

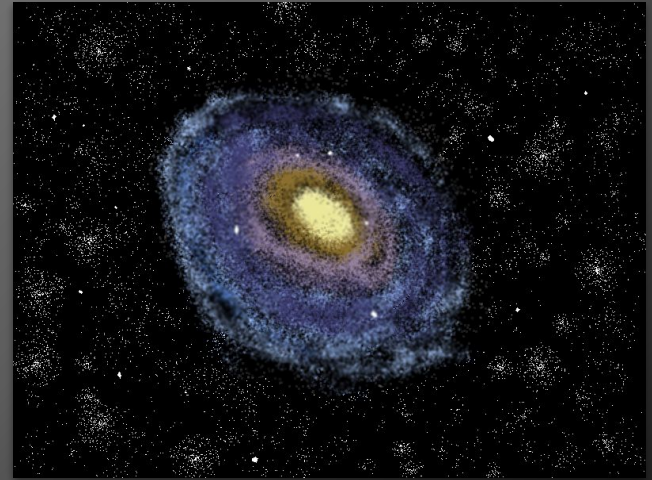


Three-Dimensional Simulation and Visualization of Binary Asteroids

Team Andromeda

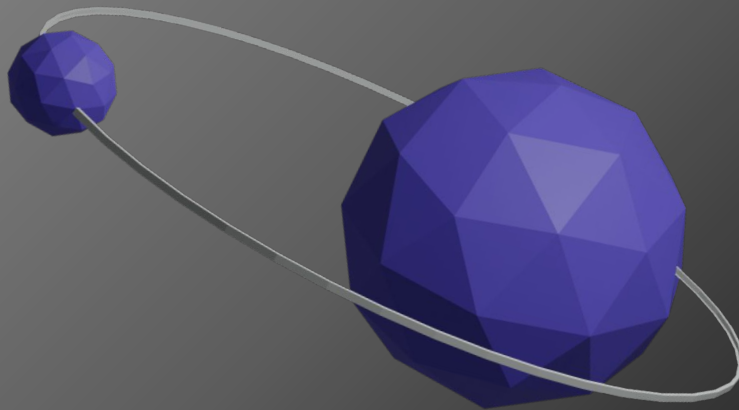
Team Members: Matthew Amato-Yarbrough, Batai Finley,
John Jacobelli, Bradley Kukuk, and Jessica Smith

Team Mentor: Isaac Shaffer



The Team

- John Jacobelli
 - Team Lead
 - Recorder
- Batai Finley
 - Team Communicator
- Matthew Amato Yarbrough
 - Architect
- Bradley Kukuk
 - Release Manager
- Jessica Smith
 - Editor
- Isaac Shaffer
 - Mentor





