



Anomaly Detection for Fraud Risk in Banking Data





Banking Transaction

City

All

2020

2021

2022

2023

2024

2025



Total Amount
\$2.40M

PY: \$3.09M
-22.24% ▼ vs 2023



Total Transaction
7.97K

PY: 10.44K
-23.62% ▼ vs 2023

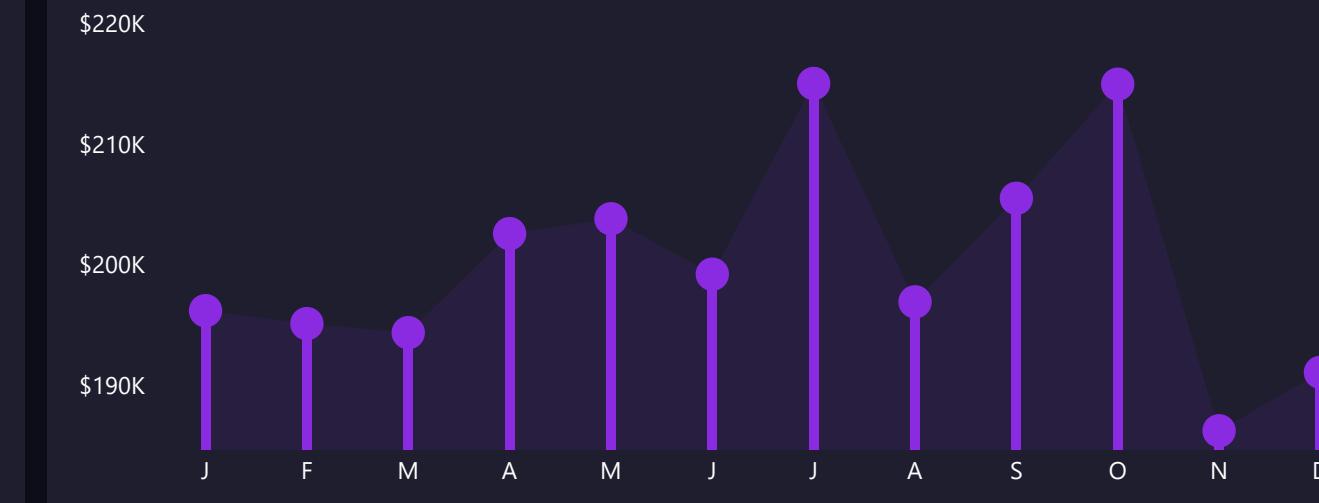


Top 20 Amount by Merchant

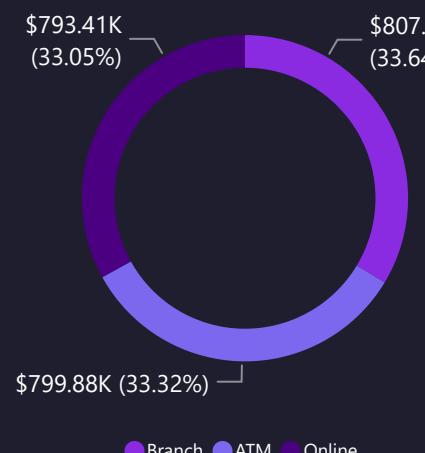
M026	\$51K
M066	\$44K
M009	\$38K
M048	\$36K
M060	\$36K
M038	\$36K
M064	\$36K
M005	\$36K
M054	\$35K
M042	\$34K
M058	\$33K
M088	\$33K
M001	\$33K
M050	\$32K
M081	\$31K
M089	\$31K
M013	\$31K
M033	\$30K
M032	\$30K
M074	\$30K



