

The Apportionment Controversy

Bringing Down the House

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“... no political problem is less susceptible of a precise solution than that which relates to the number most convenient for a representative legislature, ...”

James Madison
The Federalist 55

The Apportionment Question

How many seats in the U.S.
House of Representatives
does each state get?

CONGRESSIONAL SEATS

2010
OFFICIAL RESULTS



(US population: 309,183,463)/435 = 710,767

<http://www.census.gov/2010census/data/apportionment-data.php>

The Constitution: Article I

Section 1. All legislative Powers herein granted shall be vested in a Congress of the United States, which shall consist of a Senate and House of Representatives.

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Section 2. The House of Representatives shall be composed of Members chosen every second Year by the People of the several States, . . .

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Representatives . . . shall be apportioned among the several States . . . , **according to their respective Numbers, . . .**

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The actual Enumeration shall be made within three Years after the first Meeting of the Congress . . . , **and within every subsequent Term of ten Years, . . .**

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The actual Enumeration shall be made within three Years after the first Meeting of the Congress . . . , **and within every subsequent Term of ten Years, . . .**

The Number of Representatives shall **not exceed one for every thirty Thousand**, but **each State shall have at Least one Representative; . . .**

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The Apportionment Question: Two Views

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- Transformation View:
- Distribution View:

The Apportionment Question: Two Views

- **Transformation View:** How to transform the census into seats in the House.
- **Distribution View:**

The Apportionment Question: Two Views

- **Transformation View:** How to transform the census into seats in the House.
- **Distribution View:** How to distribute a fixed number of seats to the States.

The Apportionment Question: Two Approaches

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- **Constituency Approach:**
- **House Size Approach:**

The Apportionment Question: Two Approaches

- **Constituency Approach:** How many people should a congressperson represent?
- **House Size Approach:**

The Apportionment Question: Two Approaches

- **Constituency Approach:** How many people should a congressperson represent?
- **House Size Approach:** How many seats should there be in the House?

The First Census 1790

State	Population
CT	236841
DE	55540
GA	70835
KY	68705
MD	278514
MA	475327
NH	141822
NJ	179570
NY	331589
NC	353523
PA	432879
RI	68446
SC	206236
VT	85533
VA	630560
US	3615920

The first apportionment population census.

Source:
Balinski and Young,
Fair Representation,
Second Edition, 2001,
page 158.

The First Census 1790

State		Population
CT	5	236841
DE	1	55540
GA	3	70835
KY	2	68705
MD	6	278514
MA	8	475327
NH	3	141822
NJ	4	179570
NY	6	331589
NC	5	353523
PA	8	432879
RI	1	68446
SC	5	206236
VT	2	85533
VA	10	630560
US	65	3615920

The first apportionment population census.

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The First Census 1790

State		Population
CT	5	236841
DE	1	55540
GA	3	70835
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NJ	4	179570
NY	6	331589
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RI	1	68446
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First Apportionment Bills

Census

House Bill

State Population	
CT	236841
DE	55540
GA	70835
KY	68705
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First Apportionment Bills

Census		House Bill
State	Population	Divisor 30000
CT	236841	
DE	55540	
GA	70835	
KY	68705	
MD	278514	
MA	475327	
NH	141822	
NJ	179570	
NY	331589	
NC	353523	
PA	432879	
RI	68446	
SC	206236	
VT	85533	
VA	630560	

First Apportionment Bills

Census		House Bill
State	Population	Divisor 30000
CT	236841	7.895
DE	55540	1.851
GA	70835	2.361
KY	68705	2.290
MD	278514	9.284
MA	475327	15.844
NH	141822	4.727
NJ	179570	5.986
NY	331589	11.053
NC	353523	11.784
PA	432879	14.429
RI	68446	2.282
SC	206236	6.875
VT	85533	2.851
VA	630560	21.019

First Apportionment Bills

Census		House Bill	
State	Population	Divisor 30000	Seats
CT	236841	7.895	7
DE	55540	1.851	1
GA	70835	2.361	2
KY	68705	2.290	2
MD	278514	9.284	9
MA	475327	15.844	15
NH	141822	4.727	4
NJ	179570	5.986	5
NY	331589	11.053	11
NC	353523	11.784	11
PA	432879	14.429	14
RI	68446	2.282	2
SC	206236	6.875	6
VT	85533	2.851	2
VA	630560	21.019	21

