Mining Administrative Databases: An application to Developing Countries

Alvaro J. Riascos
University of los Andes and Quantil

HACKER DOJO

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Contents

Introduction

- Traditional databases (transactional, communications, images, financial, auctions, health records, surveys, etc.) contain core information.
- Usually it is costly to obtain this information or there are real consequences at stake.
- Their study is sometimes theory based (auctions, health records, surveys, etc.)
- Machine learning and data mining techniques provide new tools for exploring traditional databases complemented or not with sound theories.

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Health records

- Colombia has a mandatory competitive health insurance system.
- Every person is entitled to a (broad) health insurance package.
- Specialized private institutions (HMOs) compete for affiliates and act as health insurance. They pay health providers (hospitals) for health services.
- In turn, at the beginning of every year the government pays insurance providers a risk adjusted payment per affiliate (a capitation payment).

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- Capitation payments are determined using information provided by HMOs. Risk of manipulation, misreport, errors, etc.
- The problem to be solved is to design a system that helps the Ministry to detect all sorts of anomalous behaviour.
- Key elements:
  1. Diagnostic related groups: Long Duration Medical Conditions Groups - LDG (this is where theory is critical).
  2. Unsupervised learning techniques (we use the concept of relative entropy).

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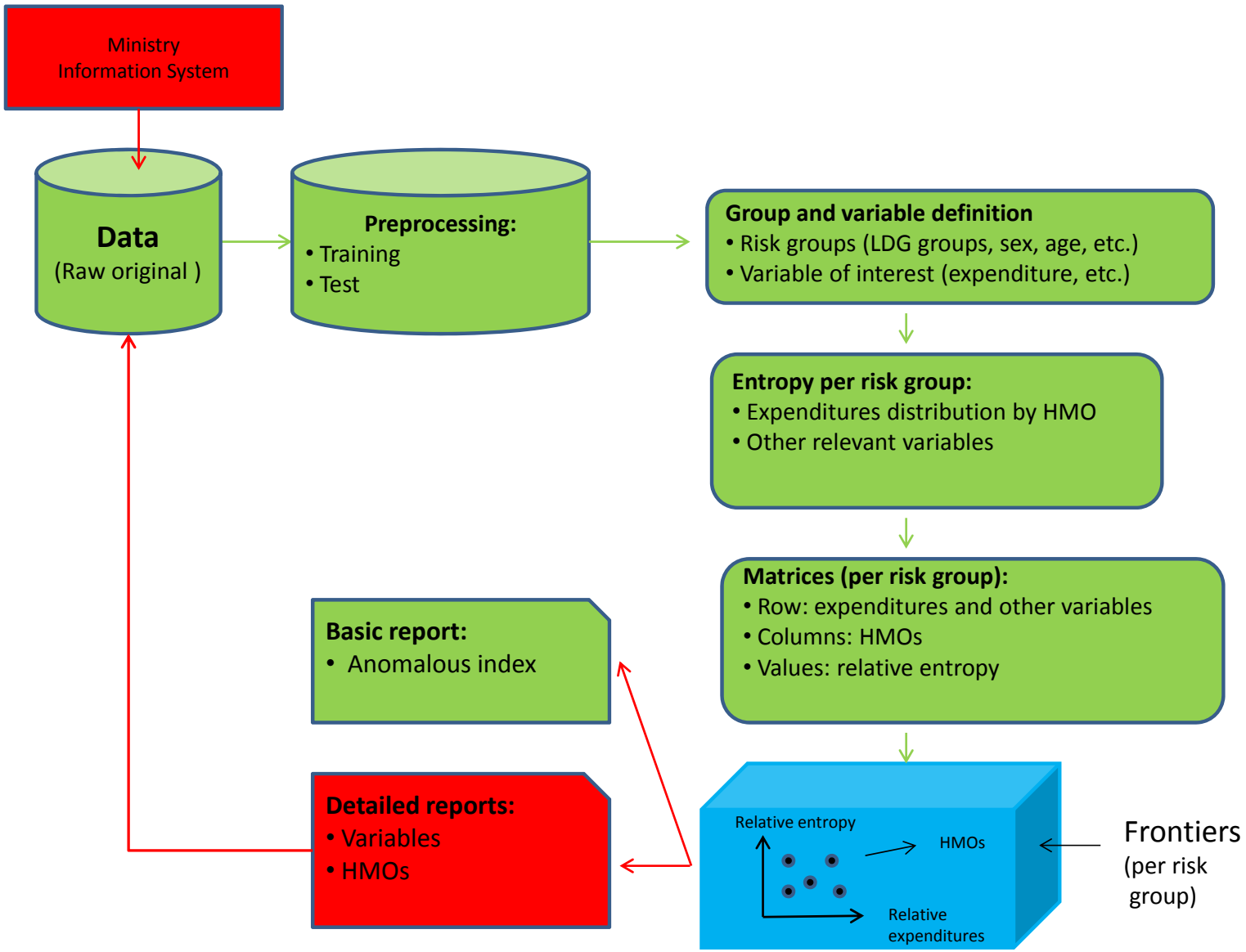

