

UNCORRELATED ORBITAL TRACK PROCESSING

TEAM CONTACT

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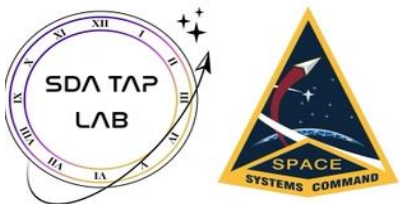
COP4934: Computer Science Senior Design I

Dr. Richard Leinecker

University of Central Florida

Orlando, Florida

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EXPECTATIONS

It is our expectations in this team that we ensure each team member is able to learn and grow from this project. In hopes of being able to apply the things we learn for future knowledge and careers in computer science. To be able to prosper and graduate together within our field of study in Computer Science. Each member of this project is expected to be able to contribute equally and fairly among all members and have the freedom to pursue what they are interested in within this project. Since our project is more research based, members are expected to learn the skills of being able to exercise their curiosity through their own autonomy. In correlation to the project, they are expected to conduct research on their own from papers or open-source guidelines of the technology used, have open communication of their work, have the mindfulness of others effort and deadlines throughout the duration of the project, and be able to make meaningful contributions to the project. It is important that each member holds each other accountable to ensure the success of the project. To hold each other accountable to make sure we are on track with deadlines and project sponsor needs. Most importantly as well to make sure that everyone is heard and transparent with each other. Behind or ahead, we support each other to make sure everyone is delivering on time and is able to learn from each other. We'll rely on one another to carry out our parts and stay open with each other when unexpected challenges arise. We expect everyone in this group to act with professionalism and maturity. If there are disagreements in the future between any group members or ideologies, we expect to be able to talk about it as a group since we are all responsible for each other and the project.

MEETINGS

Meetings will be divided into two categories: general body meetings and technical meetings. General body meetings, held every Tuesday, will focus on team building and overall group matters. Topics may include challenges faced by team members, scheduling conflicts, and quality-of-life improvements. This meeting is scheduled early in the week to ensure that members have material to contribute during the technical sessions and don't feel isolated in their work. Since our project treats every member as a researcher, each person has the autonomy to follow their own curiosity and approach problems in their own way, since both the challenges and solutions are open-ended. We also hold this meeting early in the week to encourage communication and knowledge sharing to each team member, ensuring that any team members facing difficulties have the chance to ask for help and pointers to the right direction. Attendance is mandatory alongside documentation even if things are going smoothly of your end. Since group members may all be working towards a common goal and tasking. This is a way to share different approaches to the problem with each other and assist each other in their own research. It will only be thirty minutes but can go over if things need to be discussed.

The second category is our technical meetings, held on Fridays. These sessions focus on presenting findings, proposed solutions, and evidence of progress toward sponsor goals. Each meeting is scheduled for an hour, though the length may vary depending on the discussion of deadlines and objectives. Technical meetings also serve to bring everyone up to speed on the project's progress before the week concludes. We recognize the importance of maintaining a healthy balance outside of academia, which is why all meetings are scheduled on weekdays, leaving weekends free for personal time and rest. This meeting is required alongside with documentation. This meeting will most likely be recorded in order to be able to play back what was talked about.

The third category of meetings is with our sponsors and partner team, held every Wednesday. These meetings provide an opportunity to clarify the sponsor's expectations for deliverables and to check in on the progress of the partner team.

ACCOUNTABILITY

Since this project is more research focused, a way to hold each other accountable is our multiple required meetings. The purpose of these meetings is not to be intrusive throughout the week for each group members' schedule. But a way to create an environment of being able to share and help each other along the process. It is a way to count on each other if one gets behind and also a way to be open and honest with the team about your thoughts and concerns. We will hold each other accountable for the work that we do through the meetings which act as a check in for progress reports, monitor performance, and address issues to one another. This is a way to uplift one another and help each other out. But that does not mean that you don't have to do work since the team will be there to help. You are still held accountable to what you said you will do or with the taskings you agreed upon. We want to create an environment where we can learn from another and teach one another freely. Although logging is very meticulous, we will download Discord Daily Bot as requested from Dr. Leinecker. But more importantly we would like to track progress through a GitHub we set up. Where each member has the autonomy to contribute to their own directory which GitHub will then track with the code they contribute whenever they work. Since we would like to promote an open environment to be able to freely communicate and assist each other. We trust each member to do their part and contribute to the well-being of each team member and the project. If a member is seen to continuously miss these responsibilities and what is expected of them. We will hold a meeting to address the issues as a team. And if it continues then we will reach out to Dr. Leinecker to see if we can work something out with a third-party and resolve the issues.