First Apportionment Bills

Census		House Bill	
State	Population	Divisor 30000	Seats
CT	236841	7.895	7
DE	55540	1.851	1
GA	70835	2.361	2
KY	68705	2.290	2
MD	278514	9.284	9
MA	475327	15.844	15
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RI	68446	2.282	2
SC	206236	6.875	6
VT	85533	2.851	2
VA	630560	21.019	21
			112

First Apportionment Bills

Census		House Bill		Senate Bill	
State	Population	Divisor	30000 Seats	Divisor	33000 Seats
CT	236841	7.895	7	7.177	7
DE	55540	1.851	1	1.683	1
GA	70835	2.361	2	2.147	2
KY	68705	2.290	2	2.082	2
MD	278514	9.284	9	8.440	8
MA	475327	15.844	15	14.404	14
NH	141822	4.727	4	4.298	4
NJ	179570	5.986	5	5.442	5
NY	331589	11.053	11	10.048	10
NC	353523	11.784	11	10.713	10
PA	432879	14.429	14	13.118	13
RI	68446	2.282	2	2.074	2
SC	206236	6.875	6	6.250	6
VT	85533	2.851	2	2.592	2
VA	630560	21.019	21	19.108	19
		112		105	

Hamilton's Method

Federalists apply a new idea:

1. Determine the House size, h .
2. Calculate each state's fair share of h :

$$\text{quota} = h \times \frac{\text{state population}}{\text{US population}}$$

The House Bill

Census

House Bill

State Population		Divisor 30000	Seats
CT	236841	7.895	7
DE	55540	1.851	1
GA	70835	2.361	2
KY	68705	2.290	2
MD	278514	9.284	9
MA	475327	15.844	15
NH	141822	4.727	4
NJ	179570	5.986	5
NY	331589	11.053	11
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VA	630560	21.019	21

The House Bill

Census

House Bill

State Population		Divisor 30000	Seats
CT	236841	7.895	7
DE	55540	1.851	1
GA	70835	2.361	2
KY	68705	2.290	2
MD	278514	9.284	9
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SC	206236	6.875	6
VT	85533	2.851	2
VA	630560	21.019	21
			112

The House Bill

Census

House Bill

State Population		Divisor 30000	Seats	Quota $h=112$
CT	236841	7.895	7	7.336
DE	55540	1.851	1	1.720
GA	70835	2.361	2	2.194
KY	68705	2.290	2	2.128
MD	278514	9.284	9	8.627
MA	475327	15.844	15	14.723
NH	141822	4.727	4	4.393
NJ	179570	5.986	5	5.562
NY	331589	11.053	11	10.271
NC	353523	11.784	11	10.950
PA	432879	14.429	14	13.408
RI	68446	2.282	2	2.120
SC	206236	6.875	6	6.388
VT	85533	2.851	2	2.649
VA	630560	21.019	21	19.531
			112	112

The House Bill

Census		House Bill		
State	Population	Divisor 30000	Seats	Quota $h=112$
CT	236841	7.895	7	7.336
DE	55540	1.851	1	1.720
GA	70835	2.361	2	2.194
KY	68705	2.290	2	2.128
MD	278514	9.284	9	8.627
MA	475327	15.844	15	14.723
NH	141822	4.727	4	4.393
NJ	179570	5.986	5	5.562
NY	331589	11.053	11	10.271
NC	353523	11.784	11	10.950
PA	432879	14.429	14	13.408
RI	68446	2.282	2	2.120
SC	206236	6.875	6	6.388
VT	85533	2.851	2	2.649
VA	630560	21.019	21	19.531
			112	112

The Quota Rule
is violated.

