Finals Projects Symposium

ASU PHY494 Computational Methods in Physics (Spring 2018)

Arizona State University, Department of Physics
Room PSH 355

Thursday May 3, 2018, 11:00am–2:00pm

1 Posters

#	title	authors
1	Analysis of Baseball Pitch Motion	Andrew Peerenboom, Chris Hollowell
2	Black Hole Simulator	Tyler Cox, Reid Baker
3	Fourier Transforms with Wave Functions	Lauren Farmer, Dakota King, Jonah Shoemaker
4	Housing Structural Heat Analysis	Marko Gonzales, Zhichao Ma, Milan Patel
5	Complex dynamics in a stratified lid-driven cavity flow	Paige Weisman, Narges Masoumi, Ke Wu
6	Formation of Wind	Kacey Clark, Christian Burgoyne

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 • Analysis of Baseball Pitch Motion • Andrew Peerenboom, Chris Hollowell
`https://github.com/ASU-CompMethodsPhysics-PHY494/final-2018-phy494_final_baseball`

In the day and age of metric-focused data in baseball, new scenarios and gameplans are strategized using raw, hard data. Using pitching and batting data from a given season, one can scientifically show a players weakness that can be either exploited, or reinforced depending on the side of the plate you stand on. The goal of the simulation is to simulate an at-bat at the major league level for two of the most potent members of a lineup, the closer and the clean up man. Depending on the role that you wish to play when reviewing this data you can end up coaching a player to improve upon their weaknesses or, as a pitching coach, use those weaknesses against the dangerous batter. The simulation can be run in all sorts of conditions to simulate different ballparks and different combinations of batter or pitcher, bringing an invaluable tool to the ever-evolving climate of baseball.

#2 • Black Hole Simulator • Tyler Cox, Reid Baker
`https://github.com/ASU-CompMethodsPhysics-PHY494/final-2018-doubularity`

Massive, compact objects such as black holes are well known for the interesting areas of physics that come about because of them. One such phenomenon is the warping of spacetime due to their mass. Our team looked to simulate the motion of light around a

[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.

black hole due to the curvature of spacetime and to visualize a variety of scenarios such as viewing objects directly behind a black hole and objects behind the viewer. By integrating a series of simple differential equations defined by General Relativity, the motion of rays of light were simulated. Once the motion of these rays of light were defined a simple backwards ray tracer was implemented to color each pixel in the frame according to where the ray of light landed. Implementing these techniques allowed our team to generate sets of low-resolution images in which we were able to observe objects directly behind a black hole and directly behind an observer looking at a black hole. These images closely matched images generated by other computational models and observed gravitational lensing around galaxies.

#3 • Fourier Transforms with Wave Functions • Lauren Farmer, Dakota King, Jonah Shoemaker
`https://github.com/ASU-CompMethodsPhysics-PHY494/final-2018-fourier-transforms`

The purpose of this study was to find the most efficient method of using Python to compute momentum-space Fourier transforms of one-dimensional position-space wave functions. Three methods were used: calculating the transforms by hand as a control, using the FFT function in Numpy, and building an algorithm to find the transforms. The algorithm was built with a for loop, which calculated the FT integral with different discrete wave-number values in each iteration using a Riemann sum technique. While the home-made algorithm was less accurate than the FFT function, it was designed to be easier to implement by the user for quantum transform applications. In addition, the self-designed algorithm was less robust at evaluating complex-valued wave functions, but more versatile at handling real-valued sinusoidal functions with no additional modifications required. Future goals include expanding the algorithm into multiple dimensions and incorporating numerical evaluations of complicated potentials to implement an all-inclusive user-friendly package for finding both position- and momentum-space functions of any potential.

#4 • Housing Structural Heat Analysis • Marko Gonzales, Zhichao Ma, Milan Patel
`https://github.com/ASU-CompMethodsPhysics-PHY494/final-2018-494_heat_wizards`

Our team investigated the temperature distribution within a basic house over a two day period during summer and winter by simulating the heat equation in 1D and 2D for various materials and wall thicknesses. The problem is particularly interesting in the context of living in Arizona as the data will indicate what kinds of insulations and wall thicknesses produce the best results for maintain- ing a comfortable internal house temperature without the aid of air condition- ing. The code used to analyze the heat equation consists of a 1D and 2D version of the Crank-Nicolson algorithm, producing temperature distributions that are then plotted in a convenient and readable manner. The simulations are run for the various materials and wall thicknesses in 1D before being processed into two sets of plots: one comparing the effects of each insulation material and another comparing the effects of wall thickness. The temperature distributions will de- pict to what degree the selected parameters allow heat to disperse through the walls of the house. In the future, the implementation will be extended to 3D while accounting for possible structural integrities, such as windows and doors. Additionally, realistic house layouts will be analyzed, accounting for internal walls/rooms.

#5 • **Complex dynamics in a stratified lid-driven cavity flow** • Paige Weisman, Narges Masoumi, Ke Wu

https://github.com/ASU-CompMethodsPhysics-PHY494/final-2018-final_project_ke_paige_narges

The dynamic response to shear of a fluid-filled square cavity with stable temperature stratification is investigated numerically. The shear is imposed by a constant velocity on the top lid, which is quantified by associated Reynolds number Re $= 2750$. The stratification, quantified by a Richardson number, is imposed by maintaining the temperature of the top lid at a higher constant temperature than that of the bottom, and the sidewalls are insulating. The Navier-Stokes equations under the Boussinesq approximation are solved, using a pseudospectral collocation method, over a wide range of Richardson numbers. Particular attention is paid to the dynamical mechanism associated with the onset of instability of steady state solutions, and to the complex and rich dynamics occurring beyond.

#6 • **Formation of Wind** • Kacey Clark, Christian Burgoyne

https://github.com/ASU-CompMethodsPhysics-PHY494/final-2018-windformation

Wind in simple terms is the movement of air. Often, this movement is caused by temperature differences in the atmosphere due to solar heating. In order to model this interaction, parameters such as humidity and pressure were analyzed as were their interferences with themselves over space and time. Large arrays of these values were utilized to simulate the movement of the humidity and pressure levels in three dimensional space. It was successfully demonstrated how slight variations in atmospheric pressure can form wind. Tornadoes are formed when two regions of air, one hot and one cold, meet and create violent funnels of wind. While the objective of simulating this phenomenon was initialized, it was ultimately left for potential future development. Knowing how these initial conditions can lead to large-scale phenomena can aid in the predicting and preparation for natural disasters like tornadoes. The code is written in Python.