Amount by Month



Amount by Channel



Total Customer
493

PY: 495
-0.40% ▼ vs 2023



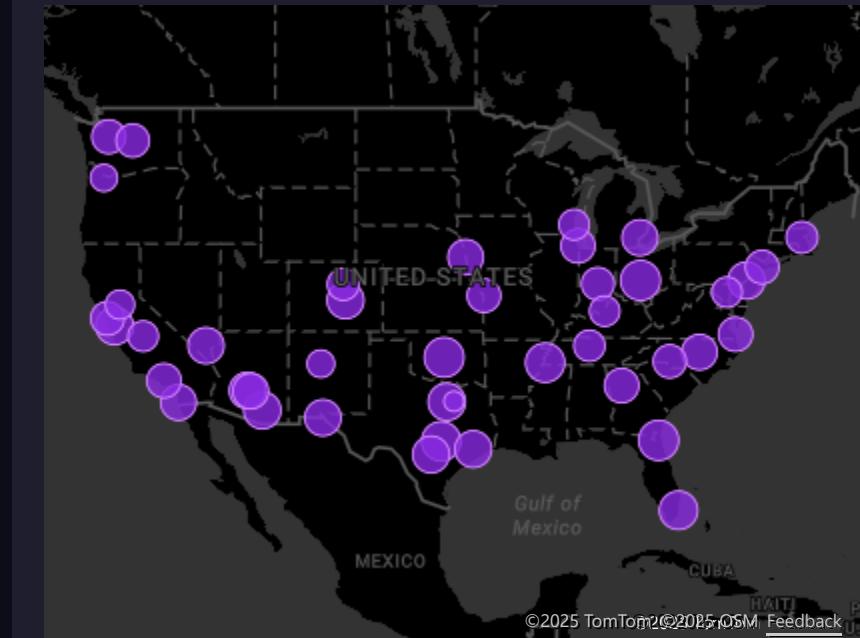
Avg Trans Value
\$301.20

PY: \$295.87
1.80% ▲ vs 2023

Amount by Transaction Type



Amount by Location



City [Top 5]	Amount %	Total Amount
Jacksonville	20.57%	\$77,912.00
Columbus	20.32%	\$76,967.00
Oklahoma City	20.06%	\$75,987.00
Austin	19.59%	\$74,203.00
Memphis	19.47%	\$73,774.00



