ARTIFICIAL INTELLIGENCE AND TECHNOLOGY IN ACCOUNTING AND AUDITING

Applying to Government Issues
5 SBCASP - April 26, 2018 - Brasilia
Miklos A. Vasarhelyi
KPMG Distinguished Professor of AIS
Rutgers Business School
Outline

• The CarLab
• RADAR
• Big Data
• Exogenous Data
• Disruption
  – Artificial Intelligence and cognitive computing
  – Blockchain
  – Intelligent Process automation
  – Apps and Ubiquitous data
  – Human Behavior Change
The CarLab

Continuous Audit and Reporting Laboratory

—Graduate School of Management
—Rutgers University
<table>
<thead>
<tr>
<th>Areas</th>
<th>Ranking 2008-2013</th>
<th>Ranking 2002-2013</th>
<th>Ranking 1990-2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIS</td>
<td>#1 out of 179</td>
<td>#1 out of 207</td>
<td>#1 out of 241</td>
</tr>
<tr>
<td>Audit</td>
<td>#6 out of 320</td>
<td>#7 out of 370</td>
<td>#11 out of 438</td>
</tr>
<tr>
<td>Financial</td>
<td>#70 out of 356</td>
<td>#89 out of 406</td>
<td>#83 out of 470</td>
</tr>
<tr>
<td>Managerial</td>
<td>#120 out of 286</td>
<td>#80 out of 346</td>
<td>#66 out of 413</td>
</tr>
<tr>
<td>Tax</td>
<td>#53 out of 129</td>
<td>#76 out of 178</td>
<td>#79 out of 246</td>
</tr>
<tr>
<td>Other</td>
<td>#35 out of 171</td>
<td>#18 out of 248</td>
<td>#25 out of 341</td>
</tr>
</tbody>
</table>
Usage

http://raw.rutgers.edu/RADL.html
# Content

## Undergraduate, Graduate, PhD, & Audit Analytics Content

<table>
<thead>
<tr>
<th>Undergraduate</th>
<th>Graduate</th>
<th>PhD</th>
<th>Audit Analytics Certificate</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Introduction to Financial Accounting</td>
<td>• Accounting Principles and Practices</td>
<td>• Special Topics in Accounting</td>
<td>• Introduction to Audit Analytics</td>
</tr>
<tr>
<td>• Introduction to Managerial Accounting</td>
<td>• Information Technology</td>
<td>• Survey of Accounting</td>
<td>• Special Topics in Audit Analytics</td>
</tr>
<tr>
<td>• Intermediate Accounting I</td>
<td>• Government and Not-for-Profit Accounting</td>
<td>• Information Systems</td>
<td>• Information Risk Management</td>
</tr>
<tr>
<td>• Intermediate Accounting II</td>
<td>• Advanced Auditing and Information Systems</td>
<td>• Current Topics in Auditing</td>
<td>• Tutorials for Risk Management</td>
</tr>
<tr>
<td>• Advanced Accounting</td>
<td>• Advanced Accounting</td>
<td>• Machine Learning</td>
<td></td>
</tr>
<tr>
<td>• Auditing Principles</td>
<td>• Corporate Taxation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Management and Cost Accounting</td>
<td>• Income Taxation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Accounting Information Systems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Business Law I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Business Law II</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Federal Taxation I</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Accounting in the Digital Era</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Computer Augmented Accounting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Decoding of Corporate Financial Communications</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Our Government Accounting Efforts

- Leading Master’s Program in Government Accounting (online)
- Linking with our technological leadership
- Working with Exchange Regulatory Commissions
  - CVM, Indonesia, Korea
- Proposing several approaches for government reporting at federal, state, and municipality
- Working with the Volcker alliance
- Armchair audit work
Introduction to Audit Analytics:

https://www.youtube.com/playlist?list=PLauepKFT6DK8nsUG3EXi6lYVX0CPHUngj

Special Topics in Audit Analytics:

https://www.youtube.com/playlist?list=PLauepKFT6DK-PpuseJtSMlly-YBhaV4TH

Information Risk Management:

https://www.youtube.com/playlist?list=PLauepKFT6DK8uxePhPCoHjDf8DIhRtGS
Rutgers AICPA Data Analytics Research Initiative

The mission of RADAR is to facilitate the further integration of data analytics into the audit process, and to demonstrate through research how this can effectively lead to advancements in the public accounting profession.

