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IMPROVING THE USE OF DATA ANALYTICS

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AGENDA

1. An overview of data analytics.
2. Case Study: Technology Purchases.



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OVERVIEW: DATA ANALYTICS

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Polling Question #1

How familiar are you with data analytics?

- 1. I use data analytics regularly in my work.**
- 2. I'm familiar but have not had opportunities to apply them in my work.**
- 3. What are data analytics?**



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DATA ANALYTICS



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APPLY

- Advanced statistics and data science tools.
- Expertise to examine large datasets that describe an organization's transactions and functions.

HELPS IDENTIFY

- Inefficiencies, fraud, or data-quality problems.
- Risks in transactions or process data.
- Causes and effects of issues.

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DENVER AUDITOR'S OFFICE

DATA ANALYTICS

BACKGROUND



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- We began our audit analytics program in 2017.
- Our dedicated audit analytics team currently has four staff.

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DATA ANALYTICS BACKGROUND *continued*



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OUR TEAM

- Performs single analyses.
- Scripts continuous analyses.
- Explores new areas of risk.

WE SUPPORT AUDIT TEAMS THROUGH

- Methodology development.
- Testing.
- Sampling and estimation.
- Attribute development.
- Internal trainings.

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TWO TYPES OF DATA ANALYTICS

**TESTING DIRECT
PRESENCE
OF RISK.**

**TESTING
INDICATORS
OF RISK.**



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TESTING DIRECT PRESENCE OF RISK



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Criteria: City and County of Denver has a spending limit on the use of purchase cards.

Risk: Cardholders may “split” a single purchase into multiple transactions to circumvent the spending limit.

TESTING STEPS

- Create an analytic to flag all split transactions.
- Any flagged transactions may be noncompliant, according to city rules.

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TESTING DIRECT PRESENCE OF RISK *continued*



EXAMPLE: SPLIT TRANSACTIONS

The City and County of Denver has a \$2,000 spending limit on the use of purchase cards.

Cardholder	Vendor	Description	Date	Amount
D. Summers	BEST BUY	Order #111-9048008-0516229	1/24/2022 5:28:56 PM	\$ 1,250
D. Summers	BEST BUY	Order #111-9048008-0516229	1/24/2022 5:30:42 PM	\$ 1,250

TESTING INDICATORS OF RISK



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- Helps to identify potential risk.
- Requires additional work to determine effectiveness (e.g., interviews, review of backup documentation).

Limitation: Flagged transactions potentially contain many “false-positives” — compliant transactions that were wrongly flagged as noncompliant.

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TESTING INDICATORS OF RISK *continued*



EXAMPLE: FLAGGING EVEN-DOLLAR TRANSACTIONS

- These transactions may be compliant with city rules but could also indicate risky transactions that require further testing.
- **Limitation:** Governments may not pay sales tax.

Cardholder	Vendor	Description	Date	Amount
C. Wilson	Amazon	Amazon.com order number: 382-4576124-6537802	6/8/2021	\$ 1,100.00
D. Summers	Grainger	Invoice #113-9900245-7	3/22/2022	\$ 650.00

Polling Question #2

What type of risk analytic would you consider even-dollar tests?

- 1. It is an indicator of risk.**
- 2. It tests the direct presence of risk.**
- 3. I don't know. I'm here for the CPE.**



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TESTING INDICATORS OF RISK *continued*



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MEASURING EFFECTIVENESS USING RISK INDICATORS

- **RECALL** – are all possible issues identified?
 - **Limitation:** Over-estimates and under-estimates.
- **PRECISION** – are all possible issues actual issues?
 - **Limitation:** False-positives and false-negatives.

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TRADITIONAL AUDIT TECHNIQUES TO IMPROVE INDICATORS OF RISK

- **STATISTICAL SAMPLING** – Identifies frequency of errors in a population by looking at a sample of transactions (i.e., recall).
- **ATTRIBUTE TESTING** – Evaluates risk for each item included in sample (i.e., precision).



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CASE STUDY: TECHNOLOGY PURCHASES

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TECHNOLOGY PURCHASES

1. Background.
2. Developing risk indicators.
3. Statistical sampling and attribute testing.
4. Reducing false-positives.