Banking Transaction

MTD

QTD

YTD

City

All

2020

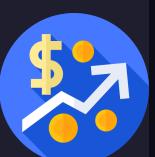
2021

2022

2023

2024

2025



Amount MTD

\$200.40K

PY: \$190.18K

5.38% ▲ vs 2021



Transaction MTD by Channel

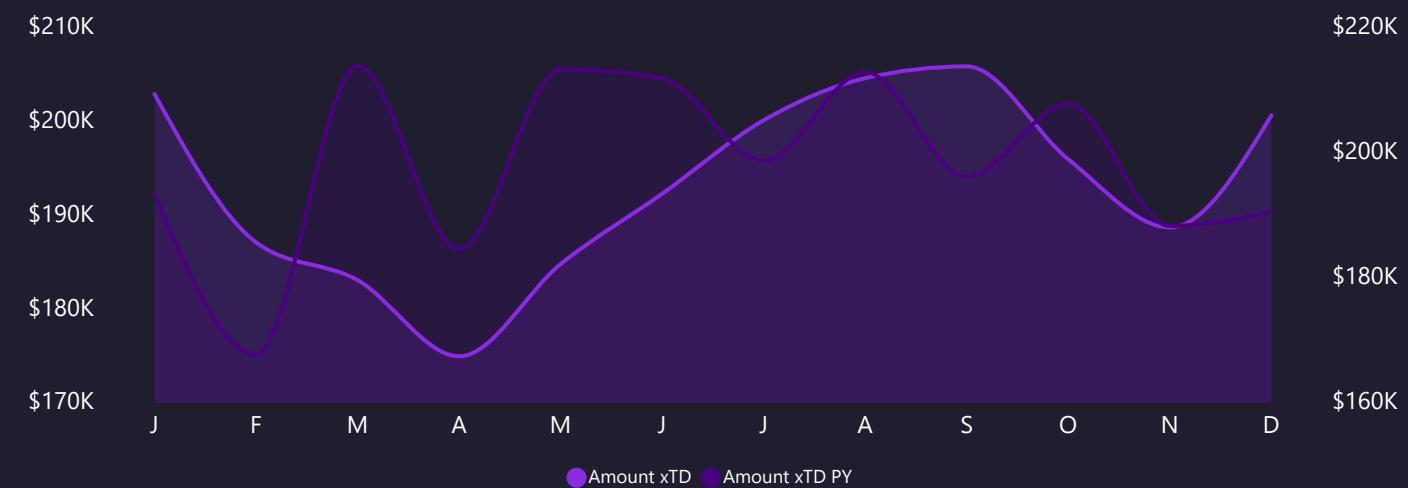
666

PY: 680

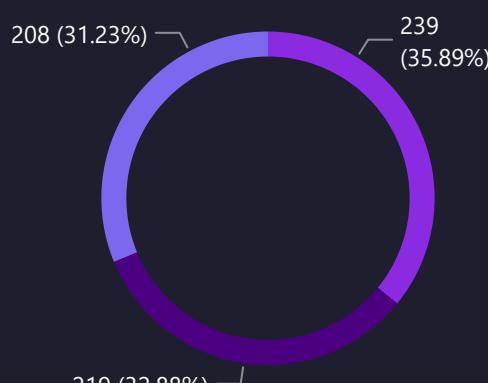
-2.06% ▼ vs 2021



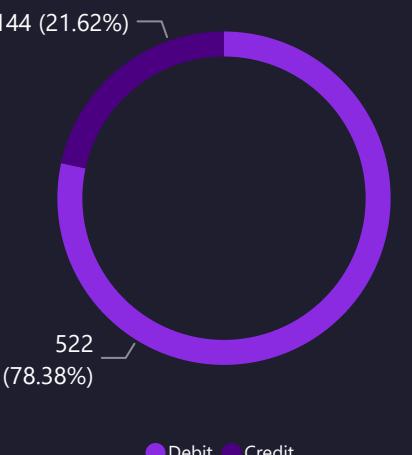
Amount MTD and Amount MTD PY by Month



Transaction MTD by Channel



Transaction MTD by Transaction Type



Avg Trans Value MTD

\$300.90

PY: \$279.67

7.59% ▲ vs 2021



Top 20 ACV MTD by Customer

AC00078	\$3.3K
AC00344	\$2.7K
AC00230	\$2.3K
AC00248	\$2.3K
AC00439	\$2.3K
AC00179	\$2.1K
AC00182	\$2.1K
AC00277	\$2.1K
AC00030	\$2.0K
AC00202	\$1.9K
AC00378	\$1.9K
AC00480	\$1.9K
AC00348	\$1.9K
AC00460	\$1.8K
AC00067	\$1.8K
AC00099	\$1.8K
AC00203	\$1.8K
AC00265	\$1.8K
AC00251	\$1.7K
AC00465	\$1.7K



Top 10 Amount MTD by Device

D000310	\$2.9K
D000594	\$2.9K
D000614	\$2.7K
D000643	\$2.6K
D000022	\$2.4K
D000503	\$2.3K
D000294	\$2.1K
D000073	\$2.1K
D000381	\$2.1K
D000673	\$2.0K

City [Top 7]	Trans Growth % xTD
Raleigh	41.46%
Denver	39.53%
San Francisco	37.14%
Kansas City	17.07%
Virginia Beach	18.92%
Albuquerque	29.03%
Fort Worth	23.53%



Banking Transaction

City

All

2020

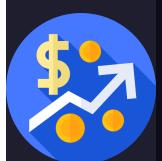
2021

2022

2023

2024

2025



Total Customer
495

PY: 495
0.00% ▼ vs PY



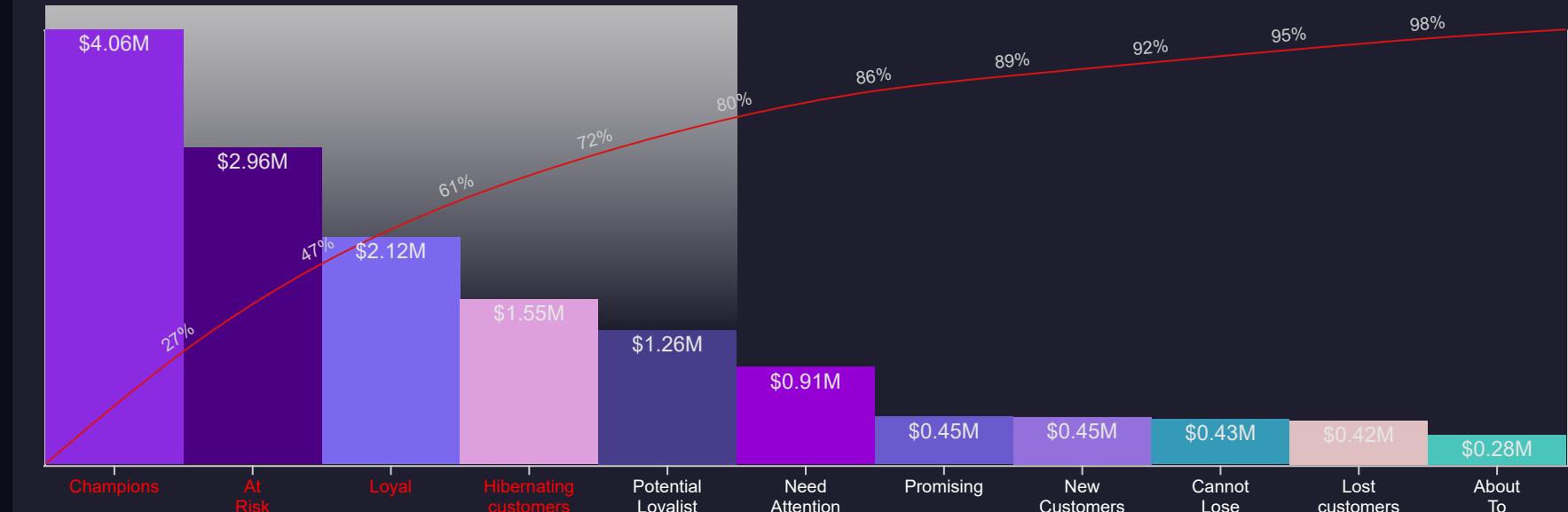
R Average Recency
29



Total Customer by Segment Customer



Pareto Analysis of Customer Segments



AccountID	Segment Customer	RFM_Score	Recency	Frequency	Monetary
AC00014	Champions	555	3	176	\$64,202
AC00030	Champions	555	4	184	\$61,908
AC00032	Champions	555	3	187	\$72,499
AC00035	Champions	555	4	190	\$48,228
AC00086	Champions	555	2	146	\$62,681
AC00095	Champions	555	3	179	\$81,857
AC00136	Champions	555	1	159	\$77,692
AC00204	Champions	555	2	153	\$54,651