Additional information can be found at: [http://raw.rutgers.edu/radar](http://raw.rutgers.edu/radar)
Rutgers AICPA Data Analytics Research Initiative

• Scope and Objectives

  – The scope of the Initiative encompasses the testing of theory and methodology

  – Theory and methodology tested under RADAR helped to inform the development of the AICPA Guide to Audit Data Analytics and Analytical Procedures

  – The research findings will also serve as the basis for a dialog with the Auditing Standards Board (ASB), the International Audit and Assurance Standards Board (IAASB) and the Public Company Audit Oversight Board (PCAOB)
Rutgers AICPA Data Analytics Research Initiative
• Research Projects
  – Multidimensional Audit Data Selection
  – Process Mining
  – Visualization
BIG DATA
Section

BIG DATA

Traditional data

Web data

Scanner data

Scanner data

Hand collection

Text mining

Security videos

News videos

Media programming videos

Security recordings

Telephone recordings

Automated collection

Complex data analysis

Multi-URL analysis

Traditional IT

Unstructured data

Descriptive Statistics

Visualiztion and Dynamics

Dashboards

Analytic modeling and discovery tools

What did you buy?

What Products relate?

Can you control inventory online?

Can you audit inventory real-time?

Can you keep real-time inventory?

Can you predict results?

Where are/were you?
Exogenous data analytics for Auditing

Miklos A. Vasarhelyi
Helen Brown Liburd

Rutgers Business School
Some sources

- Amazon sales
- Google searches
- Apps used
- Calls made
- GPS or JEEP location
- Sites accessed
- Car license plates photographed
- Pictures of parking lots
- Face recognition pictures
- Site clickpaths
Exogenous Data

ED may be of easier access
ED is likely less tamperable
ED relationships will be stochastic
ED may create many new procedures
ED is a form of confirmation
ED may complement many current procedures

- Social Media
- Internet of Things
- Click data
- Economic data
- Weather data
- Search Data
- Locational data
- Internet sales data
Facilitating Citizens’ Voice and Process Reengineering Using a Cloud-based Mobile App

Daniel E. O’Leary
University of Southern California
© 2018
How do Boston and other cities Monitor Infrastructure?

• City generated information
  – Employee generated (Historical Process)
  – City Worker App
  – (Maximo Integration (IBM Asset Management))

• Data gathered from citizens
  – Call Center (Started with the telephone)
  – Web Page (Started with the Internet/Web)
  – Citizens Connect App (focus of this paper)
  – Twitter

• It is possible to see “layering of technologies”
Citizens Connect AKA Boston 311
Cloud-based app allows you to report infrastructure issues

At this point, a number of cities around the US use this app.

Pictures and GPS
Potholes And Repairs? Boston Has An App For That

A few weeks ago, 41-year-old Bostonian Heather Sears thought the coolest app on her iPhone was SitOrSquat—a listing of the city’s cleanest, closest restrooms. But today, she’s even more excited about Boston's Citizens Connect—a new way to use an iPhone to fight city hall.

The new app allows anyone to make a one-touch kvetch about anything from potholes to broken streetlights in Boston.

