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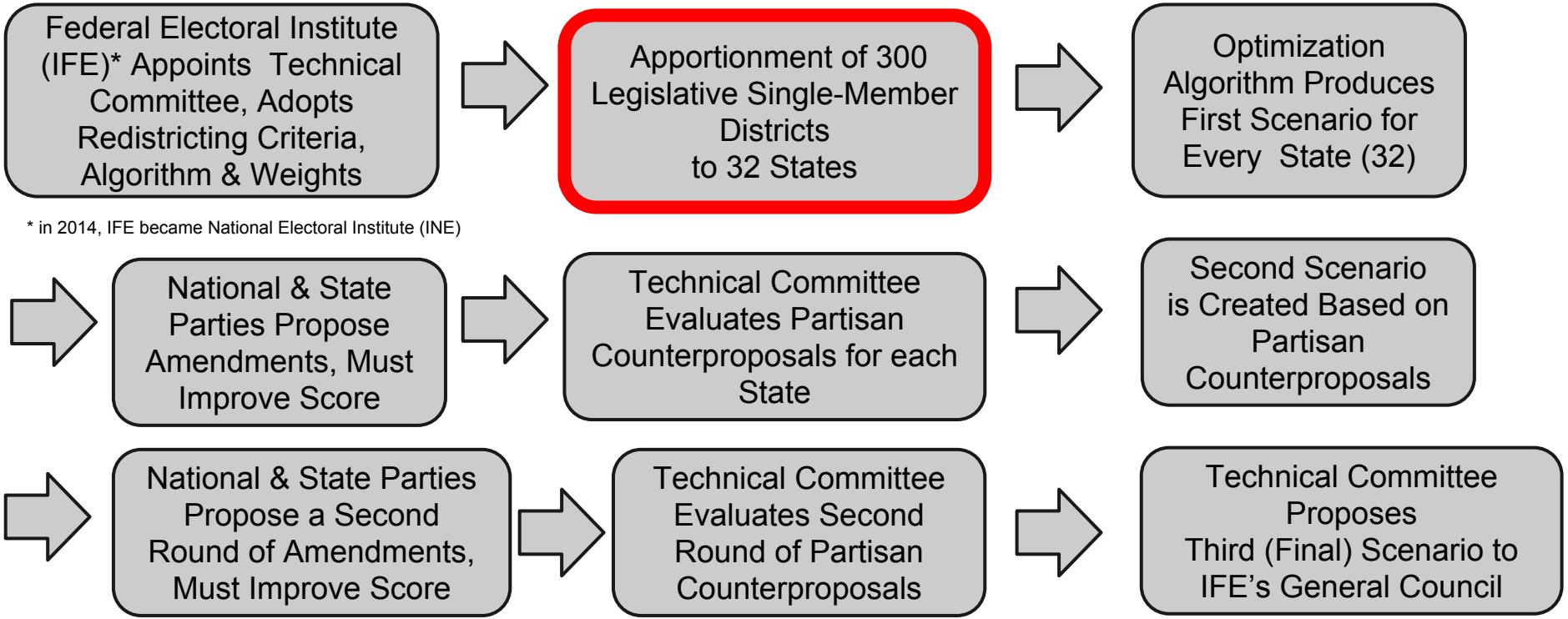
The Effects of Automated Redistricting and Partisan Strategic Interaction on Representation: The Case of Mexico