Dr. Audrey Thirouin



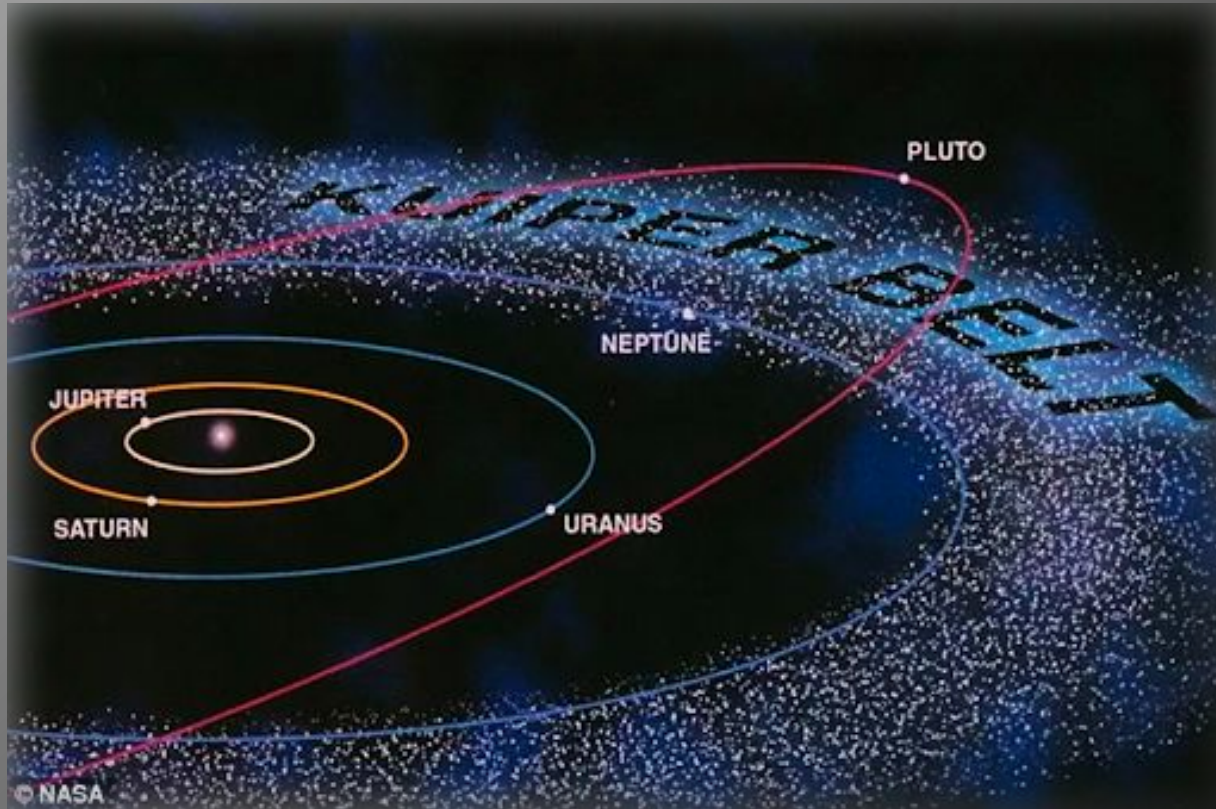
Studies binary objects

Dr. Will Grundy

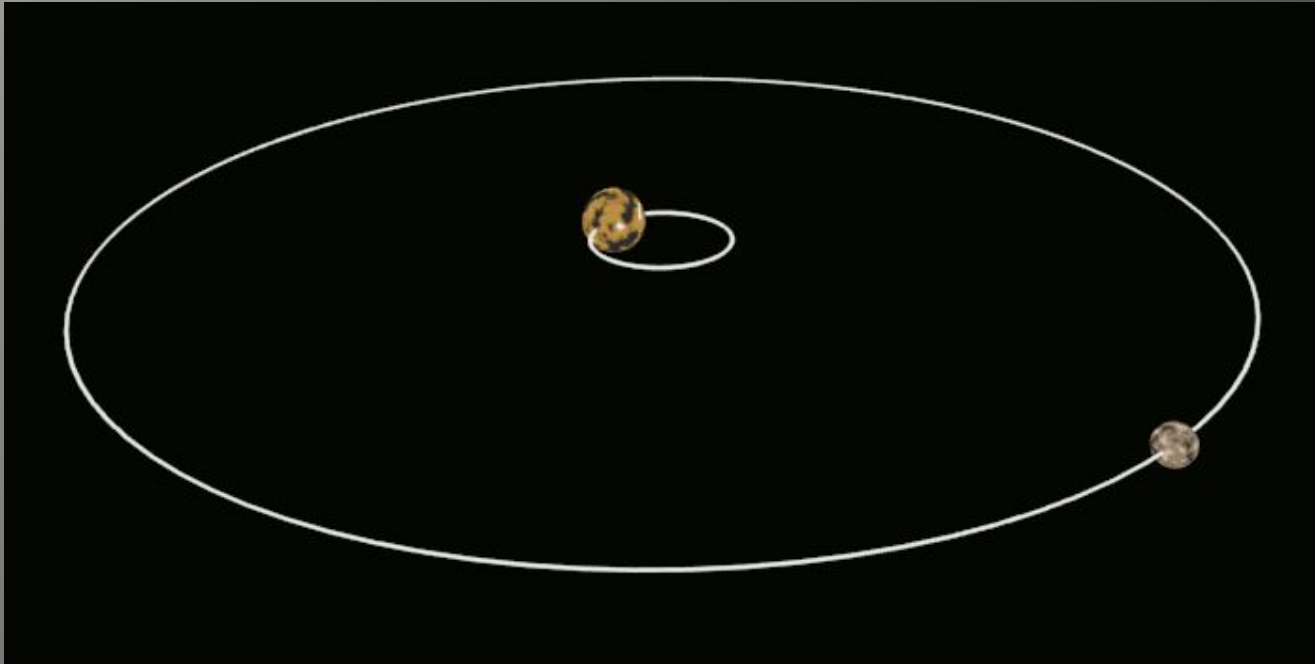


