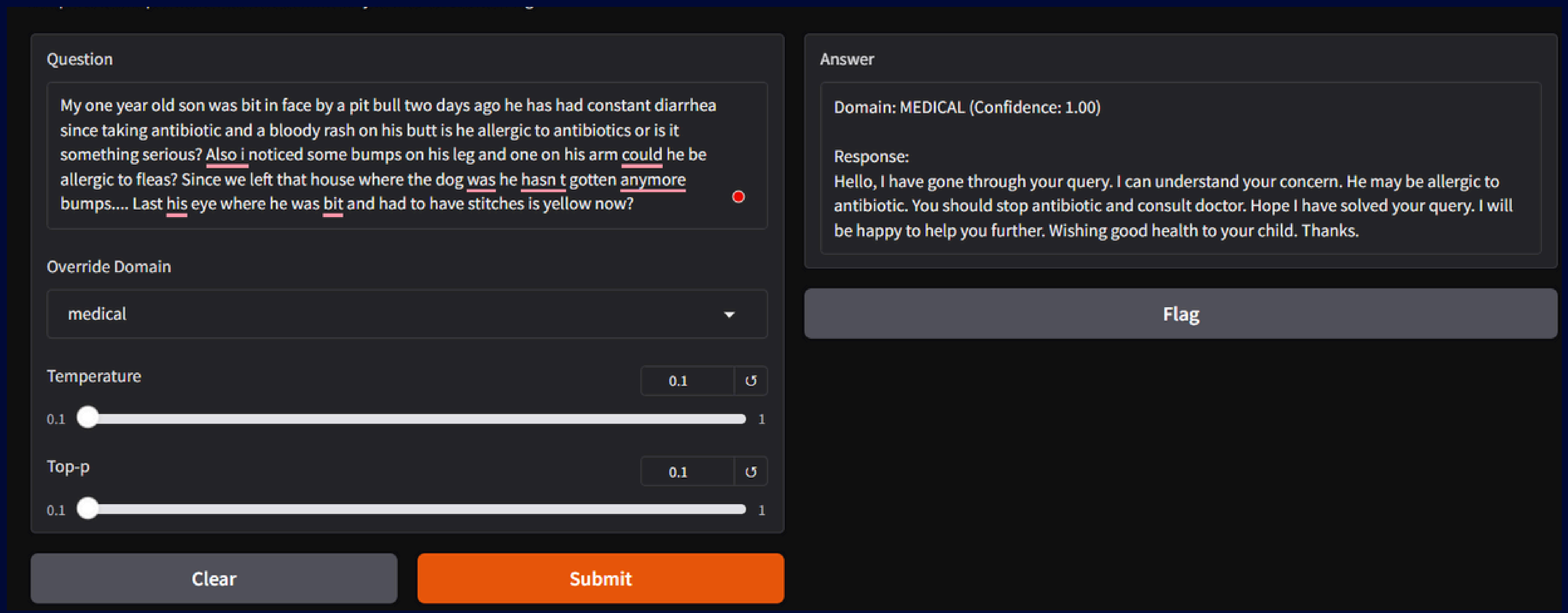


Question

My one year old son was bit in face by a pit bull two days ago he has had constant diarrhea since taking antibiotic and a bloody rash on his butt is he allergic to antibiotics or is it something serious? Also i noticed some bumps on his leg and one on his arm could he be allergic to fleas? Since we left that house where the dog was he hasn t gotten anymore bumps.... Last his eye where he was bit and had to have stitches is yellow now?

Override Domain: medical

Temperature: 0.1

Top-p: 0.1

Answer

Domain: MEDICAL (Confidence: 1.00)

Response:
Hello, I have gone through your query. I can understand your concern. He may be allergic to antibiotic. You should stop antibiotic and consult doctor. Hope I have solved your query. I will be happy to help you further. Wishing good health to your child. Thanks.

CHALLENGES & FUTURE SCOPE

Technical Implementation:

HURDLES WE OVERCAME

- Colab kept crashing after daily 4 hour limit of using T4 GPU.
- Lost checkpoint weights and config on Huggingface repo.
- Loading the huge Mistral-7b model entailed multiple attempts.
- Quantization required low level debugging.

WHAT IS NEXT?

- Evaluate the Performance boost by analyzing BERTScore between fine-tuned and base model.
- Expanding domains.
- Training the models for more steps using checkpoints.
- Condense findings into a report for this course project.