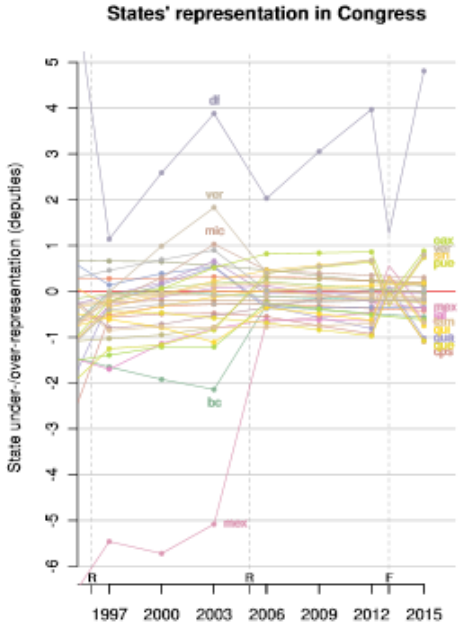
Mexico's Redistricting Process

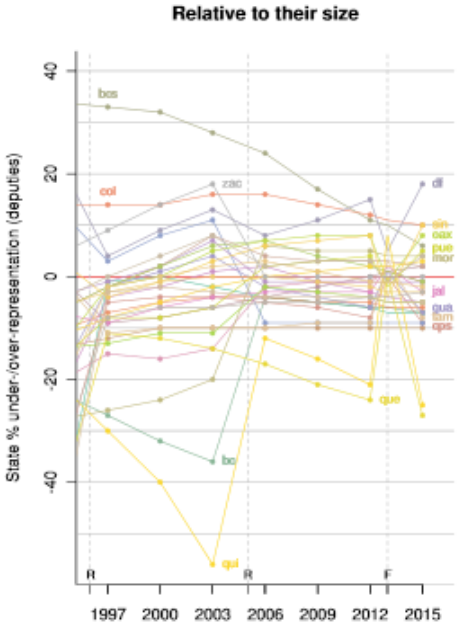


(Mal)apportionment

- Seats awarded to states using Hamilton method of largest remainders.
- Redistricting is based on censuses conducted in years ending in ‘0’, but redistricting can happen any time.
  - Since Mexico has 300 single-member districts, new plans have been drawn for the 1979, 1997, 2006, and 2015 elections.

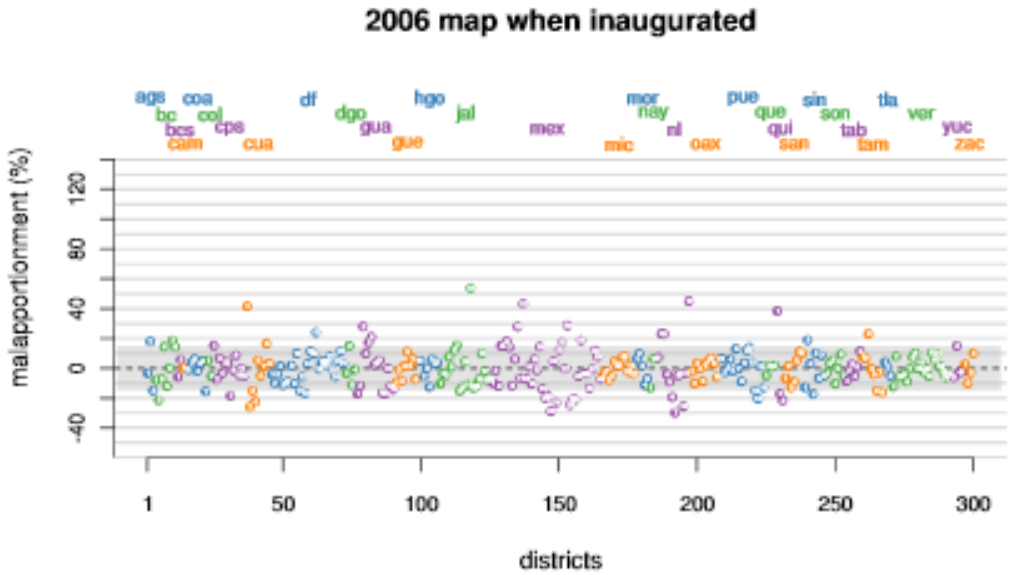
(Mal)apportionment





(Mal)apportionment

Unequal district population size due to use of out-of-date census



Grey band represents IFE's allowed population tolerance, using most recent census, our figures project population to time of redistricting