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1. BACKGROUND



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CRITERIA: EXECUTIVE ORDER NO. 18

Updated in January 2021, the City and County of Denver's Executive Order No. 18:

- Defines technology purchases as all hardware and software that connects to the city's network.
- Requires the city's Technology Services agency to review and approve all technology purchases.
- Prohibits using purchase cards to buy technology items.

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2. DEVELOPING RISK INDICATORS

- **Ledger Account** – flags all purchase card transactions recorded to the technology-specific ledger accounts.
- **Spend Category** – flags all purchases associated with a spend category related to technology.
- **Merchant Category Codes** – flags all purchases associated with a code related to technology.
- **Risky Word List** – flags all purchases containing a risky word in the description or vendor field.



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2. Risk Indicators **EXAMPLE RECORDS**

We combined useful fields from purchase card data (green) with journal line fields (blue):

ID	LEDGER ACCOUNT	AMOUNT	DESCRIPTION	SPEND CATEGORY	VENDOR	MERCHANT CATEGORY CODE
PC-00154503	702400:Technology Supplies and Equipment	1,537.30	iPad, Apple Pencil	43210001 - Computers and Tablets	APPLE	5735
PC-21001577	601000:Professional Services	29.99	WF Records Storage	80160000 - Business administration services	(blank)	(blank)
PC-00114911	701900:Office Supplies and Fixtures	74.18	Spiral notebooks from Staples	44120000 - Office supplies	STAPLS	5111
PC-00120869	702400:Technology Supplies and Equipment	133.45	Staff services project	32130000 - Electronic hardware, component parts and accessories	MICRO CENTER #181 RETAIL	5734
PC-22001274	611900:Dues, Licenses and Subscriptions	36.16	MailChimp Subscription	94101600 - Professional associations	(blank)	(blank)



2. Risk Indicators **EXAMPLE RECORDS**

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PC-21001577	601000:Professional Services	29.99	WF Records Storage	80160000 - Business administration services	(blank)	(blank)
PC-00114911	701900:Office Supplies and Fixtures	74.18	Spiral notebooks from Staples	44120000 - Office supplies	STAPLS	5111
PC-00120869	702400:Technology Supplies and Equipment	133.45	Staff services project	32130000 - Electronic hardware, component parts and accessories	MICRO CENTER #181 RETAIL	5734
PC-22001274	611900:Dues, Licenses and Subscriptions	36.16	MailChimp Subscription	94101600 - Professional associations	(blank)	(blank)

3. STATISTICAL SAMPLING...



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Statistical Random Sample

Attribute Sample Sizing

Type of Attribute Sampling

- Discovery Acceptance
- One-Step Acceptance
- Two-Step Acceptance
- Rate (of occurrence) Estimation

The Universe to be Sampled

Total Items

Presumed Universe Error Rate

Judgmental assessment of the percentage of the universe items that are in error. (Maximum: 50%)

Precision Goals: Precision/Materiality, Confidence

Desired maximum precision range of the rate (width of the sample rate's confidence interval). (%)

Desired confidence level (assurance that the sample's confidence interval includes the actual error rate. (Maximum: 99%))

Sample Size

Compute

Exit Back To OutPut

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...AND ATTRIBUTE TESTING

Attribute Test – Definition

- Yes = transaction is related to technology hardware or software.
 - Subscription service for SurveyMonkey.
 - Cloud storage.
 - Laptop.
- No = transaction is not related to technology hardware or software.
 - Laptop bag.
 - I-Pad case.
 - Digital newspaper subscriptions.



