Modeling and Simulation of French Elections
Yves A. Paegay / INRIA Sophia Antipolis Méditerranée

Abstract

First round of the French regional elections took place on March 14th, 2010, and second round on March 21st. The official results were available online very few time after the end of the consultation. During the week between the two rounds, surveys were very popular, as well as public debates, analyses of strategies of alliances, and people were very excited in showing statistics, trying to predict or discover what will be the final results.

Instead of using more or less well founded statistical approaches to forecast the results of the second round, we developed a complete model at the granularity of municipalities based on similar elections in 2004. Our guess was that at this level the reactions of people to political alliances should be very similar from one election to the next one.

We will described our approaches and implementations, and demonstrated that Mathematica is really a valuable tool for performing very easily the necessary tasks of such a modeling and simulation process: acquiring data, checking it, analyzing it, building models, prototyping simulation engines, and visualizing the results.

In this current talk, we are focusing on the models themselves. We will describe namely:

- how a textual analysis of the lists of candidates could provide heuristics to derive the models,
- how models can help in verifying political hypothesis on what has an influence on votations,
- how uncertainty in models can be held with the help of intervals
- how the developed framework could be easily extended to analyse and/or predict results of elections everywhere in the world

Presentation

Motivations
- an original application of modeling and simulation methods
- case study of decent size with available data
- big potential of application

Regional Elections
- Two-rounded elections held every 6 years
- 43 millions of people electing 1880 councillors in 26 regions
- List votation with merging between the 2 rounds

Results
- Published on the web
- Given in terms of regions (26), departments (100) and communes (36718)
Given in terms of votes and of number of elected people, for list of candidates and political families
Data Acquisition

Web - Based : "SLAMing" the site (75)
Data Model

Datas (100)

Geographical Data

Political Data

Regions

Departments

- Department Code: "041"
- # of Communes: 291
- Region: "024"

Regions Departments

Geographical Data

Political Data

Department Code

# of Communes

Region
Results (75)

France | Regions | Departments

![Chart showing data for France, Regions, and Departments with bar plots and pie charts.](talkyvesPapegay.nb)
Data Curating

A vote cannot be lost

At France level

CheckResult[year_, round_, "FRANCE"] :=
  FranceResult[year, round, "Inscrits"] - (FranceResult[year, round, "Abstentions"] + FranceResult[year, round, "Blancs ou nuls"] + Total[Map[FranceResult[year, round, n] &, familyCodes[year, round]]]) = 0

Outer[CheckResult[H1, H2, "FRANCE"] &, {"04", "10"}, {"H1", "H2"}]
Position[{}, Except[True], {3}, Heads -> False]
  {True, True}, {True, True}

{};

At Region level

CheckRegionResult[year_, round_, reg_] :=
Outer[CheckRegionResult, {"04", "10"}, {"R1", "R2"}, regionCodes[]];
Position[%, Except[True], {3}, Heads -> False] 

At Department level

CheckDepartmentResult[year_, round_, dept_] :=
If[ListQ[Candidat[year, round, Region[dept]]],
DepartmentResult[year, round, "Inscrits", dept] -
(DepartmentResult[year, round, "Abstentions", dept] +
DepartmentResult[year, round, "Blancs ou nuls", dept]) +
Total[Map[DepartmentResult[year, round, n, dept] &,
Candidate[year, round, Region[dept]]]] == 0, True]

Outer[CheckDepartmentResult, {"04", "10"}, {"R1", "R2"}, departmentCodes[]];
Position[%, Except[True], {3}, Heads -> False] 

At Commune level

CheckCommuneResult[year_, round_] := Map[CheckCommuneResult[year, round, n] &, communeCodes[year]]

CheckCommuneResult[year_, round_, comm_] :=
If[ListQ[Candidat[year, round, Region[Department[comm]]]],
CommuneResult[year, round, "Inscrits", comm] -
(CommuneResult[year, round, "Abstentions", comm] +
CommuneResult[year, round, "Blancs ou nuls", comm]) +
Total[Map[CommuneResult[year, round, n, comm] &,
Candidate[year, round, Region[StringTake[comm, 3]]]]] == 0, True]

Outer[CheckCommuneResult, {"04", "10"}, {"R1", "R2"}];
Position[%, Except[True], {3}, Heads -> False] 

Geographical Consistency

Between France and Regions

Clear[check]
check[year_, round_] := Map[check[year, round, n] &,
Join[{"Inscrits", "Abstentions", "Blancs ou nuls", "Exprimés", "Votants"}, familyCodes[year, round]]]
check[year_, "R1", res_] := FranceResult[year, "R1", res] +
Total[Map[RegionResult[year, "R1", res, n] &, regionCodes[year]]]
check[year_, "R2", res_] := FranceResult[year, "R2", res] +
Total[Map[RegionResult[year, "R2", res, n] &, Select[regionCodes[year], ListQ[Candidat[year, "R2", n]]]]]