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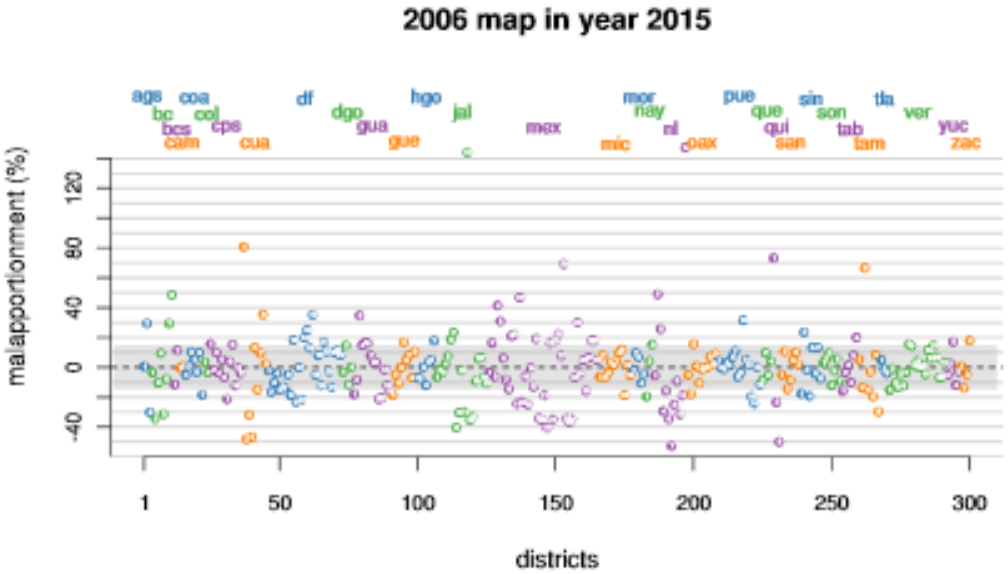

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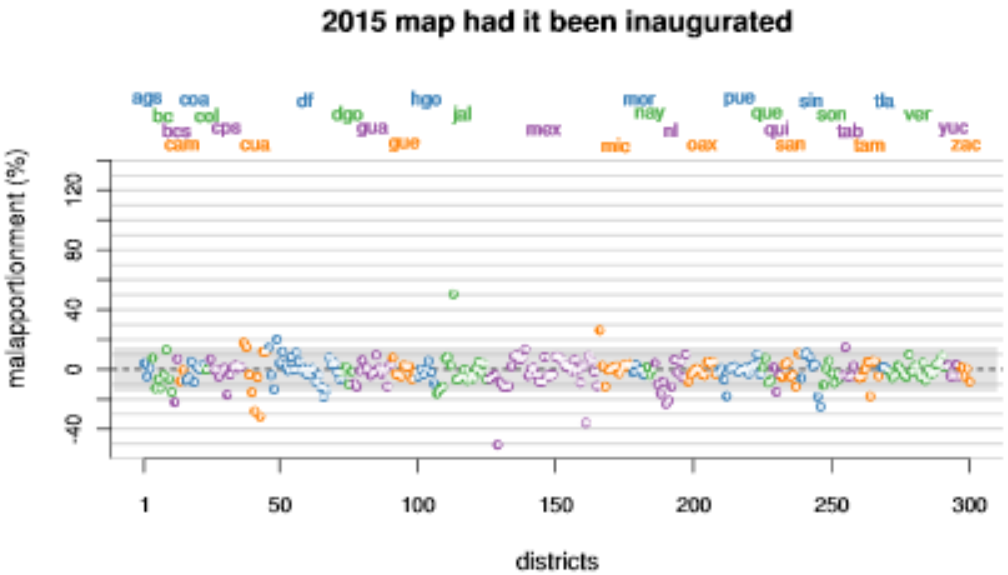