"I was thrilled to be able to walk down the alley to where I park my car and say, 'All right, there's more graffiti. I want it off now!'" Sears says. "I was like armed and dangerous."
Hirschman’s Exit, Voice, Loyalty

- (Provides a theory with which to “think” about app use and anticipate what is going on in the data.)
- Cloud-based app provides another voice channel to government.
- With the app, the voice becomes more visible, potentially clearer and actualized in real time.
  - Phone pictures make reports clearer.
  - GPS can make data better.
- Would expect use of pictures to be a key issue in app use.
- Would expect that the use of the app would grow over time, as people use it to voice their concerns and opportunities.
  - Would expect citizens to voice using app if it directly affects them – e.g., in their zip code.
- Potential forms of exit: Move, Vote against Party, Vote against existing or forthcoming legislation, Make social media remarks against personnel.
- Hirschman suggests more voice if exit is difficult.
Imagineering Audit

Jun Dai and Miklos A Vasarhelyi
ASSURING INVENTORY and other things

The Internet of Things
• Forget about privacy…. Its gone…. 
• Fortunately you are not very interesting 
• Technology giveth …. 
• Technology taketh
Disruption

• Apps
• Blockchain and Smart Contracts
• Deep Learning / AI
• Cognitive computing – Siri/ Alexa-like specialized tools
• Intelligent Process Automation
• Drones and Robots
How Blockchain works – Bitcoin Example
Auditing with Smart Contracts in a Blockchain

April 16, 2018
Introduction

• The advent of new technologies has forced businesses to adapt to an electronic world and modify their business practices

• Blockchain demonstrates great potential as a tamper-proof audit trail, fused with smart contracts, blockchain can improve business processes
  • Bills of lading and debt covenants

• How will blockchain and smart contracts disrupt the audit profession?
  • Audit blockchain and smart contracts
  • Audit with blockchain and smart contracts
Evolving Auditing with Blockchain and Smart Contracts

• The traditional audit model was not designed for a digital business environment

• Auditors should rethink the audit process in light of emerging technologies
  • Blockchain and smart contracts improve process quality and thus have the potential to improve audit quality
  • Blockchain provides a unified platform for reliable digital audit evidence and (smart) audit analytics

• Smart contracts deployed on a blockchain can facilitate the execution of audit procedures, provide close to real-time audit reporting and more transparency to stakeholders
Smart Contracts Background and Relevance to Auditing

- Smart contracts are “computerized transaction protocol that executes the terms of a contract” (Szabo 1994)
Smart Contracts Background and Relevance to Auditing (cont’d)

- Smart audit procedures can help reduce the expectation gap between the procedures auditors perform versus those procedures audit inspectors, and investors, expect them to perform.
Initial Scope - Libra Blockchain Audit Tools

Trading Platforms
- LedgerX, TeraExchange
  Central databases / ERP System / Data Centers

Exchanges / Payment Processors
- Wallets (Coinbase, Kraken, Gemini, etc.)
- Payment Proc (Bitpay, Circle, etc.)
  Central databases / ERP System / Data Centers

Issuance Platforms
- Linq, tO
  Central databases / ERP System / Data Centers

Blockchain Tool Providers
- Chain, Consensys, Symbiont, Blockstream, Libra
  Central databases / ERP System / Data Centers

Oracles
- SSAE-16
Conclusion

• Blockchain and smart contracts have the potential to disrupt business ecosystems and consequently, the audit ecosystem

• Smart audit procedures as a emerging audit analytic tools can change the way audits are performed
Developing A Cognitive Assistant For Audit Plan Brainstorming Sessions

Qiao Li

Rutgers Business School
Architecture of the Proposed Audit Cognitive Assistant

Modules:
- Automatic Speech Recognition (ASR)
- Language Understanding
- Dialogue Management
- Natural Language Generation
- Text-to-Speech synthesis

Recommended Topics:
- General understanding
- New events
- Business risks...

Processing...

You may also be interested in:

Audit Related Applications It Can Access:
- Web Search
- Open standards
- Calendar

Knowledge Database:
- Domain Knowledge
- Unstructured data
- Knowledge about users

Backstage supporter:
- Auditor
- Auditor's assistant
- Client

Interface:
- Luca
  - Industry
  - Client
  - Position

Automatic Speech Recognition

Query Classifier

Question or Action

Open an application

Open a calculator

Audit workpaper

Web Search

Open (AGL, IDEA...)