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All

▼



Retention Customer by Month after First Transaction Month

First Transaction Month	2020-Jan	2020-Feb	2020-Mar	2020-Apr	2020-May	2020-Jun	2020-Jul	2020-Aug	2020-Sep	2020-Oct	2020-Nov	2020-Dec	2021-Jan	2021-Feb	2021-M
01/01/2020	350	262	261	265	264	255	248	269	259	270	261	279	264	235	210
02/01/2020		79	50	48	53	47	49	49	43	42	52	57	51	44	30
03/01/2020			33	20	20	20	14	21	17	21	17	20	18	16	10
04/02/2020				14	7	6	10	7	7	5	9	3	9	5	3
05/04/2020					7	2	5	3	3	4	4	1	2	3	1
06/04/2020						4	3	2	3	1		2	4	2	1
07/09/2020							3		1	1			1		1
11/09/2020											1				
12/23/2020												2		1	
02/09/2021													1		
04/08/2021															
Total	350	341	344	347	351	334	332	351	333	344	344	364	349	307	3

Retention Rate by Month after First Transaction Month

First Transaction Month	2020-Jan	2020-Feb	2020-Mar	2020-Apr	2020-May	2020-Jun	2020-Jul	2020-Aug	2020-Sep	2020-Oct	2020-Nov	2020-Dec	2021-Jan	2021-Feb	2021-M
01/01/2020	100.00%	74.86%	74.57%	75.71%	75.43%	72.86%	70.86%	76.86%	74.00%	77.14%	74.57%	79.71%	75.43%	67.14%	76.00%
02/01/2020		100.00%	63.29%	60.76%	67.09%	59.49%	62.03%	62.03%	54.43%	53.16%	65.82%	72.15%	64.56%	55.70%	56.90%
03/01/2020			100.00%	60.61%	60.61%	60.61%	42.42%	63.64%	51.52%	63.64%	51.52%	60.61%	54.55%	48.48%	60.60%
04/02/2020				100.00%	50.00%	42.86%	71.43%	50.00%	50.00%	35.71%	64.29%	21.43%	64.29%	35.71%	57.14%
05/04/2020					100.00%	28.57%	71.43%	42.86%	42.86%	57.14%	57.14%	14.29%	28.57%	42.86%	42.86%
06/04/2020						100.00%	75.00%	50.00%	75.00%	25.00%		50.00%	100.00%	50.00%	25.00%
07/09/2020							100.00%		33.33%	33.33%			33.33%		66.67%
11/09/2020										100.00%					
12/23/2020											100.00%		50.00%	50.00%	
02/09/2021												100.00%	100.00%		

Summary

- **Clear early churn:** most customers leave within the first 1-3 periods.
- **Large cohort (2020-01)** dominates overall trends; smaller cohorts retain fewer and vanish quickly.
- **Retention steadily declines** over time, with many cohorts dropping to zero after a few periods.
- **Churn concentrates in early stages.**

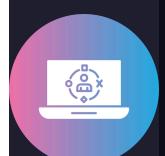




Banking Transaction

City

All



Quarter-over-Quarter Transaction Growth

\$0.5M
\$0.0M
(\$0.5M)2020 2020 2020 2020 2021 2021 2021 2022 2022 2022 2023 2023 2023 2024 2024 2024 2025 2025 2025
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
● Total Trans Amount — QoQ Growth (%)

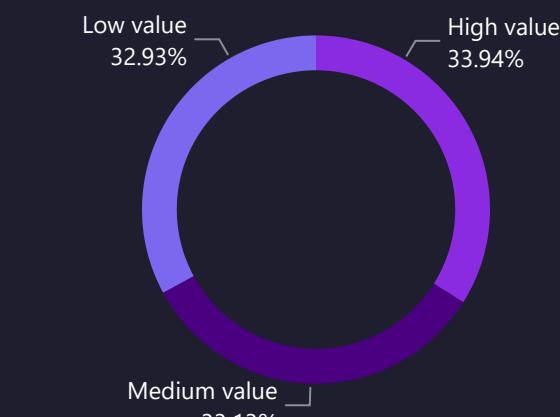
Distribution of Customer Lifetime Value

20%
0%
-20%
\$0.0M \$0.5M \$1.0M \$1.5M \$2.0M

Revenue & Account Count by Quarter (with QoQ Growth)

\$0.8M
\$0.6M
\$0.4M
\$0.2M
\$0.0M2020 2020 2020 2020 2021 2021 2021 2022 2022 2022 2023 2023 2023 2024 2024 2024 2025 2025 2025
Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4 Q1 Q2 Q3 Q4
● Total Trans Amount — Total Customer

CLV Segment Distribution



CLV [Top 11]

