



RUTGERS

# Digital transformation of audit – Trends, Challenges and Opportunities

Miklos A. Vasarhelyi

KPMG Distinguished Professor of AIS

Rutgers Business School

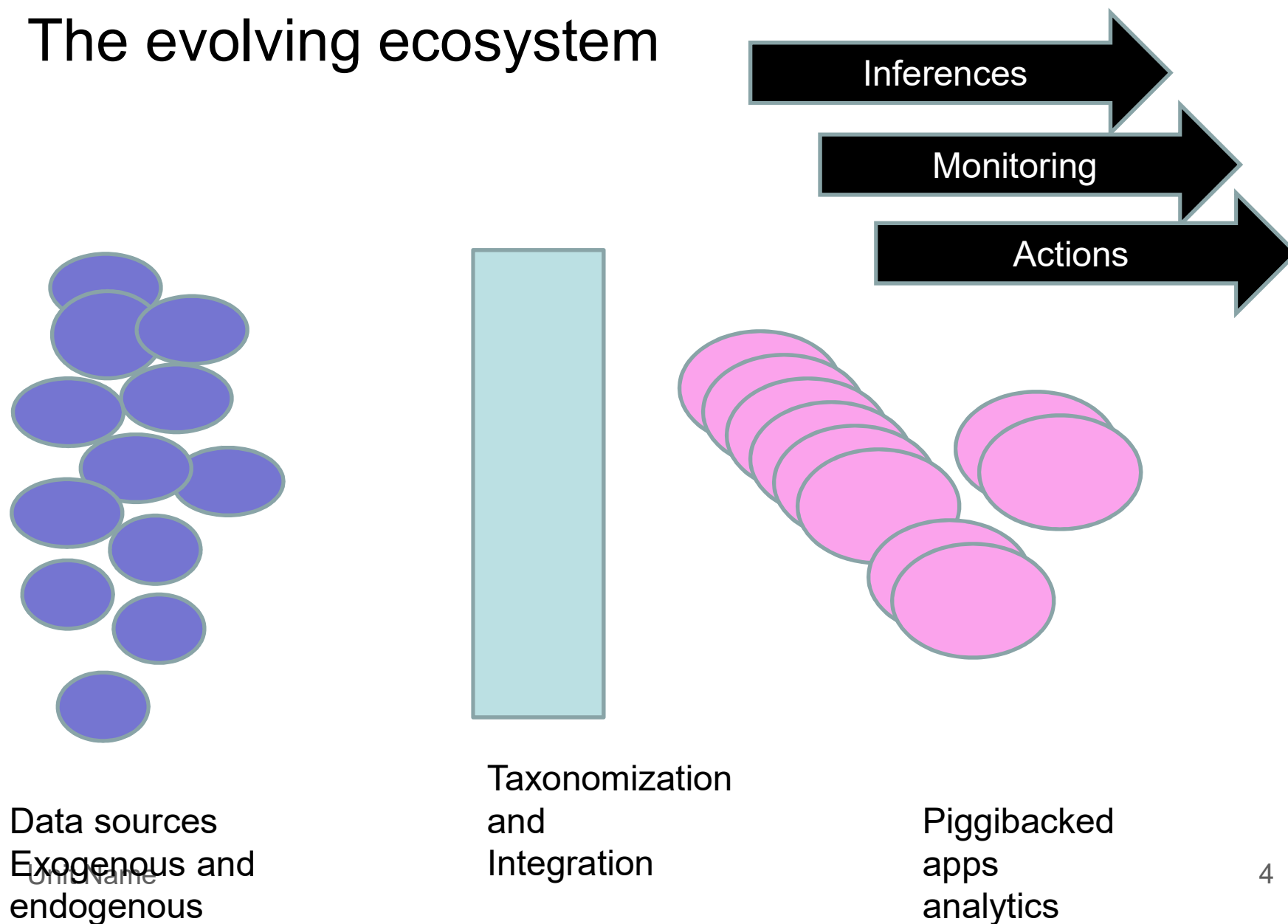
## A contemporary dilemma

- The cost benefits of performing an audit have changed and will change more with automation.
- How do you deal with full population testing?
- If you can perform full population tests at nearly zero costs do you need to perform the current form of risk assessment?
- With the degreasing significance of financial statements what is happening with the value of the financial audit?
- Can you perform an external audit just with exogenous variable evidence (from big data)?
- If we can substantial parts of the audit in as smart contracts are we finally evolving to a continuous audit?

# Outline

1. The new data Ecosystem
2. Data analytics in audit procedures
3. Full population testing (MADS)
4. Audit automation (RPA / IPA)
5. Auditing with smart contracts
6. AI and machine learning in auditing
7. Audit 4.0
8. Auditing with exogenous variables
9. Conclusions

# The evolving ecosystem



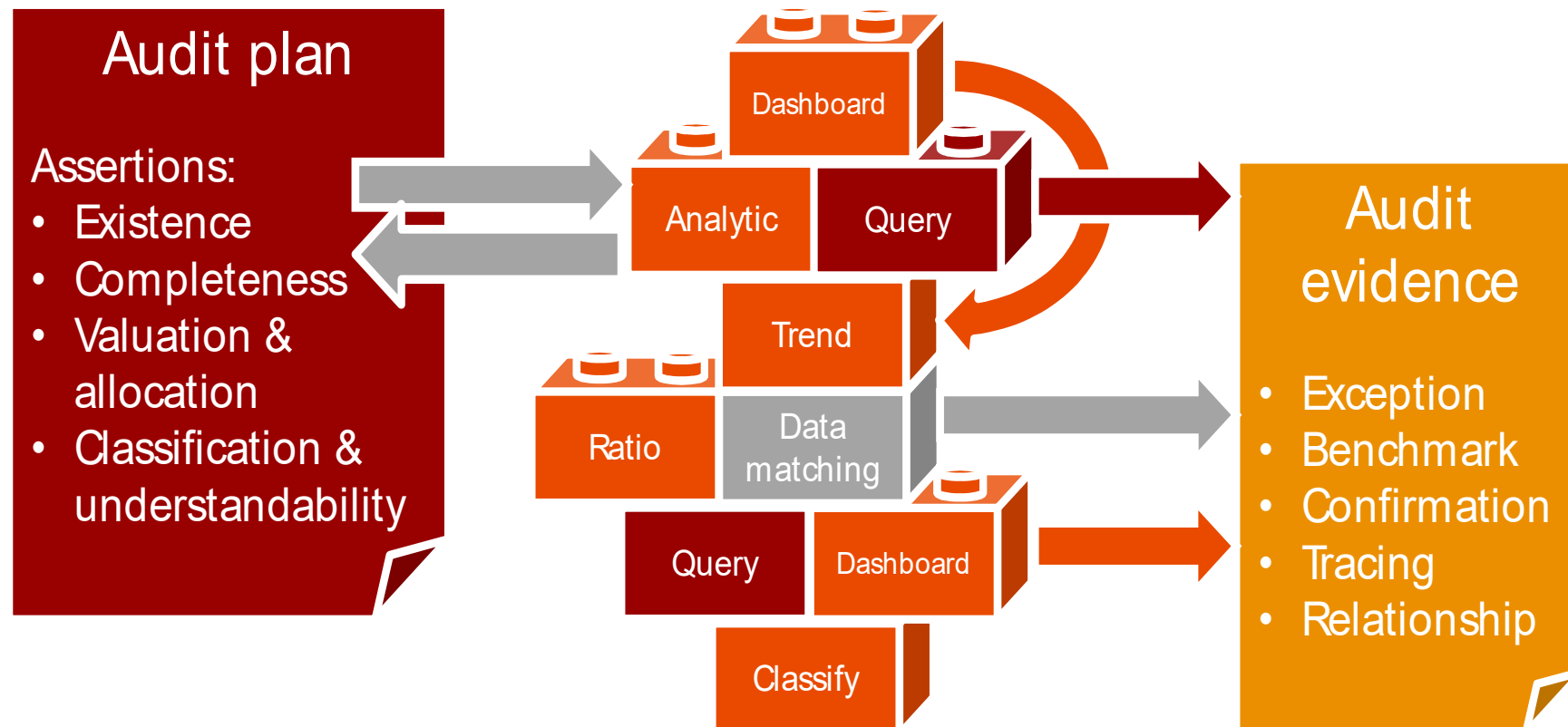
# **1. THE NEW DATA ECOSYSTEM: AN AUDIT VIEW**

Unit Name

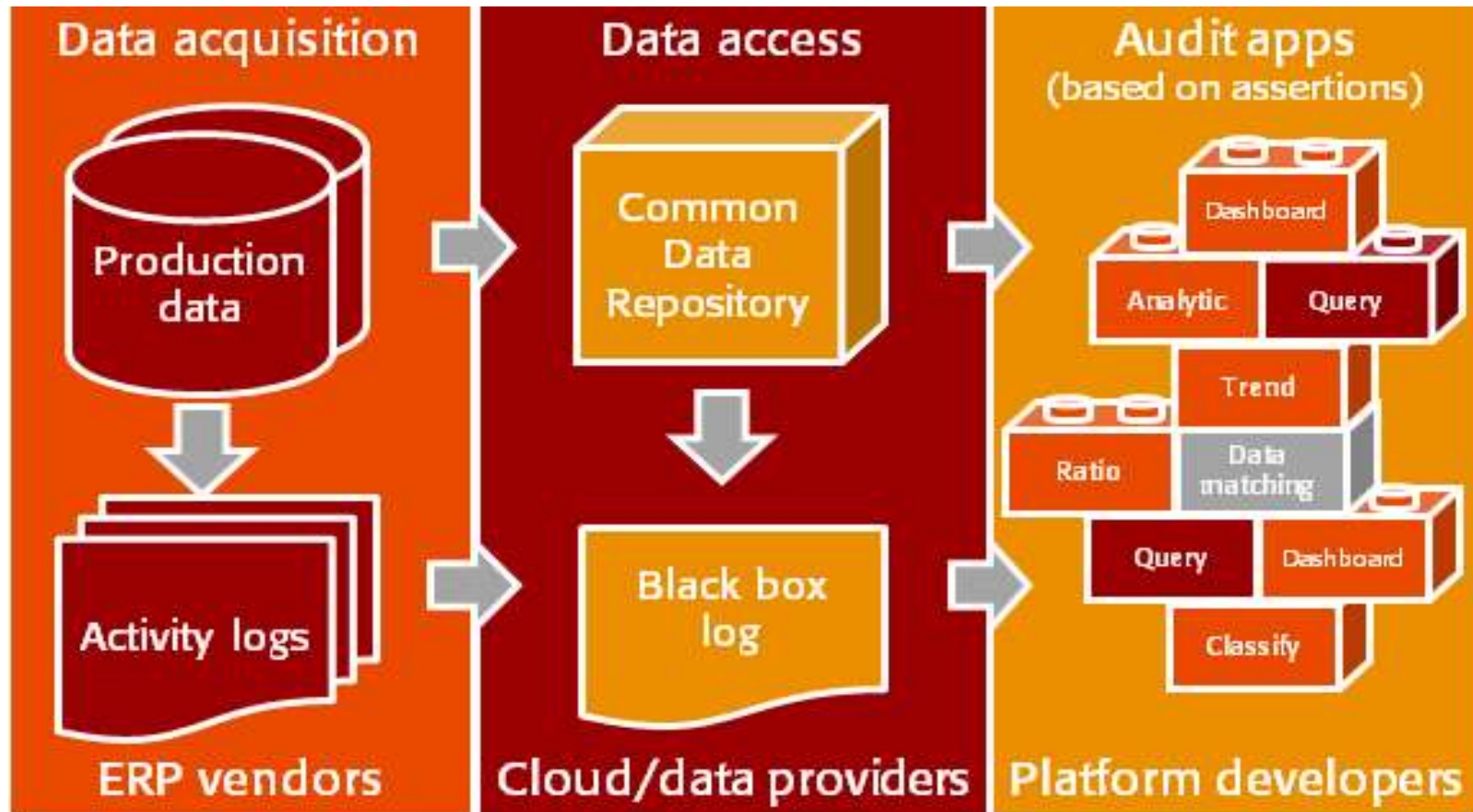
# The new audit ecosystem

- Embedded into corporate ERPs?
- Producing audit evidence and evaluating on a frequent basis?
- Cloud-based tapping information at all locations?
- Implementing audit heuristics at process levels?
  - Issues with knowledge capture
  - Issues with knowledge creation (how will experience be obtained / developed?)
- Delivering evidence on an alert basis with scores and frequent indicators
- Depending on much higher standardization than just ADS
- How will the profession (external) integrate into this scenario?