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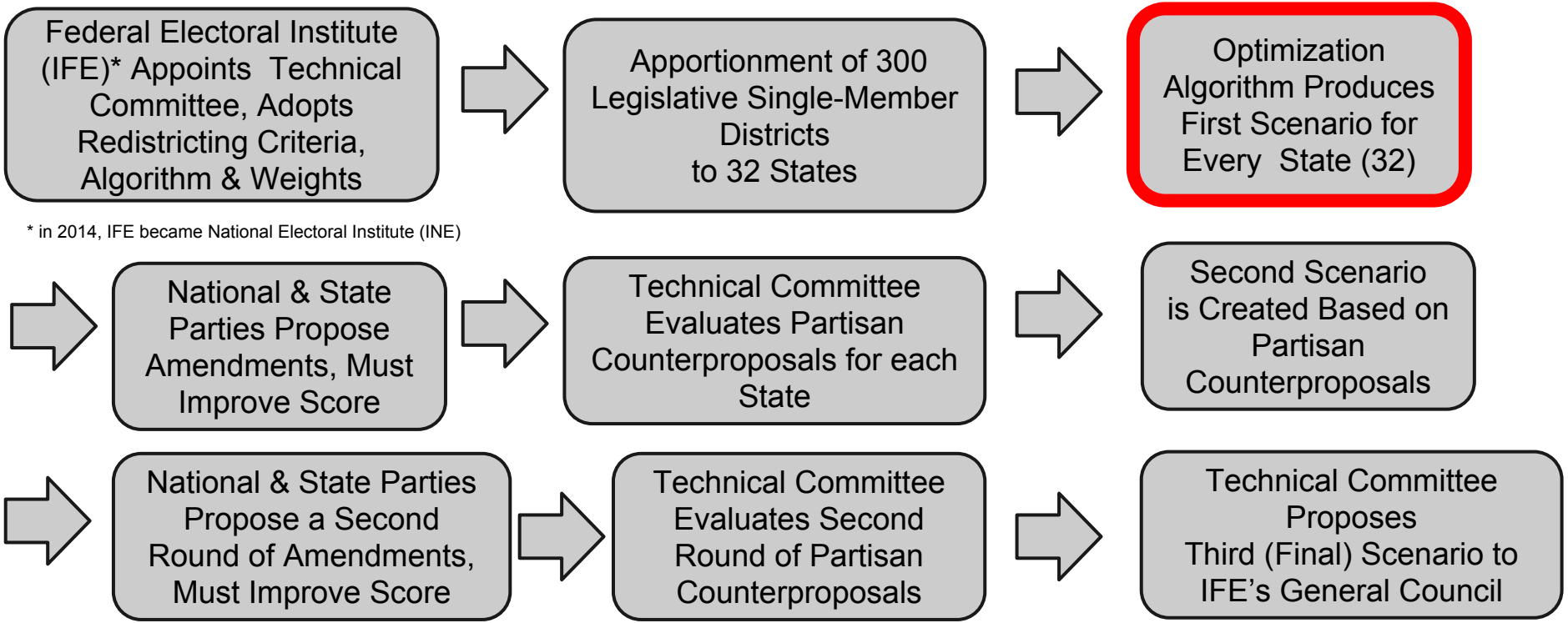


Optimization Cost Function*

$$C(E) = \sum_{i=1}^{4} \propto_i C_i(E) = \propto_1 C_1(E) + \propto_2 C_2(E) + \propto_3 C_3(E) + \propto_4 C_4(E)$$

$C_1(E)$ = Population balance (up to +/- 15% tolerance). Weight: $\alpha_1 = 40\%$

$C_2(E)$ = Preservation of municipality boundaries. Weight: $\alpha_2 = 30\%$

$C_3(E)$ = Minimization of travel time. Weight: $\alpha_3 = 20\%$

$C_4(E)$ = District Compactness. Weight: $\alpha_4 = 10\%$

Base geography (*secciones*) modified such that indigenous communities (municipios with at least 40% of indigenous population) cannot be split.

