- Previous Lecture:
  - Insertion sort vs. merge sort
  - Timing with `tic toc`
  - Time efficiency vs. memory efficiency
- Today's Lecture:
  - Models and data
    - Congressional apportionment
    - Sensitivity analysis
- Announcements
  - Section in computer lab
  - Project 6 due 5/1, 6pm.
  - Survey on "clicker" use—see announcement on the web
  - CS100M final will be 5/8 (Thurs) 9am. Tell us now if you have a final exam conflict. Email Kelly Patwell with your complete exam schedule (course #s and times)

The ratio of population to delegation size as a measurement of fairness

Distribute 435 Congressional seats among the 50 states so that the ratio of population to delegation size is roughly the same from state to state.

Sounds specific, but even with this "definition" of fairness there're different models that can be used as demonstrated throughout history… and in this lecture.

Related questions

How "close" is a state to losing a Congressional district because of population changes?

If Puerto Rico and/or Washington DC become states and the number of Congressional seats remain the same, which states would lose a seat?

- Reasoning about change is very important!
- How does the "answer" change if the data change or if the assumptions that underlie the computation change?
  → **Sensitivity analysis**

What are the "errors" in calculating the surface area of the Earth?

```
myPi= 3.14;
r= 3961.11345;
earthArea= 4*myPi*r*r;
```

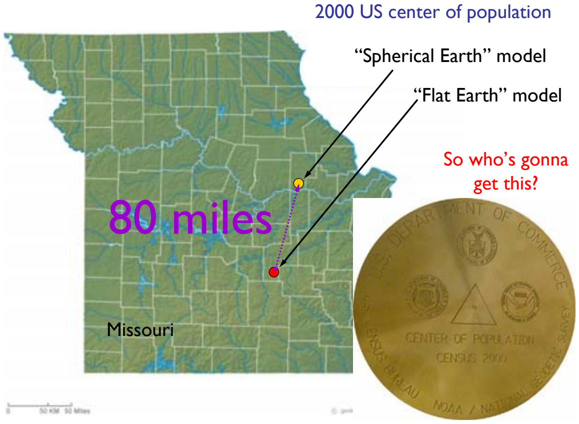
A. Math error in myPi

B. Measurement error in r

C. Rounding error in arithmetic

D. *All of the above*

2000 US center of population



Sensitivity analysis

How far would the "center" of US population move if one more person moves to NY14850?

Order of…

A. kilometers

B. meters

C. millimeters

D. Micrometers→ no change

Definition

An Apportionment Method determines delegation sizes d(1),…,d(n) that are whole numbers so that representation is approximately equal:

$$\frac{p(1)}{d(1)} \approx \ldots \approx \frac{p(n)}{d(n)}$$

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```
% Every state gets a district
d= ones(50,1);
% "Deal out" remaining districts
for k= 51:435
    % Let i be the index of the state that
    % most deserves an additional district
    d(i)= d(i) + 1;
end
```

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How to quantify "most deserving"?

The Method of Equal Proportions

At this point in the "card game" deal a district to the state having the largest value of

```
sqrt( p(i)/d(i) * p(i)/(d(i)+1) )
```

Compromise via the geometric mean

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Allocate using the method of equal proportions

```
% Every state gets a district
d= ones(50,1);
% "Deal out" remaining districts
for k= 51:435
    [z,i]= max((p./d).*(p./(d+1)))
    d(i)= d(i) + 1;
end
```

See posted version for detail

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A Sensitivity Analysis

- The 435th district was awarded to North Carolina.
- Was that a "close call"? Was there another state that "almost" won this last district? Quantify the close call.

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Example

```
C = CensusData;
Pop  = C(10).pop;
Reps = C(10).reps;
P = 0; D = 0;
for i=1:length(pop)
   P = P + Pop(i);
   D = D + Reps(i);
end
r = P/D;  % r is the ideal ratio based
          % on the 10th census
```

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