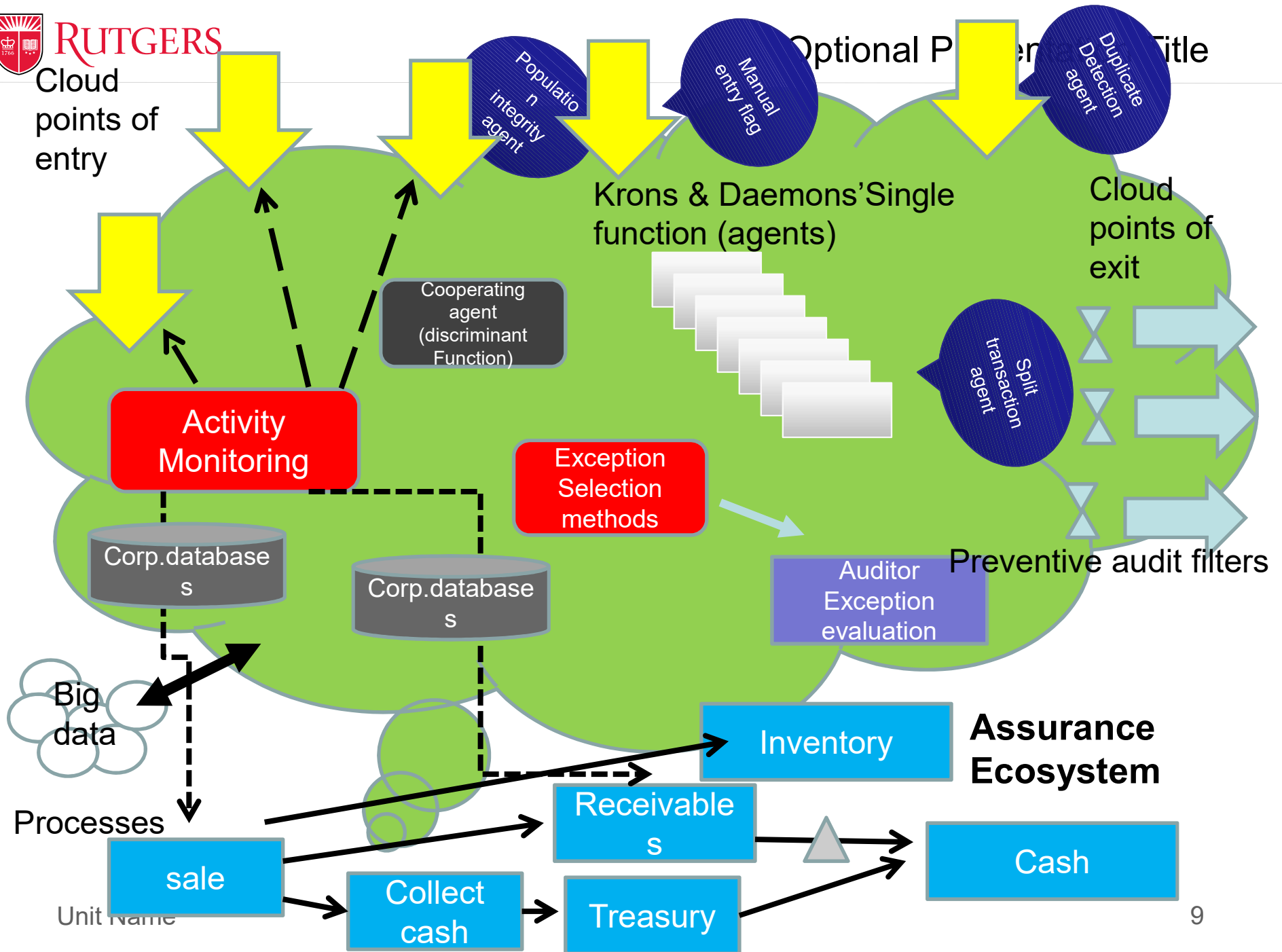
# A Progressive Automation Scenario

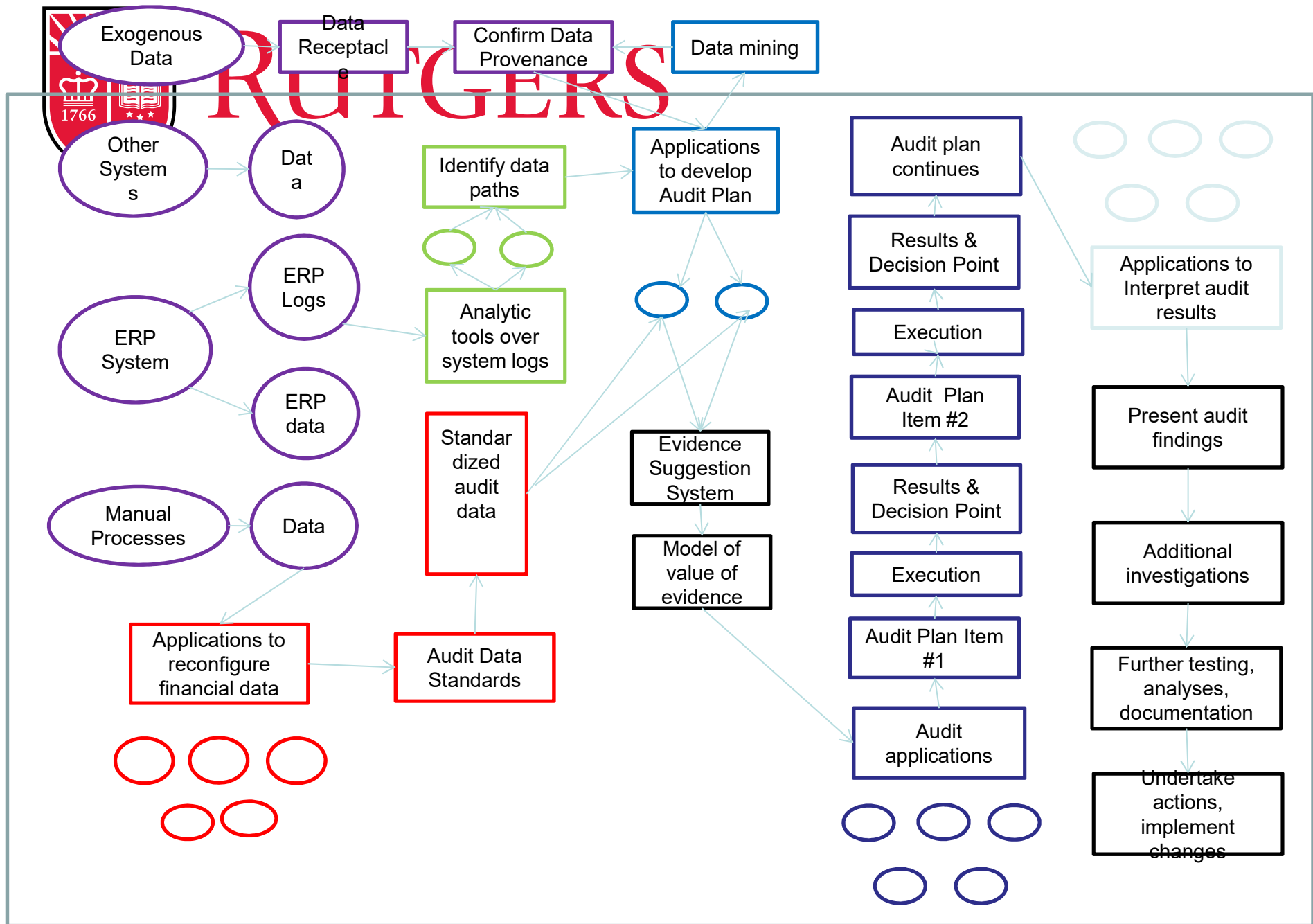


# The Audit Data Standard Architecture









## **2. DATA ANALYTICS IN AUDIT PROCEDURES**

# Audit Data Analytics

Bob Dohrer, IAASB Member and Working Group Chair

Miklos Vasarhelyi

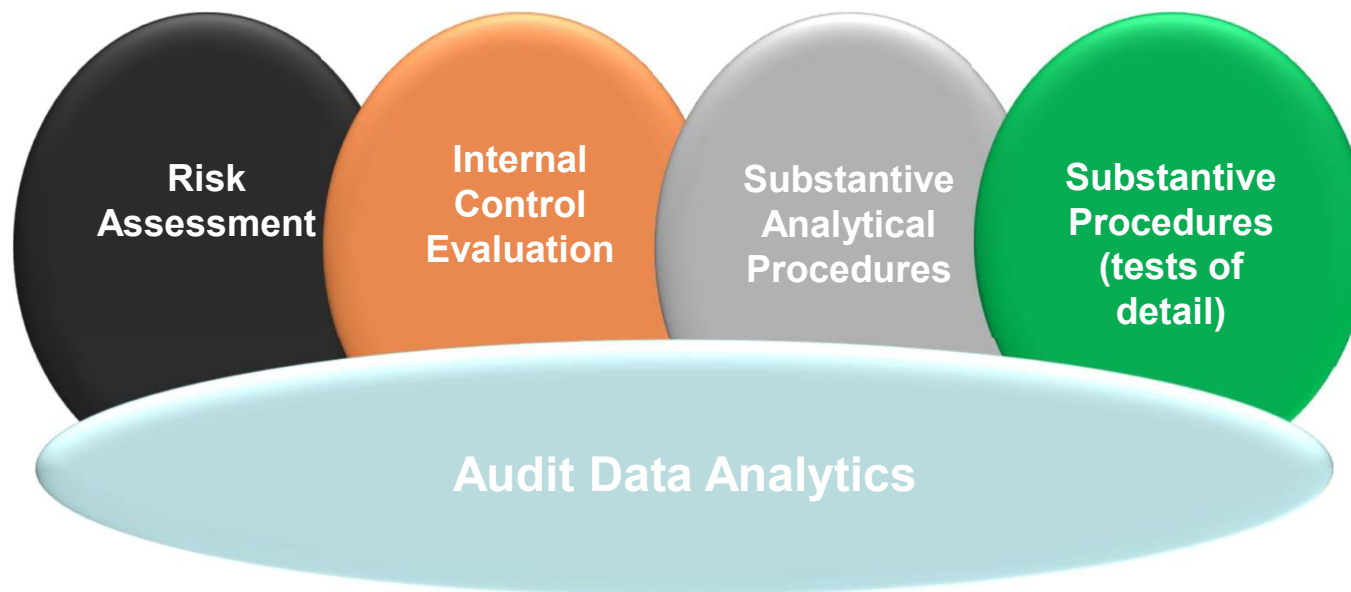
Phillip McCollough

IAASB Meeting

September 2015

Agenda Item 6-A

# Traditional Stages of the Audit





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# **PUBLIC AUDITING, ANALYTICS, AND BIG DATA IN THE MODERN ECONOMY**

Dissertation Defense by Deniz Appelbaum

Wednesday April 5, 2017

Committee Chair: Dr. Miklos A. Vasarhelyi

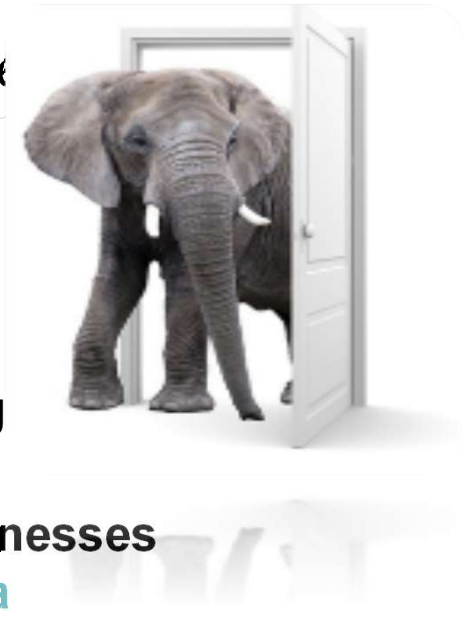
# Evolution of the External Audit Analytics Framework

<b>Predictive</b>	Engagement	Planning	Testing	Review	Opinion	Continuous activities
Analytical Hierarchy Processes (AHP)	✓	✓		✓	✓	✓
Artificial Neural Networks (ANN)	✓	✓		✓	✓	✓
Auto Regressive Integrated moving Average (ARIMA)					✓	✓
Bagging and Boosting models	✓	✓		✓	✓	✓
Bayesian Theory/Bayesian Belief Networks (BBN)	✓				✓	✓
Benford's Law	✓	✓		✓	✓	✓
C4.5 Statistical Classifiers		✓	✓	✓	✓	✓
Dempster-Shafer Theory Models	✓	✓	✓	✓	✓	✓
Expert Systems/Decision Aids	✓					✓
Genetic Algorithms	✓	✓		✓	✓	✓
Hypothesis Evaluations	✓	✓	✓		✓	✓
Linear Regression	✓	✓				✓
Log Regression		✓		✓		✓
Monte Carlo Study/Simulation	✓	✓	✓	✓	✓	✓
Multi-criteria Decision Aid				✓		✓
Probability Theory Models	✓				✓	✓
Process Mining: Process Optimizations	✓	✓	✓	✓	✓	✓
Structural Models					✓	✓
Support Vector Machines (SVM)	✓	✓		✓	✓	✓
Time Series Regression					✓	✓
Univariate and Multivariate Regression Analysis					✓	✓

<b>Descriptive</b>	Engagement	Planning	Testing	Review	Opinion	Continuous activities
Clustering Models	✓	✓	✓	✓	✓	✓
Descriptive Statistics						✓
Process Mining: Process Discovery Models	✓	✓	✓	✓	✓	✓
Ratio Analysis						✓
Spearman Rank Correlation		✓	✓	✓		✓
Measurement						
Text Mining Models			✓	✓	✓	✓
Visualization	✓	✓	✓	✓	✓	✓

<b>Prescriptive</b>	Engagement	Planning	Testing	Review	Opinion	Continuous activities
Artificial Neural Networks (ANN)	✓	✓	✓	✓	✓	✓
Auto Regressive Integrated Moving Average (ARIMA)	✓	✓	✓	✓	✓	✓
Expert Systems/Decision Aids	✓	✓	✓	✓	✓	✓
Genetic Algorithms	✓	✓	✓	✓	✓	✓
Linear Regression	✓	✓	✓	✓	✓	✓
Log Regression		✓	✓	✓	✓	✓
Monte Carlo Study/Simulation	✓	✓	✓	✓	✓	✓
Time Series Regression	✓	✓	✓	✓	✓	✓
Univariate and Multivariate Regression Analysis	✓	✓	✓	✓	✓	✓



## Big Data

- Big Data has become the new business currency
- 4 V's of Big Data: Variety, Volume, and Velocity create a bigg of **VERACITY** (quality & provenance)
- **Gartner: In 2015, more than \$2.5 Billion paid by U.S. businesses for AML violations due to incomplete and inaccurate data**
- Businesses using Big Data for decision making
- External Auditors:
  - May need to verify or re-perform client applications of Big Data
  - May want to access Big Data for industry and client assessment, risk analysis, confirmations, reasonableness tests
- Internal Auditors:
  - Access Big Data to perform efficiency and fraud examinations
  - Verify the validity of the data underlying firm decisions
  - Similar interests as the External Auditor
  - More exposure to Big Data



# **3. FULL POPULATION TESTING (MADS)**

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Rutgers and AICPA Data Analytics Research Initiative

# Multidimensional Audit Data Selection (MADS)

## PCAOB – CARLab Meeting



# MADS ANALYTIC FRAMEWORK

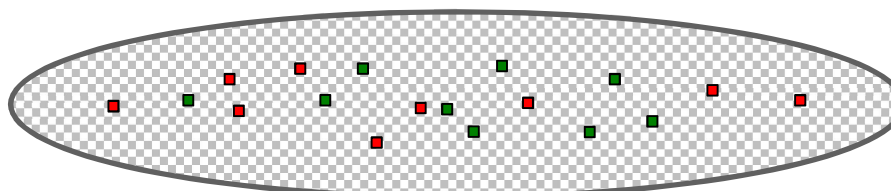
## MADS Model Build Process

Whole Transaction Data  
(Entire Population)

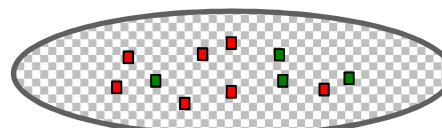
Step 1:  
Filters for Significant Potential  
Risk Factors

Step 1 Outputs

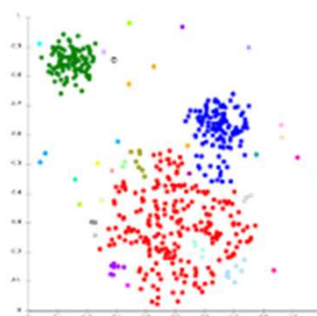
Step 2:  
Data Analytic Techniques



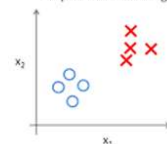
Apply a set of filters to examine significant risks (i.e., **What Could Go Wrong**) (e.g., duplicate payment)



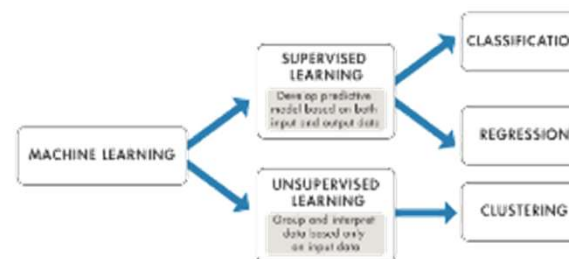
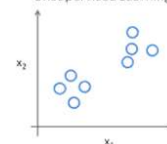
- Additional Filters
- Visualization Techniques (e.g., scatter plots)
- Professional Judgement (e.g., knowledge and experiences)
- Outlier Detection Techniques (e.g., classification & clustering).