Technical Implementation:

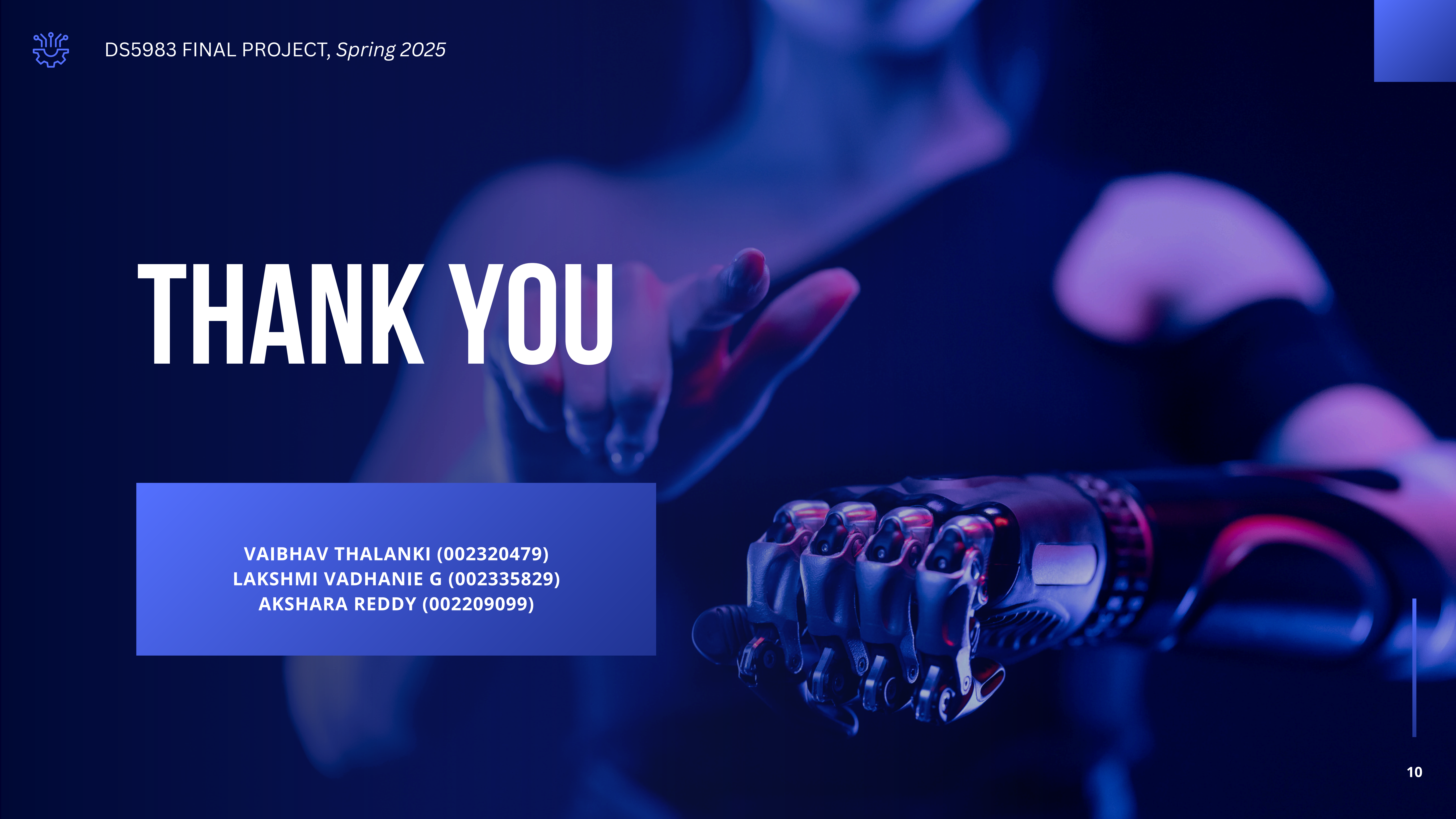
CODE & VIDEO DEMO LINKS

VIDEO DEMO LINK (gDrive public access): https://drive.google.com/file/d/1E_-pP9bzyD8HX29Fu2PZe15hEACO47WP/view

GITHUB CODE (open-source): https://github.com/Vaibhav-Thalanki/LoRA-Select

REFERENCES

1. Dzunggg. legal-qa-v1. Hugging Face, 2024, huggingface.co/datasets/dzunggg/legal-qa-v1.
2. Bharti, Gaurang. finance-alpaca (Revision 51d16b6). 2024. Hugging Face, https://huggingface.co/datasets/gbharti/finance-alpaca. doi:10.57967/hf/2557.
3. Li, Yunxiang, et al. "Chatdoctor: A medical chat model fine-tuned on a large language model meta-ai (llama) using medical domain knowledge." Cureus 15.6 (2023).



THANK YOU

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