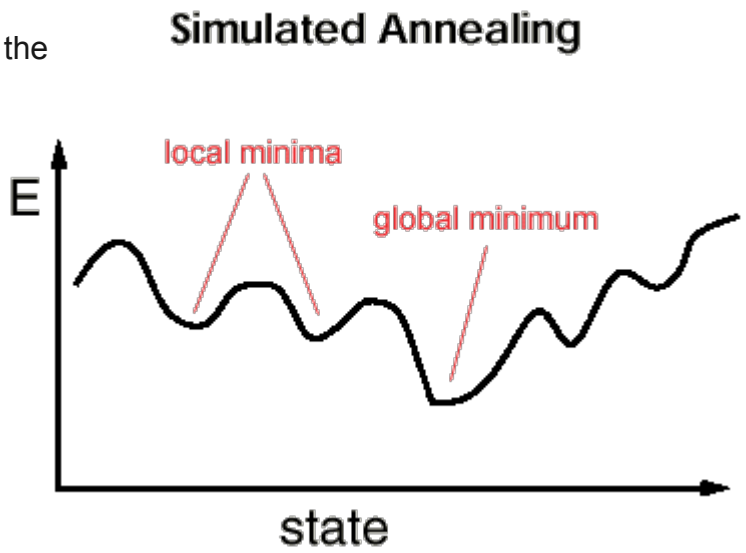
*Source: Federal Electoral Institute Agreement CG50/2013

Optimization Algorithm

Simulated Annealing. Probabilistic meta-heuristic for the global optimization problem of locating a good approximation to the global optimum of a given function in a large search space.

The algorithm attempts to find the global minimum temperature of the **cost function** through thousands of iterations (using secciones) and restricted by the four parameters mentioned above.

This combinatorial optimization algorithm was used to generate the first scenario in every one of the 32 states.



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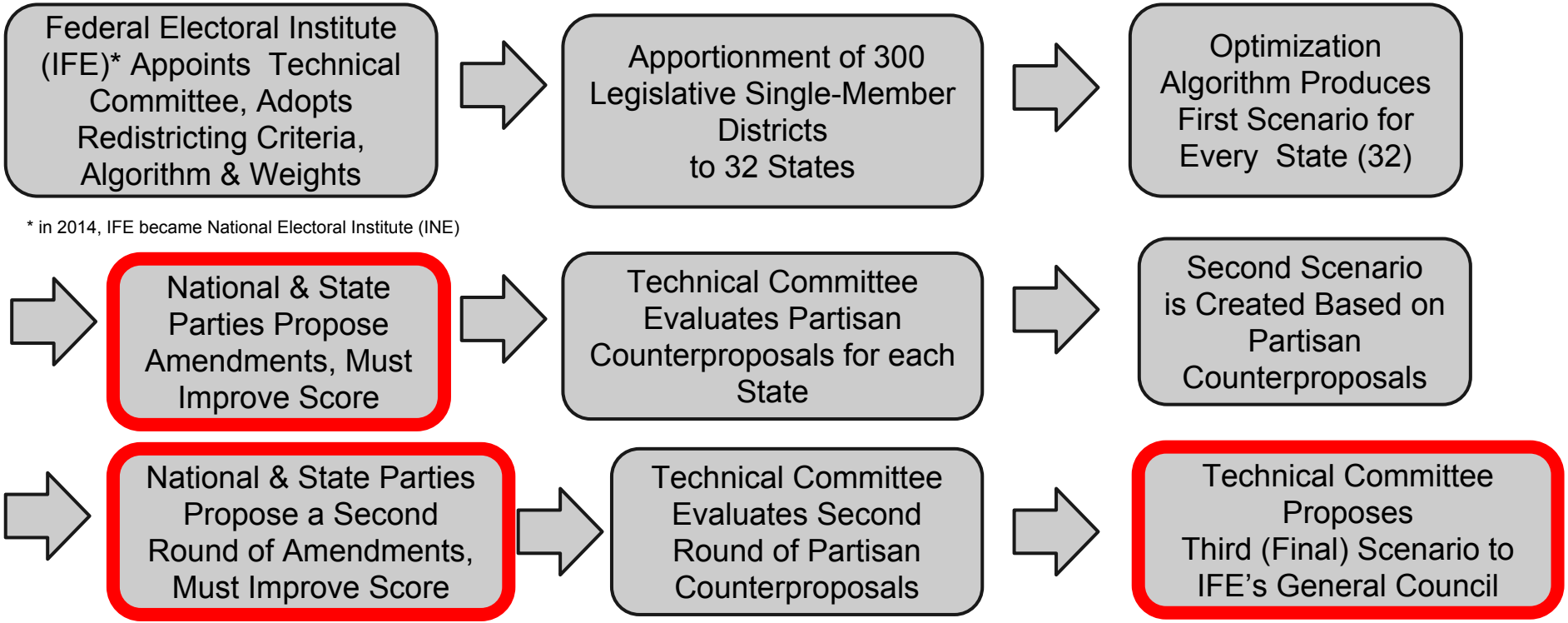