Supervised Learning



Unsupervised Learning





## MADS Model Build Process

Whole Transaction Data  
(Entire Population)

Step 1:  
Filters for Significant Potential  
Risk Factors

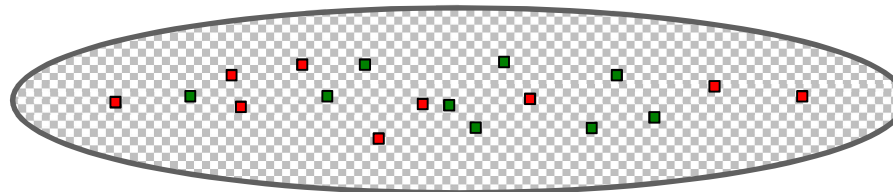
Step 1 Outputs

Step 2:  
Data Analytic Techniques

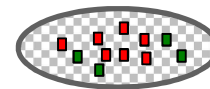
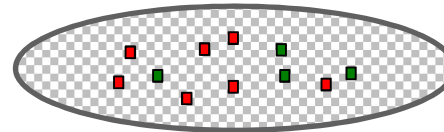
Step 2 Outputs

Step 3:  
Prioritization

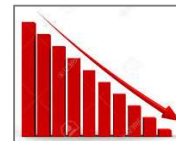
Prioritized  
Notable Items



Apply a set of filters to examine significant risks (i.e., **What Could Go Wrong**) (e.g., duplicate payment)



- Additional Filters
- Visualization Techniques (e.g., scatter plots)
- Professional Judgement (e.g., knowledge and experiences)
- Outlier Detection Techniques (e.g., classification & clustering).
- Use professional judgement based on the importance of each step 1 filter and step 2 filter.
- Use the step 1 and/or step 2 results.
- Use a reasonable factor (e.g., dollar amount).



# **4. AUDIT AUTOMATION (RPA / IPA)**

Unit Name

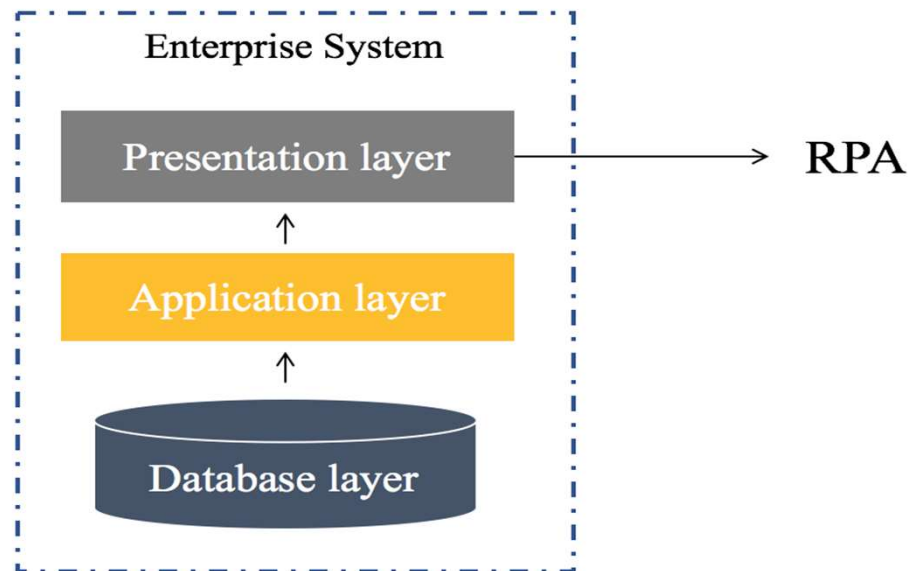
# Robotic Process Automation (RPA) and Intelligent Process Automation (IPA) in Audit

Presented by Abby Zhang

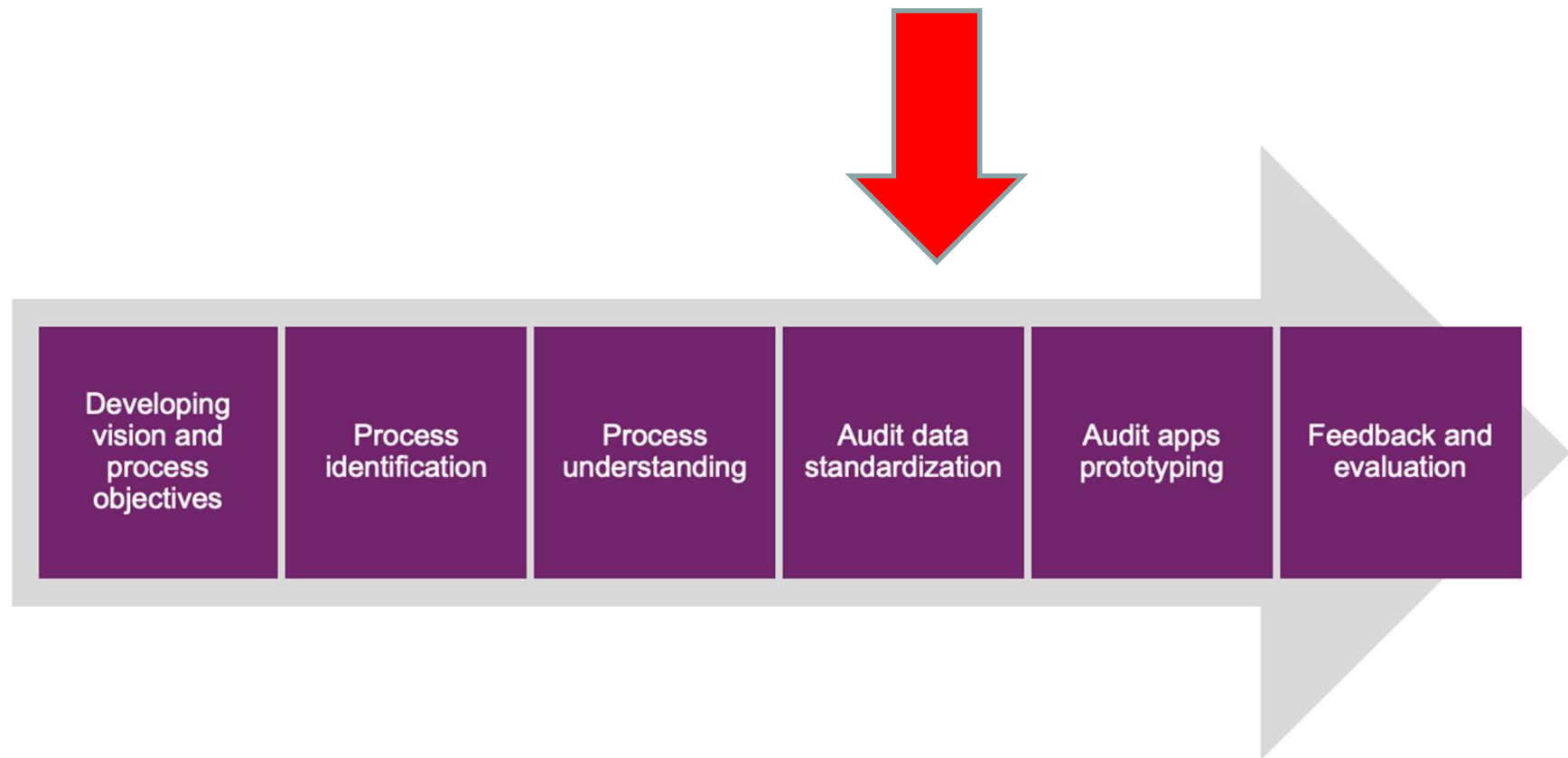


# Robotic Process Automation

Robotic Process Automation (RPA) runs application software in the same way that a person works with that software.



## Framework of RPA in Audit



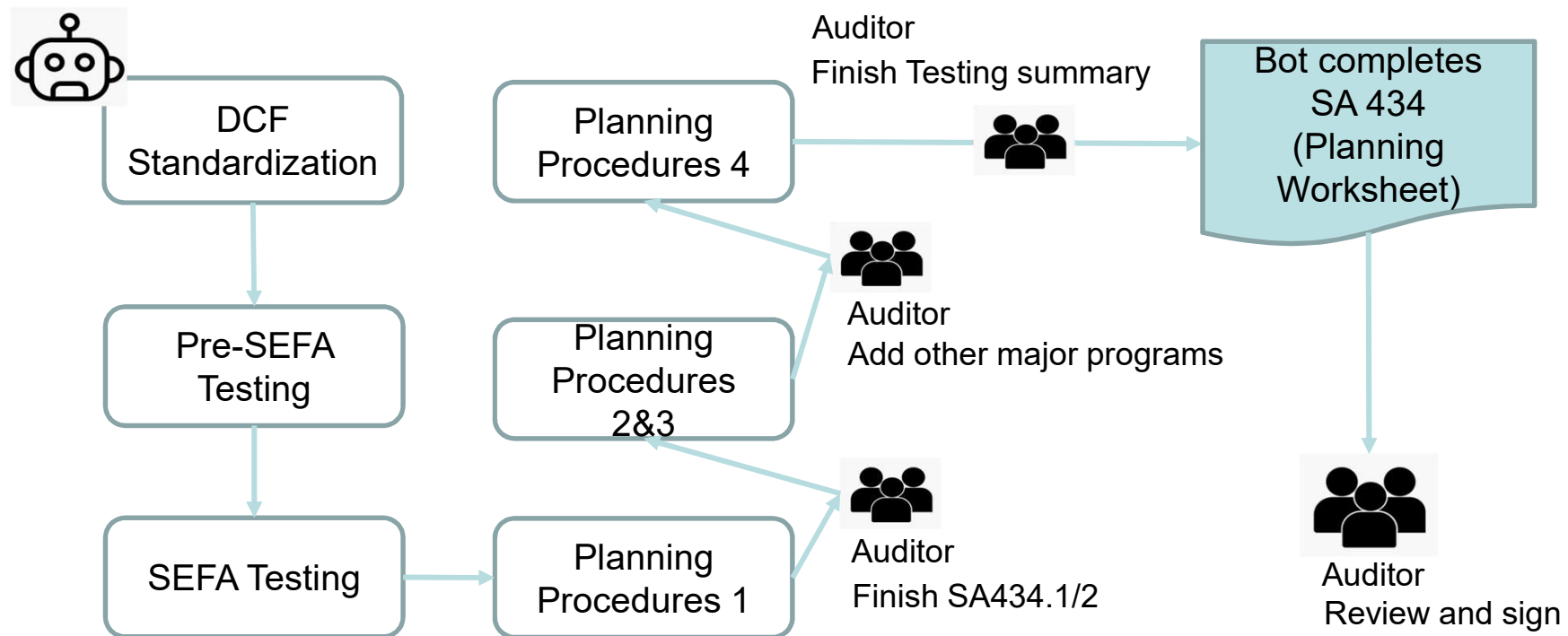
Rozario, A. (2018)



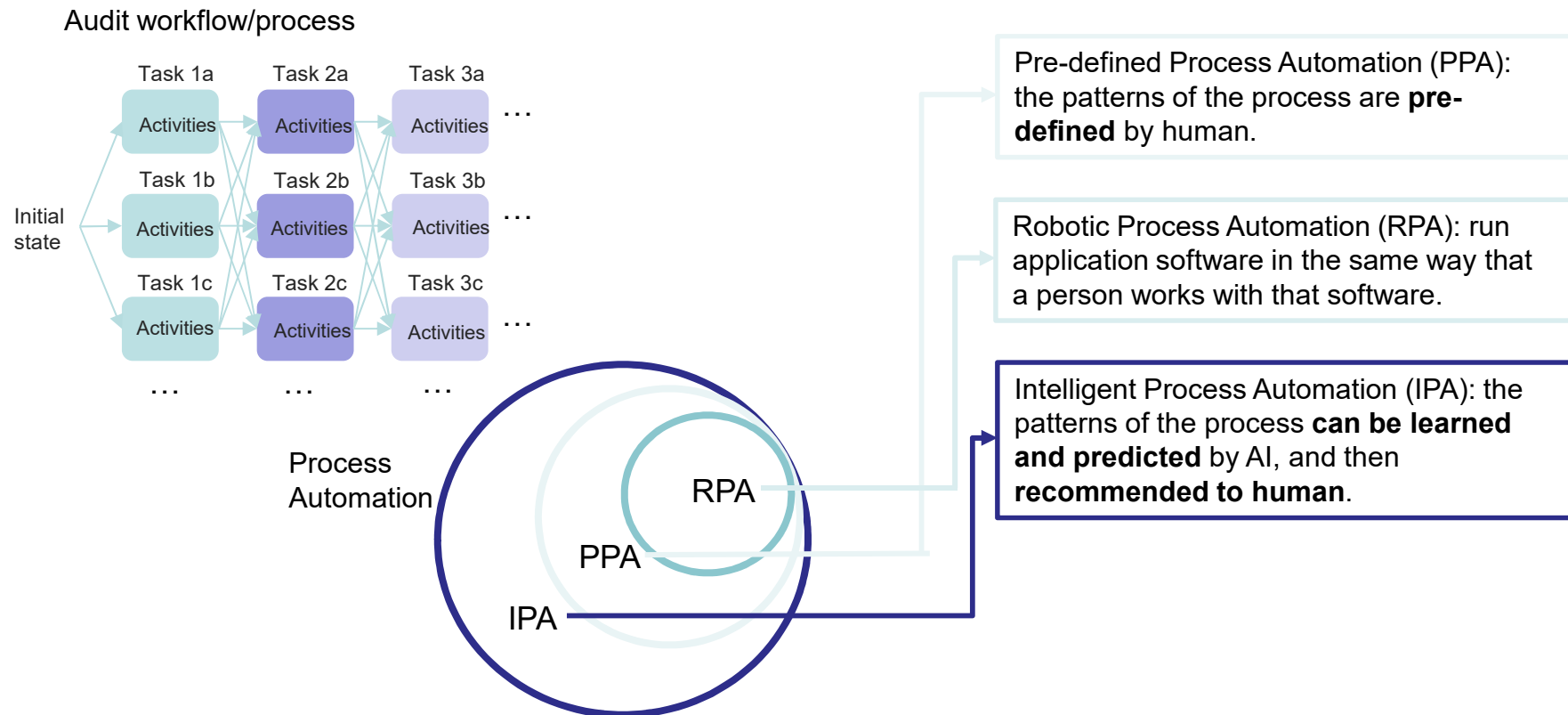
## RPA prototype in audit planning

- Auditors select the candidate tasks and we observe the actual execution those tasks
- Process redesign
- Fill in a planning worksheet using information generated from a series of simple analytical procedures and auditor's professional judgement.