Domain Knowledge

Open templates

Unstructured data

Calculato r

Knowledge about users

……..
APPLICATIONS OF DATA ANALYTICS:
VISUALIZATION AND CLUSTER ANALYSIS OF
GOVERNMENTAL DATA

Prof. Miklos Vasarhelyi
Zamil S. Alzamil
• **Data:** Volcker’s Survey Results Data *(Average Grades, 2015 - 2017).*  
  – How the U.S. states score on an annual basis on **budgeting**.  

• **Using five-variables:**
  1. Budget Forecasting.
  2. Budget Maneuvers.
  3. Legacy Costs.
  4. Reserve Funds.
  5. Transparency.

• **Methodology:**
  a. Data Visualization.
  b. Data Analytics: *k*-means & hierarchical cluster analysis.
DATA VISUALIZATION

Variables Correlation Coefficient

First we establish that there is a moderate correlation (relationship) between the variables of legacy costs and budget maneuvers (~0.512)

- This analysis could assist in:
  - More insights into the survey results data.
  - Assist in selecting appropriate variables to build models.
K-MEANS CLUSTERING: Representation of Clusters Solution

PC1 - the direction of the most variation in the data
As shown from the previous figure, the states are clustered as follow (based on their scores of these five variables):

1. Budget Forecasting.
2. Budget Maneuvers.
3. Legacy Costs.
4. Reserve Funds.
5. Transparency.

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>ID, SD, NE, IA, UT, OR, WI, OK, MS, NV, NC, MT</td>
</tr>
<tr>
<td>#2</td>
<td>NJ, IL, KS</td>
</tr>
<tr>
<td>#3</td>
<td>TX, VT, GA, MO, ND, OH, NH</td>
</tr>
<tr>
<td>#4</td>
<td>TN, MN, DE, CA, HI, SC, IN</td>
</tr>
<tr>
<td>#5</td>
<td>AK, WA, AZ, FL, ME, WV, MI, RI</td>
</tr>
<tr>
<td>#6</td>
<td>CT, NY, PA, MA, VA, MD, LA, KY, CO</td>
</tr>
<tr>
<td>#7</td>
<td>NM, AL, AR, WY</td>
</tr>
</tbody>
</table>
Hierarchical Clustering: A dendrogram Representation of Clusters Solution
Dynamic Visualization as Audit Evidence

– Graduate School of Management
– Rutgers University
Dynamic Visualization as Audit Evidence
3D scatter Interactive Visualization

- Use 3D scatter plot to investigate relationship between more than three values and identify potential risks
- Provides more information than using 2D plot
- Process Mining Data Log
  - Value of Purchase Order
  - Value of Payment
  - Value of Goods Received

[Image of 3D scatter plot with labels: 'VALUE_ORDER', 'VALUE_PAYMENT', 'VALUE_GDR', and categories: Large, Median, Small]
Dynamic Visualization as Audit Evidence (cont’d)

Time Series Interactive Visualization

- Investigate the time change of more than 2 values
- Select only cases you want to examine with Interactive Visualization Technique
- See how the target changes compared with other cases
  - Total Liabilities
  - Total Assets
The DATA Act

5/09/2014
DATA
ACT is
law

5/09/2015
Pilot
starts

5/09/2017
Pilot
finishes

5/09/2018
OMB
reports to
Congress

8/09/2018
Pilot
becomes
law?

**Timeline of the Grantee Pilot Program:**

<table>
<thead>
<tr>
<th>Date</th>
<th>DATA ACT/PILOT PROGRAM EVENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/09/2014</td>
<td>DATA ACT passed into law</td>
</tr>
<tr>
<td>5/09/2015</td>
<td>Pilot Program begins with selected grant recipients</td>
</tr>
<tr>
<td>5/09/2017</td>
<td>Pilot program finishes</td>
</tr>
<tr>
<td>5/09/2018</td>
<td>OMB reports results to Congress</td>
</tr>
<tr>
<td>8/09/2018</td>
<td>OMB decides to require (or not) grant recipients to report in the format</td>
</tr>
<tr>
<td></td>
<td>required by the DATA ACT</td>
</tr>
</tbody>
</table>
The DATA Act