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...and Attribute Testing **EXAMPLE RECORDS**

ID	LEDGER ACCOUNT	AMOUNT	DESCRIPTION	SPEND CATEGORY	VENDOR	MERCHANT CATEGORY CODE	ACTUAL TECHNOLOGY PURCHASE?
PC-00154503	702400: Technology Supplies and Equipment	1,537.30	iPad, Apple Pencil	43210001 - Computers and Tablets	APPLE	5735	
PC-21001577	601000: Professional Services	29.99	WF Records Storage	80160000 - Business administration services	(blank)	(blank)	
PC-00114911	701900:Office Supplies and Fixtures	74.18	Spiral notebooks from Staples	44120000 - Office supplies	STAPLS	5111	
PC-00120869	702400: Technology Supplies and Equipment	133.45	Staff services project	32130000 - Electronic hardware, component parts and accessories	MICRO CENTER #181 RETAIL	5734	
PC-22001274	611900:Dues, Licenses and Subscriptions	36.16	MailChimp Subscription	94101600 - Professional associations	(blank)	(blank)	



...and Attribute Testing **EXAMPLE RECORDS**

ID	LEDGER ACCOUNT	AMOUNT	DESCRIPTION	SPEND CATEGORY	VENDOR	MERCHANT CATEGORY CODE	ACTUAL TECHNOLOGY PURCHASE?
PC-00154503	702400: Technology Supplies and Equipment	1,537.30	iPad, Apple Pencil	43210001 - Computers and Tablets	APPLE	5735	Yes
PC-21001577	601000: Professional Services	29.99	WF Records Storage	80160000 - Business administration services	(blank)	(blank)	Yes
PC-00114911	701900:Office Supplies and Fixtures	74.18	Spiral notebooks from Staples	44120000 - Office supplies	STAPLS	5111	No
PC-00120869	702400: Technology Supplies and Equipment	133.45	Staff services project	32130000 - Electronic hardware, component parts and accessories	MICRO CENTER #181 RETAIL	5734	Yes
PC-22001274	611900:Dues, Licenses and Subscriptions	36.16	MailChimp Subscription	94101600 - Professional associations	(blank)	(blank)	Yes

...and Attribute Testing **EVALUATION**



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Attribute Test – Sample Evaluation

Attribute Sample Evaluation

Type of Attribute Sampling

Discovery Acceptance, One-Step Acceptance, or Rate Estimation Two-Step Acceptance

The Universe to be Sampled

Total Items

Sample Results

Sample Size Number of occurrences

Precision (or Confidence) Limit Options

Limit(s) Compute achieved limit(s) for specified confidence
 Compute achieved confidence for specified limit(s)

Desired confidence level (%)

Sample occurrence rate (%)	<input type="text" value="34.42"/>
Lower precision limit (%)	<input type="text" value="29.35"/>
Upper precision limit (%)	<input type="text" value="39.76"/>

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4. REDUCING FALSE-POSITIVES



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Risk Scores

Performed statistical analysis using the attribute testing results to develop a weighted risk score.

RISK INDICATOR	MARGINAL EFFECT	WEIGHTED SCORE
Journal-Entry Word	0.12	0.092
Ledger Account	0.23	0.167
Spend Category	0.33	0.245
P-card Vendor	0.11	0.083
Merchant Category Code	0.56	0.413
TOTALS	1.35	1.00

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4. Reducing False-Positives **EXAMPLE RECORDS**

Risk Score = (1*First Flag Weight) + (1*Second Flag Weight)...

ID	LEDGER ACCOUNT	AMOUNT	DESCRIPTION	SPEND CATEGORY	VENDOR	MERCHANT CATEGORY CODE	RISK SCORE
PC-00154503	702400: Technology Supplies and Equipment	1,537.30	iPad, Apple Pencil	43210001 - Computers and Tablets	APPLE	5735	
PC-21001577	601000: Professional Services	29.99	WF Records Storage	80160000 - Business administration services	(blank)	(blank)	
PC-00114911	701900: Office Supplies and Fixtures	74.18	Spiral notebooks from Staples	44120000 - Office supplies	STAPLS	5111	
PC-00120869	702400: Technology Supplies and Equipment	133.45	Staff services project	32130000 - Electronic hardware, component parts and accessories	MICRO CENTER #181 RETAIL	5734	
PC-22001274	611900: Dues, Licenses and Subscriptions	36.16	MailChimp Subscription	94101600 - Professional associations	(blank)	(blank)	

Polling Question #3

Which example record should have the highest risk score?