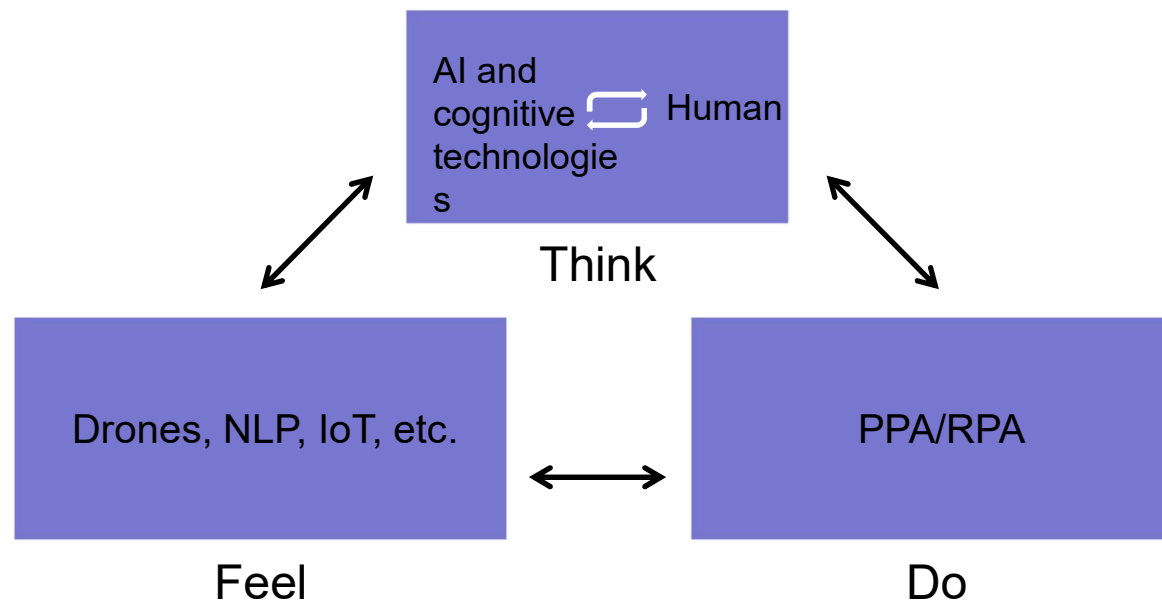
# RPA prototype in audit planning



# From RPA to IPA



## Potential Application of IPA in Audit-Inventory testing



# **5. BLOCKCHAIN AND SMART CONTRACTS**

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# Reengineering the Audit with Blockchain and Smart Contracts

*Presented by:*

Andrea M. Rozario

Ph.D. Candidate

Rutgers Business School

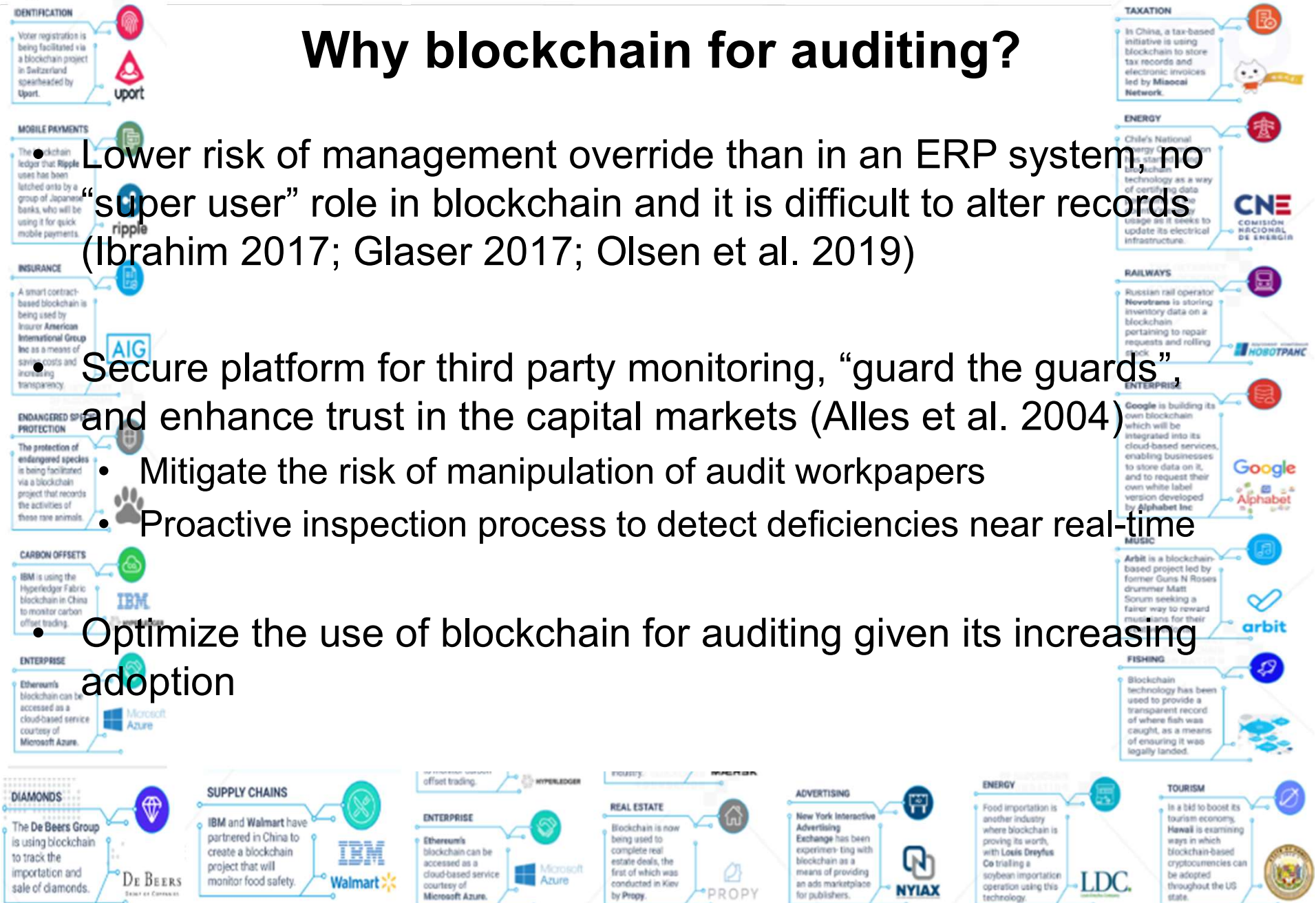
# Why blockchain for auditing?

Lower risk of management override than in an ERP system, no “super user” role in blockchain and it is difficult to alter records (Ibrahim 2017; Glaser 2017; Olsen et al. 2019)

Secure platform for third party monitoring, “guard the guards”, and enhance trust in the capital markets (Alles et al. 2004)

Mitigate the risk of manipulation of audit workpapers  
Proactive inspection process to detect deficiencies near real-time

Optimize the use of blockchain for auditing given its increasing adoption

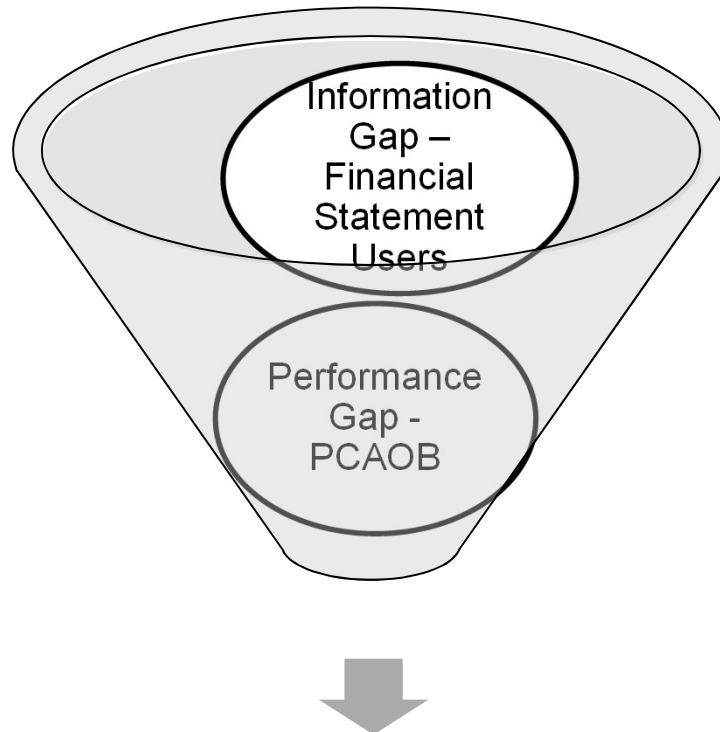


## Objectives

- **How can auditors leverage blockchain and smart contracts as audit data analytic tools to enhance audit quality?**
- Map the characteristics of blockchain that can enhance audit evidence to PCAOB requirements
- Propose an external audit blockchain supported by a variety of smart audit procedures
- Propose novel functions for the PCAOB and a holistic audit framework



# Motivation



Expectations gap

Increasing adoption of blockchain

Important to explore how auditors can leverage blockchain and smart contracts to narrow gap

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BLOCKCHAIN NEWS FEBRUARY 14, 2017 17:25

## 'Big Four' Giant Deloitte Completes Successful Blockchain Audit



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Get exclusive analysis and cybersecurity insights on HackerNews for just \$15 per month.

Multinational services firm and one of the so-called 'Big Four' accounting firms Deloitte has announced the completion of its latest blockchain endeavor. The firm scrutinized permissioned blockchain protocols and applications with professional auditing standards.

The aim of the project, Deloitte says, was to "enhance the utility and trust of a permissioned blockchain system" by putting it through both professional audit and assurance standards.

## PwC Has an Answer for the Blockchain: Audit It

Accounting firm unveils new service for clients' use of blockchain



PricewaterhouseCoopers LLP says its new service will facilitate and encourage companies' use of the blockchain, a still-new technology that faces a host of obstacles to adoption. PHOTO: MATT CARDY/GETTY IMAGES

By:

Michael Rapoport

Updated March 15, 2018 10:50 a.m. ET

[18 COMMENTS](#)

If blockchain technology can validate transactions the way an auditor traditionally does, what's left for an auditor to do?

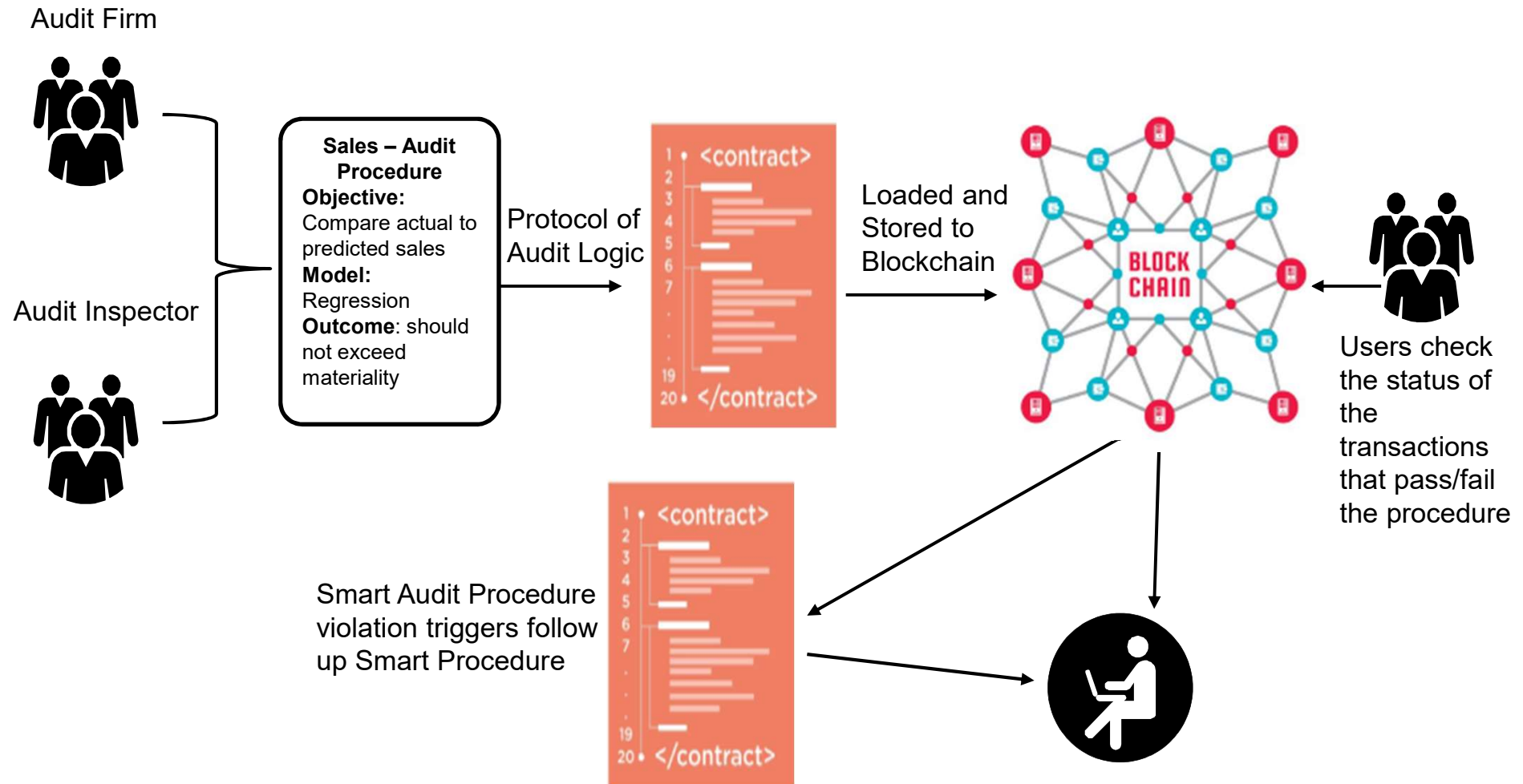
PricewaterhouseCoopers LLP's answer: Validate the validators.

# Blockchain can Improve the Reliability of Internal and External Audit Evidence

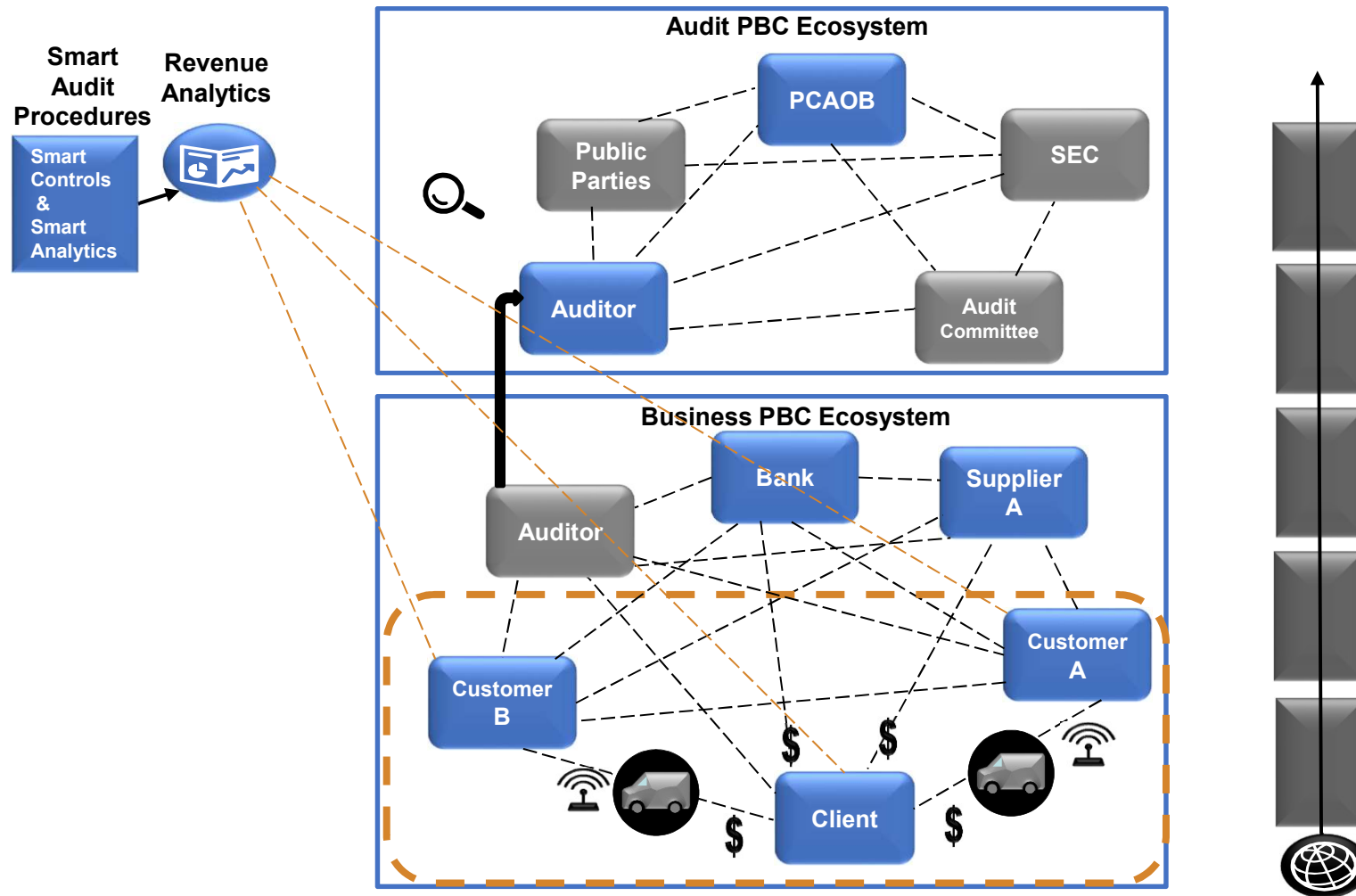
- Requirements of audit evidence: **sufficiency, relevance and reliability** (PCAOB AS 1105 2010)