The Senate Bill

Census

Senate Bill

State Population		Divisor 33000 Seats	
CT	236841	7.177	7
DE	55540	1.683	1
GA	70835	2.147	2
KY	68705	2.082	2
MD	278514	8.440	8
MA	475327	14.404	14
NH	141822	4.298	4
NJ	179570	5.442	5
NY	331589	10.048	10
NC	353523	10.713	10
PA	432879	13.118	13
RI	68446	2.074	2
SC	206236	6.250	6
VT	85533	2.592	2
VA	630560	19.108	19
			105

The Senate Bill

Census

Senate Bill

State Population		Divisor 33000 Seats		Quota $h=105$
CT	236841	7.177	7	6.877
DE	55540	1.683	1	1.613
GA	70835	2.147	2	2.057
KY	68705	2.082	2	1.995
MD	278514	8.440	8	8.088
MA	475327	14.404	14	13.803
NH	141822	4.298	4	4.118
NJ	179570	5.442	5	5.214
NY	331589	10.048	10	9.629
NC	353523	10.713	10	10.266
PA	432879	13.118	13	12.570
RI	68446	2.074	2	1.988
SC	206236	6.250	6	5.989
VT	85533	2.592	2	2.484
VA	630560	19.108	19	18.310
		105		105

Problem

Census		Senate Bill		
State	Population	Divisor	33000 Seats	Quota $h=105$
CT	236841	7.177	7	6.877
DE	55540	1.683	1	1.613
GA	70835	2.147	2	2.057
KY	68705	2.082	2	1.995
MD	278514	8.440	8	8.088
MA	475327	14.404	14	13.803
NH	141822	4.298	4	4.118
NJ	179570	5.442	5	5.214
NY	331589	10.048	10	9.629
NC	353523	10.713	10	10.266
PA	432879	13.118	13	12.570
RI	68446	2.074	2	1.988
SC	206236	6.250	6	5.989
VT	85533	2.592	2	2.484
VA	630560	19.108	19	18.310
		105		105

Large states are favored over small states.

Hamilton's Method

State	Population	
CT	236841	
DE	55540	
GA	70835	
KY	68705	
MD	278514	
MA	475327	
NH	141822	
NJ	179570	
NY	331589	
NC	353523	
PA	432879	
RI	68446	
SC	206236	
VT	85533	
VA	630560	
US	3615920	120.5307

$d = 30000$

Hamilton's Method

State	Population	$h = 120$
CT	236841	
DE	55540	
GA	70835	
KY	68705	
MD	278514	
MA	475327	
NH	141822	
NJ	179570	
NY	331589	
NC	353523	
PA	432879	
RI	68446	
SC	206236	
VT	85533	
VA	630560	
US	3615920	120.5307

$d = 30000$

Hamilton's Method

State	Population	$h = 120$	Quota
CT	236841		7.860
DE	55540		1.843
GA	70835		2.351
KY	68705		2.280
MD	278514		9.243
MA	475327		15.774
NH	141822		4.707
NJ	179570		5.959
NY	331589		11.004
NC	353523		11.732
PA	432879		14.366
RI	68446		2.271
SC	206236		6.844
VT	85533		2.839
VA	630560		20.926
US	3615920	120.5307	120

$d = 30000$

Hamilton's Method

State	Population	$h = 120$	Quota	Lower Q
CT	236841		7.860	7
DE	55540		1.843	1
GA	70835		2.351	2
KY	68705		2.280	2
MD	278514		9.243	9
MA	475327		15.774	15
NH	141822		4.707	4
NJ	179570		5.959	5
NY	331589		11.004	11
NC	353523		11.732	11
PA	432879		14.366	14
RI	68446		2.271	2
SC	206236		6.844	6
VT	85533		2.839	2
VA	630560		20.926	20
US	3615920	120.5307	120	111

$d = 30000$

Hamilton's Method

State	Population	$h = 120$	Quota	Lower Q	Appt
CT	236841		7.860	7	8
DE	55540		1.843	1	2
GA	70835		2.351	2	2
KY	68705		2.280	2	2
MD	278514		9.243	9	9
MA	475327		15.774	15	16
NH	141822		4.707	4	5
NJ	179570		5.959	5	6
NY	331589		11.004	11	11
NC	353523		11.732	11	12
PA	432879		14.366	14	14
RI	68446		2.271	2	2
SC	206236		6.844	6	7
VT	85533		2.839	2	3
VA	630560		20.926	20	21
US	3615920	120.5307	120	111	120

$d = 30000$

Hamilton's Method

State	Population	$h = 120$	Quota	Lower Q	Appt
CT	236841		7.860	7	8
DE	55540		1.843	1	2
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KY	68705		2.280	2	2
MD	278514		9.243	9	9
MA	475327		15.774	15	16
NH	141822		4.707	4	5
NJ	179570		5.959	5	6
NY	331589		11.004	11	11
NC	353523		11.732	11	12
PA	432879		14.366	14	14
RI	68446		2.271	2	2
SC	206236		6.844	6	7
VT	85533		2.839	2	3
VA	630560		20.926	20	21
US	3615920	120.5307	120	111	120

First apportionment bill passed by Congress.

