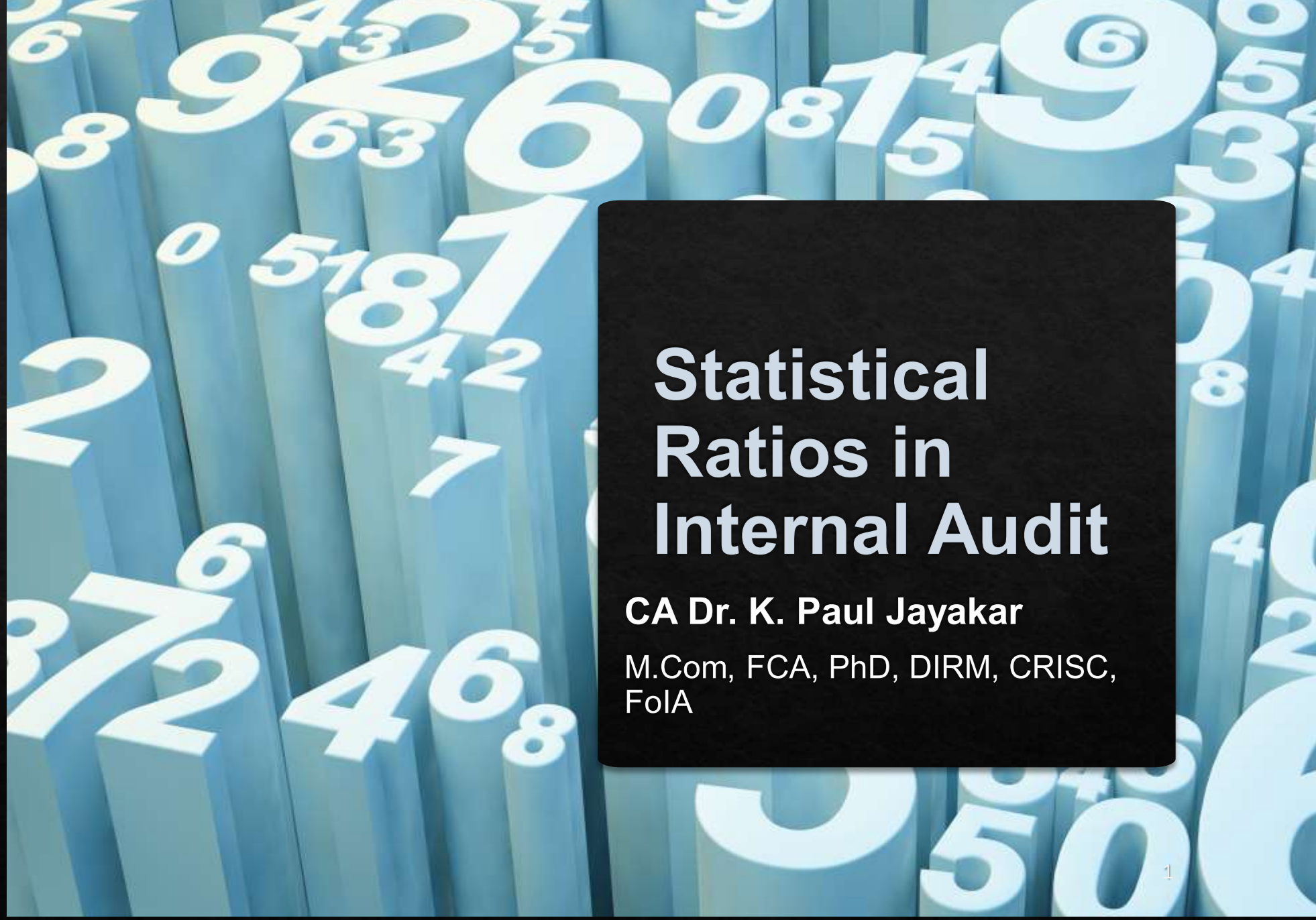


Statistical Ratios in Internal Audit

CA Dr. K. Paul Jayakar

M.Com, FCA, PhD, DIRM, CRISC, FoIA

Sir Ronald Aylmer Fisher (1890-1962), renowned as "his time's greatest scientist," was a British **statistician and biologist** who made significant contributions to experimental design and population genetics. He is widely regarded as the "Father of Modern Statistics and Experimental Design."

Father of Indian Statistics:

Prof. Prasanta Chandra Mahalanobis is also known as the father of Indian Statistics. He was **a physicist by training,** a statistician by instinct and a planner by conviction.

Statistics allow accountants **to look at financial data in a different way.** By using statistical data, we can analyze the data to identify trends, patterns, and relationships that would otherwise be difficult to detect.

What is a ratio in simple words?

- A ratio is **a relationship between two things when it is expressed in numbers or amounts**.

- For example, if there are ten boys and thirty girls in a room, the ratio of boys to girls is 1:3, or one to three.

What is an example of a ratio statistic?

- Ratio data can include variables like **income, height, weight, annual sales, market share, product defect rates, time to repurchase, unemployment rate, and crime rate.**
- As an analyst, you can say a crime rate of 10% is twice that of 5%, or annual sales of $2 million are 25% greater than $1.5 million.

Why are ratios important in statistics?

- Ratios **help us express relationships between quantities in a way that makes them easier to understand**.
- They communicate information in a concise and meaningful way. Simplifying ratios is critical to this process.
- When working with ratios, it's important to simplify them down to the smallest whole numbers possible.

What are ratios in statistics and probability?

- **The probability of an event is expressed as a ratio that can be used to predict the likelihood of an event occurring**.
- Probability ratios are values ranging from 0 to 1.
- Probability ratios may be represented as fractions, decimals, or percentages.
- If an event has a probability equal to 0, then it is impossible.

What is the best example of a statistic?

- Statistics are numbers that describe the properties of samples. For example, **the average income for the United States is a population parameter**.
- Conversely, the average income for a **sample drawn from the U.S. is a sample statistic.**
- Both values represent the mean income, but one is a parameter vs a statistic.

Fraud detection using data analytics

Fraud detection

- We begin by distinguishing between fraud **prevention** and fraud **detection**.
- Fraud prevention describes measures to stop fraud from occurring in the first place.
- Fraud detection comes into play once fraud prevention has failed.
- Many fraud detection problems involve huge data sets that are constantly evolving.
- Processing these data sets in a search for fraudulent transactions or calls requires the use of statistical models.

Statistics to identify frauds

- Statistics provide effective solutions for fraud detection.
- Statistics can be applied to detect activities such as money laundering, e-commerce credit card fraud, telecommunications fraud and computer intrusion.
- Statistical tools/models for fraud detection can be used.
- Data from different applications can be diverse in both size and type.
- Further, It can be classified as Organization level tests and Data level tests.