Studies Kuiper Belt objects

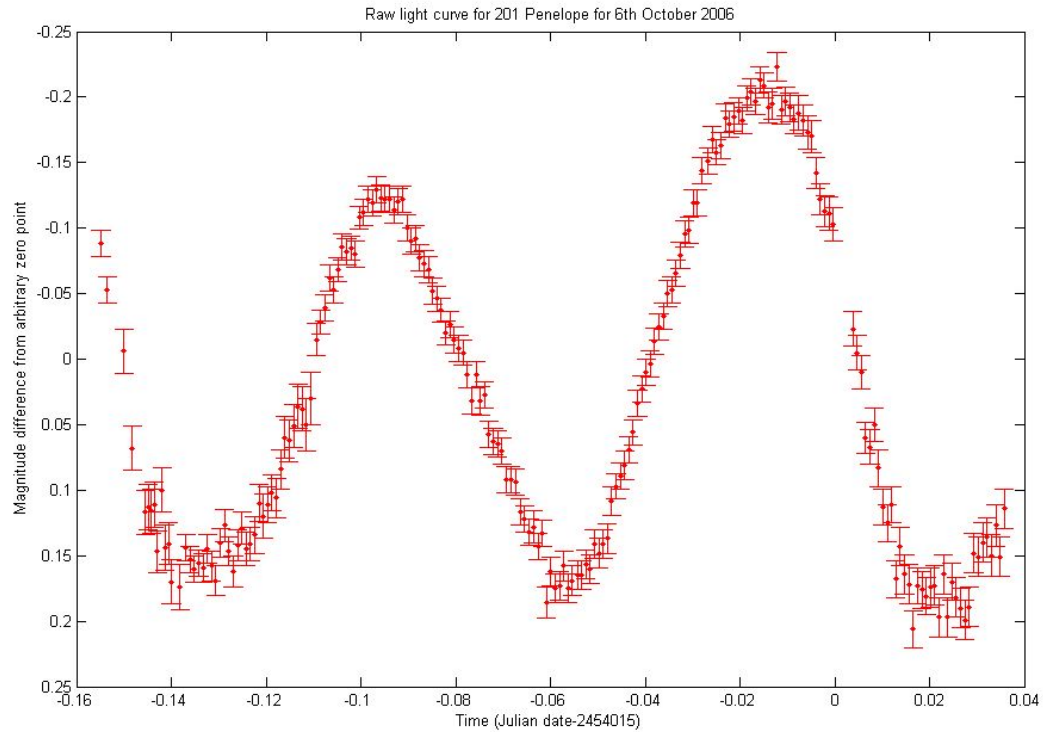
The Kuiper Belt



Model of a Binary System (Pluto and Charon)

