FAQs

1. **Who is your customer? Who will be using your product/solution?**

   The primary customers are researchers and scientists in the physical science domain (such as fluid dynamics, astronomy) that are in need of a high scaled image data. This tool can also be transferred to other domains like medical imaging, and facial recognition tasks to be used by the general public as well.

2. **How does your product make your customer's life significantly better? What is the problem to solve?**

   It creates high-resolution images from low-quality data, saving time and computational costs while maintaining accuracy and coherence. This high quality data (especially in fluid systems) will help researchers analyze images that are close to the real physical world.

3. **What deep learning techniques are candidate solutions?**

   One of the traditional methods in deep learning to solve this problem is to use Convolutional Neural Networks (such as SRCNN, FSRCNN, etc.). Further, Deep Residual Networks have also proved to be very useful for Super-Resolution. The other deep learning techniques that are getting more popular nowadays such as GANs and Attention Based Networks (like Transformers) can also be utilized as a solution to this problem. We will be employing a couple of algorithms to compare how our tool does with different models.

4. **How will the customer discover or find our product? Is this a web, mobile, desktop, or a specialized tool/app?**

   This is a specialized tool/application for now for people in niche areas like fluid dynamics, astronomy to use. But this can extend as a web or mobile application platform and can be expanded to various use cases given proper dataset.

5. **How will you measure success?**

   We will measure success on our deep learning techniques by comparing the generated high res dataset with the ground truth dataset. In the field that it is going to be used, we can also assume success, if test subjects like researchers find it useful in their field of study (for now it will be given to researchers working on fluid dynamics who will test it). If they report that the tool is close to the real world physical systems, then we can say that it was quite successful.

6. **What are examples of existing solutions (e.g., papers, blogs, etc.)? What techniques were employed? What is the performance of these solutions?**

   The reference for this task can be accessed here. The models mentioned in this reference have pretty good accuracy with structural similarity index more than 80% in most cases. We aim to build on this with recent algorithms. Due to the nature of the dataset (time dependent), the solution time can not be directly compared with other models that process static images.

7. **What is the dataset for your project?**

   We have generated a dataset by solving the Navier-Stokes Kraichnan turbulence problem numerically with accuracy of 4th order Runge-Kutta. The generated dataset will be 2048*2048 pixels for each snapshots, a solution time of 4 secs with time-stepping of 1e-4 secs. We will also try to use datasets with different Reynolds numbers if the project timeline permits.

8. **What are the computational needs for your solution? Can you train the solution on a regular laptop or do you need a high-end GPU to execute?**

   Low end systems and regular laptops are not sufficient to train the solution. The solution requires a system that has good enough VRAM (because of the high resolution of the image dataset) and enough computation resources in terms of GPU. VRAM upwards of 30GB is required for training the dataset. The other solution is to get a virtual system from a cloud provider like AWS, or Google (Colab Pro+).

   Note: We have the required resources due to us being part of a lab. We have secured the following resources for our project: 1x 4090, 64 GBs of memory and 5 TBs of storage, as well as access to a Apache Spark cluster.

9. **What are the key milestones in your roadmap:**

The project milestones (the deadline in between might be flexible)

	Milestone/Feature Description	Priority	Deadline
1	Define Project Scope (PRFAQ)	High	02/18/2025
2	Collect Training Data	Medium	02/21/2025
3	Develop Initial Models and tool	Medium	02/30/2025
4	Test several model on samples	Medium	03/7/2025
5	Select best model and post processing	Medium	03/18/2025
6	Midterm Project Report	High	03/25/25
7	Use combination of parameter tuning	Medium	04/01/25
8	Improve accuracy on the selected models	Medium	04/07/25
9	Final pipeline and tooling setup	Medium	04/15/25
10	Final testing & validation	Medium	04/20/25
11	Set up user interface to interact with the tool	Medium	04/25/25
12	Delivery of project presentation	High	04/29/25
13	Delivery of final project report	High	05/06/25