Pilot Program:
- Affects state and local governments, transportation authorities, hospitals, universities, charities and not-for-profits
- Little standardization in accounting practices across jurisdictions and recipients (Bloch et al 2015)
- Standardization of data terms/definitions
- Reports must be published in machine readable transparent format

Federal Level:
- Separated reports and agencies will now be standardized
- Newly formed central reporting website [www.usaspending.gov](http://www.usaspending.gov) where all will file statements and reports will be published
- Currently all financial statements are in PDF: DATA Act requires that reports be in machine-readable and open data format, such as that of XBRL
US Open Data Initiatives

- http://www.data.gov
- http://www.ohiocheckbook.com
- https://data.austintexas.gov/
- http://www.data.cityofchicago.gov
- http://www.checkbooknyc.com/
- https://data.cityofnewyork.us/
- http://www.data.detroitmi.gov
- https://www.usaspending.gov/Pages/Default.aspx
In Brasil, ahead of the US

- Data Portal
- SPED
- SICONFI
- etc
Deep Learning

Ting Sun and Miklos Vasarhelyi
Rutgers Business School
July 24, 2016
What is deep learning?

Deep learning mimics how a human brain thinks. It makes a machine think like human.

“The general idea of deep learning is to use neural networks to build multiple layers of abstraction to solve a complex semantic problem.”

-- Aaron Chavez, formerly chief scientist at Alchemy API
Biological Neurons

- Dendrites
- Soma
- Axon
- Electrical impulse
- Terminal Branches of Axon
Training data

<table>
<thead>
<tr>
<th>Fields</th>
<th>class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4 2.7 1.9</td>
<td>0</td>
</tr>
<tr>
<td>3.8 3.4 3.2</td>
<td>0</td>
</tr>
<tr>
<td>6.4 2.8 1.7</td>
<td>1</td>
</tr>
<tr>
<td>4.1 0.1 0.2</td>
<td>0</td>
</tr>
<tr>
<td>etc …</td>
<td></td>
</tr>
</tbody>
</table>

And so on ….

Repeat this thousands, maybe millions of times – each time taking a random training instance, and making slight weight adjustments

*Algorithms for weight adjustment are designed to make changes that will reduce the error*
Deep neural network

ANN vs. DNN: The depth of the hidden layers

Extract features from unstructured data like image, audio, video and text

As layers go further, it recognizes more advanced and more abstract features of data

Each successive layer uses features in the previous layer to learn more complex features

Each hidden layer going further into the network is a weighted non-linear combinations of the lower level layers

The entire deep learning process is about refining the weights
object models

object parts (combination of edges)

edges

pixels

pixels
DEEP LEARNING APPLICATIONS IN AUDIT DECISION MAKING

Dissertation Defense
Ting Sun

Dissertation Committee
Chair: Dr. Miklos A. Vasarhelyi
Dr. Alexander Kogan
Dr. Helen Brown-Liburd
Dr. Rajendra P. Srivastava

April 16, 2018
Outline

- **Introduction**

- **Essay One**: The Incremental Informativeness of Management Sentiment in Conference Calls for the Prediction of Internal Control Material Weaknesses

- **Essay Two**: The Performance of Sentiment Features of MD&As for Financial Misstatements Prediction: A Comparison of Deep Learning and Bag of Words Approaches

- **Essay Three**: Predicting Audit Fees with Twitter: Do the 140 Characters reveal a company’s audit risk?

- **Conclusion, Limitation, and Future Research**
Examples of applications

- Voice search/voice-activated assistants: NLP
- Recommendation engines: scan, keywords
- Image recognition
- Image tagging/image search: google+
- Textual analysis
Design of Apps for Armchair Auditors to Analyze Government Procurement Contract

Jun Dai
Rutgers University

Qiao Li
Rutgers University

Miklos A. Vasarhelyi
Rutgers University
Introduction

Government procurement:

- 10%-15% of GDP; 7 trillion dollars annually in U.S.
- Not always Open and Transparent
- Fraud schemes: bid rigging, bribery, kickbacks, cost mischarging, defective pricing, product substitution …
Introduction