1. Record #1 (first row).
2. Record #3
3. Record #4
4. Record #5 (last row).



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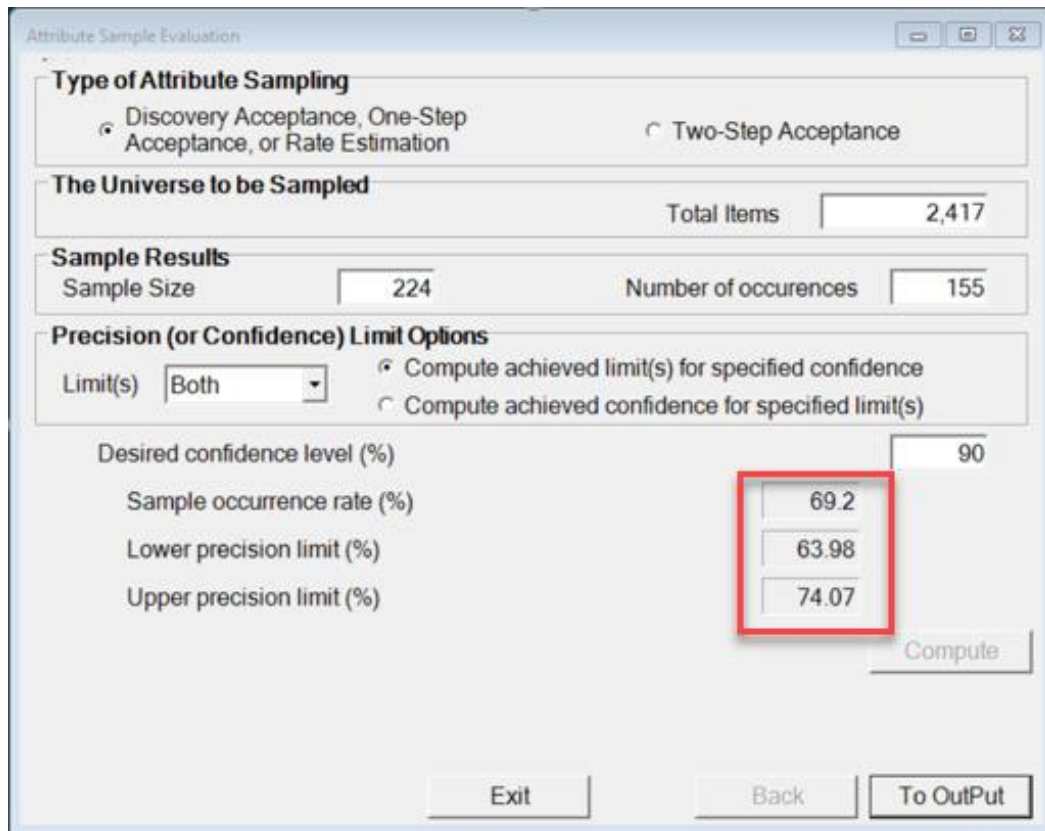
4. Reducing False-Positives EXAMPLE RECORDS

Risk Score = (1*First Flag Weight) + (1*Second Flag Weight)...

ID	LEDGER ACCOUNT	AMOUNT	DESCRIPTION	SPEND CATEGORY	VENDOR	MERCHANT CATEGORY CODE	RISK SCORE
PC-00154503	702400: Technology Supplies and Equipment	1,537.30	iPad, Apple Pencil	43210001 - Computers and Tablets	APPLE	5735	1.0
PC-21001577	601000: Professional Services	29.99	WF Records Storage	80160000 - Business administration services	(blank)	(blank)	0.09
PC-00114911	701900: Office Supplies and Fixtures	74.18	Spiral notebooks from Staples	44120000 - Office supplies	STAPLS	5111	0.09
PC-00120869	702400: Technology Supplies and Equipment	133.45	Staff services project	32130000 - Electronic hardware, component parts and accessories	MICRO CENTER #181 RETAIL	5734	0.83
PC-22001274	611900: Dues, Licenses and Subscriptions	36.16	MailChimp Subscription	94101600 - Professional associations	(blank)	(blank)	0.26

4. Reducing False-Positives **RISK SCORE CUT-OFF**

Evaluated the use of a risk score cut-off to identify a high-risk sub-population.