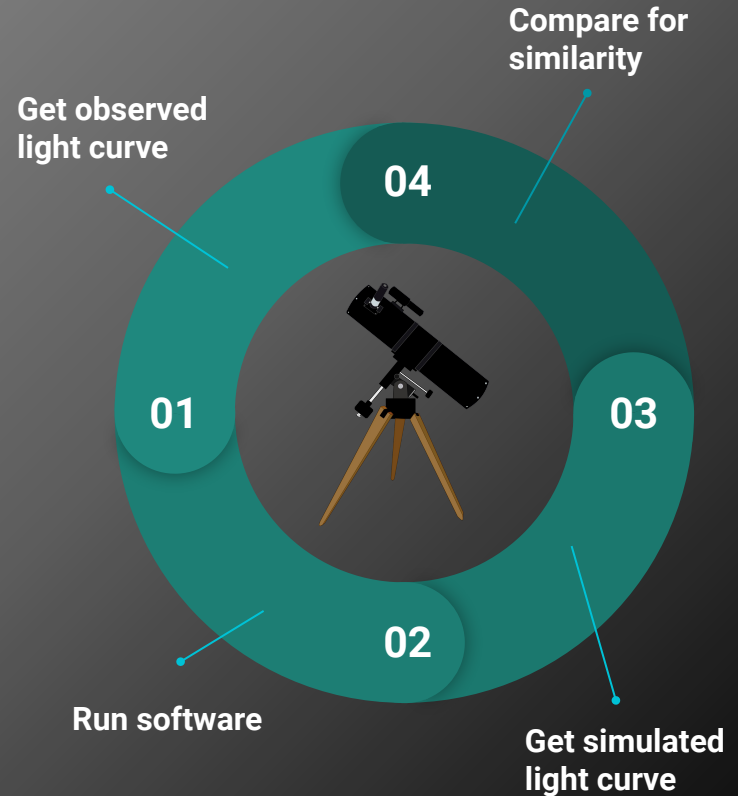


Light Curve



Problem Statement

- 50+ parameters must be entered on a command line
- Current software lacks a mix of fast runtime and greater accuracy of simulations
- Our clients need a way to determine best fit parameters based upon observed data
- Current software generates rendered images, but not videos

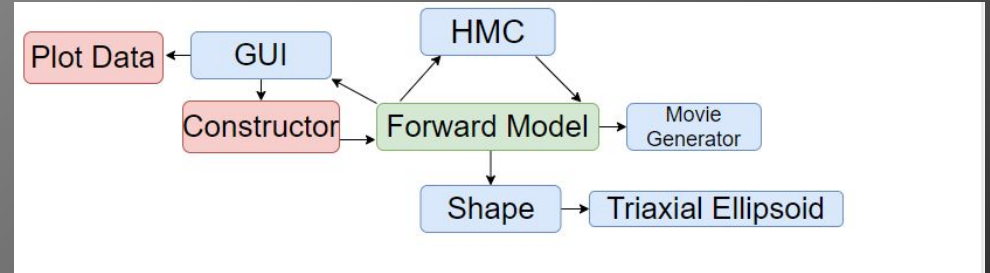


Solution Overview

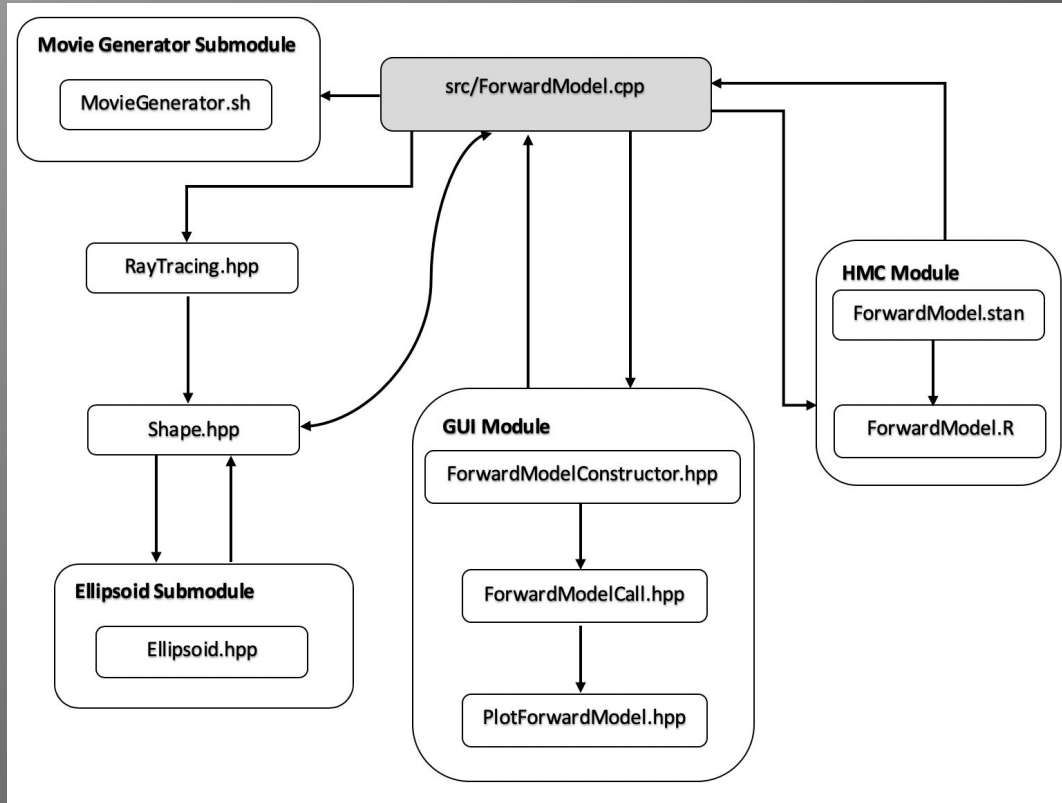
- Create GUI for parameter input
- Implement HMC
- Accelerate forward model
- Integrate video generator