What data to use?
Who has interest?
How to detect anomalies?
Background

Open Data Initiatives

- Make info available and transparent
- 45 countries and 163 international regions
- U.S.
  - Data.gov
  - 39 states and 46 cities and counties
  - formats: Excel, CSV, XML, API, HTML, open XML, text, pdf
- Government procurement data:
  - China: ccgp.gov.cn
  - Australian: tenders.gov.au
  - Canada: buyandsell.gc.ca
  - Brazil: dados.gov.br
  - UK: gov.uk
Background

“Armchair Auditor”

-- Crowdsourcing analysis of government data (DE O’Leary, 2015)
-- Informal, voluntary and no requirements
Background

“Armchair Auditor”

- Pilot projects:
  - 2 English councils: Isle of Wight council and Hull City council
  - calculated government payments information

- Achievements
  - in 2011, a group of activists uncovered a £1.3m audit scandal at their local council (Patrick, 2011; Patrick, 2011)

- Barrier:
  - Quality and comparability of information
  - Tools and knowledge
  - Rules and community
Objective

Although we have open government data, few studies discuss:
• how to use
• what tools

This paper:

Propose a list of audit apps that help armchair auditors to
• analyze open government procurement data
• Spot anomalies and identify potential issues
• find out suspicions contracts which have higher probability of fraud
Why Audit Apps

What is it
- Formalized audit procedures that are performed through computer scripts (Dai et al. 2014)

Example
- Caseware and ACL: test journal entries, account payable, assets, etc

Advantages
- simplify data analytics procedures, require few user interactions, improve audit quality

No apps for open government data analysis or for non-professional auditors such as “armchair auditors”
# Proposed Apps for Government Expenditure Audit

## Anomaly Type:

1. Data incompleteness and unreliability

<table>
<thead>
<tr>
<th>No.</th>
<th>Purpose of the app</th>
<th>Data needed</th>
<th>Anomaly Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Contract values check (unusual “0” and tiny)</td>
<td>initial values of contracts</td>
<td>Unusual number in the values, such as 0, 0.01, 0.05</td>
</tr>
<tr>
<td>2</td>
<td>Data Completeness and Integrity Check (Missing suppliers / bidding mode/ dates)</td>
<td>contracts data</td>
<td>Missing values</td>
</tr>
</tbody>
</table>
# 2. Unqualified suppliers

<table>
<thead>
<tr>
<th>No.</th>
<th>Purpose of App</th>
<th>Data needed</th>
<th>Anomaly Indicator</th>
<th>Potential Fraud</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Relationship check (gov. personnel VS contractor)</td>
<td>Background information of both parties</td>
<td>employment of contractor or sub-, or their family member in government personnel</td>
<td>Bribery, Kickback</td>
</tr>
<tr>
<td>2</td>
<td>Contractor qualification check (“blacklist” companies)</td>
<td>Contractor information, “blacklist”</td>
<td>Contractor once occurred in the “blacklist”</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>“Waived bidding” contracts check</td>
<td>Bidding type information</td>
<td>firm has very high percentage of “waived bidding” contracts in all contracts with gov</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bids wining history check</td>
<td>Statistic contract data</td>
<td>a certain contractor always or never wins a bid, or all contractors win an equal volume of contracts over time</td>
<td>bid rigging</td>
</tr>
</tbody>
</table>
### 3. Unnormal prices

<table>
<thead>
<tr>
<th>No.</th>
<th>Purpose of App</th>
<th>Data needed</th>
<th>Anomaly Indicator</th>
<th>Potential Fraud</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Contract prices comparison (gov. VS other clients)</td>
<td>Prices to different clients</td>
<td>Contractor submit higher price bids to government for exactly same product/service</td>
<td>bid rigging</td>
</tr>
<tr>
<td>2</td>
<td>Split purchases detection</td>
<td>Contract</td>
<td>Contracts with same suppliers, same dates and same goods</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Winning price prediction (Regression)</td>
<td>Bidding process</td>
<td>Abnormal winning price</td>
<td>bid rigging</td>
</tr>
</tbody>
</table>
4. Unnormal bidding procedure and mode