Hamilton's Method

State	Population	$h = 120$	Quota	Lower Q	Appt
CT	236841		7.860	7	8
DE	55540		1.843	1	2
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MD	278514		9.243	9	9
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VA	630560		20.926	20	21
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First apportionment bill passed by Congress.

26 March 1792:
bill sent to President Washington for approval.

Hamilton's Method

State	Population	$h = 120$	Quota	Lower Q	Appt
CT	236841		7.860	7	8
DE	55540		1.843	1	2
GA	70835		2.351	2	2
KY	68705		2.280	2	2
MD	278514		9.243	9	9
MA	475327		15.774	15	16
NH	141822		4.707	4	5
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NY	331589		11.004	11	11
NC	353523		11.732	11	12
PA	432879		14.366	14	14
RI	68446		2.271	2	2
SC	206236		6.844	6	7
VT	85533		2.839	2	3
VA	630560		20.926	20	21
US	3615920	120.5307	120	111	120

First apportionment bill passed by Congress.

26 March 1792:
bill sent to President Washington for approval.

5 April 1792: Washington vetoes the bill.

Hamilton's Method

State	Population	$h = 120$	Quota	Lower Q	Appt
CT	236841		7.860	7	8
DE	55540		1.843	1	2
GA	70835		2.351	2	2
KY	68705		2.280	2	2
MD	278514		9.243	9	9
MA	475327		15.774	15	16
NH	141822		4.707	4	5
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RI	68446		2.271	2	2
SC	206236		6.844	6	7
VT	85533		2.839	2	3
VA	630560		20.926	20	21
US	3615920	120.5307	120	111	120

U.S.:
 $3615920/120 = 30,132.66\dots$

Hamilton's Method

State	Population	$h = 120$	Quota	Lower Q	Appt
CT	236841		7.860	7	8
DE	55540		1.843	1	2
GA	70835		2.351	2	2
KY	68705		2.280	2	2
MD	278514		9.243	9	9
MA	475327		15.774	15	16
NH	141822		4.707	4	5
NJ	179570		5.959	5	6
NY	331589		11.004	11	11
NC	353523		11.732	11	12
PA	432879		14.366	14	14
RI	68446		2.271	2	2
SC	206236		6.844	6	7
VT	85533		2.839	2	3
VA	630560		20.926	20	21
US	3615920	120.5307	120	111	120

Connecticut:
 $236841/8 = 29605.13$

Delaware:
 $55540/2 = 27770$

U.S.:
 $3615920/120 = 30,132.66...$

Basic Jefferson Method

After Washington's veto, in 6 days Congress passed the original Senate bill.

Washington signed it on 14 April 1972.

Basic Jefferson Method

1. Decide on a divisor (constituency).
2. Calculate each state's quotient:
$$\text{quotient} = \text{population} / \text{divisor}$$
3. A state's apportion is the quotient rounded down.

Basic Jefferson Method

1. Decide on a divisor (constituency).
2. Calculate each state's quotient:
$$\text{quotient} = \text{population} / \text{divisor}$$
3. A state's apportion is the quotient rounded down.

The House size is the sum of the state apportionments.

First 50 years

The method was used until 1840.

- ❖ 1790: $s = 15$; $d = 33000 \Rightarrow h = 105$
- ❖ 1800: $s = 16$; $d = 33000 \Rightarrow h = 141$
- ❖ 1810: $s = 17$; $d = 35000 \Rightarrow h = 181$
- ❖ 1820: $s = 24$; $d = 40000 \Rightarrow h = 213$
- ❖ 1830: $s = 24$; $d = 47700 \Rightarrow h = 240$

Basic Jefferson Method

Problems were discovered as the method was used;
however, the defects were evident from the start:

Basic Jefferson Method

Problems were discovered as the method was used; however, the defects were evident from the start:

- systematically favors larger states;
- can violate the Quota Rule.

John Quincy Adams

John Quincy Adams was concerned about the apportionment bill based on the 1830 census.