Attribute Sample Evaluation

Type of Attribute Sampling
 Discovery Acceptance, One-Step Acceptance, or Rate Estimation
 Two-Step Acceptance

The Universe to be Sampled
Total Items

Sample Results
Sample Size Number of occurrences

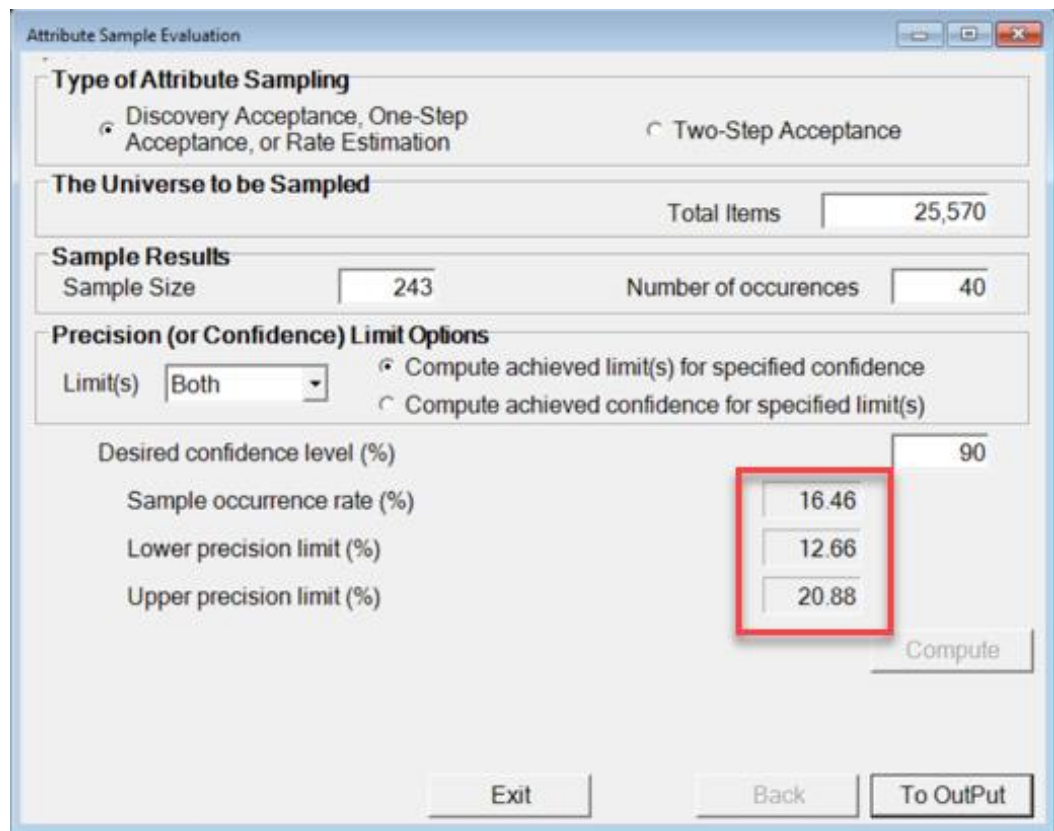
Precision (or Confidence) Limit Options
Limit(s) Compute achieved limit(s) for specified confidence
 Compute achieved confidence for specified limit(s)

Desired confidence level (%)

Sample occurrence rate (%)	69.2
Lower precision limit (%)	63.98
Upper precision limit (%)	74.07

Compute

Exit Back To OutPut



Attribute Sample Evaluation

Type of Attribute Sampling
 Discovery Acceptance, One-Step Acceptance, or Rate Estimation
 Two-Step Acceptance

The Universe to be Sampled
Total Items

Sample Results
Sample Size Number of occurrences

Precision (or Confidence) Limit Options
Limit(s) Compute achieved limit(s) for specified confidence
 Compute achieved confidence for specified limit(s)

Desired confidence level (%)

Sample occurrence rate (%)	16.46
Lower precision limit (%)	12.66
Upper precision limit (%)	20.88

Compute

Exit Back To OutPut

TAKE-AWAYS

1. Data analytics can identify non-risky transactions.
2. By using traditional audit techniques, you can improve the analytics' ability to better identify actual risks.
3. It's an iterative process.



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QUESTIONS?



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