Health records

- Any data visualization technique, correlation analysis, etc. on this data set is extremely valuable for policy makers and health scientists.
- We've explored:
  1. Risk adjustment (exante and expost).
  2. Evaluated policy interventions (e.g. the expected cost of structural reforms such as introducing an almost unlimited health benefit package).

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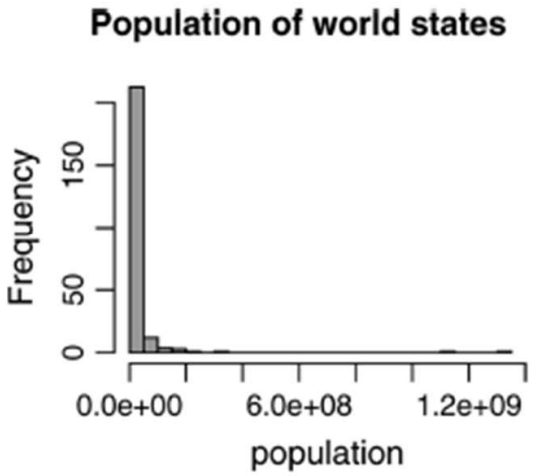
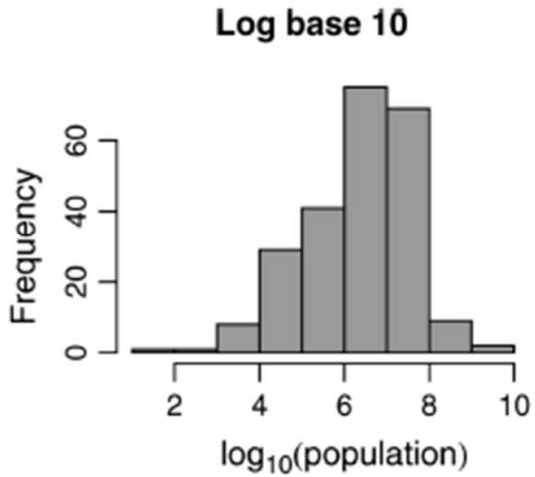
Nationwide Elections

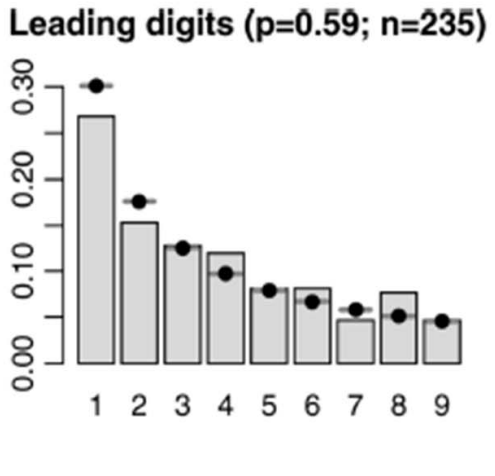
- Problem: detect anomalous behaviour in voting.
- Three main techniques:
  1. Benford Law (little down to earth theory).
  2. Beber and Sccaco tests (some theory).
  3. Supervised learning (a theory of fraud).