<table>
<thead>
<tr>
<th>No.</th>
<th>Purpose of App</th>
<th>Data Needed</th>
<th>Anomaly Indicator</th>
<th>Potential Fraud</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Monopoly check</td>
<td>Market data</td>
<td>only very fewer suppliers</td>
<td>bid rigging, Collusion</td>
</tr>
<tr>
<td>2</td>
<td>Bidders withdraw detection</td>
<td>Bidding process information</td>
<td>Qualified bidders inexplicably withdraw valid bids</td>
<td>bid rigging</td>
</tr>
<tr>
<td></td>
<td>(in a short time period)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Law check</td>
<td>Procurement law; bidding mode</td>
<td>The bidding process doesn’t comply with the law (such as waive of bidding)</td>
<td>Bribery, Kickback</td>
</tr>
</tbody>
</table>
5. Unnormal products or services implementation

<table>
<thead>
<tr>
<th>No.</th>
<th>Purpose of the app</th>
<th>Data needed</th>
<th>Anomaly indicator</th>
<th>Potential Fraud</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Address check (company’s &amp; delivery)</td>
<td>addresses</td>
<td>Delivery location is not the office, plant, or job site</td>
<td>Charging for products not used or services not rendered</td>
</tr>
<tr>
<td>2</td>
<td>Weird working hours check</td>
<td>invoices</td>
<td>Employees bill for more hours than typically worked in a day</td>
<td>See above</td>
</tr>
</tbody>
</table>
Proposed Framework

**Anomaly type**
- Data incompleteness and unreliability
- Unqualified suppliers
- Unnormal prices
- Unnormal bidding procedure and mode
- Unimplemented products or services

**Software Platform**
- General analytics sw
- Audit analytics sw
- Visualization sw

**Data type**
- Inside info
- Other outside data
- Gov open data

**Technology**
- Basic
- Statistics
- Machine Learning
- Software Platform

**Knowledge Level**
- High
- Medium
- Low
<table>
<thead>
<tr>
<th>Proposed Audit apps</th>
<th>Anomaly type</th>
<th>Data</th>
<th>Techniques</th>
<th>Software Platform</th>
<th>Knowledge Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptive dashboard</td>
<td>Data incompleteness and unreliability</td>
<td>Contract</td>
<td>Descriptive Analysis</td>
<td>Qilk sense</td>
<td>Medium and above</td>
</tr>
<tr>
<td>Missing values</td>
<td>Data incompleteness and unreliability</td>
<td>Contract</td>
<td>Query</td>
<td>IDEA</td>
<td>Low and above</td>
</tr>
<tr>
<td>Split purchases</td>
<td>Contracts with same suppliers, dates and goods</td>
<td>Contract</td>
<td>Matching</td>
<td>SAS</td>
<td>Medium and above</td>
</tr>
<tr>
<td>Winning price prediction</td>
<td>Abnormal winning price</td>
<td>Bidding process; Goods and service</td>
<td>Regression</td>
<td>R</td>
<td>Medium to high and above</td>
</tr>
<tr>
<td>Suppliers cluster</td>
<td>Unqualified suppliers</td>
<td>Contract; Supplier; Bidding process</td>
<td>Clustering</td>
<td>R</td>
<td>Medium to high and above</td>
</tr>
<tr>
<td>Abnormal actions in a bidding</td>
<td>Unfair bidding process</td>
<td>Biding process</td>
<td>Classification</td>
<td>R</td>
<td>Medium to high and above</td>
</tr>
</tbody>
</table>
Illustrations

Data:
Contracts of Brazil federal government from 1989 to 2014 from SIASG (Brazilian public federal procurement information system)

1. Descriptive dashboard

Software: Qlik Sense Enterprise

-- dashboard for visualization
Data incompleteness and unreliability Check

Software: Caseware IDEA
-- Integrity Check for Missing Contractors

In 470,683 contracts,
- 35,516 contracts lose contractor information
- 6,167 contracts lose bidding mode
- 1,000 contracts lost valid dates
Data incompleteness and unreliability Check