CLV

CLV [Top 11]	CLV
AC00460	\$2,378,294.10
AC00363	\$2,200,737.30
AC00337	\$1,793,822.10
AC00095	\$1,743,554.10
AC00021	\$1,684,830.00
AC00020	\$1,656,735.30
AC00136	\$1,654,839.60
AC00358	\$1,622,463.60
AC00202	\$1,612,899.90
AC00439	\$1,591,259.10
AC00257	\$1,546,763.40



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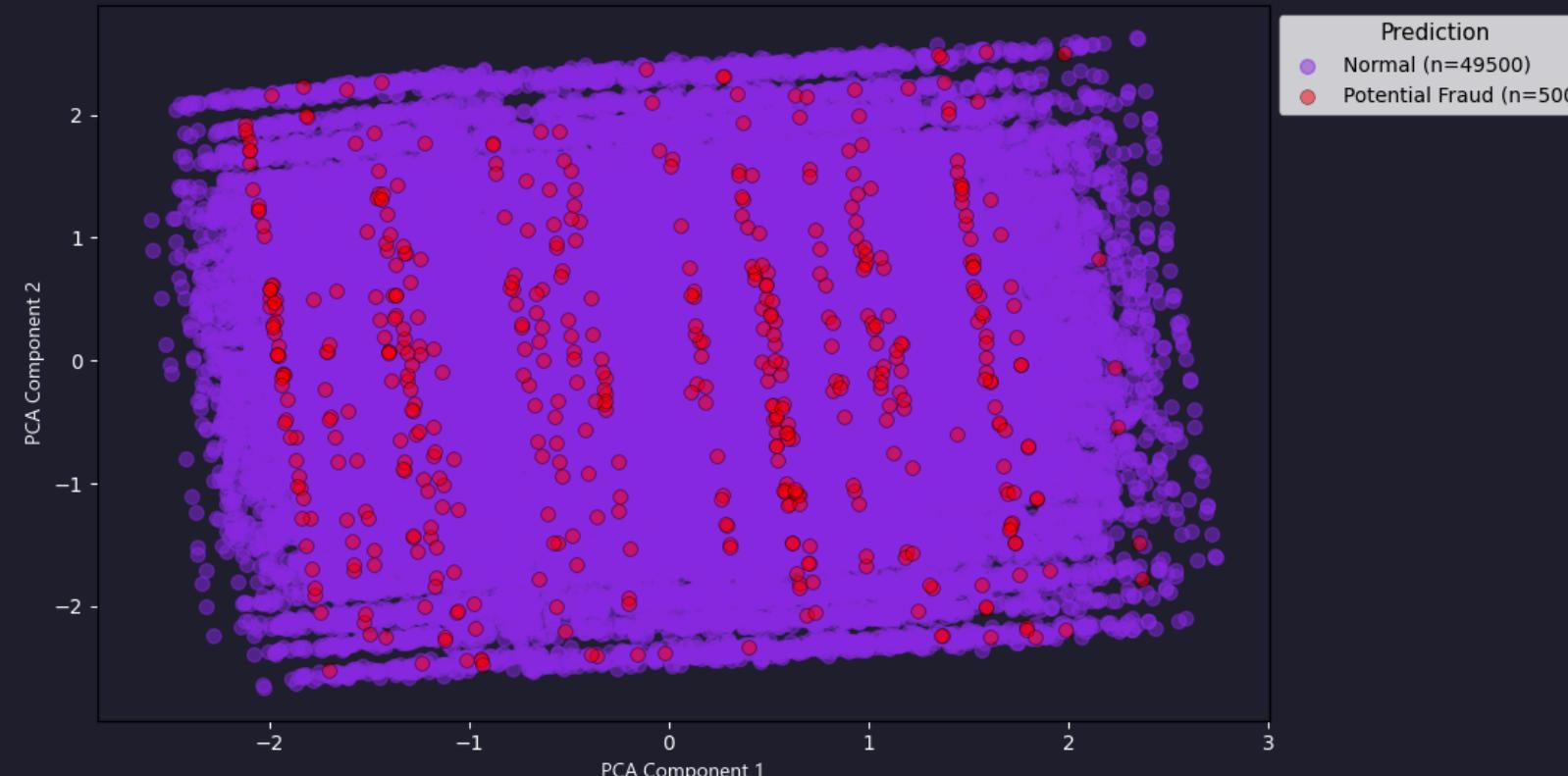
2023