1. Organisation Level Tests

- Falsification of books/ Manipulation indicator
  - Montier's C-score
  - Beneish M-score
- Bankruptcy Indicators
  - Ohlson's O-score
  - Altman's Z-score
  - Piotroski F-Score

Montier’s C-score

- Montier's C-Score is a discrete score between 0-6 which reflects six criteria used to determine whether a company is cooking the books.
- The 6 Parameters are as follows:
  1. Growing divergence between net income and cash flow (1 point)
  2. Increasing receivable days (1 point)
  3. Increasing inventory days (1 point)
  4. Increasing other current assets (1 point)
  5. Declines in depreciation relative to gross fixed assets (1 point)
  6. Total asset growth in excess of 10% (1 point)

Interpretation of results

If a company scores 0 there is no evidence of earnings manipulation whilst 6 suggests there is lots of evidence.

Beneish M-score

- The Beneish M-score consists of eight indices capturing financial statement anomalies that can result from earnings manipulation or other types of fraudulent activity.
- Actual data in the financial statements builds the calculations of the indices that create the overall M-Score describing the degree of possible earnings manipulation or possible other fraudulent activity, such as concealing embezzlement activity.

Formula

- M =-4.84 + 0.92 DSRI + 0.528 GMI + 0.404 AQI + 0.892 SGI + 0.115 DEPI – 0.172 SGAI + 4.679 TATA – 0.327 LVGI
- The formula is a weighted average of these components:
  - DSRI—Days sales in receivable index
  - GMI—Gross margin index
  - AQI—Asset quality index
  - SGI—Sales growth index
  - DI or DEPI—Depreciation index
  - SGAI or SGAEI—Selling, general and administrative expenses index
  - TATA—Total accruals to total assets index
  - LI or LVGI—Leverage index

Interpretation of results

If the calculation of the Model is greater than -2.22, the calculation suggests a higher probability of financial statement manipulation (-2.21 is greater than -2.22 and -2.23 is less than -2.22).

Altman's Z-score

- The Z-score is a linear combination of four or five common business ratios, weighted by coefficients.
- $Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$

Where,

X_1 = working capital / total assets

X_2 = retained earnings / total assets

X_3 = earnings before interest and taxes / total assets

X_4 = market value of equity / book value of total liabilities

X_5 = sales / total assets

Interpretation of results

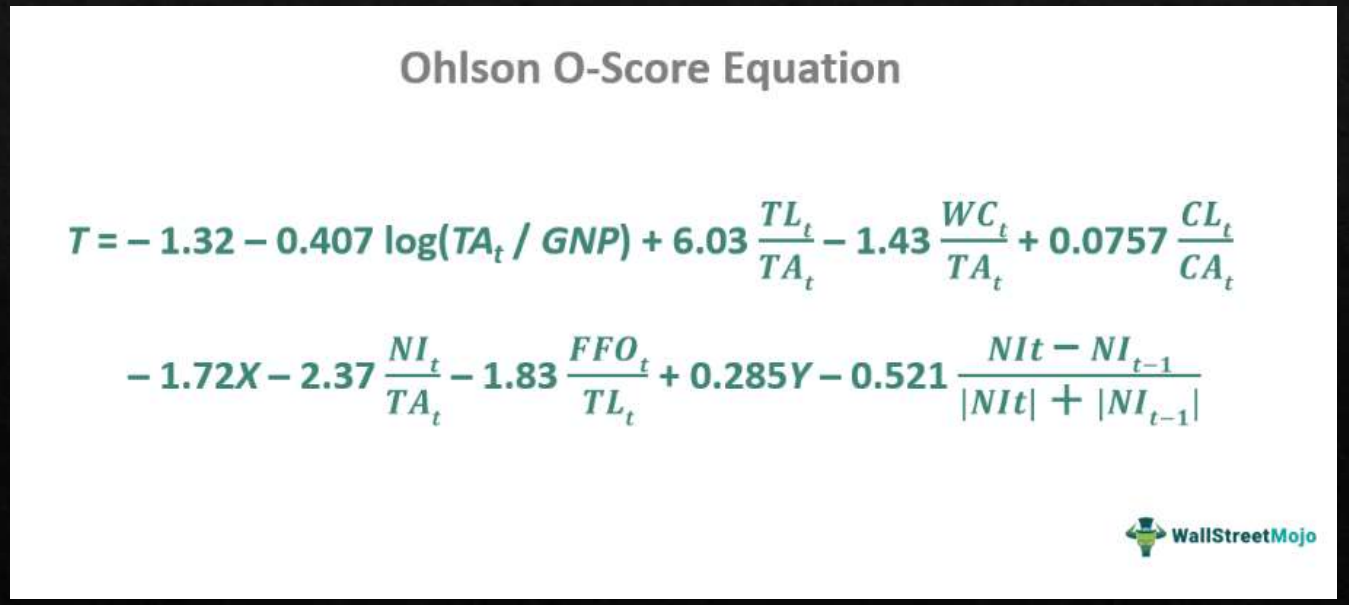
- Financially sound if greater than 2.99 (“Safe” Zone)
- Caution required if between 2.77 - 2.98 (“Grey” Zone)
- Likely to go bankrupt within 2 years if between 1.8 - 2.7 (“Distress” Zone)

Ohlson's O-score

- The Ohlson O-Score is a multi-factor financial formula for predicting financial distress.
- The formula to calculate the score:
- T= -1.32-0.407log(TA/GNP)+6.03(TL/TA)-1.43(WC/TA)+0.0757(CL/CA)-1.72X-2.37(NI/TA)-1.83(FFO/TL)+0.285Y-0.521(NIn-NIn-1)/(NIn+NIn-1)
- Where,
- TA = Total Assets
- GNP = Gross National Product
- TL = Total Liabilities
- WC = Working Capital
- CL = Current Liabilities
- CA = Current Assets
- X = 1 if TL > TA, 0 otherwise
- NI = Net Income
- FFO = Funds From Operations
- Y = 1 if a net loss for the last two years, otherwise 0

Interpretation of the result

- If the O-Score is greater than 0.5 it suggests that the firm will default within two years.