SICKNESS & UNAVOIDABLE CONFLICTS

If a team member becomes ill or encounters an unavoidable conflict that prevents them from completing assigned tasks or attending required meetings, they must notify the team as soon as possible. In cases involving graded components for the senior design class, such as TA check-ins, the individual is also responsible for emailing the professors and attaching the team to ensure transparency. This communication helps the team adapt to the circumstances and ensures the professors are aware of the situation. This ensures that troubles won't fall onto the team. Affected team members should meet with the group to review any work that may be delayed and discuss how responsibilities can be redistributed if deadlines are approaching. It is mandatory to provide an estimate of when they expect to return. In order to allow the team to understand the situation and work around it. While each of us contributes individually, it is the responsibility of every member to ensure that all aspects of the project are completed. Even in the face of illness or unavoidable conflicts, the team must collaborate to prevent any portion of the project from being left unfinished. This openness and mindfulness strengthen team morale and support the overall success of the project.

Signed by:

Aaron Nagues Date: 09/23/2025

Ezra J. Stone Date: 09/23/2025

Ruben D. Dennis Date: 09/23/2025

Aurela Broqi Date: 09/23/2025

Kyle F. Galang Date: 09/23/2025

General Concept of Operations

The general scope of operations is that the Air Force Research Laboratory has uncorrelated track processing built from a past project. They have the means to observe these unknown objects and their trajectories but don't have a way to distinguish them from known and unknown objects in the orbit. A mathematical model has already been built into the black box. But what is proposed is using AI architecture to see if we can improve the system and benchmark the algorithms from the previous mathematical model that was built. This will be done by first researching an open-source AI tool which we will run in our local machines to solve a smaller set of problems based on their needs. Which will then get transferred once we get the evaluation script from another team to benchmark our algorithms in an HPC environment using the MITRE supercomputer. We will then benchmark full problem sets to see if the AI has developed more efficient algorithms and create a poster of our findings to the Air Force Research Laboratory to see if the usage of AI in uncorrelated track processing is viable.

Technical Outline

This project builds on a black-box framework developed by a previous group. Their system can already track and predict orbital trajectories of objects, but it currently lacks the ability to determine whether those objects are known or unknown using open-source databases. To address this gap, our team will research academic papers and GitHub documentation on the use of OpenEvolve, an open-source counterpart to Google's DeepMind AlphaEvolve. OpenEvolve is a Gemini-powered coding agent designed for developing advanced algorithms. We plan to install OpenEvolve on our local machines for training and practice using available GitHub examples and documentation. However, local computational resources are insufficient for the scale of data we expect to process. To meet these demands, we will collaborate with a partner team developing evaluation scripts for mathematical models. These scripts will allow us to test our algorithms against their models in a high-performance computing (HPC) cluster environment, primarily running on Linux. This setup will provide access to the Air Force Research Laboratory's supercomputing resources, ensuring we can handle large-scale experiments effectively. OpenEvolve supports multiple programming languages, including Python, Rust, R, and Metal shaders, giving us flexibility in implementation and optimization.

Aaron Nogues' Section**Deliverable**

My interest in the Uncorrelated Orbital Track Processing project stems from a long-standing fascination with applying complex AI concepts to solve challenging, real-world problems. My coursework in both Computer Vision and Artificial Intelligence was theoretically fascinating, but I always felt that the real-world application was what I was missing. This project, with its focus on researching and applying OpenEvolve, is the perfect opportunity to bridge that gap. When the team decided to tackle this, what really stood out to me was the potential to create a genuinely more efficient algorithm for a critical and complex domain.