Challenges of Gathering Audit Evidence	Blockchain Attributes	Blockchain Benefits
Traceable origins of sources (veracity)	Decentralization Immutability Accountability	Data Integrity to improve the <b>reliability</b> of audit evidence
Disaggregated data sources (variety)	Decentralization	One distributed depository for financial and nonfinancial data to improve the accuracy and timeliness of audit procedures and obtain a deeper understanding of the client

# Blockchain Audit Evidence and Smart Audit Procedures can Improve Audit Quality and Reporting



# Interlinked Blockchain Ecosystems



## Evolving the role of the PCAOB

- The PCAOB oversees audit firms to ensure audits are conducted in accordance with GAAS
  - Seeks to improve their inspection process
  - Expected to enhance efficiency by relying on technology
- New role for PCAOB as an active node on the audit blockchain to **validate** smart audit procedures and **review** their results
- Issues such as the performance of inadequate audit procedures can be mitigated

# Holistic Audit Approach for Revenue

Risk	Assertions	Risk Assessment	Substantive Analytics	Tests of Controls	On BC?
Fictitious or erroneous revenue transactions are entered into the system	Occurrence	Cognitive analytics is used to read and analyze terms of pdf legal contracts, such as amount, approvals, contracting parties			No
		Rules-based system is configured to automatically match the terms of legal contracts to the terms in legal smart contracts			No
		Smart Control is configured to automatically match legal smart contract code from previous audit period to legal smart contract code of current audit period			Yes
		Smart Analytic is configured to predict benchmark for current weekly revenue using revenue, locational, and temperature data from previous weeks		Smart Control is configured to automatically match location and temperature of goods that are being delivered to expected location and temperature of goods	Yes
		Smart Control is configured to automatically match revenue, invoice, and shipment amount from the client's blockchain			Yes
		Not applicable	Not applicable	Smart Control is configured to automatically match the access level of customer node	Yes
		Not applicable	Not applicable	Smart Control is configured to automatically match customer name per legal smart contract to customer name on active digital wallets	Yes
Revenue transactions are not recorded in the correct period	Cut-off	Not necessary, the record of the transaction and transaction event itself are triggered at the same time			Yes
		Although not necessary to verify <b>cut-off</b> on BC, the following procedure, which is used to verify occurrence, can serve as a secondary test to verify the cut-off assertion:			Yes
		Smart Control is configured to automatically match sales order, sales invoice, and shipment amount from the client's blockchain			
Revenue is not recorded	Completeness	Not necessary, reconciliations occur as transactions are validated and then posted			Yes
		Although not necessary to verify <b>completeness</b> on BC, the following procedure, which is used to verify occurrence, can serve as a secondary test to verify the completeness assertion:			Yes
		Smart Control is configured to automatically match sales order, sales invoice, and shipment amount from the client's blockchain			
Revenue returns are not recognized	Occurrence	Inspect and evaluate revenue return estimates			No

Unit Name

# Issues and Future Research

Limitation	Future Research
Computational power	Why do users of private and permissioned blockchains opt out of using centralized databases?
Storage capabilities	Which methods can meet the demand to store big data on the blockchain?
Cybersecurity risk	How to design and implement a continuous monitoring system to reduce the risk of collusion on the blockchain network?
Litigation risk	How much transparency should be provided to financial statement users while maintaining an acceptable level of audit litigation risk?
Vulnerability of smart contracts	What are the quality processes that public accounting firms should have in place to ensure smart audit procedures are free of error?
Regulatory acceptance	How will the oversight model of financial statement audits be disrupted?
Economics	Would blockchain and smart contracts be developed in-house, or would it be outsourced?

## **Contributions**

- Explores the evolution of auditing in light of blockchain of smart contracts by:
  - Proposing an external audit blockchain supported by smart audit procedures
  - Discussing the issues related to the application of these technologies

## **Limitations and Future Research**

- Existing audit risks were considered, new audit risks may emerge
- Described purpose and usefulness of the external audit blockchain



# **6. AI AND MACHINE LEARNING IN AUDITING**

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# Artificial Intelligence prospective in audit

Helen Brown-Liburd

Ivy Munoko

Miklos Vasarhelyi

Rutgers Business School

# Current implementations: All Big 4 accounting firms are reporting the use of these AI blocks

Machine Learning	Big AI / Smart Analytics	Natural Language Processing	Machine Vision	Intelligent RPA	Speech Recognition
<ul style="list-style-type: none"><li>• Classifier ( tax transaction, contract)</li><li>• Fraud detection</li><li>• Review full population for outliers</li></ul>	<ul style="list-style-type: none"><li>• Large scale data analysis</li><li>• discover facts and relations that are difficult for the human mind</li></ul>	<ul style="list-style-type: none"><li>• Synthesis of text<ul style="list-style-type: none"><li>• e.g. review of contracts, vendor invoices, emails, transcribed conversation</li></ul></li></ul>	<ul style="list-style-type: none"><li>• OCR + Machine learning to extract data from images</li><li>• Drones + IoT to perform inventory inspection</li></ul>	<ul style="list-style-type: none"><li>• Test of transactions</li><li>• Document workpapers</li><li>• GL review</li><li>• Bank confirmation</li></ul>	<ul style="list-style-type: none"><li>• Decode conversation</li><li>• Chat bots</li><li>• Digital Assistants</li></ul>

# Current implementations: Small / medium size accounting firms are using AI SaaS



**CASEWARE**



**74%** of firms say they want to be "data-driven",  
but only **29%** are actually successful at connecting analytics to action.



Forrester

Organizations have access to more data than ever. Making sense of this data and providing actionable insights, however, can be a challenge.

Our next-generation application employs predictive analytics to drive real business outcomes from data. Combining our proprietary XBRL, Artificial Intelligence, and Machine Learning technologies, the application examines historical data and applies statistical analysis to identify patterns. Now, accountants are able to forecast the likelihood an SEC filing will require amendment.


**Ensemble AI:**  
Combines Machine learning with Domain expertise / business rules and statistical methods to:

-gain actionable insight into large data


-review 100% of data

-sample from outliers


-perform risk assessments




**MindBridge**




**Redefining reasonable assurance**  
Dozens of the most powerful risk-detection criteria on Earth, including expert taught AI and machine learning algorithms, working together to analyze 100% of your data, including all monetary flows between accounts? That's not some pipe dream for the future, that's MindBridge Ai Auditor today. Welcome to reasonable assurance, redefined.



**100% data analysis**  
A wise man once said, "Sampling is a coping mechanism for dealing with large data." Don't leave risk assessment to chance, Ai Auditor analyzes your entire data set, and unlike any other solutions it examines full transactions, looking at the monetary flows between accounts, all credits and all debits. Oh, and we also provide a sleek sample-selector tool that helps you adhere to current processes, and to justify if required, precisely why those samples were selected.

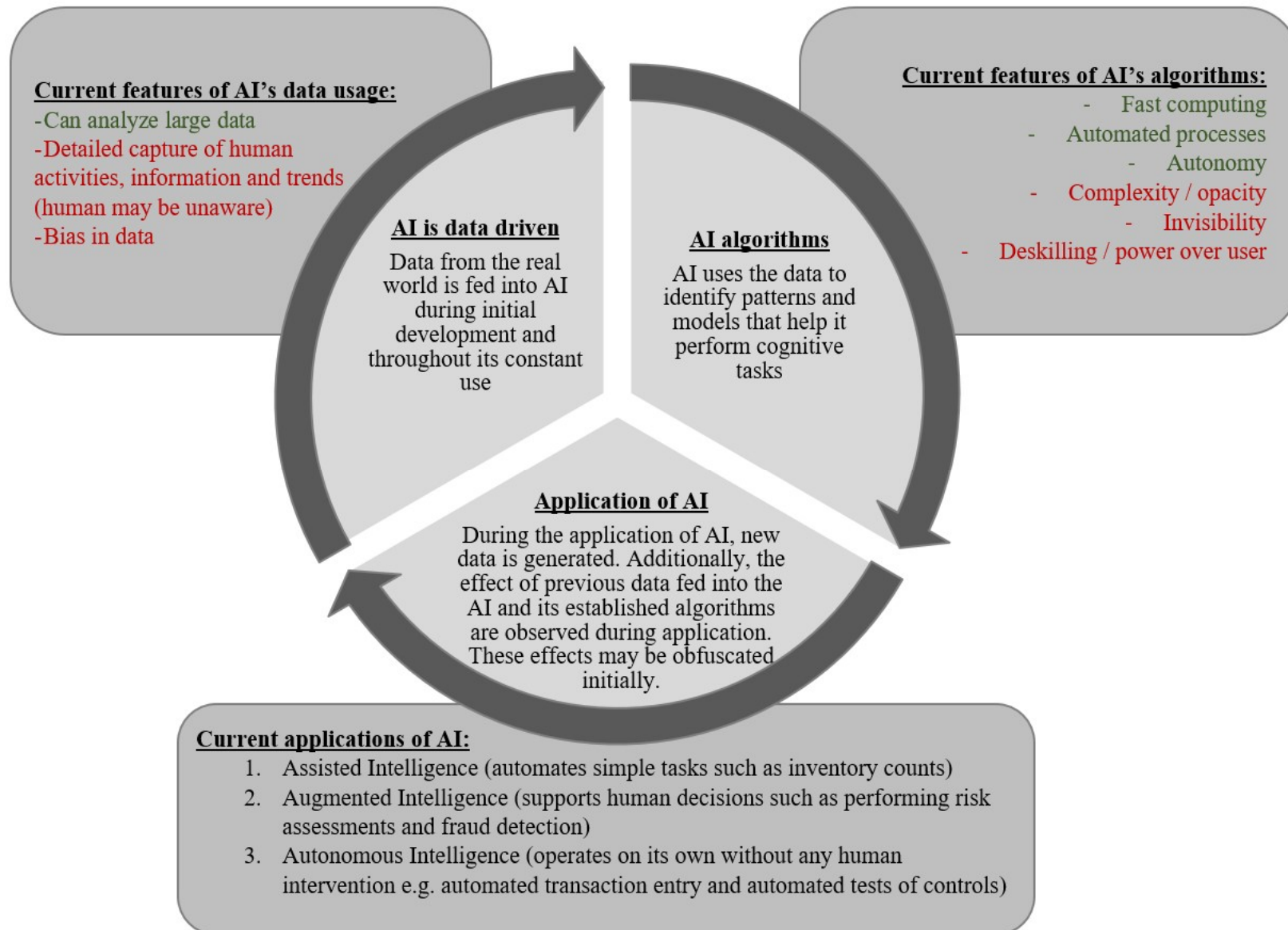


**Zero scripting, zero training**  
Wasting time on data ingestion and account groupings are now a relic of the past. Solutions that require IT resources, scripting and training on CAAT tools, those solutions are working against you, not with you. Ai Auditor works by your side, taking care of the heavy lifting, providing the best possible analysis for your audits, while freeing you spend time where it matters.



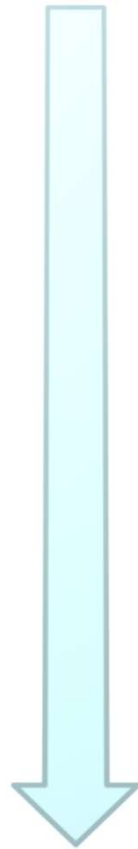
**Identify risk, in seconds**  
With a powerful and intuitive reporting interface, Ai Auditor empowers you to examine and compare risk assessments across your entire data set, whether it be by account, by time, by user, vendor or transaction. The visually compelling drill down functionality provides a beacon to explore the data at a more granular level, where detailed risk assessments, and their explanations are just a click away.

# Current Features and Applications of AI



# Current Applications of AI - Assisted, Augmented and Autonomous

As AI shifts  
from assisted  
towards  
autonomous,  
the tool  
sophistication,  
resultant  
benefits as  
well as the  
risks increase



## **Group 1: Assisted AI: Support lower level decisions**

**Examples:** *Chatbots*

## **Group 2: Augmented AI: Support high risk decisions**

**Examples:** *Performing audit risk assessments, Fraud detection,  
Going concern evaluations*

## **Group 3: Autonomous AI: Assumes decision making**

**Examples:** *Expense compliance*



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## **A conceptual framework of an audit plan cognitive assistant**