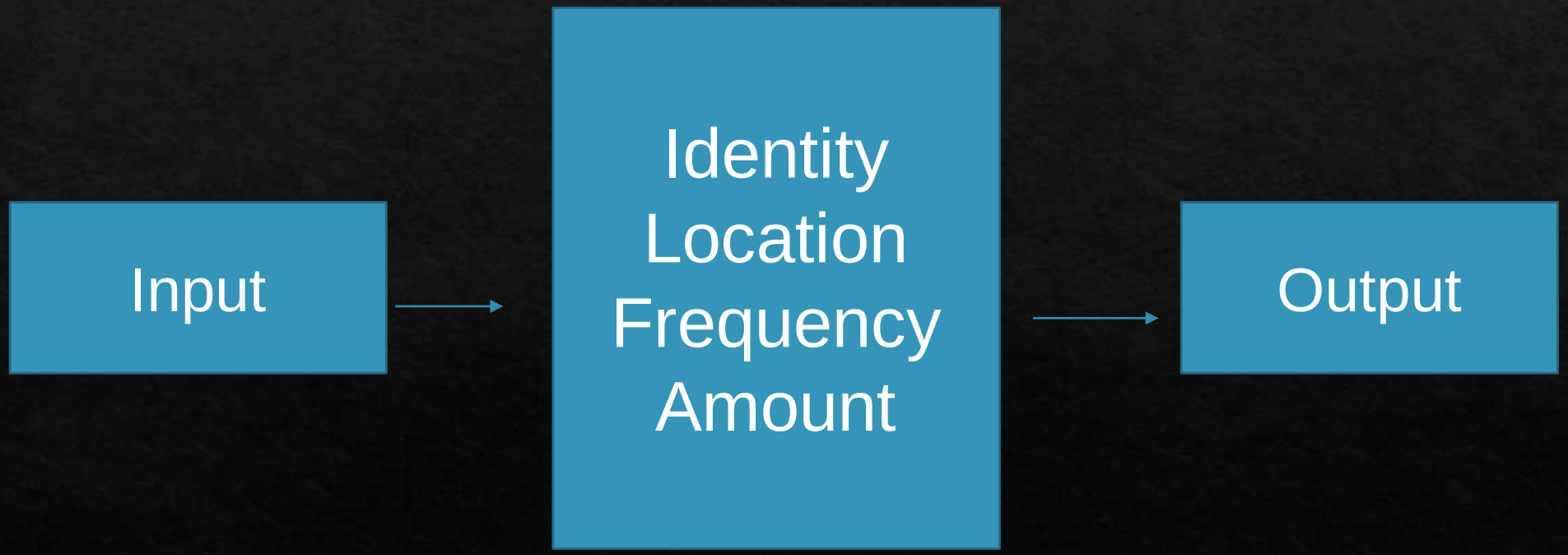
Piotroski F-Score

- **Piotroski F-Score** is a number between 0-9 which is used to assess the strength of company's financial position.
- The score is calculated based on 9 criteria divided into 3 groups:
- ***Profitability***
  Return on Assets (1point if it is positive in the current year, 0 otherwise)
  Operating Cash Flow (1 point if it is positive in the current year, 0 otherwise)
  Change in Return on Assets (ROA) (1 point if it is higher in the current year, 0 otherwise)
  Accruals (1 point if it is higher than in the current year, 0 otherwise)
- ***Leverage, Liquidity and Source of Funds***
  Change in Leverage (long-term) ratio (1 point if lower this year compared to p/y, 0 otherwise);
  Change in Current ratio (1 point if it is higher this year compared to the p/y, 0 otherwise)
  Change in the number of shares (1 point if no new shares were issued during the last year)
- ***Operating Efficiency***
  Change in Gross Margin (1 point if it is higher this year compared to the p/y, 0 otherwise)
  Change in Asset Turnover ratio (1 point if it is higher this year compared to the p/y, 0 otherwise)

