Finals Projects Symposium

ASU PHY494 Computational Methods in Physics (Spring 2017)

Arizona State University, Department of Physics
Room PSH 355

Thursday May 4, 2017, 12:10am–3:15pm

1 Posters

#	title	authors
1	In the Life of a Protostar	Jacob Cluff, Kelsie Crawford
2	Visualizing Quantum Wavepackets	Nate Chrisman, Brian Pickens, Andrew Shurman
3	Modeling Self Driving Vehicles	Caleb Madsen, Brian Horne, Alex Smith
4	Population Dynamics	Cameron Howard, Uma Vrudhula, Michael Nuccio
5	Dynamics of the Solar System	"Scout Smith", Vishal Mehta
6	Limb Darkening and Light Curve Simulation	Kezman Saboi, Tienchen Gong, Edgar Escalante

2 Procedures

Mount your poster on the provided poster board and attach the number assigned to you (see table above). At the end of the symposium, return all mounting materials and take your poster with you.

Note that the instructor might take pictures of the posters as an additional record for grading purposes.

2.1 Q&A

- Each member of the team will be asked to engage in an individual Q&A with the instructor in front of the poster of about 6 minute duration. The Q&A will be graded and be part of the final grade.

- The TAs will also ask questions and report their assessment to the instructor. However, they will only report positive evaluations, i.e., you cannot make your grade worse by talking to a TA.
- If you are not engaged in a Q&A then you are free (and encouraged) to look at other posters.

2.2 Poster prize

Participants will be able to vote for the best poster. Ballots will be provided: rank order the top three posters and drop your ballot into the collection container. The winning team will be awarded a prize (which will *not* influence the grade).

3 Abstracts

Abstracts[1] are listed in the order of appearance in the program.

#1 • In the Life of a Protostar • Jacob Cluff, Kelsie Crawford
`https://github.com/ASU-CompMethodsPhysics-PHY494/final-2017-beta-team`

In this model, we take several clouds of different mass and determine how long it will take for the cloud core to get hot enough to allow for sustainable nuclear fusion and how long it will take for the cloud to collapse. The general approach we take is to calculate the Jean's radius for each cloud, the volume (assuming spherical symmetry), and then the density. For now, we are assuming a free fall and adiabadic collapse, but we plan on including gas pressure in the future. We calculate the adiabadic constant and use the changing volume to calculate shell temperatures; for the core temperature, we use the virial theorem and the change in the potential energy of the collapsing cloud. For our 60 solar mass cloud, the core gets hot enough after .003 Myr and the free fall collapse occurs at 1.6 Myr.

#2 • Visualizing Quantum Wavepackets • Nate Chrisman, Brian Pickens, Andrew Shurman
`https://github.com/ASU-CompMethodsPhysics-PHY494/final-2017-bogus_project`

The goal of this project was to visualize a quantum wavepacket in 2-D and 3-D within a box and isotropic harmonic oscillator potential. The method of approach included the use

[1] The 200-word limit to the abstract text is indicated by graying out any text beyond the limit. For a real conference, your abstract would have been truncated or rejected by the submission system.

of a stepping algorithm to determine the real and imaginary parts of the wave equation in alternating half time-steps (Maestri et al.) and then using two modules, YT and imageio, to create images of the time-evolution of the wavepacket. To test the accuracy of the solutions, constant calculations of total probability and the observation of phenomena such as quantum revival were used. Images of a wavepacket in both potentials was observed, however, these proved to be incorrect as neither probability was conserved nor was quantum revival observed. The cause of the error has yet to be determined even through extensive reworking of the algorithm implementation This has lead us to believe that the problem maybe with the algorithm itself and another will need to be found. Future work would include exploring other algorithms that meet our requirements.