Miklos A. Vasarhelyi

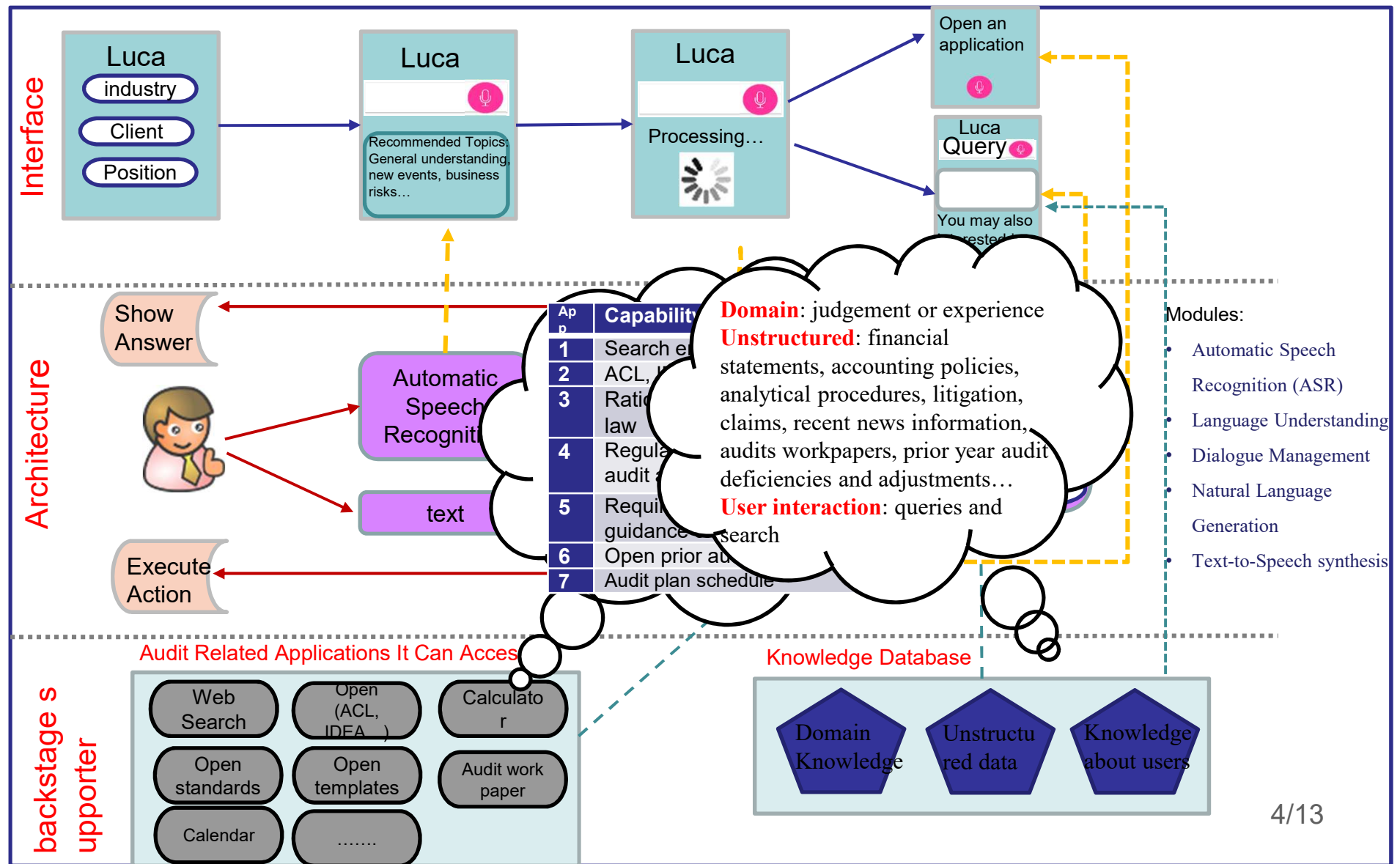


**Rutgers, the State University of New Jersey**



# Proposed Audit Cognitive Assistant Luca

Optional Presentation Title







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# DEEP LEARNING APPLICATIONS IN AUDIT DECISION MAKING

*Dissertation Defense*

Ting Sun

## 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**



Unit Name

# **7. AUDIT 4.0**

Unit Name



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# Imagineering Audit 4.0

Jun Dai and Miklos A Vasarhelyi

# Background

- Advances in sensors, Cyber-Physical Systems (CPS), Internet of Things (IoT), Internet of Service (IoS), and Smart factory promote a new industry revolution
  - <https://www.youtube.com/watch?v=F06gB7mJX98>
  - <https://www.youtube.com/watch?v=b0kHh-VuQA4&t=200s>
  - <https://www.youtube.com/watch?v=h9t06cyC7Es>
- Industry 4.0 (Industrie 4.0) became publicly known at Hannover Fair in 2011. . It has quickly spread across the world, especially in the EU, the US, China ,and Brazil.
- This project foresees the impact of the Industry 4.0 on the auditing profession, imagineers the use of new technologies for audit purposes, and identifies challenges in the transformation towards the new generation of auditing: “Audit 4.0”

## Evolution of Auditing: From 1.0 to 4.0

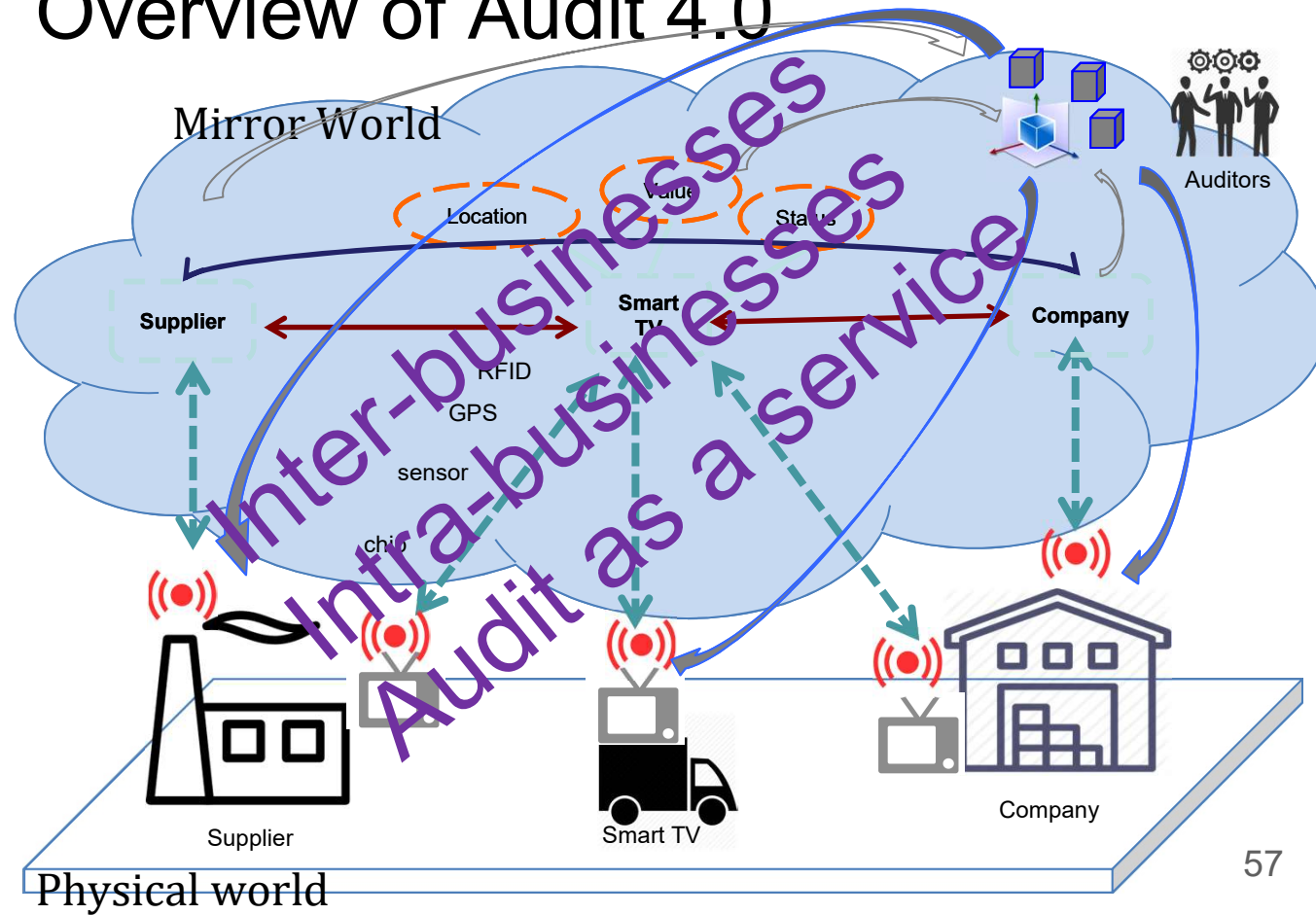
Audit 1.0	Audit 2.0	Audit 3.0	Audit 4.0
<ul style="list-style-type: none"><li>▪ Manual audit</li><li>▪ Tools: pencils, calculators</li></ul>	<ul style="list-style-type: none"><li>▪ IT audit</li><li>▪ Tools: Excel, CAAT software</li></ul>	<ul style="list-style-type: none"><li>▪ Inclusion of non-financial data in audit analytics</li><li>▪ Tools: analytical software</li></ul>	<ul style="list-style-type: none"><li>▪ Semi- and progressive automation of audit</li><li>▪ Tools: sensors, CPS, IoT/S, RFID, GPS</li></ul>

# Technology

- Sensors: collect real-time accounting information, such as quality of inventory, working hours of employees...
- Cyber-physical systems: embedded computers and networks monitor and control the physical processes, usually with feedback loops where physical processes affect computations and vice versa
- Internet of things: objects linked through a network
- Internet of service: service vendors can offer their services via the internet
- Smart factories : use CPS, and IoT/S to assist people and machines in the execution of their tasks
- Others: RFID, GPS, and data analytics



## Overview of Audit 4.0



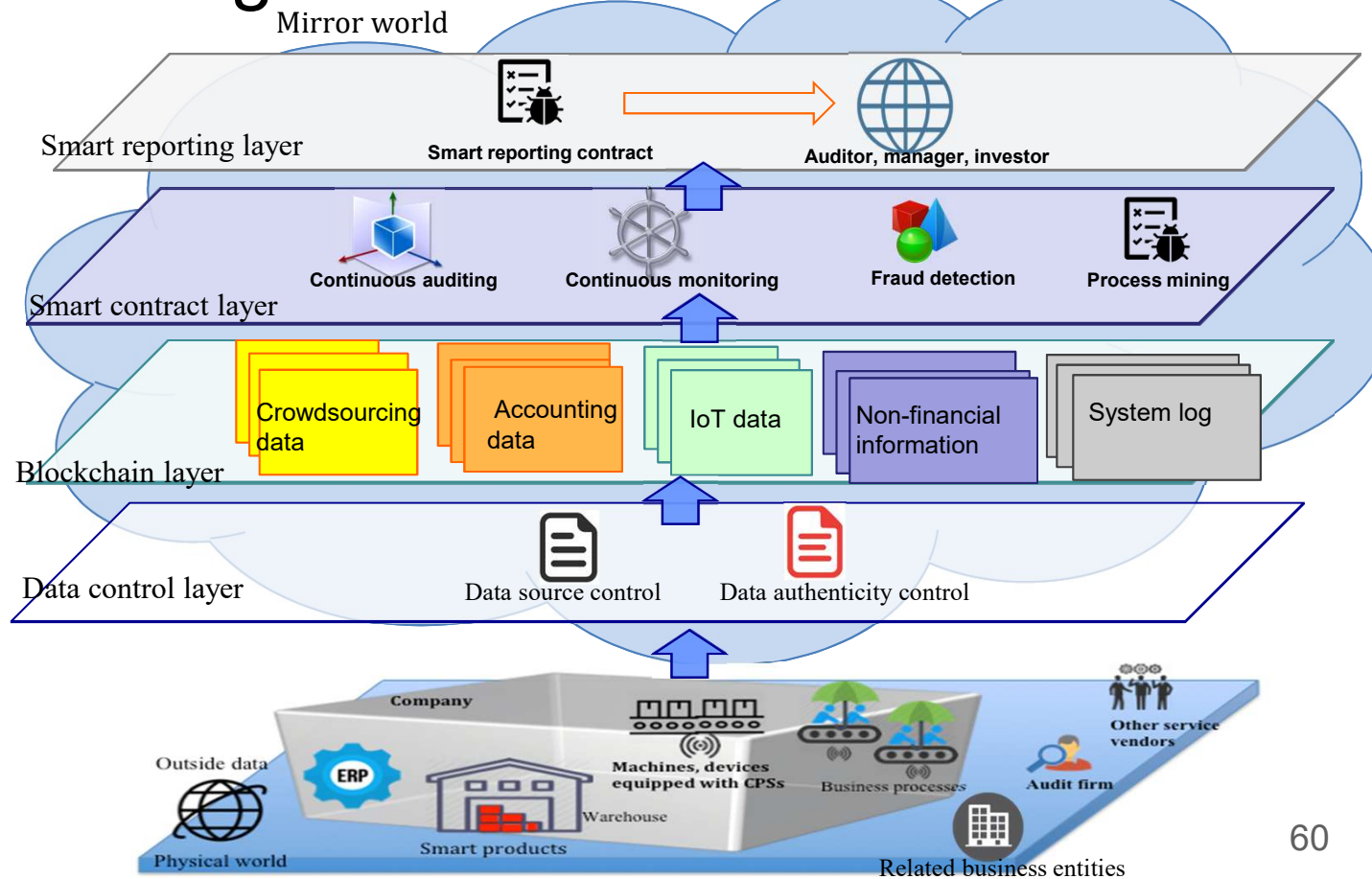
## Challenges

- Digital crime: technique given, technique taken
- Security and privacy issues of companies' data
- Standardization of information and data

## Using Blockchain and Smart Contracts to facilitate Audit 4.0

- **Audit 4.0** collects data using smart sensors, IoT, and other technologies, and performs a variety of tests and analytics via intelligent audit modules to identify anomalies and useful information.
- **Blockchain** ensures the reliability and integrity of the audit-related data collected in Audit 4.0.
- **Smart contracts** enforce the correct operations of the intelligent audit modules without human intervention.

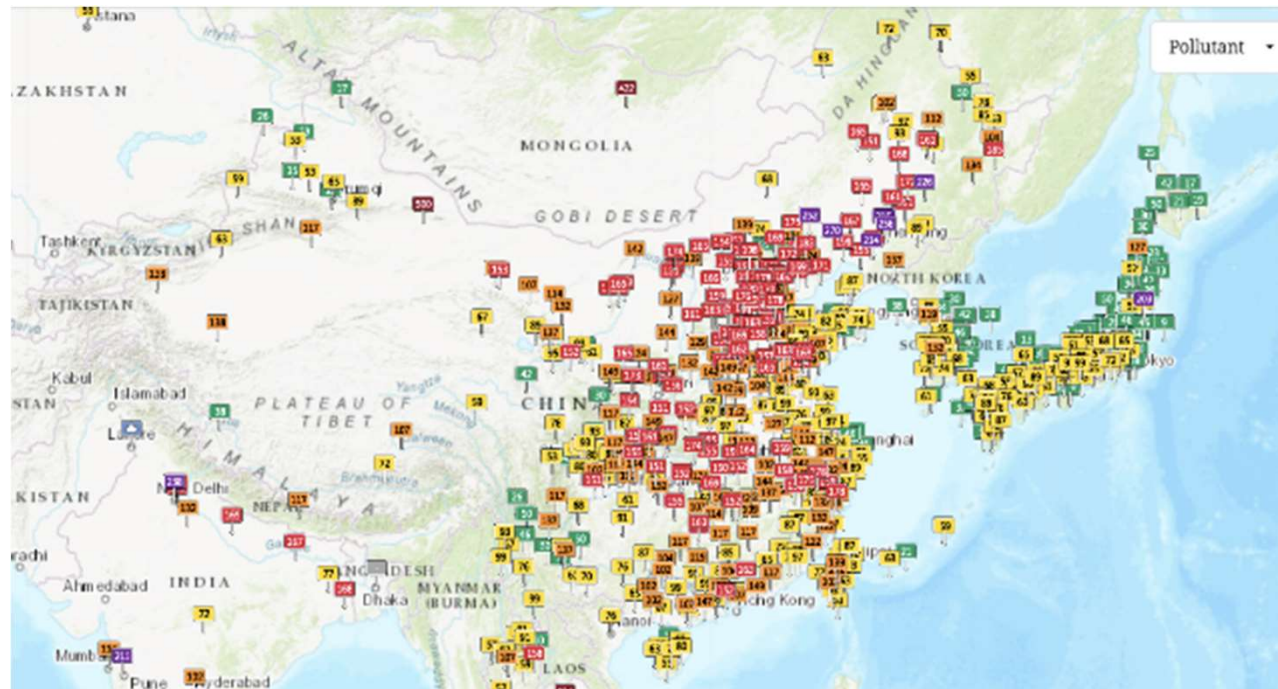
# Linking Blockchain to Audit 4.0



## Applying Audit 4.0 to Accountability Audit of Air Pollution Controls In China

- Environmental accounting and auditing recently raise attentions from both academia and practice because of accelerating climate change, desertification, pollution, etc.
- In 2017, Chinese government issued a new regulation on the accountability audit of natural resource, including air, and considered it as an important factor for government officials' evaluation.