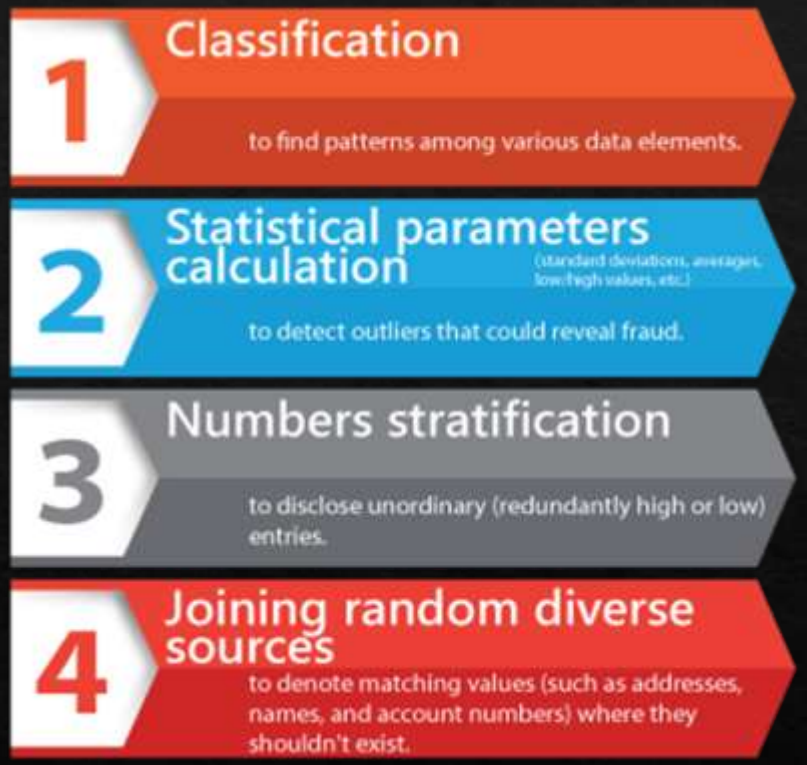
Interpretation of the results

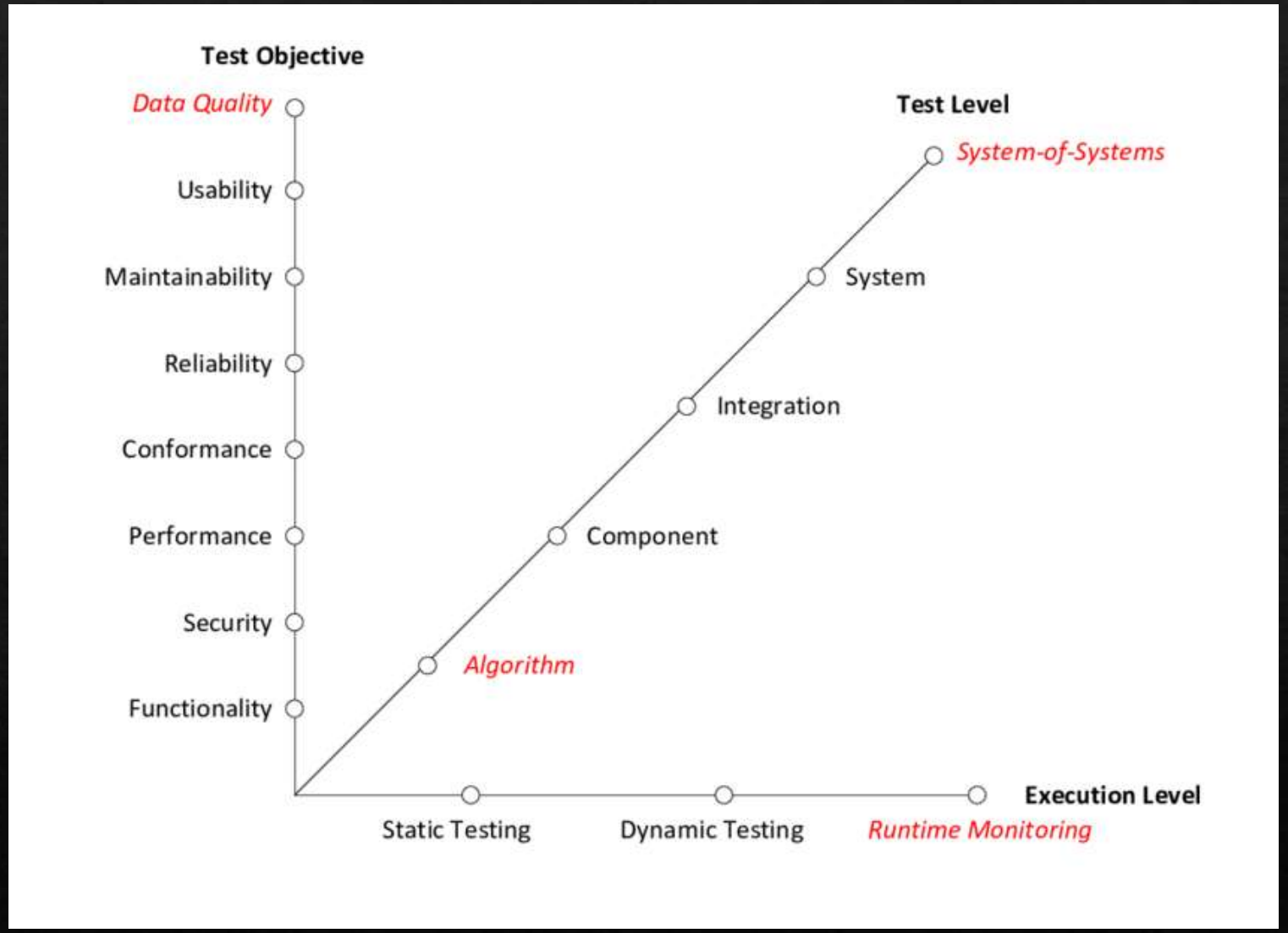
- A company that has Piotroski F-Score of 8-9 is considered to be strong.
- Alternatively, firms achieving the Score of 0-2 are considered to be weak.

Parameters to consider for the test



2. Data level tests




Test Objective
Data Quality
Usability
Maintainability
Reliability
Conformance
Performance
Security
Functionality
Test Level
System-of-Systems
System
Integration
Component
Algorithm
Execution Level
Static Testing
Dynamic Testing
Runtime Monitoring

Hidden Markov model

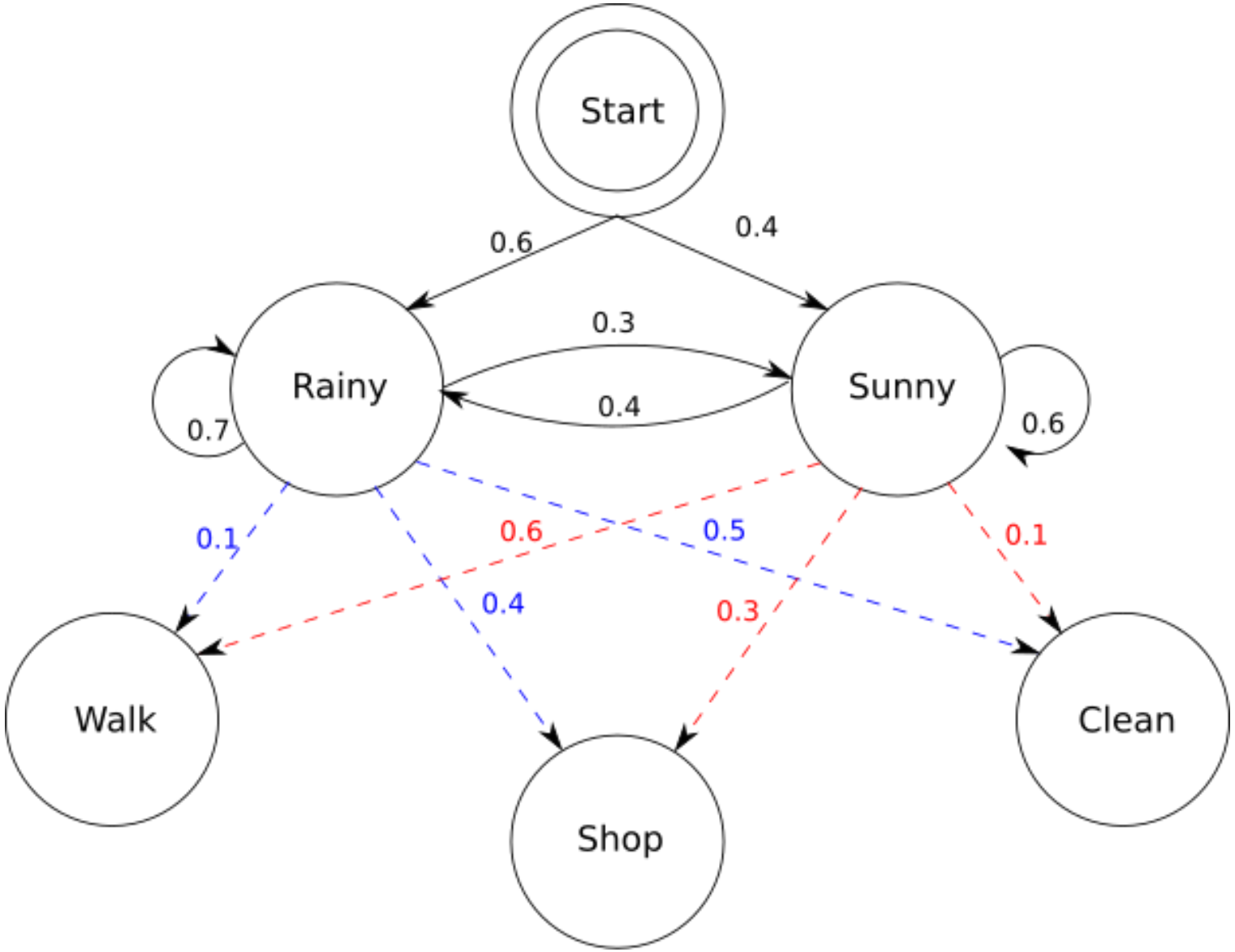
- A hidden Markov model is a statistical Markov model in which the system being modeled is assumed to be a Markov process with unobservable states. As part of the definition, HMM requires that there be an observable process Y whose outcomes are "influenced" by the outcomes of X in a known way.
- The essential difference between a Markov chain and a hidden Markov model is that **for a hidden Markov model there is not a one-to-one correspondence between the states and the symbols**. It is no longer possible to tell what state the model was in when x was generated just by looking at x.