From a technical standpoint, I am particularly motivated by the challenge of adapting the OpenEvolve framework in general in addition to our specific use case. The opportunity to work with an open-source version of a sophisticated system like Alpha Evolve is incredibly exciting. It's a chance to move beyond the textbook examples from my classes and into a hands-on, practical application of evolutionary algorithms. I believe that successfully leveraging this framework will not only be a valuable contribution to the team's goals but will also be a significant step in my own professional development as I pursue a career in applied AI.

Ultimately, I am driven by the prospect of contributing to a meaningful research effort for something brand new in the AI field.

Work Distribution

From a technical perspective, most of the effort would be just in reviewing OpenEvolve and actively implementing examples and other problems. This effort contributes to the main goal of determining the value of Open Evolve and by extension Alpha Evolve as it relates to the Airforce's research department. Perhaps a visual focus on improvements created by the Open Evolve in action, comparing iterations of the algorithms that are returned.

Signature: Aaron Nogues Date: 09/23/2025

Ezra Stone's Section

Deliverable

The Uncorrelated Orbital Track Processing (UCTP) project to me presents an exciting opportunity to build upon my little experience with LLM technologies. My journey so far through Computer Science has had a large emphasis on data structures and algorithms. Instilling in me the critical need for efficient and reliable algorithms to process large scale data. The work on benchmarking UCTP algorithms as outlined in the original project plan is a testament to this. The ability to accurately classify and characterize space events is paramount for both civilian and military applications and I am driven by the idea of developing a solution that can improve these existing methods.

The core motivation for me lies in the idea of building a system that can improve itself. From my point of view the current methods being used are inefficient and can be greatly improved if done correctly. The concept of an agent which can autonomously generate, test, and tweak algorithms represents to me the possibility of a profound shift. I am excited by the challenge of applying this groundbreaking AI system to solve a problem as complex and crucial as UCTP. It possesses an opportunity to move beyond the manual optimization of individual algorithms and explore an automated approach to discovery.

My interest in AI is a direct result of my prior projects and research that I've done in course work and my own free time. Through my own research I have seen the exponential growth of data in every aspect of technology. We've all probably witnessed how traditional methods struggle to keep pace with the sheer volume and velocity of information. This has made it very clear that the future of data analysis lies in more intelligent, autonomous systems. This is especially true in domains such as government, military, and space operations.

Work Distribution

From my personal point of view, the opportunity to learn and contribute to OpenEvolve is particularly exciting because of how new it is. The openEvolve framework, being a key

component of this project, represents a new frontier in AI assisted code development. It's not just about using pre-trained models to generate code; it's about building a system that learns to “evolve” and improve its own solutions. This is a level of agentic intelligence that will move beyond automation and into the realm of co-creation. OpenEvolve’s modular design with distinct components for prompt sampling, LLM ensembles, and evaluation provide a flexible and powerful foundation for experimenting.

I am particularly interested in the evaluation process and how it can be used to provide a quantifiable fitness score for the evolving algorithms. The ability to objectively measure performance is what makes an evolutionary approach viable, and I am excited to develop this component for our specific UCTP task. In addition to this the chance to work with the Gemini API and integrate it into a real-world project is an invaluable learning and project experience. I am confident that my skills and enthusiasm for this kind of work will allow me to make a significant contribution to this project's success.

Beyond the technical aspects of the project, I am also deeply motivated by the opportunity to work with the Air Force Research Laboratory (AFRL). The chance to contribute with the SDA TAP Lab and its mission to enhance space situational awareness is incredibly exciting. I am eager to collaborate with the team at the SDA TAP Lab and to gain a deeper understanding of the unique requirements and operational constraints of the space domain.