Outer[check[SI, S2] &, {"04", "10"}, {"R1", "R2"}];
Position[%, Except[True], {3}, Heads -> False] 

Between Regions and Departments

Clear[check]
check[year_, round_, region_] := Map[check[year, round, n] &, regionCodes[year]]
check[year_, round_, region_] := If[ListQ[Candidat[year, round, region]],
Map[check[year, round, n, region] &,
Join[{"Inscrits", "Abstentions", "Blancs ou nuls", "Exprimés", "Votants"}, Candidat[year, round, region]]], {True}]
check[year_, round_, res_, region_] := RegionResult[year, round, res, region] ==
Total[Map[DepartmentResult[year, round, res, region] &,
Department[region]]]

Outer[check[SI, S2] &, {"04", "10"}, {"R1", "R2"}];
Position[%, Except[True], {4}, Heads -> False] 

Between Departments and Communes

Clear[check]
check[year_, round_, dept_] := Map[check[year, round, n] &, departmentCodes[year]]
check[year_, round_, dept_] :=
If[ListQ[Candidat[year, round, Region[dept]]],
Candidat[year, round, Department[dept]]], {True}]
check[year_, round_, res_, dept_] := DepartmentResult[year, round, res, dept] ==
Total[Map[CommuneResult[year, round, res, n] &, Commune[year, dept]]]

Concerning Seats

At Region level

CheckSeats[year_, round_, reg_] := If[ListQ[Candidate[year, round, reg]],
   Seats[year, round, reg] == Total[Map[Seats[year, round, n, reg] &, Candidate[year, round, reg]]], True]

Outer[CheckSeats, ({"04", "10"}, {"R1", "R2"}, regionCodes[]);
Position[%, Except[True], {3}, Heads -> False]
]

Between France and Regions

Clear[check]
check[year_, round_] := Map[check[year, round, n] &, familyCodes[year, round]]
check[year_, "R1", res_] :=
   Seats[year, "R1", res, "FRANCE"] == Total[Map[Seats[year, "R1", res, n] &, regionCodes[year]]]
check[year_, "R2", res_] := Seats[year, "R2", res, "FRANCE"] ==
   Total[Map[Seats[year, "R2", res, n] &, Select[regionCodes[year], ListQ[Candidate[year, "R2", n]] &]]]

Outer[check[R1, R2] &, ({"04", "10"}, {"R1", "R2"})];
Position[%, Except[True], {3}, Heads -> False]
]

Seats compare to Results

Map[Seats["10", "R2", n, "093"] &, Candidate["10", "R2", "093"]]

{21, 30, 72}

CompareSeats[year_, round_, region_] :=
    Map[Seats[year, round, n, region] &, Candidate[year, round, region]] - ComputedSeats[year, round, region]
Map[CompareSeats["04", "R1", m] & regionCodes["04"]]
Map[CompareSeats["04", "R2", m] & regionCodes["04"]]
Map[CompareSeats["10", "R1", m] & regionCodes["10"]]
Map[CompareSeats["10", "R2", m] & Rest[regionCodes["10"]]]

{{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}}

{{0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0},
 {0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0}}

Map[CompareSeats["10", "R1", m] & regionCodes["10"]]

Model\{\}

Principle

Modelling
ComputeSeat
Linear Model

Perform a Political Analysis (or Test a Political Hypothesis)

\[
\text{VoteTransfert} =
\begin{pmatrix}
0.85 & 0.73 & 0.96 & 0.67 & 0.87 & 0.99 & 0.3 & 0.24 & 0.3 \\
0 & 0.2 & 0 & 0.23 & 0.6 & 0 & 0.3 & 0.42 & 0.4 \\
0.05 & 0 & 0 & 0 & 0.2 & 0 & 0.3 & 0.08 & 0.0
\end{pmatrix}
\]
Conclusion: Results

SlideView[
Map/GraphicsRow[{PieChart[(Map[Last, reals[[#]]], Map[Last, expecteds[[#]]])], ChartLegends -> Map[First, reals[[#]]],
  France[regionCodes[[#[1]]]], ImageSize -> 800] &,
Range[Length[regionCodes]] - 1]], AppearanceElements -> {"SliderControl", "PlayPauseButton"}
}
Code

 Quit[]

Data Acquisition

Configuration
Source
Visiting Index Pages
Visiting France Page
Visiting Pages of Regions
Visiting Pages of Departments
Visiting Pages of Communes
Visiting Candidates Pages

Presentation

Data Acquisition
Map acquisition
Data Model
Conclusion

Data Model
Geographical codes
Political Concerns
Results