Software: Caseware IDEA
-- unusual initial values

App script

Integrated results:
501 contracts that have “0” value after removing contracts pertaining to government departments
527 contracts have values that <1; the values are 0.01, 0.05, 0.1, and 0.53 Brazilian real
Unnormal prices

Software: Caseware IDEA

-- Benford’s Law Check

Widely used for accounting fraud detection

Values should come from mathematical combination of numbers (quantity × price), they are expected to obey Benford’s Law

First Two Digit: “60”, “79” and “80” do not obey the First Two Digit Law
Unqualified suppliers

Software: SAS
--“black list” Contractor Detection

Integrated results:
• 25,100 contracts are made with contractors listed in the blacklist
• 1,936 unique suspicious contractors (firms)
**Unnormal bidding mode**

**Software: Excel**

--- Big Data Collection

<table>
<thead>
<tr>
<th>Contract ID</th>
<th>Bidding Mode</th>
<th>Objective</th>
<th>Link to legislation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11460650000011</td>
<td>DISPENSA DE LICITAÇÃO</td>
<td>Contratação de imóveis para instalação da Agência do IBGE</td>
<td><a href="#">De acordo com artigo 24, Inciso X, da Lei 8.666/93 C/CR.PR. 06/96, ARTIGO 3.</a></td>
</tr>
<tr>
<td>11460650000011</td>
<td>984</td>
<td>namunicípio de Conceição do Araguaia/PA.</td>
<td></td>
</tr>
<tr>
<td>38004450000011</td>
<td>DISPENSA DE LICITAÇÃO</td>
<td>Contrato de locação do imovel da Av. Dr. Vicente Machado n.º 362 -</td>
<td><a href="#">Art. 24, Inciso X, da lei 8666/93.</a></td>
</tr>
<tr>
<td>38004450000011</td>
<td>992</td>
<td>Curitiba/PR.</td>
<td></td>
</tr>
<tr>
<td>17011650000011</td>
<td>INEXIGIBILIDADE DE LICITAÇÃO</td>
<td>Contrato nº 01/88 tem por objeto a locação dos imóveis nºs 26, 38</td>
<td><a href="#">Decretos-Leis nos. 2300/86 e 2348/87 e Lei 6649/79</a></td>
</tr>
<tr>
<td>17011650000011</td>
<td>988</td>
<td>e44 da Praça Oliveira Figueiredo, Barra do Piraí, Estado do Rio de Janeiro.</td>
<td></td>
</tr>
<tr>
<td>17011950000011</td>
<td>DISPENSA DE LICITAÇÃO</td>
<td>Locação dos imóveis de nos. 26, 38 e 44 da Praça Oliveira Figueiredo</td>
<td><a href="#">Decretos-Leis nos. 2300/86 e 2348/87 e Lei 6649/79</a></td>
</tr>
<tr>
<td>17011950000011</td>
<td>990</td>
<td>para abrigar a Agência da Receita Federal em Barra do Piraí</td>
<td></td>
</tr>
</tbody>
</table>
Limitations and Future Research

- Design, improve and test the apps
- Developing rule-based algorithm for improved government procurement anomaly detection, applying the idea of exceptional exception (Issa, 2013) to rank suspicious contracts based on predefined rules
TO WRAP UP!
Electronic reporting system should be able to:

- Facilitate the medium to allow for a more transparent modern government reporting
- Increase the transparency in governmental reporting
- Modernize the supply of information for bond analysis
- Provide customized reports
- Facilitate the diffusion of financial information

What we expect from it!

XBRL enables two foreign computers to communicate. Customizable reports
What we expect from it!

- Facilitate access
- Eventually enable reports (continuous auditing & monitoring)
- On demand continuous audit & monitoring reports
- Realizable Value
- Demand
- Current Year Target
- Year Wise
- Year/Month Wise 2019
- Project Wise
- Project/Year Wise Project 1
- Project Type Wise
- Cluster 0
- Cluster 1
- Cluster 2
- Cluster 3
- Cluster 4
Thank you!