## Air Pollution In China

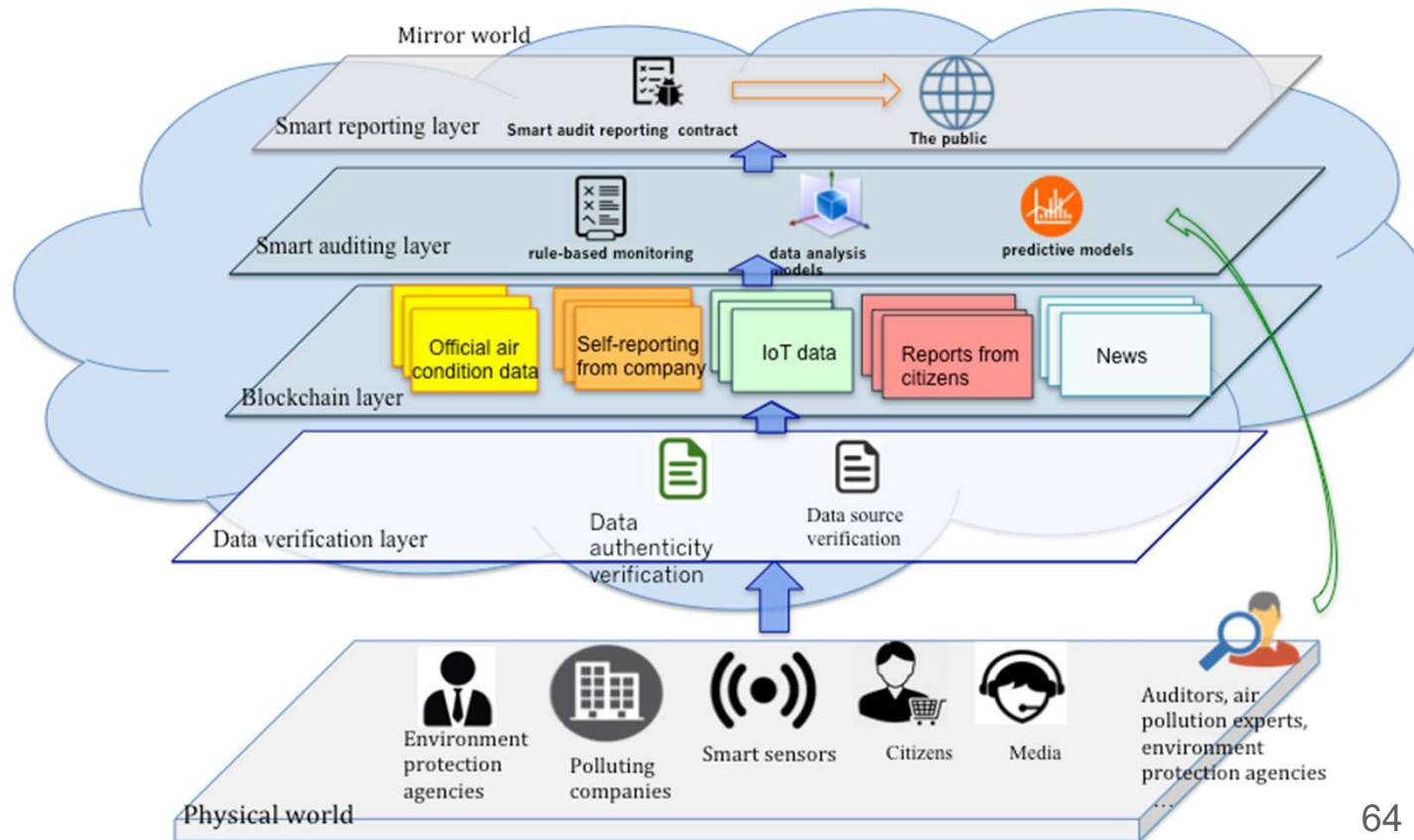


Picture source: <https://waqi.info/>. Accessing time: Oct 18, 2018, at 9:40am EDT.

# A Continuous Accountability Audit System

- A continuous accountability audit system is designed to evaluate officials' performance on air pollution controls based on Audit 4.0, blockchain, and smart contracts.
  - **Audit 4.0**: real-time air data collection via crowd sourcing
  - **Blockchain**: ensure data integrity
  - **Smart contracts**: data validation, data monitoring against predetermined rules and reporting anomalies to relevant parties in real time
- Participants: government officials, government auditors, environment protection agencies, polluting enterprises, citizens, and media

# The Vision of the Continuous Accountability Audit System



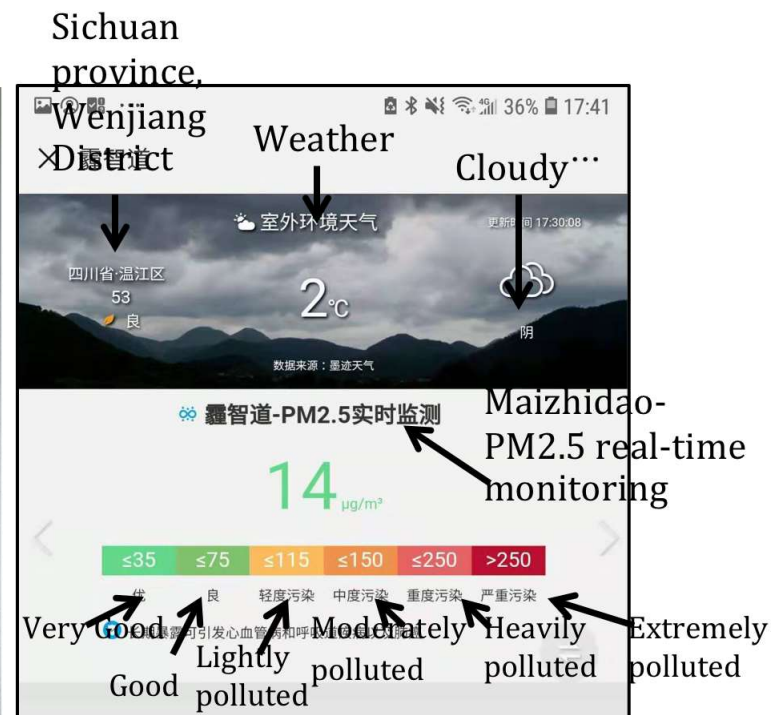


## Demo

- The Ethereum Ropsten Testnet was used as the blockchain platform to create the demo.  
<https://ropsten.etherscan.io/>
- Two researchers uploaded real PM 2.5 values (a popular air quality indicator) at their places to the blockchain from May 14 to June 1, 2018
- The official PM2.5 values were also collected from a public website, and uploaded to the blockchain
- A total of 144 data points were uploaded. The average number of data points uploaded per day is 7.58

## Demo (cont.)

- 5. Recording



# **8. EXOGENOUS (EXTERNAL) VARIABLES IN AUDIT**



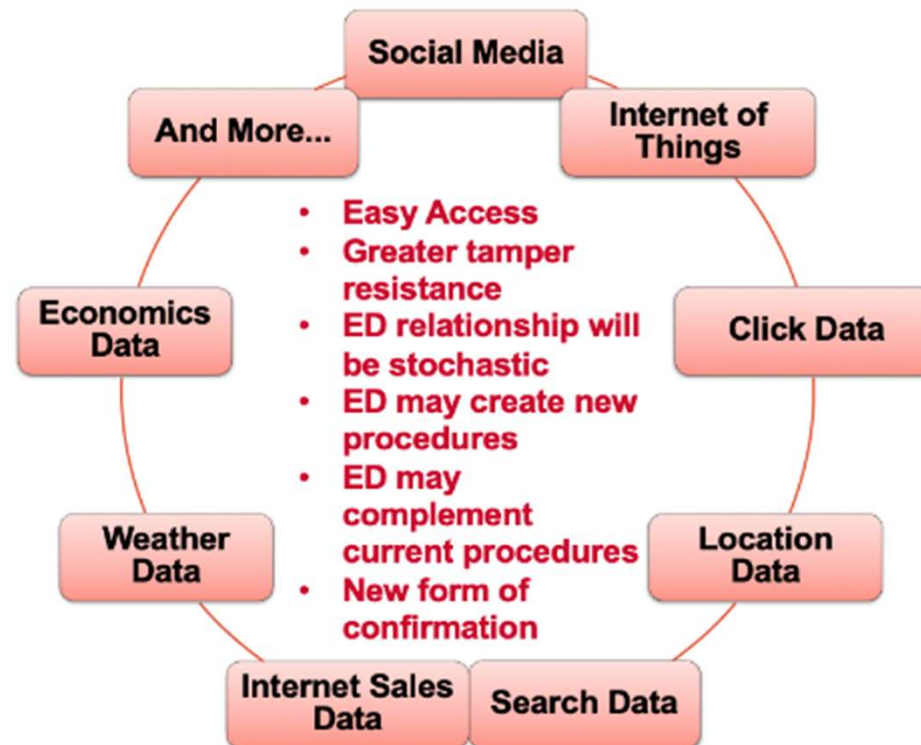
RUTGERS

Exogenous data analytics for Auditing

Miklos A. Vasarhelyi

Helen Brown Liburd

Rutgers Business School



- Forget about privacy.... Its gone....
- Fortunately you are not very interesting
- Technology giveth ....
- Technology taketh



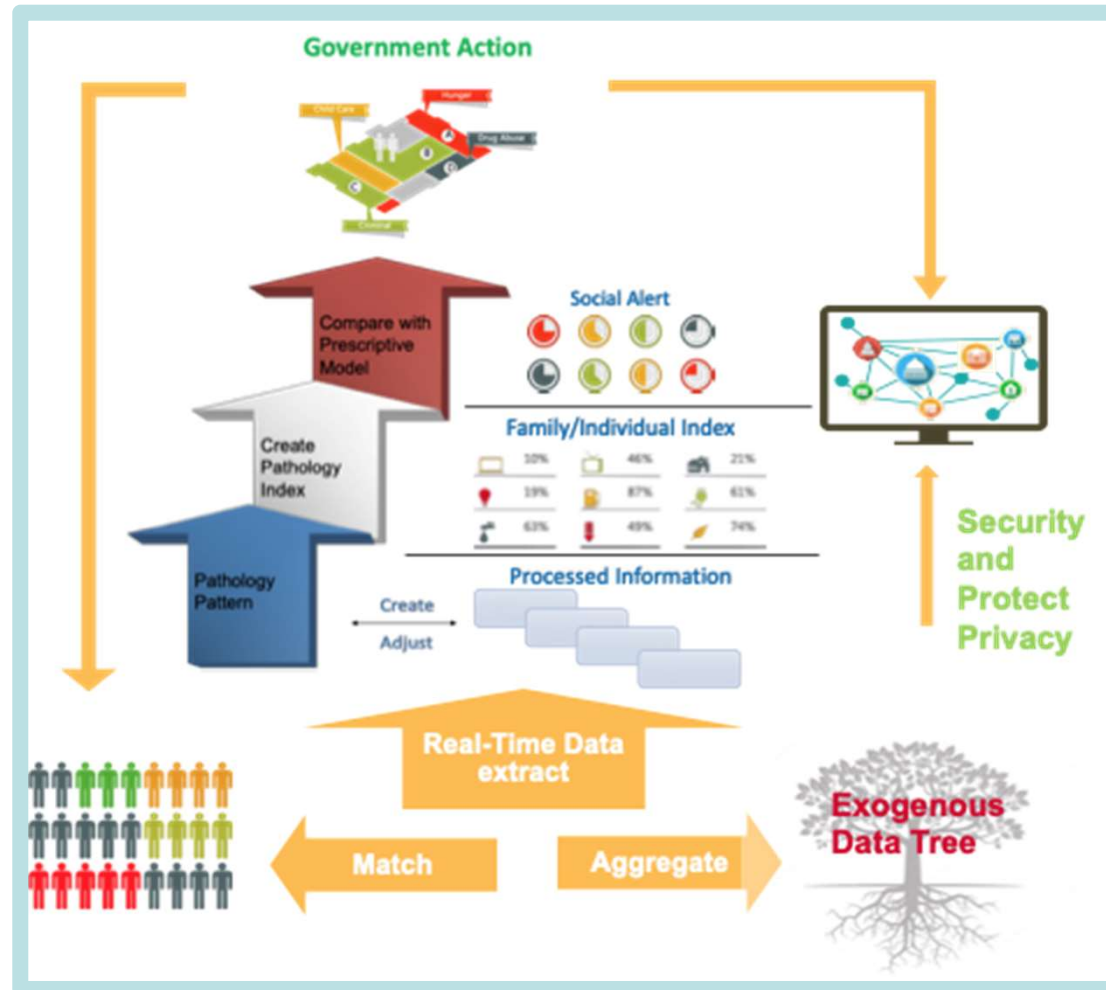
RUTGERS

# Government Economic Monitoring (GEM)

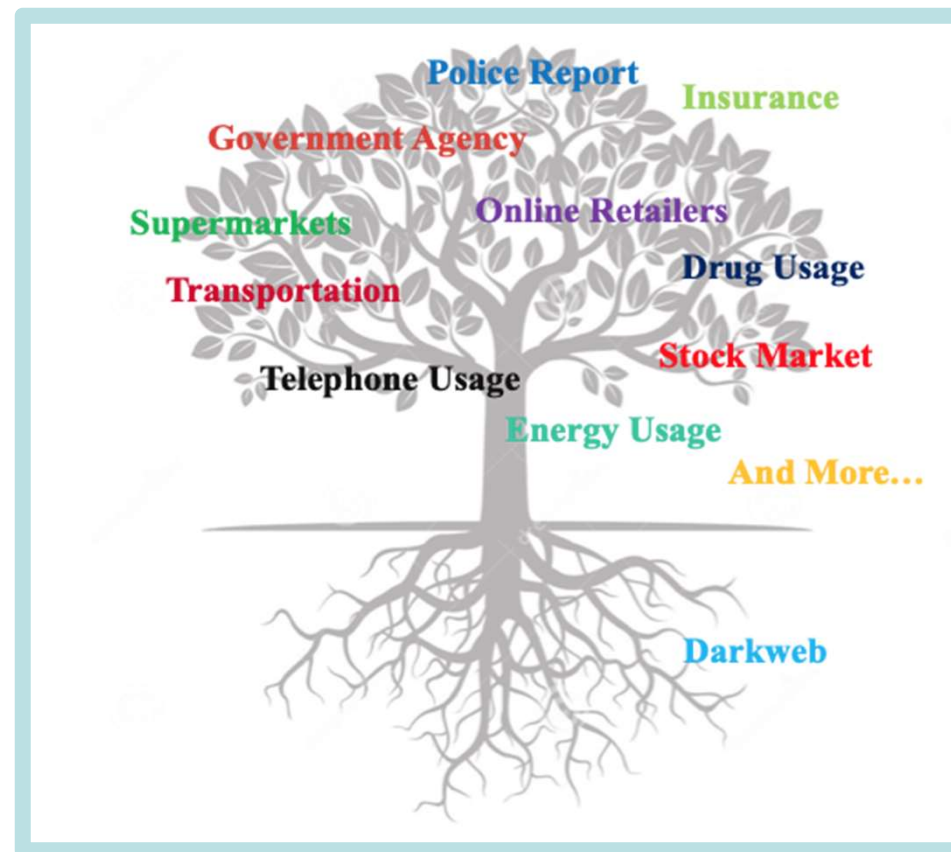
Arion Cheong, Miklos A. Vasarhelyi, Xinxin Wang,  
Deniz Appelbaum, Helen Brown-Liburn