2024

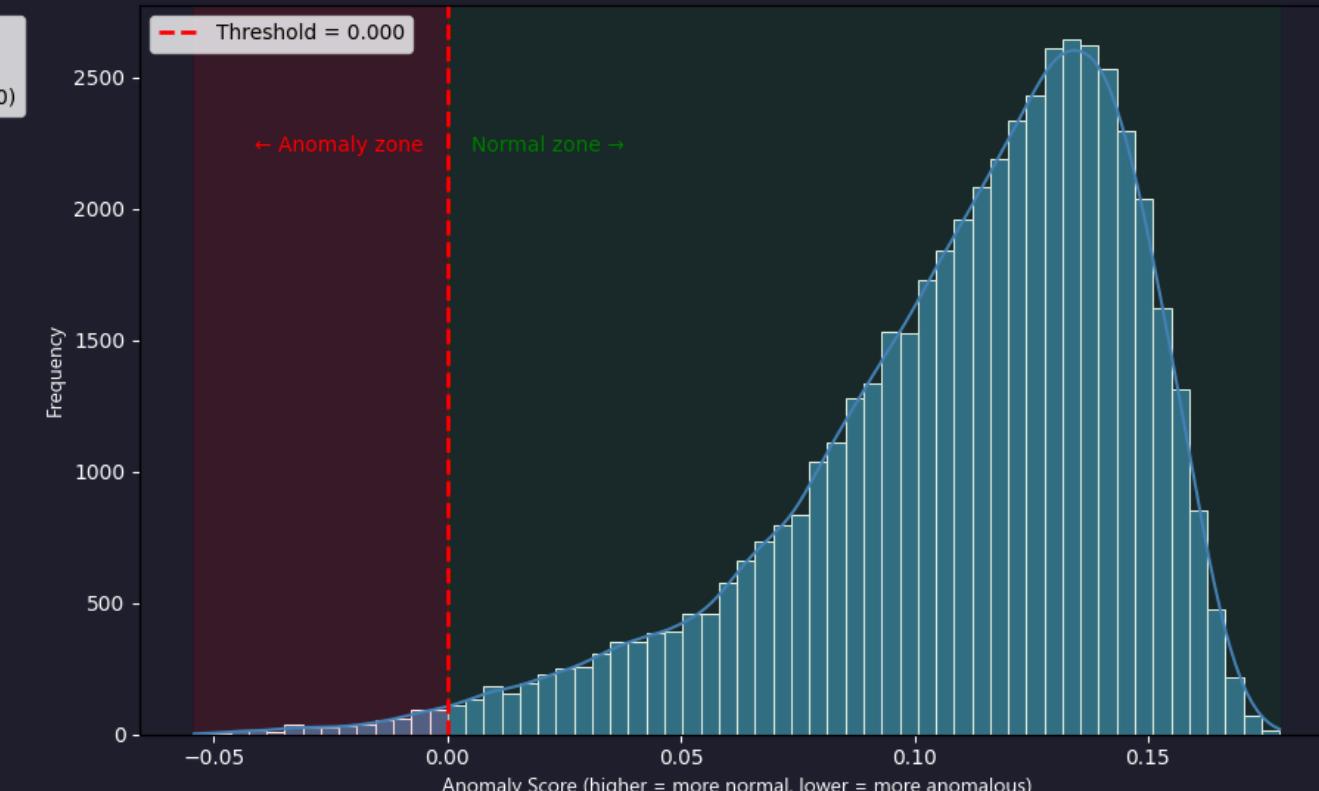
2025



Isolation Forest — Potential Frauds vs Normal (PCA 2D)



Distribution of Isolation Forest Anomaly Scores



TransactionID	AccountID	CustomerAge	CustomerOccupation	TransactionAmount	Location	Channel	TransactionType	TransactionDuration	AnomalyLabel	Segment	Customer
TX004749	AC00071	18	Student	\$124	Mesa	Branch	Debit	22	Potential Fraud	Champions	
TX005872	AC00071	18	Student	\$132	Mesa	Branch	Debit	22	Potential Fraud	Champions	
TX012221	AC00393	18	Student	\$150	Los Angeles	Online	Credit	176	Potential Fraud	Cannot Lose Them	
TX014762	AC00071	18	Student	\$123	Mesa	Branch	Debit	22	Potential Fraud	Champions	
TX021184	AC00393	18	Student	\$146	Los Angeles	Online	Credit	176	Potential Fraud	Cannot Lose Them	
TX023916	AC00071	18	Student	\$115	Mesa	Branch	Debit	22	Potential Fraud	Champions	
TX031608	AC00071	18	Student	\$118	Mesa	Branch	Debit	22	Potential Fraud	Champions	
TX031817	AC00071	18	Student	\$128	Mesa	Branch	Debit	22	Potential Fraud	Champions	
TX032465	AC00393	18	Student	\$151	Los Angeles	Online	Credit	176	Potential Fraud	Cannot Lose Them	
TX033669	AC00071	18	Student	\$122	Mesa	Branch	Debit	22	Potential Fraud	Champions	



