

**HONR 209M: Fair Division: Cake Cutting and Dispute Resolution**  
**Fall 2013, Tu-Th 12:30-1:45, CSI 3120, Professor William Gasarch**

Course Website: <http://www.cs.umd.edu/~gasarch/COURSES/209/F13.html>

**DESCRIPTION:** Alice and Bob want to cut a cake. They value different parts of the cake differently. Easy: Alice cuts and Bob chooses. What if you have  $n \geq 3$  people? What if instead of a cake you have a set of discrete items to split?

These types of problems arise in business and politics. For example, when settling an estate or negotiating a treaty. How can you divide things fairly? What does 'fairly' even mean?

In this course we will investigate protocols for allocating a resource fairly and then see what real world problems they may apply to.

The protocols will involve some (though not much) mathematics, which will be taught as needed. The applications will involve some (though not much) political science or history, which will be taught as needed.

There is a more detailed week-by-week description later in this syllabus.

**Grading:** There will be HW's, a project, Midterm, and a Final. The Midterm is worth 30% of the grade. The Midterm will be on Nov 6 6:00-7:30 at night. The day of the final will be announced. The Final is worth 30% of the grade. The Final will be on Fri Dec 20 1:30-3:30PM. The project is worth 20% of the grade. The HW is worth 20% of the grade. See sep document for info on project.

**HW, Mid, Final Excuse Policy:** The HW will typically be DUE on Tues. However, you can hand it in two days later on Thur. I regard this as having given you a 2-day extension. So if you are sick (without doctors note) or have a personal crisis (e.g., your cat died) then you do indeed get an extension from Tue to Thur. Any other extension will be given with documentation (e.g., a doctors note). If you miss an exam and can provide a documented excuse within a day then you will get a makeup. If you know you will not be able to take an exam or do a HW on time ahead of time for Religious or other reasonable reasons, let me know during the first week.

**Academic Accommodation:** Any student eligible for and requesting reasonable academic accommodations due to a disability is requested to provide, to the instructor in office hours, a letter of accommodation from the Office of Disability Support Services (DSS) within the first two weeks of the semester.

**Course Evaluations** In Dec you will be asked to fill out course evals. These are important since they give feedback on how we are doing. I urge you then, to fill it out carefully.

**REQUIRED BOOKS:** There will be no books for this course; however, I will post notes online.

**CORE:** Mathematics and the Sciences.

**Laptop Policy:** Laptops not allowed in class unless you are taking notes with it.

**Teacher and Office Hours:** Prof Gasarch, AVW 3245, 405-2698, [gasarch@cs.umd.edu](mailto:gasarch@cs.umd.edu). Office Hrs: TUESDAY: 11:00-12:15 THURSDAY: 2:00-3:30. Or by appointment.

next page is week-by-week description

## Week by Week Description

1. Week 1: Introduction: what kind of goods can be divided (continuous or discrete), different criteria for fairness (proportional or envyfree), other criteria (max utility), types of valuations (continuous or linear or uniform). The case of two people is studied in depth
2. Week 2: The case of  $n = 2$  and discrete good. Alternating methods. The Adjusted Winner method for two parties to resolve disputes. This will be what is used in the course project.
3. Week 3: Proportional Cake cutting: dividing a cake among  $n$  people that have possibly different measures so that everyone gets at least  $1/n$ . Key: The only restriction on the measures is that they be continuous. Discrete protocols. Different protocols in terms of number of cuts.
4. Week 4: Proportional Cake cutting: dividing a cake among  $n$  people that have possibly different measures so that everyone gets at least  $1/n$ . Key: The measures must be linear or piecewise linear. Discrete protocols. Different protocols in terms of number of cuts.
5. Week 5: Proportional Cake cutting as in weeks 3 and 4, but with Moving Knife Protocols.
6. Week 6: Envy Free Cake cutting: dividing a cake among  $n$  people so that everyone thinks they have the best piece, or are tied. Key: The only restriction on the measures is that they be continuous. Discrete protocols. Different protocols in terms of number of cuts.
7. Week 7: Envy Free Cake cutting: dividing a cake among  $n$  people so that everyone thinks they have the best piece, or are tied. Key: The measures must be linear or piecewise linear. Discrete protocols. Different protocols in terms of number of cuts.
8. Week 8: Envy free Cake Cutting as in weeks 6,7 but with Moving Knife Protocols. Midterm review and Midterm.
9. Week 9: Unfair division: dividing a cake with 2 players so that its in (say) ratio (2 : 3). Minimizing the number of cuts. Extend to many players.
10. Week 8: Review for Midterm, and Midterm.
11. Week 9: Lawn Mowing Problem: dividing a good that nobody wants.
12. Week 10,11: Auction Theory- Types of auctions and bidding strategies.
13. Week 12: Pirates Gold problem.
14. Week 13,14,15: Students present projects. Review for the Final.