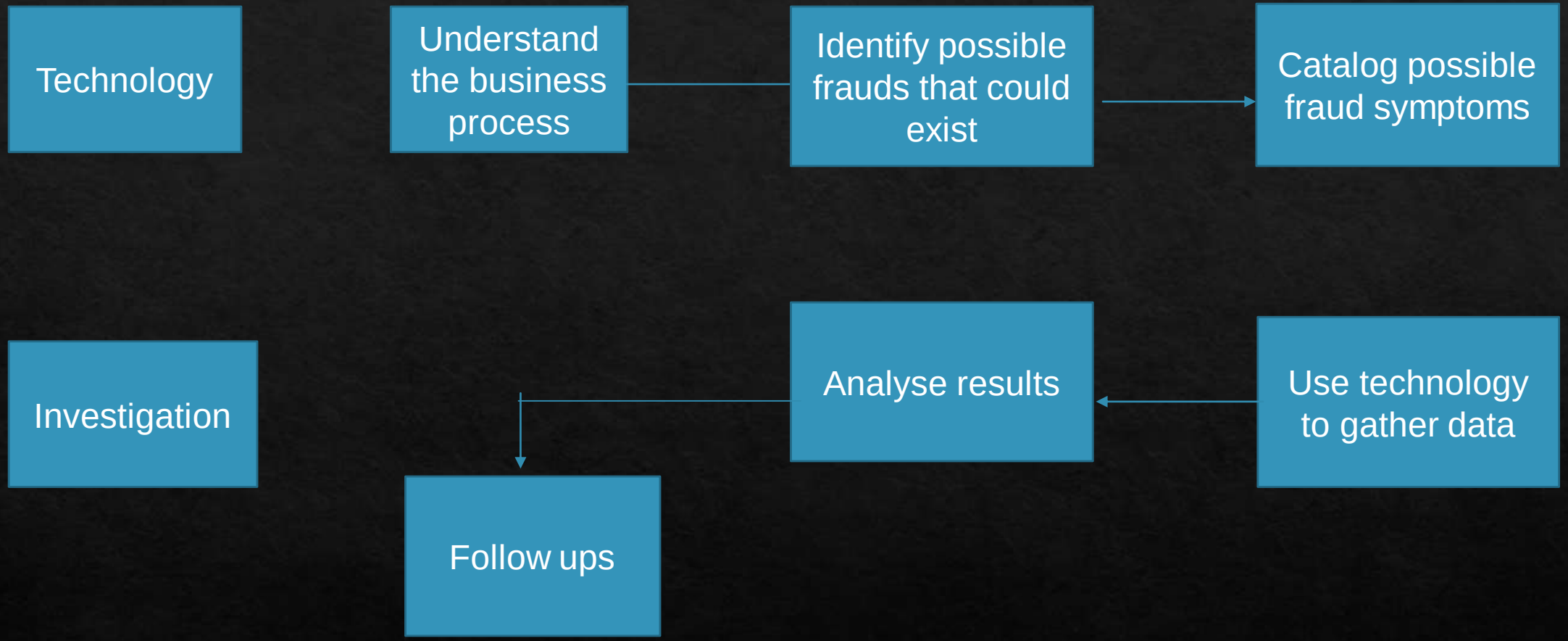
- HMM consider mainly three value ranges such as:
  a. Low (l)
  b. Medium (m)
  c. High (h).

False positives can be better minimized, while maintaining detection accuracy, by combining Extreme Learning Machine (ELM) and Hidden Markov Models (HMM) as classifiers within the context of a situation awareness framework

- Consider two friends, Alice and Bob, who live far apart from each other and who talk together daily over the telephone about what they did that day. Bob is only interested in three activities: **walking in the park, shopping, and cleaning his apartment**. The choice of what to do is determined exclusively by the weather on a given day. Alice has no definite information about the weather, but she knows general trends. Based on what Bob tells her he did each day Alice tries to guess what the weather must have been like.
- Alice believes that the weather operates as a discrete Markov chain. There are two states, "**Rainy" and "Sunny**", but she cannot observe them directly, that is, they are hidden from her. On each day, there is a certain chance that Bob will perform one of the following activities, depending on the weather: "walk", "shop", or "clean". Since Bob tells Alice about his activities, those are the observations. The entire system is that of a hidden Markov model (HMM)

- states = ("Rainy", "Sunny")
- observations = ("walk", "shop", "clean")
- start_probability = {"Rainy": 0.6, "Sunny": 0.4}
- transition_probability = {
- "Rainy": {"Rainy": 0.7, "Sunny": 0.3},
- "Sunny": {"Rainy": 0.4, "Sunny": 0.6},
- }
- emission_probability = {
- "Rainy": {"walk": 0.1, "shop": 0.4, "clean": 0.5},
- "Sunny": {"walk": 0.6, "shop": 0.3, "clean": 0.1},
- }


Start
0.6
0.4
Rainy
Sunny
0.3
0.4
0.7
0.6
0.1
0.6
0.5
0.1
0.4
0.3
Walk
Shop
Clean


Technology
Understand the business process
Identify possible frauds that could exist
Catalog possible fraud symptoms
Investigation
Follow ups
Analyse results
Use technology to gather data

Type of Ratios	WorldCom	S &P 500 Benchmark (2002)
Valuation Ratios		
Price/Book	0.57	4.1
Price/ Earning	29	35.7
Price/ Sales	1.19	1.9
Price/Cash Flow	5.23	15.1
Income Statement Profitability		
Net Income/Sales	3.93%	4-8%
Top-Line Growth	-10.1%	5-15%
Bottom-Line Growth	-0.68%	5-15%
Management Effectiveness		
Return on Assets	1.33%	8-12%
Return on Equity	2.39%	9-16%
Financial Strength		
Current Assets/Current Liabilities	0.99	1-2
Debt/Equity Ratio	0.52	0.5-1