Party Amendments

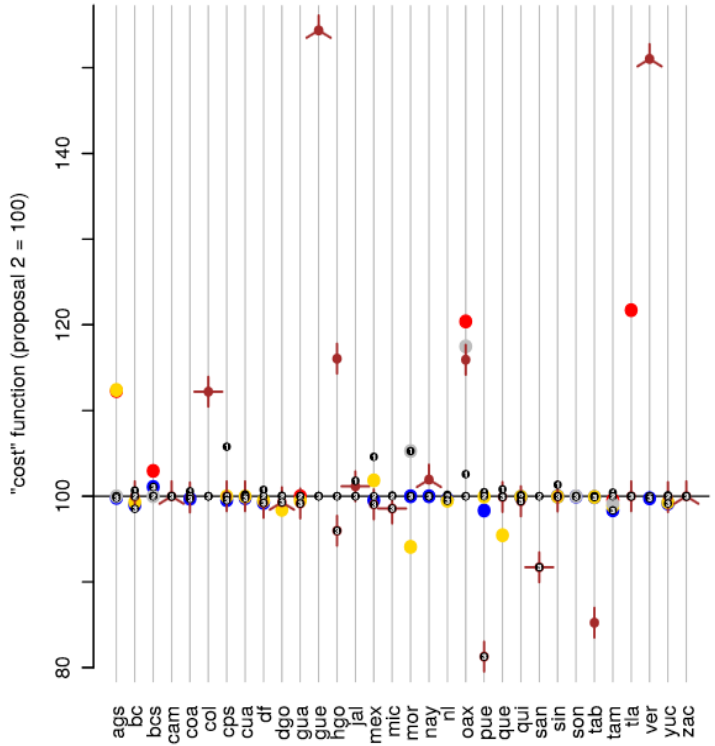
(Accepted)/(Proposed)

Party	National	State	Total 1st	National	State	Total 2nd	Total
PAN	17/22	2/20	19/42	17/24	4/16	21/40	40/82
PRI	0/0	2/28	2/28	8/30	6/26	14/56	16/84
PRD	3/27	2/21	5/48	5/29	5/18	10/47	15/95
PT	1/12	1/20	2/22	3/15	1/16	4/31	6/53
PVEM	0/0	1/20	1/20	7/28	3/17	10/45	11/65
MC	1/17	0/21	1/38	6/32	2/16	8/48	9/86
PNA	0/1	1/18	1/19	4/11	3/17	7/28	8/47
IFE	0/0	1/9	1/9	0/0	5/13	5/13	6/22
TOTAL	22/79	10/157	32/226	50/169	29/139	43/308	111/534

Party Amendments

cost scores relative to 2nd scenario

1st, 2nd & 3rd (final) Scenarios	Black numbered circles
PAN	Blue
PRI	Red
PRD	Gold
Minor	Grey
Overlaps	Brown, with a leaf for each overlap



Party Amendments

Change to districts (% of new district population in old district)

Similarity Between	min	25%	median	75%	max
2006 plan & 1st 2015 scenario	0.128	0.419	0.584	0.755	1
2006 plan & 3rd 2015 scenario	0.125	0.437	0.643	0.805	1
1st 2015 scenario & 3rd 2015 scenario	0.174	0.643	0.967	1	1

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Changes to districts from 1st to 3rd (final) scenarios generally led to districts being more similar to existing districts

