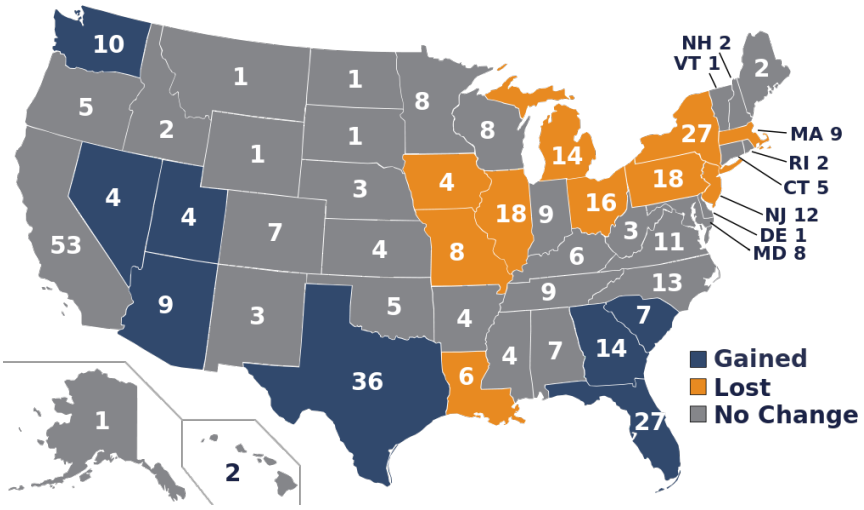
I. Introduction

You may remember that the U.S. House of Representatives has 435 seats, with the most populous states having more representatives (such as California's 53 seats) and smaller states having fewer, such as Delaware with 1 seat. The state of Kentucky has 6 representatives. The following image, from the United States Census 2010, modified by Adam Lenhardt, was taken from Wikipedia:



The constitution specifies that the representation should be based on our population, but it doesn't specify *how* this should be done. It turns out it is not as obvious as we might expect. There are also other situations in which we have a specific number of things and want to award them proportionally.

To begin this topic, you should read the Apportionment Chapter in the free online text Math in Society by David Lippman, pages 75-92. When reading mathematics it helps to read slowly and carefully; take time to **work through the examples** and take notes on the terms and how they are used.

As you read and work through the chapter, look for the following terms. **For each term below, briefly explain the term in your own words**. (18 points)

1. Divisor (standard divisor)
2. Quota
3. Lower Quota
4. Quota Rule
5. Alabama Paradox
6. New States Paradox
7. Population Paradox
8. Balinski-Young Impossibility Theorem

II. Computations

1. Choose **one** of problems 1, 3, or 7 on page 91. Clearly write up your solution for parts a, b, c, and d. You do not need to do part e. Your write-up should have both computations and sentences that explain the steps. (12 points)

2. Every group is now a country, and each group member is a governor of one of the states. The population of your state is equal to the last four digits of your student number, plus 1000. (For example, if your student number ends in 5678, your state has population 5678 + 1000 = 6678.). (35 points)

    a. Clearly write the names of your states, your names as governors, and the population of each.

    b. If your new government has 45 seats, find the apportionment using
        i. Hamilton's method.
        ii. Jefferson's method.

    c. Now the number of seats is increased to 46. Find the apportionment again using both Hamilton's method and Jefferson's method.

    d. Now suppose your country adds a new state, which has a population of your group number times 100. (For example, if your group number is 35, the state has population 35*100 = 3500.) Your country decides that the government should have 45 seats to share among all the states. Reapportion these 45 seats using Jefferson's method.

    e. Did your computations in parts b, c and d happen to demonstrate the Alabama Paradox? Did they demonstrate the New States Paradox? Explain why or why not for each.

Important note on what to turn in for questions 2, 3, and 4: All methods begin with the standard divisor. Sometimes the standard divisor produces the correct apportionment; other times you might need several adjustments to the divisor until you find the apportionment that works. In the case where the standard divisor does not work, the paper you turn in should show one divisor that does not work (with all computations), the list of other divisors you tried (without the computations), and the final divisor that does work (with all computations). Even if you manage to guess the correct divisor on the first try, you must still go back and show computations for one that did not quite work.

3. Solve **one** problem from exercises 9, 10, or 11 (pages 91-92). State the question, clearly show all steps, and include sentences in your answers to each part of the question. (12 points)

4. Suppose a country has six states with the populations given below. Determine an apportionment of 250 representatives using: (18 points)
   a. Webster's method, and
   b. Adams's method (read problem 17 on page 92).

State	***Population***
Saturn	1,646,000
Jupiter	6,936,000
Pluto	154,000
Neptune	2,091,000
Mercury	685,000
Mars	988,000
Total	***12,500,000***