FINANCIAL RATIOS

Z SCORE ANALYSIS OF WORLDCOM

RATIO	DEFINITION	1999	2000	2001
X1	Working Capital/Total Asset	(0.08)	(0.08)	(0.00)
X2	Retained Earning/Total Assets	(0.01)	0.03	0.02
X3	EBIT/Total Assets	0.08	0.08	0.04
X4	Market Value of equity/Book Value of Assets	3.58	1.13	0.54
X5	Sales/Total Assets	0.39	0.40	0.34
Z	Z-Score	2.697	1.274	0.798

Z-SCORE	REMARKS
ABOVE 2.675	FINANCIALLY STRONG
1.81-2.675	GRAY AREA
BELOW 1.81	BANKRUPT

$$Z = 1.2X1 + 1.4X2 + 3.3X3 + 0.6X4 + X5$$

WORLDCOM

FINANCIAL ANALYSIS

Altman's Z-score for International Credit Rating Agencies											
Defaulter	Amount of Liabilities	Date of Default	Z-Score					Rating at the time of default			The Consequences
	(in $ billion)		In year of default	1 year prior	2 years prior	3 years prior	4 years prior	S&P	Moody's	Fitch	
Bear Stearns	387	31-July-2007	0.29	−0.79	0.45	0.4	0.36	AA a A	A1 a A2		Acquired by JP Morgan Chase
AIG	807	16-Sep-2008	−1.03	−0.07	−0.02	0.42	0.23	AA− a A−	A1 a A2	AA− a A−	Bailed out by US Government
Lehman Brothers	392	23-Sep-2008	0.06	0.09	0.03	-0.03	0.29	AA, A1	P1 & A1	AA− & F1+	Bankrupt
Washington Mutual Bank	303	25-Sep-2008	−0.35	−0.3	−0.07	−0.13	-0.3	A− & A2	Baa1 & P2	A− & F2	Acquired by JP Morgan Chase
Ford Motors	132	6-Apr-2009	1.32	1.03	1.23	1	1.29	CC	Caa1, B3	CCC, BB	Revived
MF Global	51	31-Oct-2011	0.23	0.47	0.37	0.41	0.46		Baa2 a Caa	BBB a BB+	Bankrupt

Altman's Z-scores of largest Indian Defaulters during April 2005 to March 2013									
Defaulter	**Amount of Liabilities (in Rs cr)**	**Date of default**	**Z-Score**					**Rating at the time of default**	**The Consequences**
	in Crore		In the Year of default	1 yr prior to default	2 yr prior to default	3 yr prior to default	4 yr prior to default		
Arvind Products	251.8	10-Feb-2009	1.58	1.93	2.14	1.61	1.73	CRSIL BBB	Restructured
Ansal Properties & Infraestructure	1359	5-Oct-2009	2.3	3.21	4.22	4.85	3.06	Fitch BBB	Restructured
Kingfisher Airlines Limited	4105.88	1-Dec-2011	−2.36	1.85	0.61	0.79	1.93	CRISIL D	Non Operational
Royal Orchid Hotel Limited	220	31-Mar-2012	0.77	1.06	1.17	1.62	2.17	ICRA BBB+	Restructured
Deccan Chronicle Holdings	3902	2-Jul-2012	−0.12	2.74	3.01	2.54	2.77	Care A1	Assets sold by banks
Suzlon Energy Limited	10948	17-Jun-2012	−0.11	1.23	1.28	1.19	1.24	ICRA BBB− a D	Restructured

- **Source-**
- https://cdn.caseware.com/wp-content/uploads/2023/07/Analytics-Whitepaper-FINAL.pdf
- https://azure.microsoft.com/en-us/blog/mlops-blog-series-part-1-the-art-of-testing-machine-learning-systems-using-mlops/
- https://www.caseware.com/resources/blog/applications-for-machine-learning-in-different-sectors/
- https://cag.gov.in/uploads/media/Guidelines-on-Data-Analytics-20200627161337.pdf
- https://www.auditingalgorithms.net/AuditabilityChecklist.html
- https://www.idi.no/elibrary/relevant-sais/iota/other-resources/1899-sais-of-finland-germany-netherlands-norway-uk-auditing-ml-algorithms-2020/file
- https://ictinstitute.nl/a-checklist-for-auditing-ai-systems/
- https://www.linkedin.com/pulse/using-ai-machine-learning-algorithms-continuous-rameez-ali
- https://www.uber.com/en-IN/blog/ml-internal-audit/

Using Analytics to detect possible fraud (Tools & Techniques) – Pamela S.Mantone

Fraud Risk assessment – Building a fraud audit program – Leonard. W. Vona

Statistical Fraud Detection: A Review- Richard J. Bolton and David J. Hand

Thank You

pauljayakar@gmail.com

Internal Audit Data Analytics

- Data analytics is defined as, "The science of examining raw data with the purpose of drawing conclusions about that information…“

- Phase 1: The Setup
- Phase 2: The Analytics

Phase 1: The Setup
Step 1: Assessment

- To start, auditors should complete an audit score for audit and data analytics assessment.
- There are tools available to evaluate an audit department's current data and analytics performance. Some tools offer insight into where to focus efforts and help identify the necessary resources.
- Additionally, some tools assess responses provided against benchmarks. As an output, a report is provided that helps auditors understand how well their teams are currently performing, short- and long-term goals, and resources needed to meet strategy and business needs.

Step 2: Embedding

- Based on the audit team's existing knowledge of data analytics, training should be conducted. From there, the use of analytics can be embedded. Auditors can begin by building a bank of questions or inquiries to incorporate into their audit programs. Without understanding the desired outcome from gathering data, it is challenging to gain much from data analytics.

- A proof of concept can be developed to identify where in the organization data analytics may provide the greatest return, whether it is accounts payable, journal entry evaluation, access management, vendor management or help desk ticket analysis.

- In addition, audit teams should adapt and reinforce. Current audit processes can be adapted to incorporate data analytics into any phase of the audit.

Step 3: Utilize

- Resources such as a data analytics example library can be used to gather information and inspiration. Such libraries are collections of practices intended to help users understand how data analytics can be used in audits, consulting and continuous monitoring.

- In addition, audit teams should identify which tools they wish to use to gather data analytics. It may seem that sophisticated software programs such as Audit Command Language (ACL) or Tableau are required to perform data analytics, however, more commonly available applications such as Microsoft Excel and PowerBI can also help teams achieve their data analytics goals.