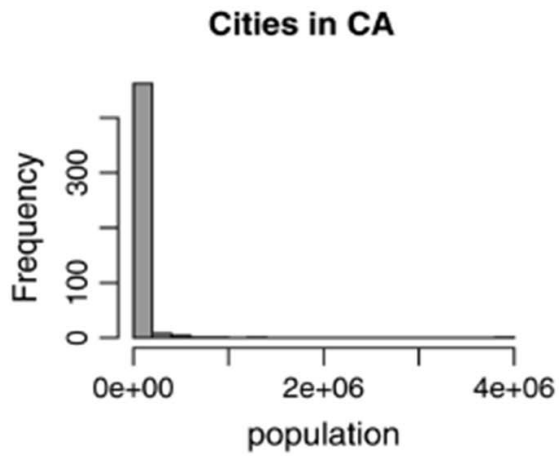
Nationwide Elections

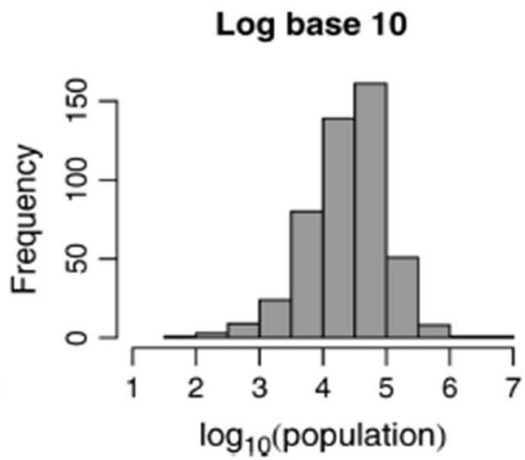
- Benford law

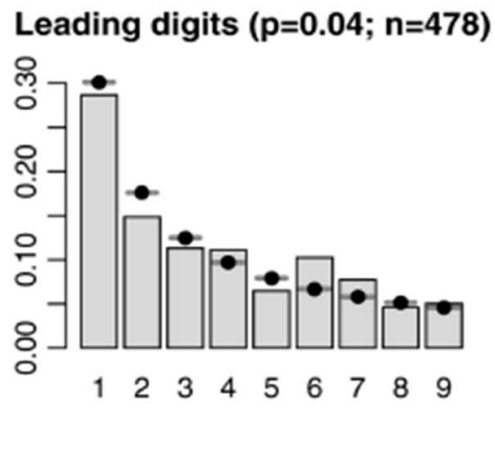












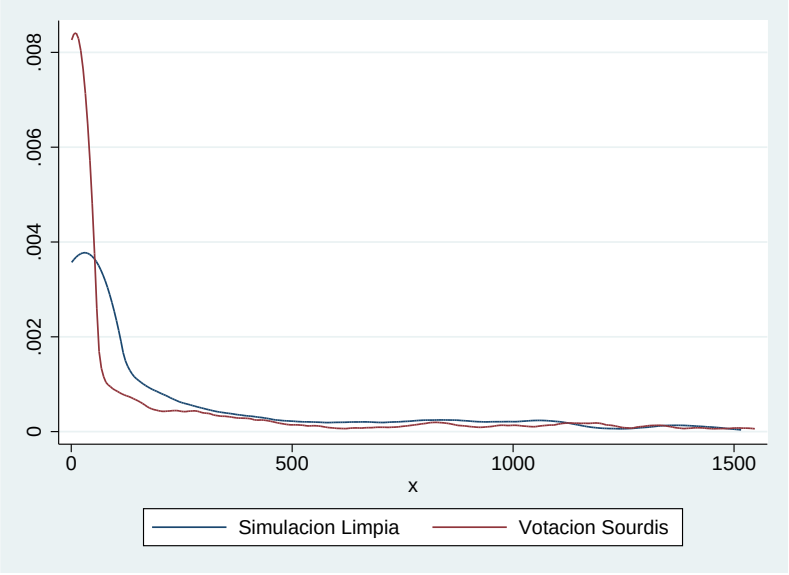
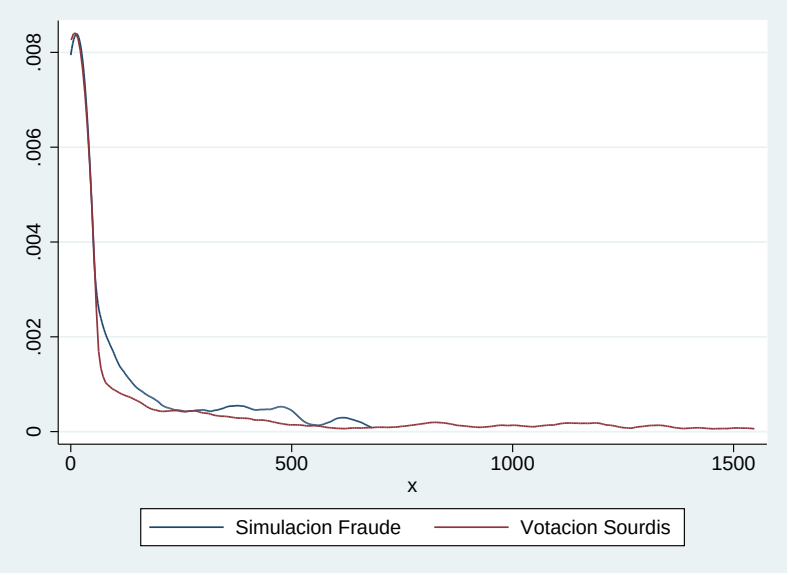
Nationwide Elections