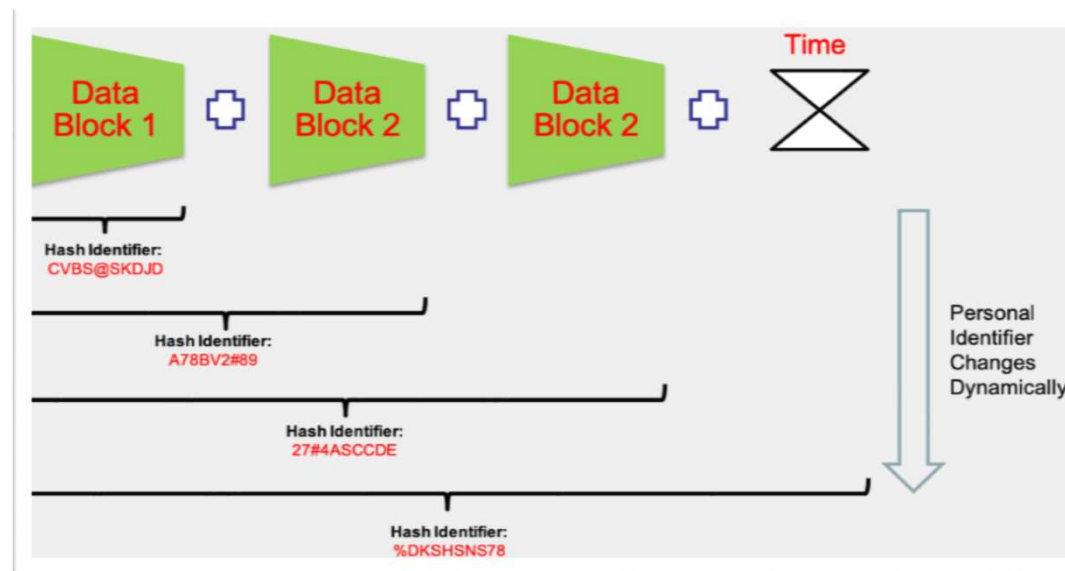
Rutgers University  
CarLab



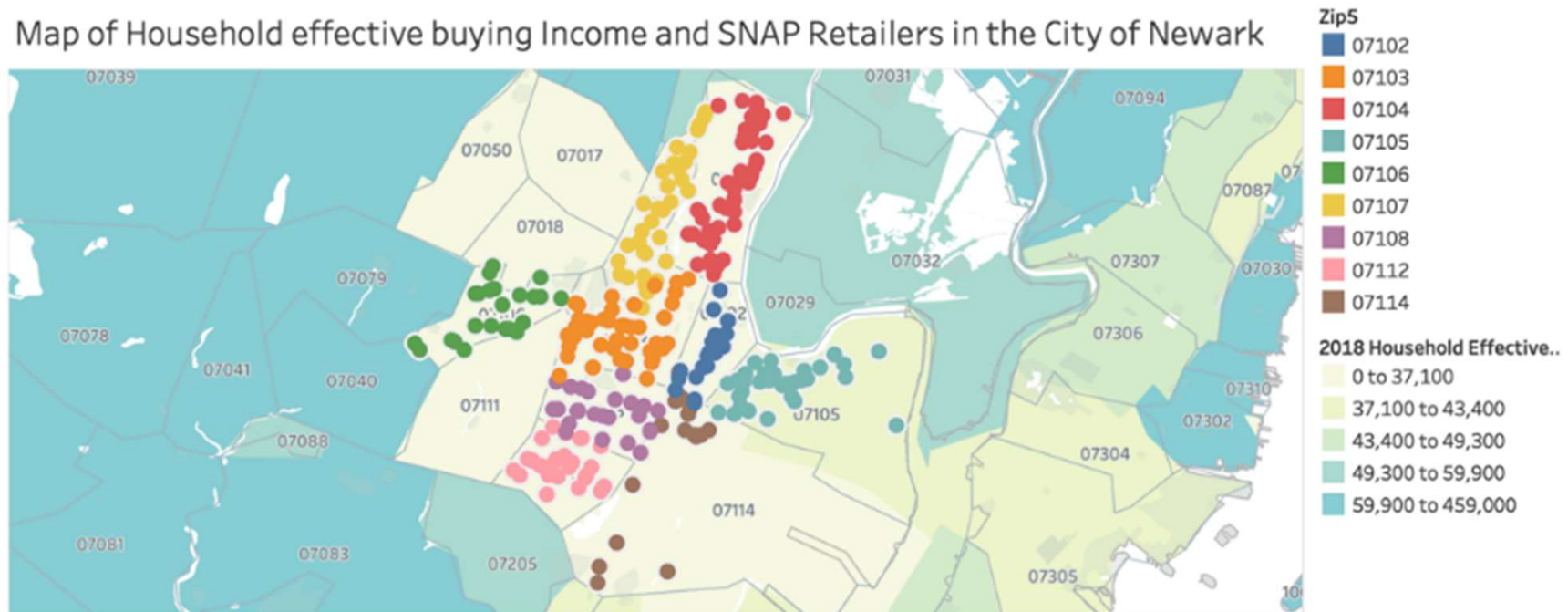




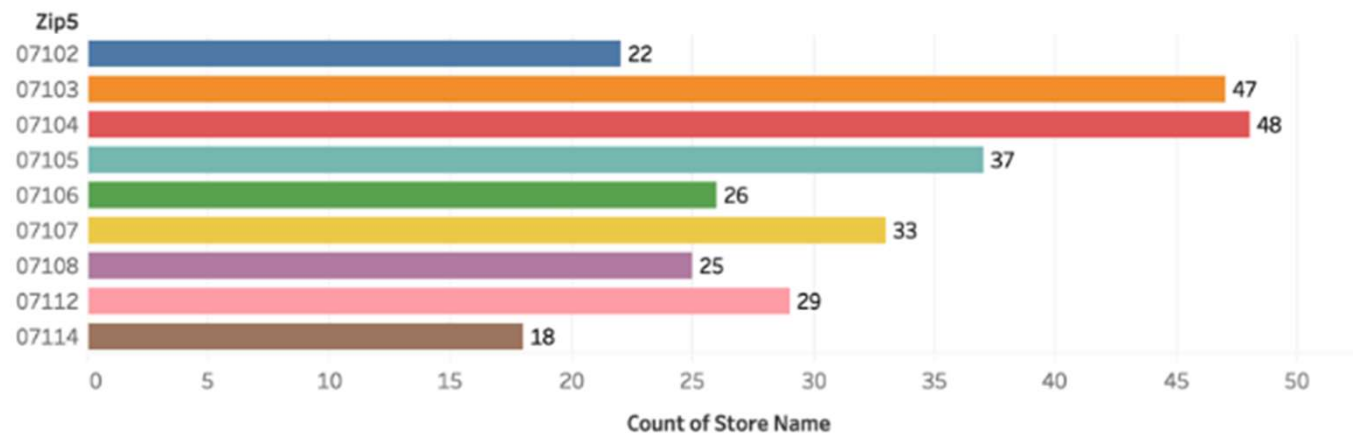


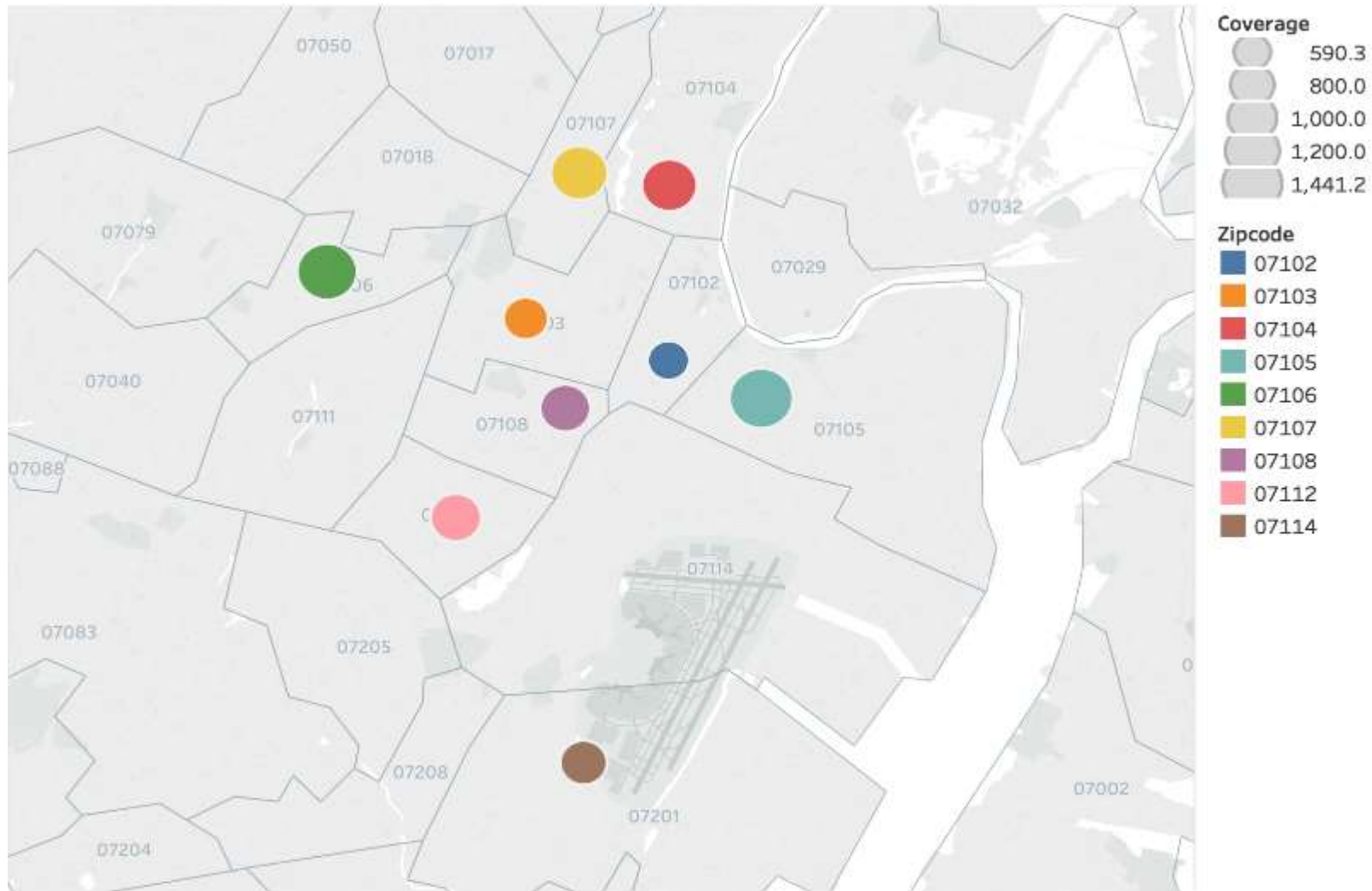


Map of Household effective buying Income and SNAP Retailers in the City of Newark



Retailer Counts by ZipCode



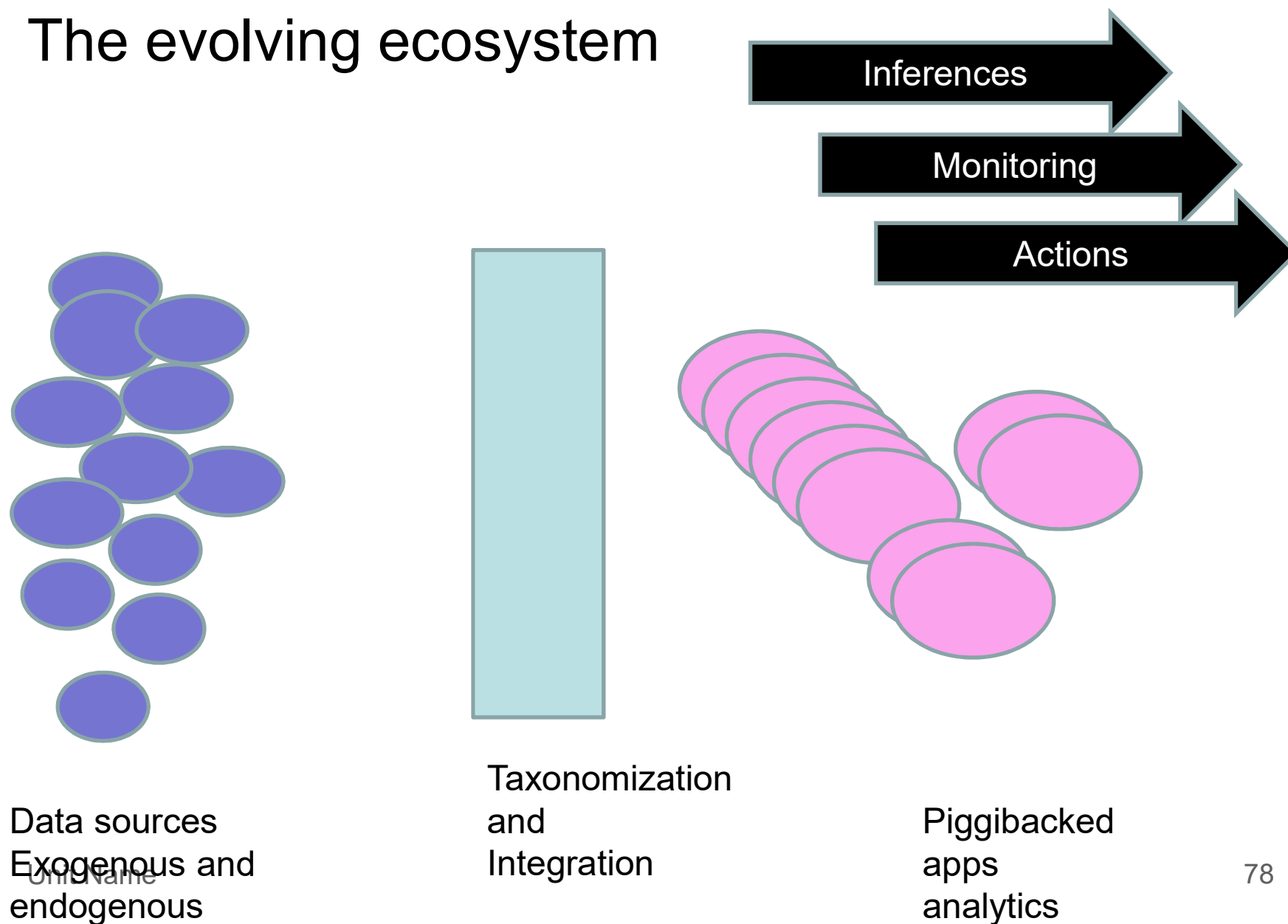


Map based on Longitude (generated) and Latitude (generated). Color shows details about Zipcode. Size shows sum of Coverage. Details are shown for Zipcode.

OTHER COOL  
STUFF

# 9. CONCLUSIONS

# The evolving ecosystem



## A contemporary dilemma

- The cost benefits of performing an audit have changed and will change more with automation.
- How do you deal with full population testing?
- If you can perform full population tests at nearly zero costs do you need to perform the current form of risk assessment?
- With the degreasing significance of financial statements what is happening with the value of the financial audit?
- Can you perform an external audit just with exogenous variable evidence (from big data)?
- If we can substantial parts of the audit in as smart contracts are we finally evolving to a continuous audit?

# What is the path to Education 4.0?

Education 1.0	Education 2.0	Education 3.0	Education 4.0
Spit and chalk	Powerpoints		
Walls of caves	Blackboard etc...		