Step 4: Data Extraction

- Tere are 7 steps that should be taken to ensure that the data are reliable and that objectives are achieved:

1. **Identify the source of the data**. Data may come from a variety of sources such as a data warehouse, application or spreadsheet. It also depends on who manages the data—is it the IT department, the business owner or a vendor?
2. **Identify the desired outcome of the data.** For example, if using analytics for accounts payable analysis, one would want the data to tell them whether there are duplicate vendor numbers, names or addresses.
3. **Determine what the results should look like**. The results could be displayed in a chart, a spreadsheet or in a Word document in paragraph format.
4. **Are the data available and accessible?** One may know what type of information they want to complete their analysis, but it must be determined whether the information is available or it requires additional resources and time of other teams.
5. **Know which tools to use at each phase of work.** Prepare the tools to obtain and analyze the data based on what information is needed.
6. **Ensure that tools and data are repeatedly tested.** This provides assurance that the outputs meet the needs.
7. **Validate the output with organizational operations.** If it looks good, then it is time to begin.

Phase 2: The Analytics
Step 1: Analysis

- Auditors can combine their training, the embedding of data analytics, their proof-of-concept models and adaptation methods into a single audit.

- They should obtain feedback from management and the business area about what worked and what did not work to determine whether the analytics met expectations.

- Once all parties involved agree that the data provided valuable insight, audit teams should record the steps taken and make the process repeatable.

Step 2: Reporting

- Once the data have been gathered, a **dashboard** that **shares** the analytics' outcomes with business owners and management should be created.
- Dashboards and reporting can help tell a **data analytics story** and educate teams so that data analytics becomes ingrained across all areas of the organization.
- One such example is **journal entry testing** to determine if journal entries were made outside of regular working hours, if manual changes or inputs were made or if the same memo was used on a nonrecurring entry.
- This type of analysis can assist in **identifying and preventing potential fraud**. Additionally, the business area can be educated on the analysis and use it to inform a continuous monitoring process.

Data Analytics Benefits in Internal Audit

Accounts payable

- Controls over supplier data such as access controls, modifying bank details and authorising payments are often key risk areas to focus on. Using data analytics can identify users with access to supplier data and identify any segregation of duty conflicts, whereas transactional data can be interrogated to identify potential fraud, duplicate payments and identifying further control limitations. Outlined below are some key analytics which can be performed in this area:

- search for duplicate invoices and payments
- confirm key suppliers, identify one-time suppliers, and suppliers set up with no transactions
- check the bank account details in the supplier master file to employee bank account records, looking for potential fraudulent activity/dummy suppliers
- search for invoices with no corresponding purchase order
- search for unapproved purchase orders
- search for multiple invoices at or just under approval cut-off levels.

- **Fraud Detection**
- It is a critical component of internal audit, and data analytics can play a significant role in detecting fraudulent activities. Using data analytics, internal auditors can identify unusual transactions or activities that may indicate fraud and investigate further.

- Some examples of fraud detection techniques include:

- Statistical analysis to identify unusual patterns in data.
- Data mining to uncover hidden relationships in data.
- Machine learning algorithms to identify potentially fraudulent activities based on past examples.

- **Risk Assessment**
- This is an essential part of the internal audit process, as it helps auditors determine the areas of an organisation that require the most attention and resources. Data analytics can play a crucial role in this process by quickly and accurately identifying areas of higher risk.

- Some common data analytics techniques used in risk assessment comprise:

- Regression analysis to identify relationships between variables.
- Decision tree analysis to identify the factors that contribute to certain outcomes.
- Cluster analysis to group similar data together.

- **Sample Selection**
- It refers to selecting a subset of data for audit testing. This is typically done because it is not practical or cost-effective to test every item in an organisation's data.

- By using data analytics in sample selection, internal auditors can effectively and efficiently identify the most relevant and representative data for audit testing. This can result in a more accurate and impactful audit.

- **Test Automation**
- It refers to using software to automate repetitive and time-consuming audit testing. This can help internal auditors save time and reduce the risk of human error.

- Automating audit testing using data analytics can be a powerful tool for internal auditors. By automating routine audit procedures, internal auditors can focus on higher-level tasks, such as analysing results and making recommendations for improvement. Additionally, automation can reduce the risk of human error and improve the efficiency of the audit process

- **Data Visualisation**
- It is the process of representing data in a graphical format, such as charts, graphs, and maps. This can be incredibly useful in internal audits, allowing auditors to understand complex data patterns and identify key insights quickly and easily.

- Some examples of data visualisation techniques include:

- Bar charts to compare data.
- Pie charts to show proportions.
- Heat maps to show patterns in data.

Continuous Auditing

- It refers to the ongoing monitoring of business operations and transactions in real-time using data analytics. This can help internal auditors identify issues and areas of risk as they occur, rather than waiting for a traditional, periodic audit.

- By using continuous auditing, internal auditors can ensure that:

- Risks are detected and addressed more quickly.
- Auditing activities are more proactive and focused on areas of higher risk.
- This can lead to a more efficient and effective audit process, as well as a more risk-aware organisational culture.
- The increasing use of data analytics in internal audits is just one example of the growing demand for professionals with strong data analytics skills.

examples

- Payroll and employee expenses

- Hunting for ghost employees, falsified wage claims and tampered-with time sheets are all key areas where data analysis can add value. Data analysis can also bring value by enabling review of electronic time entry records for compliance with existing policies, procedures and employment regulations. Some of the key analytics are likely to be:

- search for ghost employees by looking for duplicate National Insurance numbers, addresses or bank account details held on the employee master file
- search of payments made to employees after they have left
- search for unapproved time entry records
- analyse monthly/weekly payroll looking at the hours worked, level of overtime
- search expense claims at or just under approval cut-off levels.