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John Quincy Adams was concerned about the apportionment bill based on the 1830 census.

Adams proposed amending Jefferson's method by rounding up rather than down.

But Adams has flaws similar to Jefferson: it can violate the quota rule; systematically favors **smaller** states over larger states.

James Dean

James Dean was professor of mathematics at the University of Vermont. Dean wrote Webster a letter suggesting a new method.

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James Dean was professor of mathematics at the University of Vermont. Dean wrote Webster a letter suggesting a new method.

Choose a divisor and calculate each state's quotient. Then round the decimal quotient that yields a constituency closest to the divisor.

James Dean

Divisor: 50,000.

Vermont's population: 280,657.

Vermont's quotient: $280,657/50,000 = 5.613$.

Then, Jefferson assigns 5 seats to Vermont; Adams, 6 seats.

5 seats constituency: $280,657/5 = 56,131$.

6 seats constituency: $280,657/6 = 46,776$.

Now 46,776 is closer to the target of 50,000.

Dean awards Vermont 6 seats.

Daniel Webster

Adams and Dean got Webster thinking.

Just round the decimal quotient normally:

if (decimal part) $< .5$, then round down;

if (decimal part) $> .5$, then round up.

1831

How to round a decimal?

Jefferson: down.

Adams: up.

Dean: closest to constituency.

Webster: normally.

1842

In 1842 the apportionment debate began with the political game: ***Divisor!*** On one day in the 242 member House, 59 motions were made to establish a divisor; values ranged from 30000 to 141000.

1842

The Apportionment Act of 1842 specified the divisor 70680 (result: House of 223) **with rounding using Webster's method.**

The Vinton Act

The Vinton Act of 1850 was passed to head off politicizing the census figures and adopt a permanent appropriation act.

Representative Samuel Vinton
Whig, Ohio



The Vinton Act

The Vinton Act **specified a House with 233** seats apportioned by Hamilton's method.

The Vinton Act

The Vinton Act **specified a House with 233** seats apportioned by Hamilton's method.

Experience exposed problems with the Vinton Act.

1920

- No re-apportionment act was passed.
- Congress could not agree on the method of apportionment.
- Prohibition played a significant role: the dries would not consider any allocation giving the wets more power.

Lessons from History

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when the number of House seats is increased, a state's apportion may decrease.

Alabama Paradox

Results from the 1900 census doomed Hamilton's method. In particular, Maine oscillated as follows:

3 members for House size 350-382, 386, 389-390

4 members for House size 383-385, 387-388, 391-400

Today

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Suppose a state's quotient
(state population/divisor) = $q = n.d$.

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Webster: round up if $q > n.5$.

Huntington-Hill: round up if $q \geq \sqrt{n(n+1)}$.

The Aftermath

Michel Balinski, Professor of Mathematics at SUNY Stony Brook, and H. Peyton Young, Professor of Mathematics at Johns Hopkins University, proved the following theorem in 1982:

There are no perfect apportionment methods. Any method that satisfies the quota rule produces paradoxes; any method that is free of the Alabama paradox may violate the quota rule.

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In particular, any divisor method may violate the quota rule;
any quota method produces paradoxes.

Well-Rounded Ideas

A ***modified divisor method*** first fixes the House size, then seeks a divisor that when the state's quotients are rounded and summed, the house size is achieved.