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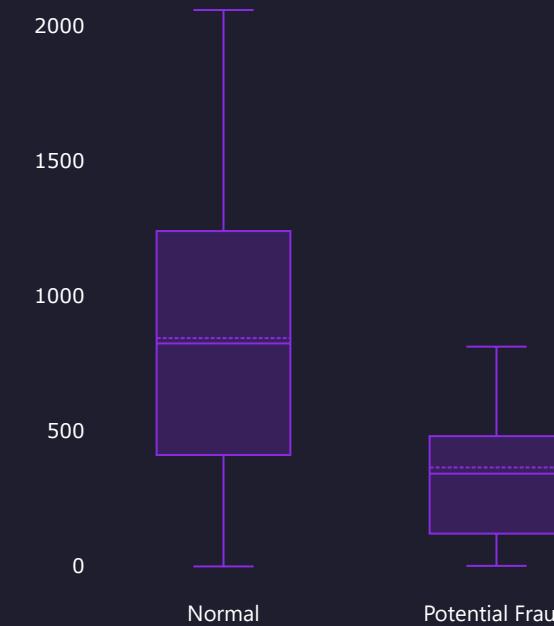
2023

2024

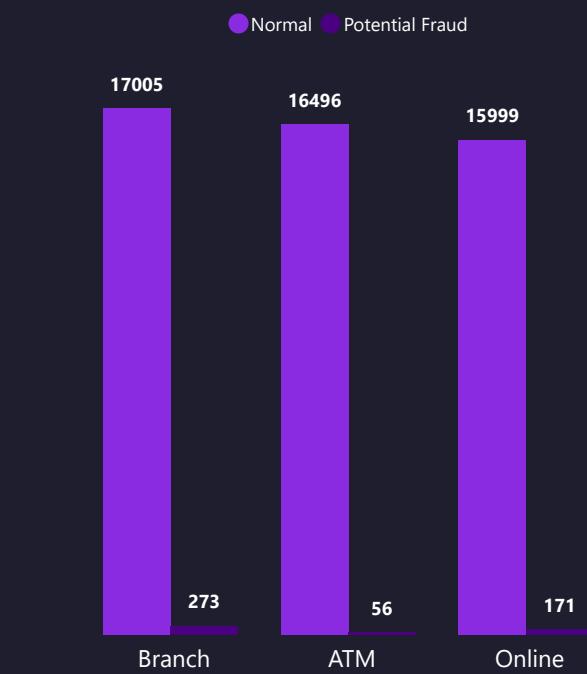
2025



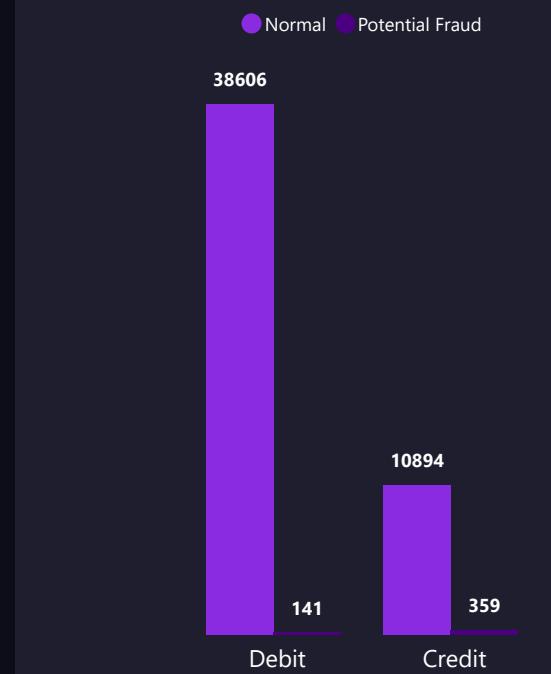
Trans Amount Distribution by Anomaly Label