Key Requirements/Implementation Overview

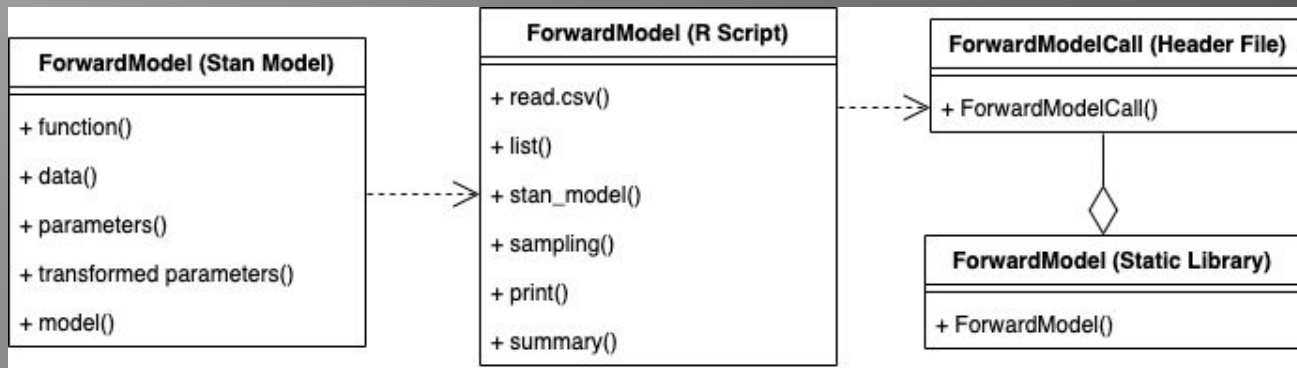
- GUI for the Forward Model
- Hamiltonian Monte Carlo
- Triaxial Ellipsoid shape
- Movie Generator



Architecture Overview



HMC Module



Inference for Stan model: 0875889791c0c03f4a21d21550a13837.

3 chains, each with iter=10000; warmup=5000; thin=1;

post-warmup draws per chain=5000, total post-warmup draws=15000.

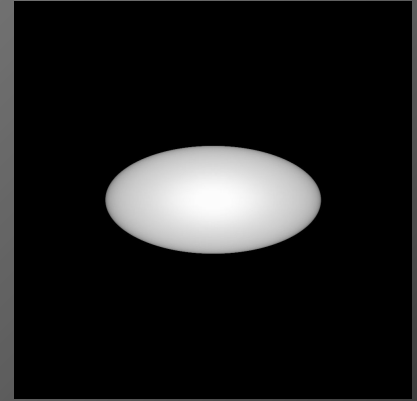
	mean	se_mean	sd	2.5%	25%	50%	75%	97.5%	n_eff	Rhat
A	-1.87	0.00	0.06	-1.99	-1.91	-1.87	-1.83	-1.76	4313	1
B	22.23	0.01	0.86	20.57	21.66	22.22	22.79	23.95	3994	1
C	-58.18	0.04	2.57	-63.31	-59.90	-58.16	-56.45	-53.20	4671	1
sigma	7.12	0.01	0.86	5.68	6.51	7.04	7.64	9.03	6181	1

Challenges and Resolution

Triaxial Ellipsoid

- Challenge: Incorrect ellipsoid lighting
- Solution: Modification to the ray tracer module