They Mean Well

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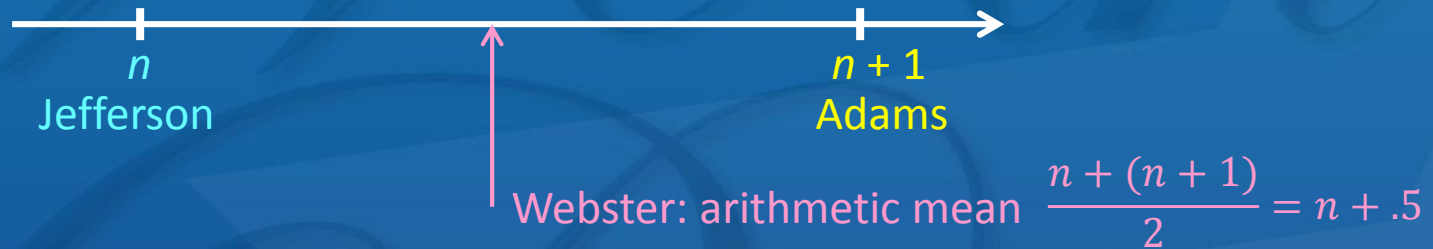
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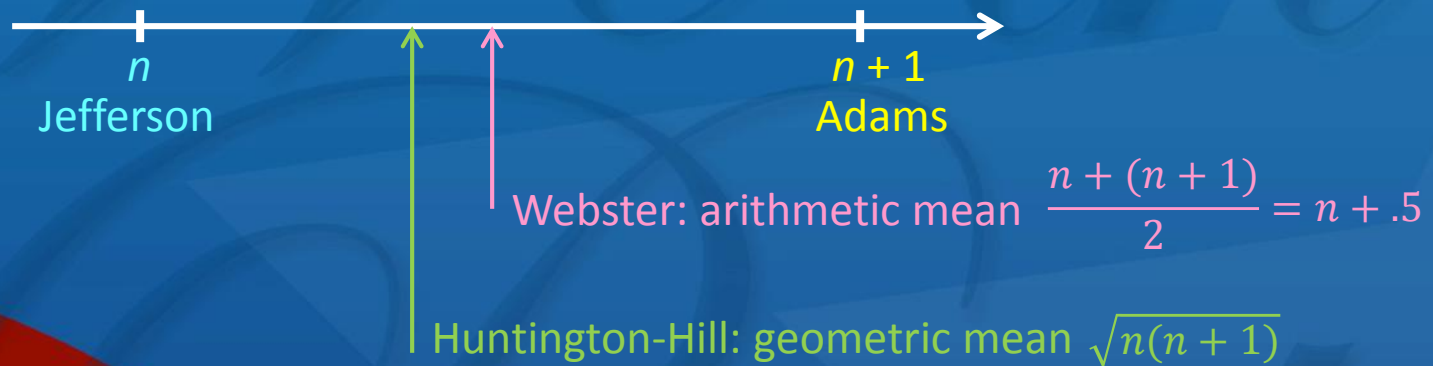
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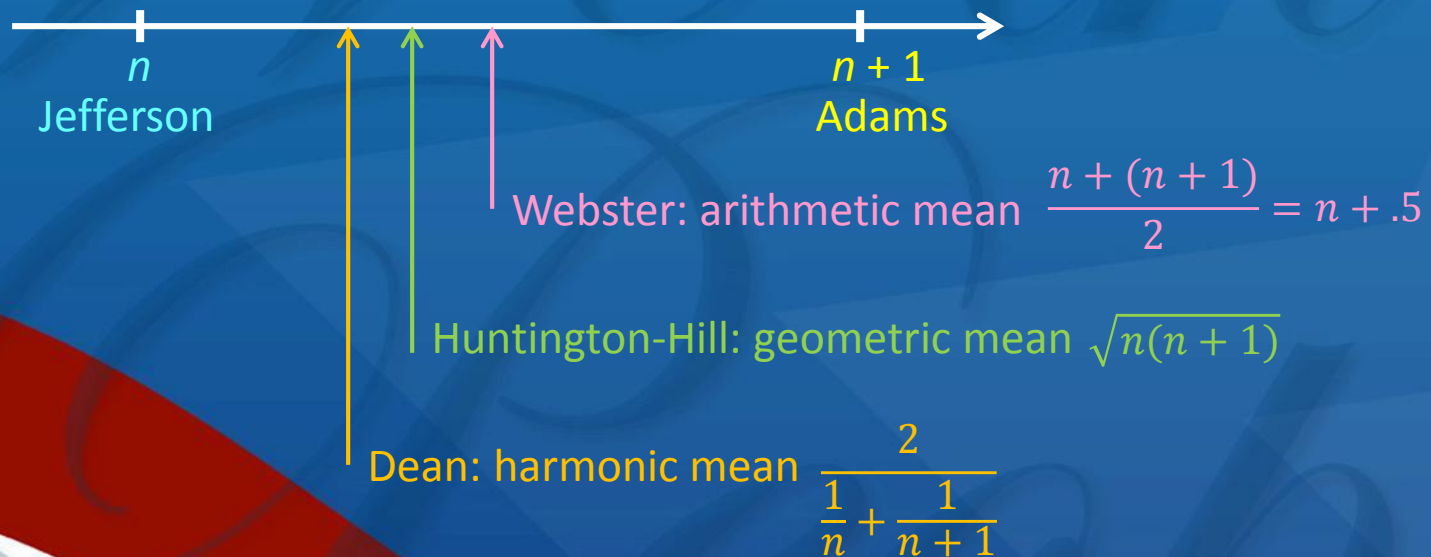
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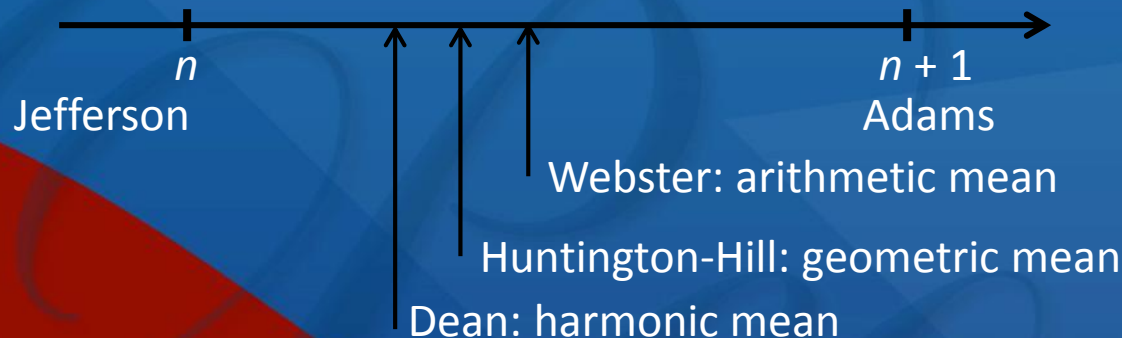
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Apportionment Problems