- Beber and Sccaco tests are based on the following facts:
  1. Theory: The last digit, consecutive digits and repeated digits of randomly generated numbers is distributed uniformly.
  2. Evidence: People rarely produce this pattern when asked for random digits.

Nationwide Elections

- Based on Cantu and Saiegh (2010): A Supervised Machine Learning Procedure to Detect Electoral Fraud Using Digital Analysis.
  1. Generate random numbers as if they had been those of a clean election.
  2. Manipulate the random generator using some hypothesis on the way fraud was implemented (ballot stuffing). Calibrate this model to observed distributions.
  3. Train a classification model using only statistics based on digits (last digit, consecutive digits, etc.)
  4. Classify your election.

Nationwide Elections

Simulacion Limpia (Sourdis)	Simulacion Fraude (Sourdis)
	

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Copy Detection in Nationwide Multiple Choice Tests

- In Colombia all high school students take mandatory multiple choice questions at different stages.
- There are all types of incentives for manipulations at student, school or teachers level.
- Coincidence on wrong answers maybe due to chance but only to some extent.
- Performance depends on non observables (ability, teacher quality) and others in principle observable, but in practice not observable (parents education, etc.)
- We estimate an polytomous item response model and do hypothesis testing.

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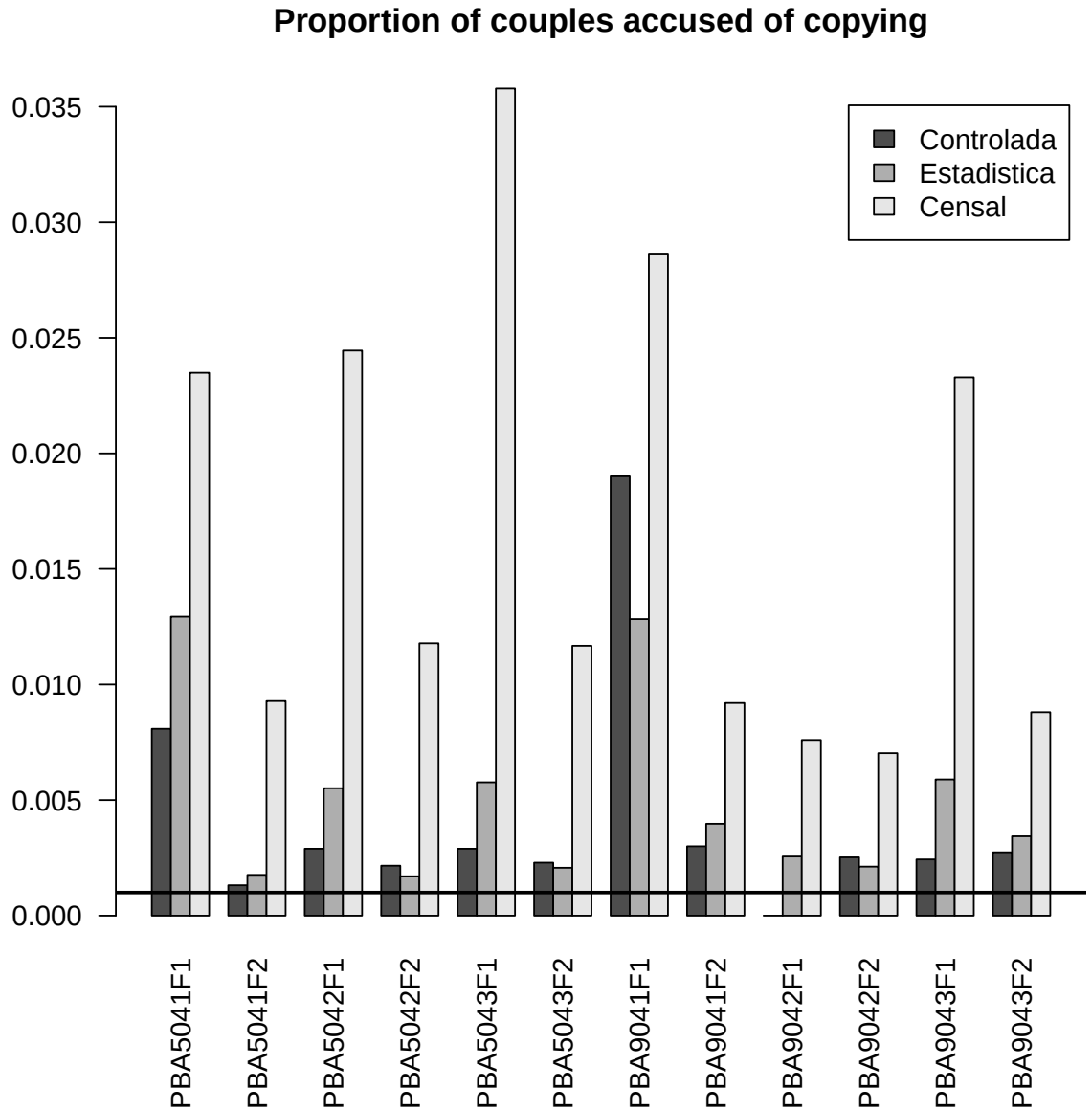

Proportion of couples accused of copying across exams and across samples using the ω_2^s index. The horizontal is the type-I error rate. Source: ICFES. Calculations: Authors.

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State Legal Defence