Party Amendments

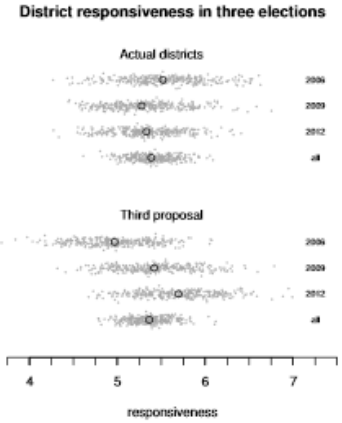
Automation vs. Party Strategic Behavior

- Humans can beat the computer(!), which enables manipulation.
- Smoking gun: four plans (3 PRD and one PRI/PVEM) objectively improved score, but were not adopted.
- Cannot know if other plans that improved score, but hurt parties, exist since they were not proposed.
    - Increased similarity of final plan to existing plan suggestive that only plans that favored status quo were proposed.
- Not all parties had the same capacity to produce efficient counterproposals.
- Parties are learning to interact strategically and more “rational” behavior is expected in subsequent rounds of redistricting at the national and local level (future research agenda).
    - PAN was, by far, the most effective in producing low cost counterproposals, but with marginal benefits for the party.

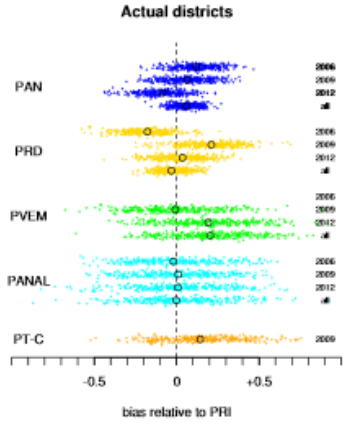
Bias and Responsiveness

- Estimate across states
  - Average seats = 9.4, tends to increase estimate of responsiveness.
  - Bias estimates presented relative to PRI, positive number indicates bias in favor of party relative to PRI

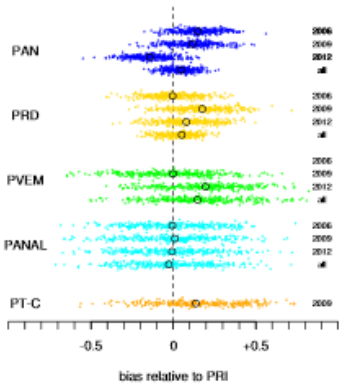
(a)


District responsiveness in three elections
Actual districts
2006
2009
2012
all
Third proposal
2006
2009
2012
all
4
5
6
7
responsiveness

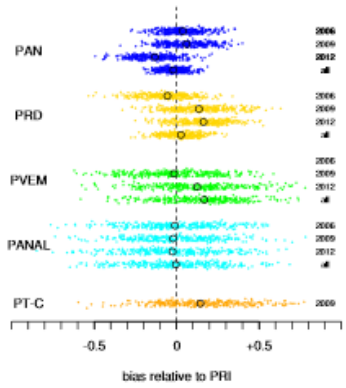
(b)


Actual districts
PAN
PRD
PVEM
PANAL
PT-C
2006
2009
2012
all
-0.5
0
+0.5
bias relative to PRI

(c)


First proposal
PAN
PRD
PVEM
PANAL
PT-C
2006
2009
2012
all
-0.5
0
+0.5
bias relative to PRI

(d)


Third proposal
PAN
PRD
PVEM
PANAL
PT-C
2006
2009
2012
all
-0.5
0
+0.5
bias relative to PRI

Bias and Responsiveness

- For current districts
  - Bias favors PRD in 2006, but favors PRI in 2009
- 2015 redistricting
  - No bias for PAN and PRD,
  - Bias favoring PVEM and PT-C
  - Slight bias favoring PRD in 1st Scenario reduced in 3rd Scenario
    - Failed PRD amendments

Conclusions

- Mexico's use of automated optimal redistricting algorithm allows strategic party amendments by virtue of limitations of automated redistricting algorithms.
- Strategic behavior is constrained. Any malapportionment or redistricting bias appears dominated by electoral conditions.