Signature: Ezra J. Stone Date: 09/23/2025

Ruben Dennis' Section**Deliverable**

The Uncorrelated Orbital Track Processing doesn't sound daunting until you start looking under the hood. We're going to be working with a newer LLM through Open Evolve, which will provide us with skills for working with future models in the industry. On top of that, we're dealing with the concept of evolutionary coding and how to iteratively improve algorithms. This project will provide some more insight into topics like benchmarking and performance tuning.

As for my motivation, I have always had interest in pretty much anything space-related and have kept tabs on projects such as the James Webb telescope. So, the opportunity to work on the Uncorrelated Orbital Track Process (UCTP) with relevant data about the objects orbiting us was super intriguing. On top of that, we will be conducting research on a newer LLM (Open Evolve), which I'm sure will be very difficult, but we also have the chance to become deeply knowledgeable about how this specific LLM runs. I have also never done a proper research project in regard to computer science, so this will provide insight into how many companies operate when conducting their own research. From my perspective the most exciting part of this entire project is exploring evolutionary coding and seeing if Open Evolve can make iterative improvements. I want to look more into how benchmarking and profiling can be integrated.

This project has the capability to pave the way for even more research into things like AI-assisted collision avoidance, orbital mechanics, and tracking already known objects like satellites. Since this is the Air Force, this research could also lead to further development of guidance systems for aircraft and missiles. In terms of my career in cybersecurity, this will provide skills in finding and fixing vulnerabilities. By working with Open Evolve to automate bug fixing and test algorithm improvements, it will allow me to gain experience in secure coding practices and automated vulnerability repair. The same skills that help verify whether an evolved algorithm is correct and efficient can also be applied to auditing software for flaws,

building more resilient systems, and ensuring that code can withstand unexpected inputs or adversarial conditions.

In addition, cybersecurity often requires a “trust but verify” mindset when dealing with new tools and technologies. This project will improve that mindset as I evaluate AI-generated code for correctness, robustness, and potential risks. Designing fitness functions, implementing fuzz tests, and considering edge cases will all mirror the kinds of systematic verification methods used in security testing. Beyond the technical overlap, this experience will also help me practice adapting to rapidly evolving technologies, something that is critical in a field where threats and defense strategies change constantly.

Work Distribution

Some ideas for the project are to be an automated repair assistant so that we can feed intentionally buggy algorithms to see if the LLM can provide insight into what we are trying to do and make the correct changes but then add some comments to where things could be improved. A self-testing code where we prompt Open Evolve to generate unit tests to catch failures. Also seeing if it can provide a fundamentally different approach to the algorithms. All these would aid in providing the best performance for UCTP. Overall, I am super excited to work on this project and the technologies that come with it. It concerns a field that is intriguing to me with space and has difficult problems to solve

Signature: Ruben D. Dennis Date: 09/23/2025

Aurela Broqi's Section**Deliverable**

My motivation for successfully completing the Uncorrelated Tracking Processing Algorithms project, sponsored by the Air Force Research Lab, is to deepen my knowledge and skills in the field of Machine Learning and AI. My background in software development only began over the summer, and I want to continue building my foundation by learning from those with more experience. I am also motivated to grow as a team member by contributing to an effective workflow environment while making impact and progress throughout the project. I also see this project as an opportunity to expand my own skill set and prepare myself for future professional roles.

My concern is that much of the work will focus on understanding how an existing model functions and integrating it into a pre-built algorithm, rather than giving us opportunities to build new algorithms or develop software from scratch. Since one of my goals is to improve my software engineering skills, I am concerned this project may not provide as much direct coding experience as I hoped. I plan to continue communicating actively with my teammates, staying prepared for each meeting, and engaging directly with the project leads to secure meaningful work throughout these eight months.

I am particularly interested in the technical aspects of this project. I hope to gain experience with the underlying models and to work on algorithm design, not just analyzing how existing models function. Ideally, I would like to extend or improve the algorithm already developed in the previous project and possibly learn a new programming language. I am motivated to provide proof that our concept is worth further investment, especially since there may be an opportunity to work on the NVIDIA SuperPod. I did not realize that this project could require resources like that, which makes me want to take it seriously and gain as much learning as possible. More than anything, I hope to come out of this project with stronger engineering and problem-solving skills.

