

# MLDS Generative AI – Assignment 3

In this project, I attempt to fine-tune the small language model using knowledge distillation from a large language model – Llama 3.1-7B, with the aim of transferring some aviation specific domain knowledge to the small model. The training data for fine-tuning is a set of 1000 QA pairs extracted from aviation related technical documentation.

Small language model: **SmolLM-135M-Instruct**

## Test Cases:

1. What factors can detract from a successful rejected takeoff?

Actual answer: Factors that can detract from a successful rejected takeoff include tire damage, brakes worn or not working correctly, error in gross weight determination, incorrect performance calculations, incorrect runway line-up technique, initial brake temperature, delay in initiating the stopping procedure, and runway friction coefficient lower than expected.

SLM answer:

*The age-old question of rejection! While it's natural to feel disappointed or frustrated when a flight is rejected, there are several factors that can contribute to a successful rejection. Here are some common ones:*

- 1. **\*\*Lack of preparation\*\***: If you haven't done your homework or rehearsed your flight, you may not have the necessary skills or knowledge to handle the situation effectively.*
- 2. **\*\*Poor communication\*\***: If you're not clear about your expectations, concerns, or questions, it can lead to misunderstandings and frustration.*
- 3. **\*\*Unrealistic expectations\*\***: If you're not sure what to expect from the flight, you may feel like you're not prepared or that the flight is not suitable for you.*
- 4. **\*\*Lack of confidence\*\***: If you're not confident in your abilities, you may not be able to handle the situation effectively.*
- 5. **\*\*Unrealistic deadlines\*\***: If the flight is not scheduled or if you're not able to meet the deadline, it can lead to disappointment and frustration.*
- 6. **\*\*Poor weather conditions\*\***: If the weather is bad, it can be challenging to navigate the flight, and you may not be able to make it to your destination.*
- 7.*

Fine-tuned answer:

*Factors that can detract from a successful rejected takeoff include:\n\n1. **\*\*Lack of preparation\*\***: Failure to prepare adequately for the flight, including checking the aircraft's systems, checking the weather, and reviewing the flight plan.\n2. **\*\*Insufficient training\*\***: Insufficient training on the aircraft's systems, including the landing gear, flaps, and instruments.\n3. **\*\*Inadequate knowledge\*\***: Insufficient knowledge of the aircraft's systems, including the landing gear, flaps, and instruments.\n4. **\*\*Inadequate communication\*\***: Inadequate communication with the ground crew or other aircraft involved in the flight.\n5. **\*\*Inadequate navigation\*\***: Inadequate navigation skills, including the use of GPS, radar, or other navigation aids.\n6. **\*\*Inadequate weather conditions\*\***: Inadequate weather conditions, including visibility, wind, and visibility.\n7. **\*\*Inadequate emergency procedures\*\***:*

*Inadequate procedures for emergency situations, such as engine failure or engine failure.*\n8. *\*\*Inadequate safety procedures\*\*:* *Inadequate procedures for safety procedures, such as emergency landing procedures.*\n9. *\*\*Inadequate emergency procedures\*\*:* *Inadequate procedures for emergency procedures, such as emergency landing procedures.*\n10. *\*\*Lack of contingency planning\*\*:*

In this example we can see that prior to fine-tuning, the model hallucinates heavily. It does not address specific causes for detracted landings, but gives vague points instead which are not related to aviation. However, in the fine-tuned answer, we can see that the answer is much more technical and addresses specific factors.

## 2. What is the purpose of the SEC F-PLN page?

Actual answer: Required NAVAIDs are manually entered using ident on the RAD NAV page. If a NAVAID is reported as unreliable on NOTAM, it must be deselected on the MCDU DATA/POSITION MONITOR/SEL NAVAID page.

SLM answer:

*The SEC F-PLN (Foreign Account Number) page is a crucial component of the Securities and Exchange Commission (SEC) system, and its purpose is to provide a unique identifier for individuals who have a foreign account in the United States. Here are the key purposes of the F-PLN page:*

*1. \*\*Identification\*\*:* *The F-PLN page is used to identify individuals who have a foreign account in the United States. This identification is essential for various purposes, including:*

*\* Tax purposes:* *The F-PLN is used to identify individuals who have a foreign account in the United States, which can be used for tax purposes, such as filing returns, paying taxes, or selling securities.*

*\* Investment purposes:* *The F-PLN is used to identify individuals who have a foreign account in the United States, which can be used for investment purposes, such as buying or selling securities.*

*\* Tax purposes:* *The F-PLN is used to identify individuals who have a foreign account in the United States, which can be used for tax purposes, such as filing returns, paying taxes, or selling securities.*

*2. \*\*Identification of foreign accounts\*\*:* *The F-PL*

Fine-tuned answer:

*The SEC F-PLN page is a technical document that provides information on the F-PLN (Flight Plan Number) and its associated information. It is a crucial tool for pilots, as it helps them understand the route, aircraft, and flight plan.*

In this example, the question asks about a specific technical document related to aircraft. In the model response before fine-tuning, we can see that the answer is not even related to aviation. The model hallucinates and gives the answer in the context of finance and accounting. However, in the fine-tuned response, we can see that now the model is addressing the right context –Flight Plan Number,

although the answer is still not as accurate as the ground truth answer. This example demonstrates the domain-knowledge learning that can be achieved through fine tuning.

### 3. What is a Primary Radar Target?

Actual answer: A Primary Radar Target is an analog or digital target presented on a radar display, exclusive of secondary radar targets.

SLM answer:

*A primary radar target is a radar system that is designed to detect and track a specific object or entity, such as a bird, a vehicle, or a person, in real-time. The primary radar target is typically a radar system that is capable of detecting and tracking the object or entity in its entirety, without the need for additional sensors or data processing.*

Fine-tuned answer:

*What is the purpose of the primary radar target?*

In this example, the question asks about a radar related term in the context of aviation. We see that before fine-tuning, the model answers about what a primary radar target is, but the context and explanation is not specific to aviation. In the fine-tuned response, we can see that the model hallucinates heavily and generates a question itself as the answer. This shows a weakness of the fine-tuning process, which could be due to the short nature of the provided ground truth answers, or the limited number of training examples.

### Conclusion:

Through these fine-tuning experiments, I have demonstrated that domain knowledge learning can be achieved to a significant degree by fine-tuning of small language models using LoRA. However, here we only supplied 1000 training examples for fine-tuning, which were also LLM generated (not human verified). Some other studies in fine-tuning for domain knowledge address this task using 50K+ training examples for a better contextual learning. Thus, if we provide several more training examples which cover the domain knowledge comprehensively, we can expect the fine-tuning process to yield much better results.