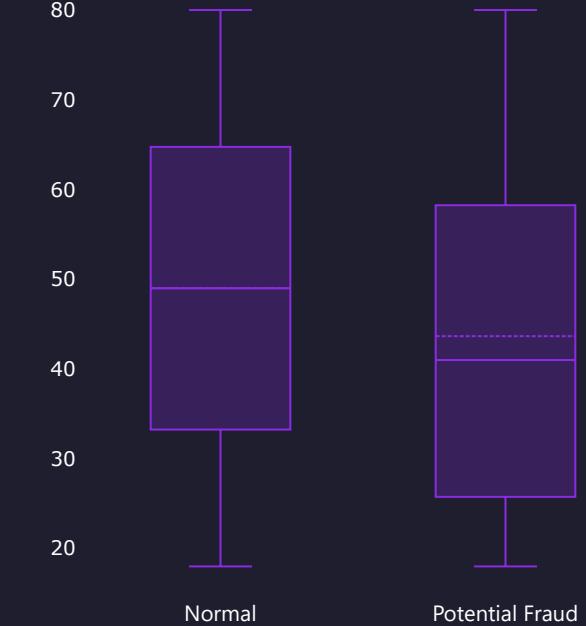
Fraud Pattern by Channel



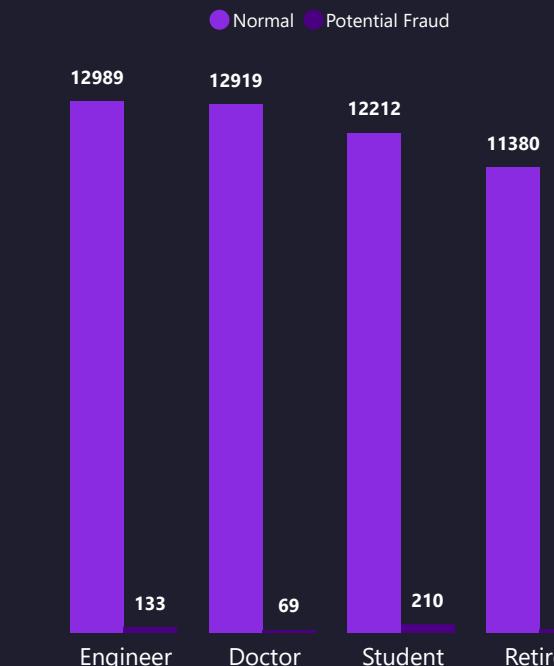
Fraud Pattern by Transaction Type



Customer Age Distribution by Anomaly Label



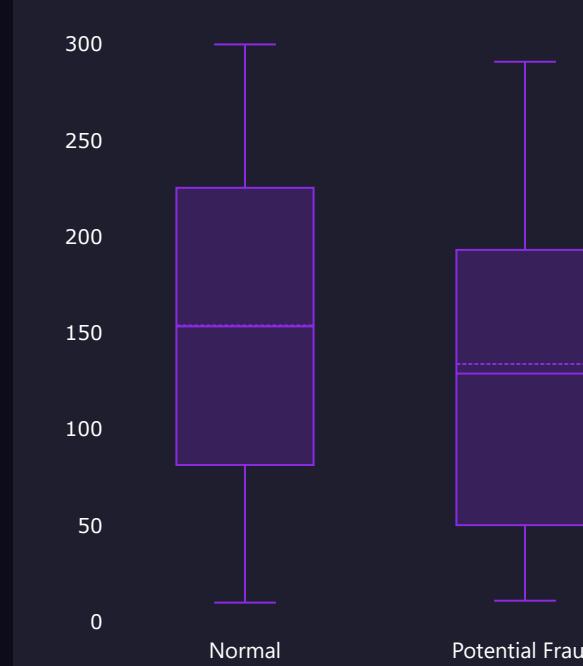
Fraud Pattern by Customer Occupation



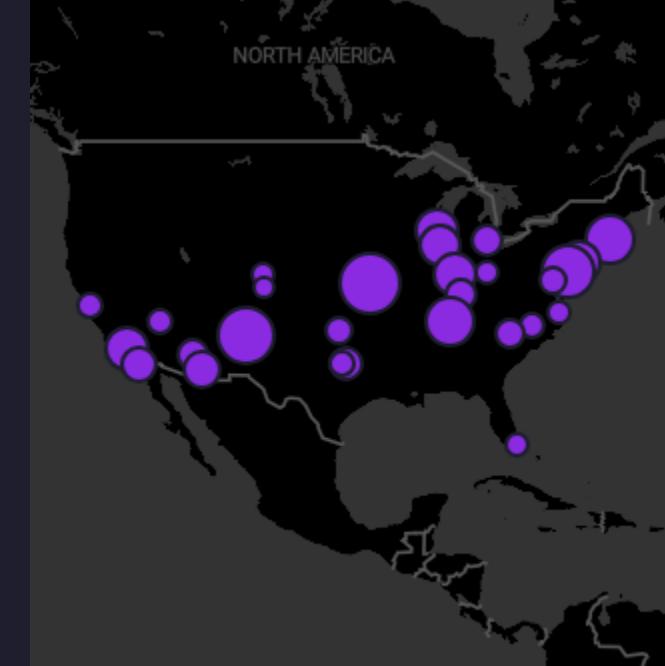
Acc Balance Distribution by Anomaly Label



Trans Duration Distribution by Anomaly Label



Geographic Distribution of Fraud





Banking Transaction

2020

2021

2022

2023

2024

2025



Monthly Trend of Average Transaction Amount by Anomaly Label

\$700

\$600

\$500

\$400

\$300

\$200

\$100

\$0

J

F

M

A

M

J

J

A

S

O

N

D

● Normal ● Potential Fraud

This chart displays the monthly trend of average transaction amounts for two categories: 'Normal' (represented by a light purple line) and 'Potential Fraud' (represented by a dark purple line). The Y-axis measures the average transaction amount in US dollars, ranging from \$0 to \$700. The X-axis shows months from January (J) to December (D) across three years. The 'Normal' series remains relatively stable around \$300-\$310. The 'Potential Fraud' series starts at approximately \$530 in January, dips slightly in February, then rises to a peak of about \$630 in October before ending at \$550 in December.