- Lawsuits against the state represent over 100 billion USD (approximately 25%*ofnationalincome*). Enough to bankrupt the state.
- It is very costly to defend the state in each one of these cases.
- We used supervised and semi supervised methods to build scoring models that would be able to prioritize cases of high probability of success.
- Data set with 150.000 cases and more than 300 variables (there is space for very valuable text mining).

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- Performance

Cuadro 5: Comparación de *auc* para los tres métodos de clasificación.

Modelo	área ROC - Entrenamiento	área ROC - Validación
Logit	0.755	0.744
Boosting	0.8054	0.7626
Redes neuronales	0.7691	0.741

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Tax Evasion (work in progress)

- Problem: Detect likely cases of tax evasion.
- Methodology:
  - Use information reported by firms to construct a proxy of taxes for each person.
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- We have three main business areas and a research and development unit:
  1. Economic modelling: Energy, health and communications sectors.
  2. Mathematical finance: hedging, valuation, quantitative risk and assets management, algorithmic trading, etc.
  3. Data mining: traditional databases, social networks.

Who are we?

- We have worked with approximately 80 organizations including:
  - Ministries (health, finance)
  - Government agencies (national planing department, energy, and communications regulatory agencies)
  - Many private companies (financial institutions, marketing agencies, call centers, commodities producers, etc.)
  - Multilaterals (World Bank, Interamerican Development Bank).

Who are we?

- Some of our our colleagues are now studying abroad: UCSD, Columbia, Carnegie Melon.

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Thank you very much! alvaro.riascos@quantil.com.co