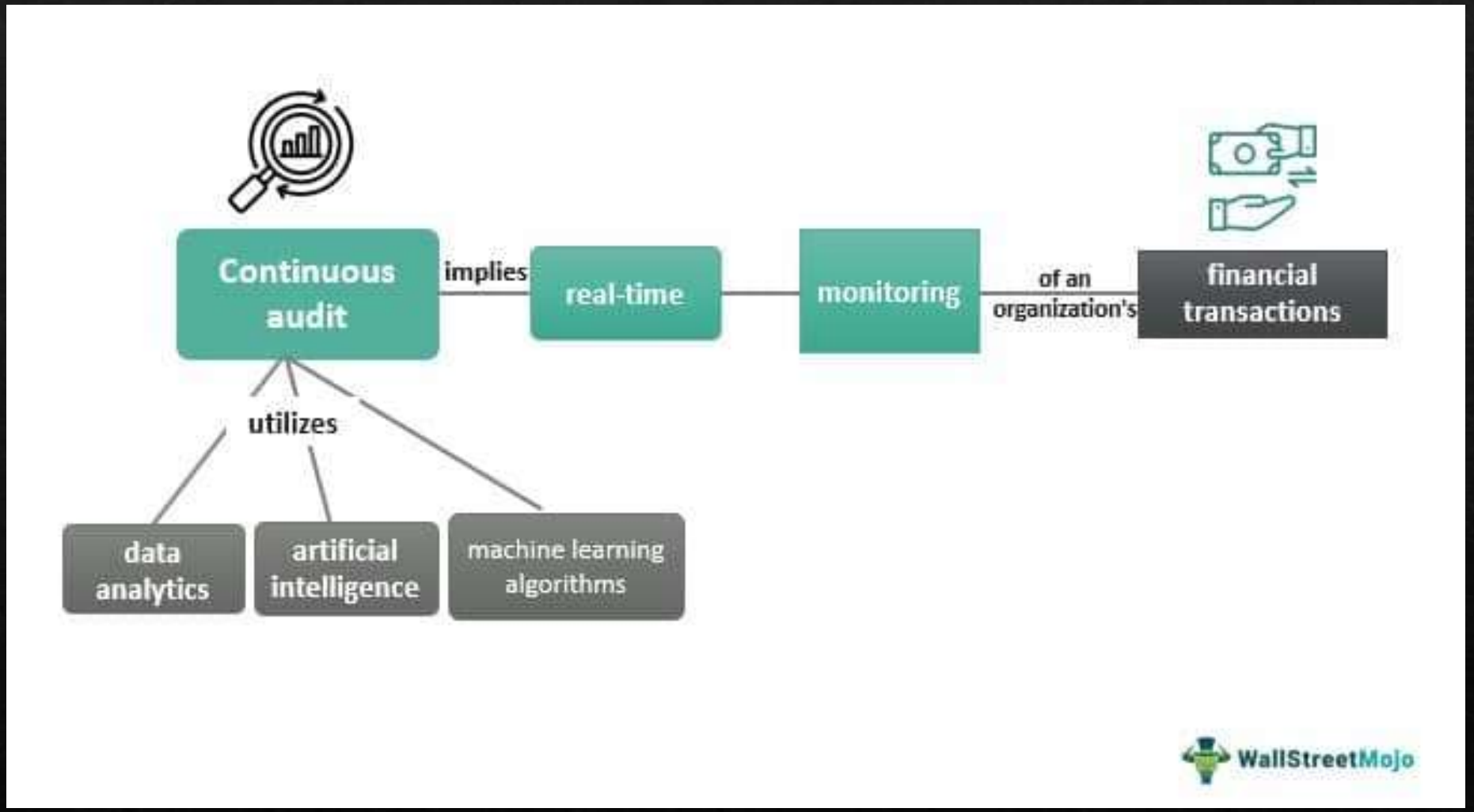
Sales processes

- For invoicing or revenue stream audits, the related IT systems can be complex and the data volumes very large, for example at a telecoms or utilities organisation. Data analytics can be very useful in checking the accuracy of the customer billing. Any billing errors can be pinpointed much more easily and quickly and can be quantified across the population.

- With accounts receivable, various analytics can be performed around searching for duplicate or missing invoices, unmatched receipts and bad debts, all of which can highlight weaknesses in the credit control process.

- **Inventory**

- Given the huge size of some inventories, data analytics can be used to conduct inventory audits. It can be used to identify potentially obsolete or slow-moving inventory and provide insights into the profile of the inventory.


Continuous audit
implies
real-time
monitoring
of an organization's
financial transactions
utilizes
data analytics
artificial intelligence
machine learning algorithms
WallStreetMojo

KPI Dashboard

Initiative #1

Diversify Product Revenue

Achieve 40% product diversity

Revenue by Vertical

$501.6K ▼57%

Collected Revenue - YTD

Xero

New Sales vs. Plan

$363.9K

New Sales - YTD

SalesForce + Google Sheets

Customers by Country

SalesForce

Initiative #2

Build Customer Trust

Customer NPS of 30+

Customer Cancellations (Churn)

-0.14% 1.23% ▼39%

Revenue Churn - YTD Logo Churn - YTD

SalesForce + Google Sheets

Customer Upsells

+$146.0K

Net Revenue Expansion - YTD

SalesForce + Google Sheets

Customer NPS

36 ▲4%

Avg NPS - YTD

Delighted

Initiative #3

Launch Stealth Product

Active accounts > 50% every week

Beta Customers

8,545 ▲66% 5,622 ▲65%

Accounts w/ Slack Beta Accounts w/ Data Explorer Beta

PostgreSQL

Active Accounts by Week

1,539 ▼66%

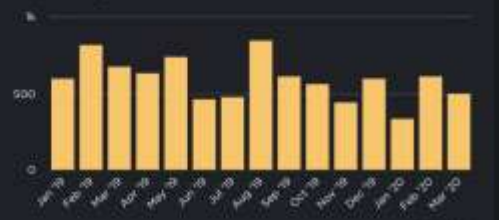
Active Accounts - This Week

PostgreSQL

Customer Reported Bugs

1,443

Reported Bugs - YTD



Zendesk

Key financial controls

- Using data analytics to test key financial controls can give high levels of assurance to verify appropriate segregation of duties and other access controls such as the ability to approve or post journals. Furthermore, the whole general ledger transactions population can be quickly reviewed, and some valuable insights obtained into when a journal is posted and by whom, the volume and value of journals.

- In summary, there are many easy wins if internal audit embraces data analytics.

- **Source-**
- https://cdn.caseware.com/wp-content/uploads/2023/07/Analytics-Whitepaper-FINAL.pdf
- https://azure.microsoft.com/en-us/blog/mlops-blog-series-part-1-the-art-of-testing-machine-learning-systems-using-mlops/
- https://www.caseware.com/resources/blog/applications-for-machine-learning-in-different-sectors/
- https://cag.gov.in/uploads/media/Guidelines-on-Data-Analytics-20200627161337.pdf
- https://www.auditingalgorithms.net/AuditabilityChecklist.html
- https://www.idi.no/elibrary/relevant-sais/iota/other-resources/1899-sais-of-finland-germany-netherlands-norway-uk-auditing-ml-algorithms-2020/file
- https://ictinstitute.nl/a-checklist-for-auditing-ai-systems/
- https://www.linkedin.com/pulse/using-ai-machine-learning-algorithms-continuous-rameez-ali
- https://www.uber.com/en-IN/blog/ml-internal-audit/

Using Analytics to detect possible fraud (Tools & Techniques) – Pamela S.Mantone

Fraud Risk assessment – Building a fraud audit program – Leonard. W. Vona

Statistical Fraud Detection: A Review- Richard J. Bolton and David J. Hand

Thank You

pauljayakar@gmail.com