Code is available at under MIT License

#3 • Modeling Self Driving Vehicles • Caleb Madsen, Brian Horne, Alex Smith
`https://github.com/ASU-CompMethodsPhysics-PHY494/final-2017-openthepodbaydoors_hal`

Traffic is something that influences every aspect of modern society. This is what makes traffic flow optimization so important. Despite there being rules that govern how people behave on the road, people deviate from these rules in various ways, which makes it difficult to find which rules optimize traffic flow. Machines on the other hand, are exceptional at following rules. Hence, machines are the optimal candidate for optimizing traffic flow based on simple rules. Here, we provide a computational model of traffic in which machine driven cars all follow the same set of rules. In an attempt to optimize traffic flow, this model incorporates a discretized set of roads, on which, we aim for maximum occupancy. This means that one of the rules does not allow too many cars on the road at a time, however, this model should help determine how many cars is too many. This model takes a set of initial conditions and simulates the motion by coupling advanced slicing techniques with boolean logic and nested for loops. Given the set of rules provided, the motion observed suggests that traffic does still build up at intersections. However, the degree to which traffic is slowed at the intersections, can be varied, by allowing more cars to occupy a given space at each instant. Furthering this research could entail building upon the complexity of the rules for the cars, and allowing them to change directions.

#4 • Population Dynamics • Cameron Howard, Uma Vrudhula, Michael Nuccio
`https://github.com/ASU-CompMethodsPhysics-PHY494/final-2017-team-az`

While mankind has an impact on animal populations through long-term effects like climate change, we can also cause more immediate impacts through things like overhunting, deforestation, and the introduction of foreign animals and disease into animal populations. Inspired by this, our goal for this project was to model a realistic food web, with creatures of the local Sonoran desert forming our example, and model what impact the sudden severe reduction of one population might have on the rest within the system. Utilizing the Lotka-Volterra system of first order ODEs, which are then integrated using the Runge-Kutta 4 method of integration, our project allows for a food web that involves both predator-prey relationships and competition between predators. Initial populations were able to be determined from real-world population statistics, but the other parameters for our system of ODEs were not readily available, and were instead contrived to form a stabilized system. Our findings show that, while our system is resilient to sudden impacts leading to extinction, these impacts severely impact other populations and rarely ever does the system recover to the same equilibrium as before. Accuracy of future results could be improved by sourcing further real-world data for parameters.

#5 • Dynamics of the Solar System • Greg "Scout Smith" Smidt, Vishal Mehta
https://github.com/ASU-CompMethodsPhysics-PHY494/final-2017-uranus_coders

There are many celestial objects wandering in our universe waiting to destroy our solar system. If one of those objects were to collide with jupiter, the heaviest planet in our solar system, how would that affect earth? The goal of this project is to determine changes in Earths orbit as a celestial object collides with Jupiter. Our major hurdles were to determine how collision would occur and how to simulate all of the orbits (including collision) in VPython. Two equations were very important in creating this simulation: Newtons universal law of gravitation and perfectly inelastic collisions. However, we used Velocity Verlet in Python to calculate the positions and velocities of the planets at each time step. Our results indicated, as we would naturally expect, the bigger the momentum of the celestial object, the more impact it had on Earths orbit. The goal was achieved as we saw great difference in earths orbit for celestial object having high momentum and almost no difference in Earths orbit for celestial object having very low momentum. For future work, we can model the path and the collision more realistically.

#6 • Limb Darkening and Light Curve Simulation • Kezman Saboi, Tienchen Gong, Edgar Escalante
https://github.com/ASU-CompMethodsPhysics-PHY494/final-2017-wasp_analyzer

Light curves are recorded by radio telescopes and are used by astronomers to help better their guesses to existence of exoplanets. In our work we are using the new WASP55 stellar system which is composed of one star and one planet. We want to be able to give the star a more closely related characteristic of limb darkening in which the edges of the surface that is facing us is less bright due to a longer radial distance. To produce these light curve plots we will be using Python 3.X. Because python cannot make spectators (like radio telescopes) easily, our sight will be a 2d array that holds the information of brightness at all points away from the origin defining the radial distance. Our project involves the simulation of a planet which partly crosses our view of the star and carries 0 brightness on all points on its surface. Our iterations of sums of our matrix as the planet moves produce our light curves. Future work on the project will be based on establishing the nature of light curves generated when the star has dark spots.