In the 1990 apportionment, Montana lost one of its two seats it held for 80 years. In 1991 MT filed suit in federal district court (MT vs. US Dept Commerce).

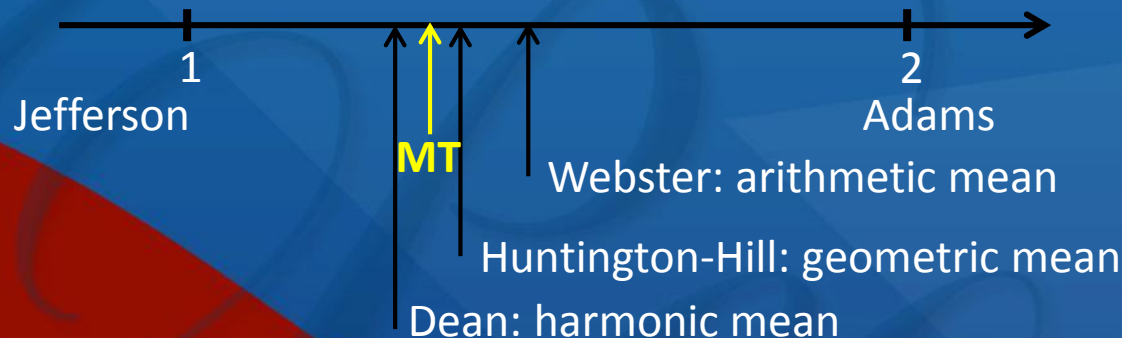
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The Apportionment Question

How many seats in the U.S.
House of Representatives
does each state get?

Reform

Three Proposals:

- Thirty-thousand.org
- The Wyoming Rule
- Neubauer and Gartner

thirty-thousand.org

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CA: 1244 seats!

The Wyoming Rule

The Wyoming Rule is a basic divisor method in which the divisor is the population of the least populous state (currently WY; hence, the name).

http://en.wikipedia.org/wiki/Wyoming_Rule

<http://www.outsidethebeltway.com/representation-in-the-house-the-wyoming-rule/>

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2010: smallest state: WY, 563626

$h = 543$ Dean **HI**

$h = 542$ Huntington-Hill

$h = 540$ Webster **NJ, SD**

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A Proposal for Apportioning the House

Michael G. Neubauer, CSU Northridge, Mathematics

Margo G. Gartner (master's degree student)

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Thank You

It is time that I took my seat in this House!

For more: <http://nia977.wix.com/drbcap>