- Challenge: Ellipsoid rotation implementation
- Solution: Matrix multiplication

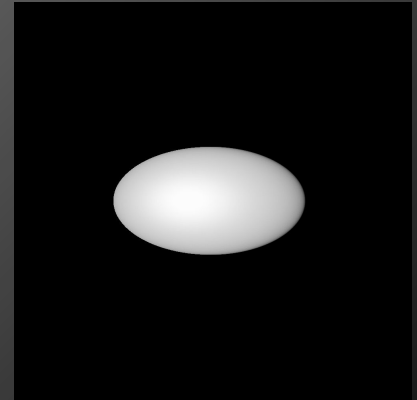


HMC

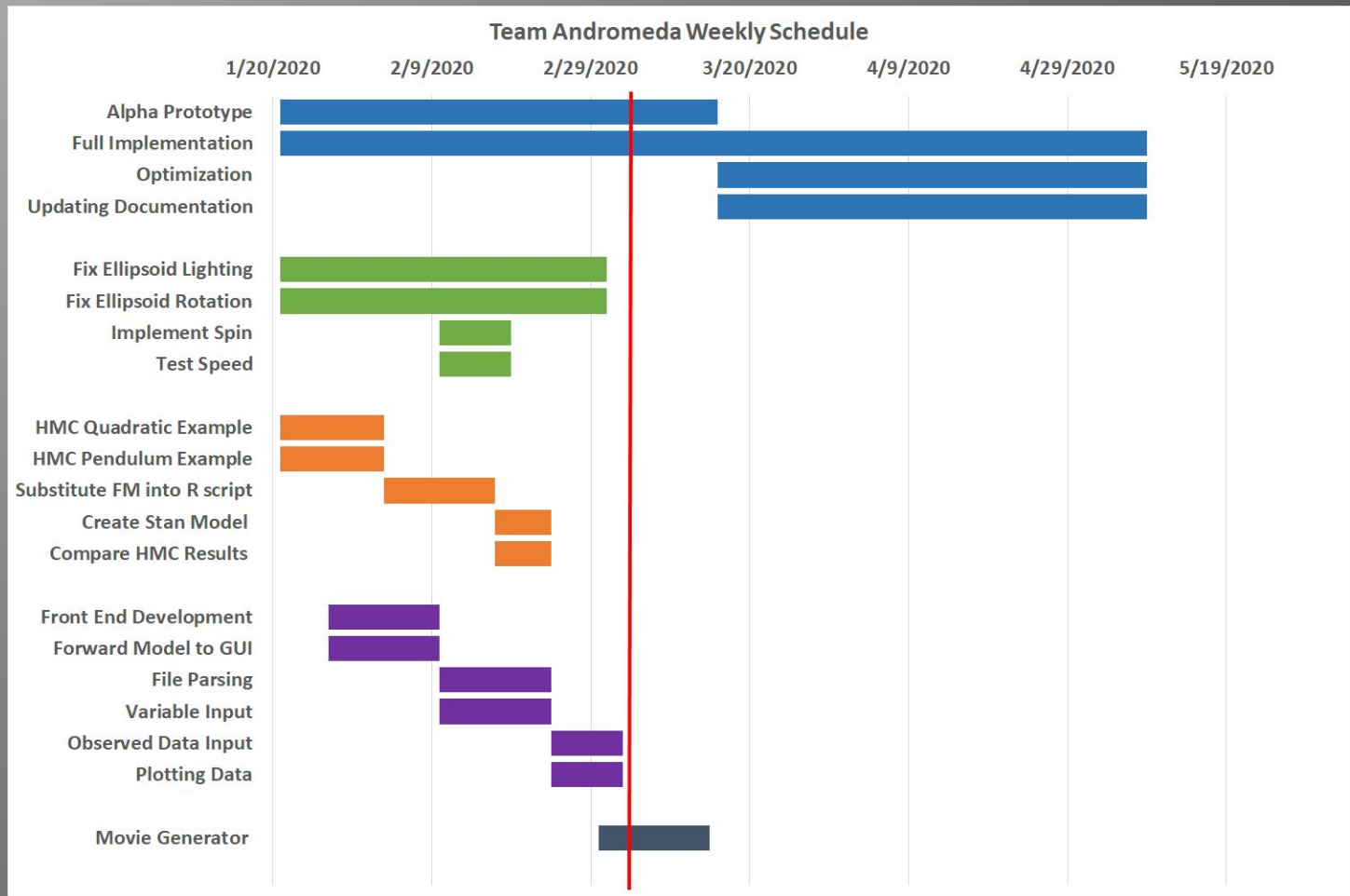
- Challenge: RStan Forward Model interface
- Solution: Forward Model static library linking

GUI

- Challenge: Text input parameter retrieval
- Solution: Data type checker function



Schedule



Conclusion

- Space and the Unknown
- Improve, Accelerate, Streamline
- Excited to present software



Discovery Channel Telescope

Thank you!

Questions?

<https://www.cefn.s.nau.edu/capstone/projects/CS/2020/Andromeda-S20/>