Work Distribution

We expect each member of our team to be proactive, engaged, and motivated to learn from this experience. It is a good opportunity to learn from mentors and from one another.

We are currently using Outlook and Teams to communicate with the sponsors and SMEs, and Discord for internal team communication. We plan to establish a weekly team meeting to make sure we are all on the same page and on track with the project. We will also be using Jira to manage code tasking and backlog items. Task assignments will be clear and easy to follow, and progress will be made visible for our sponsors to see and to help maintain accountability.

Every member is responsible for documenting their own work so they remain aware of their progress, and so the team and SMEs can also see what has been accomplished. If a member shows a lack of progress, their contribution or lack thereof will be clear in Jira, GitHub, and during our meetings.

Each person is responsible for keeping their work documented and accessible so that others can pick up tasks if necessary. When someone returns after being absent, they will have clear documentation to catch up on and continue contributing.

Signature: Aurela Broqi Date: 09/23/2025

Kyle Galang's Section**Deliverable**

My motivation to work on this project is to gain experience with AI. I have worked with the aerospace industry for 3 years now. I feel that I have worked with optimizers and automation but never got the chance to truly work on AI as a computer scientist and software engineer. Hearing the project details excites me to be able to work with tech stacks that I haven't had any experience with. Technology such as OpenEvolve which is an open-source version of Google DeepMind's AlphaEvolve which is a Gemini-powered coding agent for designing advanced algorithms, working with MITRE supercomputers with Nvidia superpods, and working on an already existing framework for uncorrelated tracking.

Some of my concerns are that it is very heavy research which makes the workload very autonomous for my group. I've had experience contributing to open-source frameworks like this one called OpenMDAO which is a multidisciplinary optimizer for aircraft conceptual design. And my concern there is that it took me a bit to really learn the existing code and how to contribute to the framework before pushing any code in during my time of the internship.

I've always liked the research roles in big industry with the flexibility and environment they uphold. So my core motivation really relies on getting to know these new technologies and trying to rebuild my career in computer science to hopefully be able to land a role as a software engineer dealing with machine learning or AI as I move away from my experience in aerospace.

My idea for the project is that we will be learning how to use OpenEvolve on our local computers with small problem sets to see if we can create our own algorithms. As we get more familiar with it and wait on the partnering team to create our evaluation script. We also need to get access to high performance computing clusters to test them on a larger scale. From there we use the evaluation script to test if the AI generated algorithms perform better or worse than the previous mathematical model that was created in the black box. Of course, the first couple of months are going to be slow since there are a lot of research papers and going through the

documentation on open-source technology. But I think the more we put into it, the easier it will get to implement it in the future.

Work Distribution

Some ideas on how I think the work distribution will be due to the fact that we're all going for the same goal. We will most likely be doing the same thing. Which is hard in regard to the class structure of using Agile methodologies and splitting work up as a developer from front-end, database, back-end, etc. In this case we will all be researchers trying to come up with the solution in our own ways. Of course, we will all have the same environment for using OpenEvolve in our local machines which we will later be transferring into an HPC server. I think the best way to keep everyone at bay is setting up a GitHub with our own directories, where we can track our codes that we push. While also being able to keep everything in one place so when we do transfer our files from local machines, we can then just zip it up and transfer it over to the HPC when doing larger scale testing.

I think also a key component to this is weekly meetings. I've set 2 in order to keep the group closer so we can help each other out. Sometimes in research it feels like you're not moving or not making any progress. But being able to talk to each other more frequently allows us to hold each other accountable while also assisting others research and methodologies on how they are solving the problems. The other key component is documentation as well for reproducibility.

One thing I also think is important is having what some may call scrum master or project lead. To be able to ensure everyone is following the contract and keeping things organized. That's one thing I've noticed in research-based environments is that you can easily stray away from things because of how flexible research is. But if we are a reinforcing person to delegate tasking and research, it will give better goals and sprint meetings to aim for which will move along the research project.

Signature: Kyle F. Galang Date: 09/23/2025