

Machine Learning for Fraud Detection

Dr. Robert Rohrkemper

“Bobby” (preferred)

November 25, 2019



Purpose:

- To tell an interesting story about creating fraud detection models

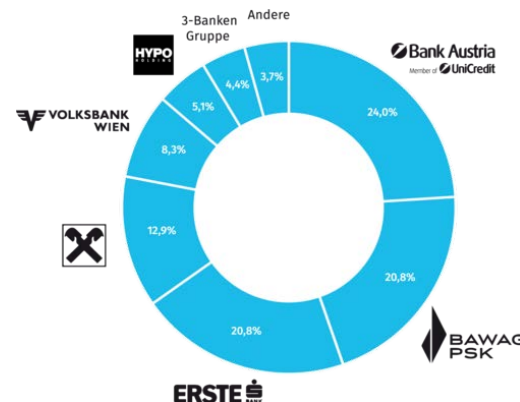
Learning objectives:

Understand

- the skills required for a ML project
- the importance of domain knowledge and supporting tools
- the technical challenges of preparing data
- organizational factors that influence success

Data Scientist at SIX Worldline

- Fraud detection for financial services
- Main customers:
 - Swisskey/SIX (Issuing for Swiss banks)
 - Payment Services Austria
- Geographically distributed team and local matrix organization
- Fraud analytics team lead by manager in Brussels



Agenda

- Position and team
- Background and education
- Fraud detection
- Machine Learning
- Data visualization
- Feature engineering
- Model Results
- Outlook

Roles



DevOps
Engineer



Data
Scientist



Application
Manager



Rule
Writer



Fraud
Investigator



Database
Developer

Innovation

- R&D and Operational Data Scientists develop fraud detection models, are located in Switzerland, France, Belgium and Germany.

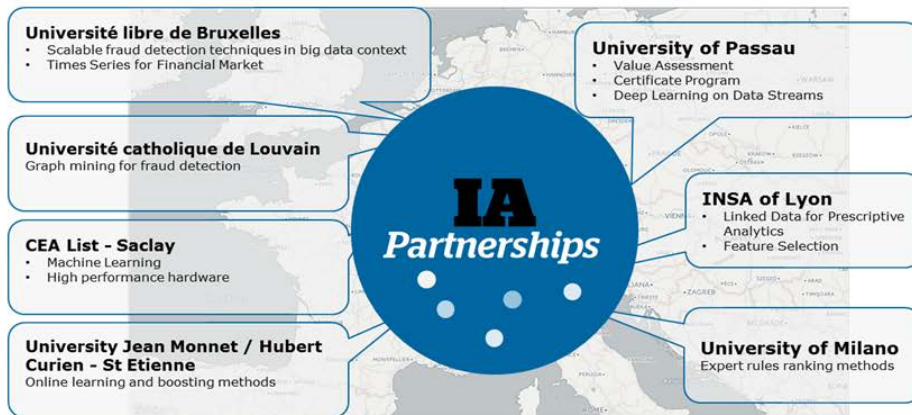


**"The 21st century
will be the century of Data,
the new resource to boost the economy,
as Finance was in the previous century"**

**50 M€
investment**

**Atos
Codex**

**Data Analytics
framework**



- Dr. Bobby Rohrkemper:
Atos Distinguished Expert,
Data Intelligence Community

Effecting
change

Expert Community Convention
10-12 September 2019



Expert Community

Atos

**2,000
Experts**

**14
Domains of
expertise**

1

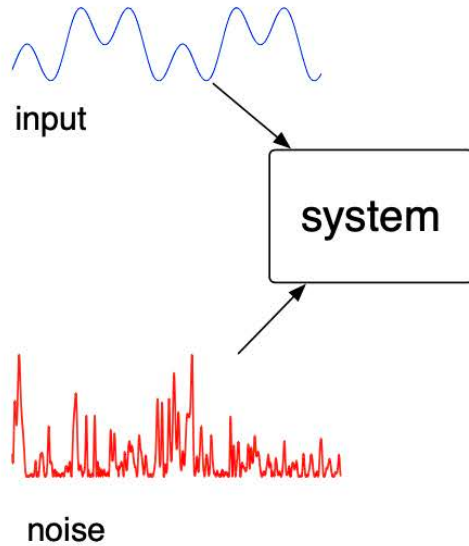
Background and education



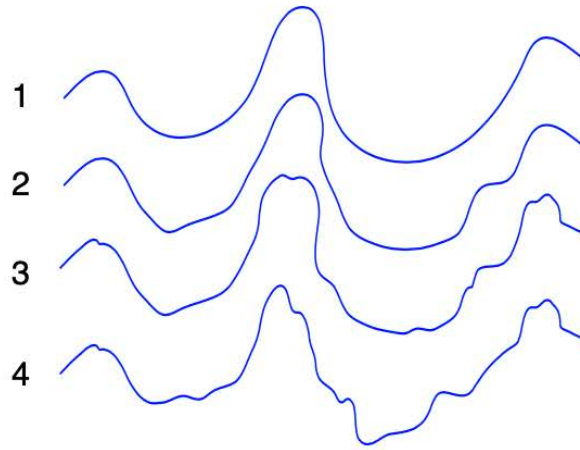
Doctoral Thesis

Effective topologies for computation in cortex-like networks

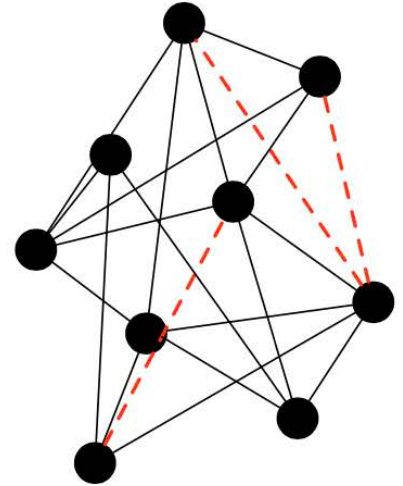
I. Resistance to **noise**



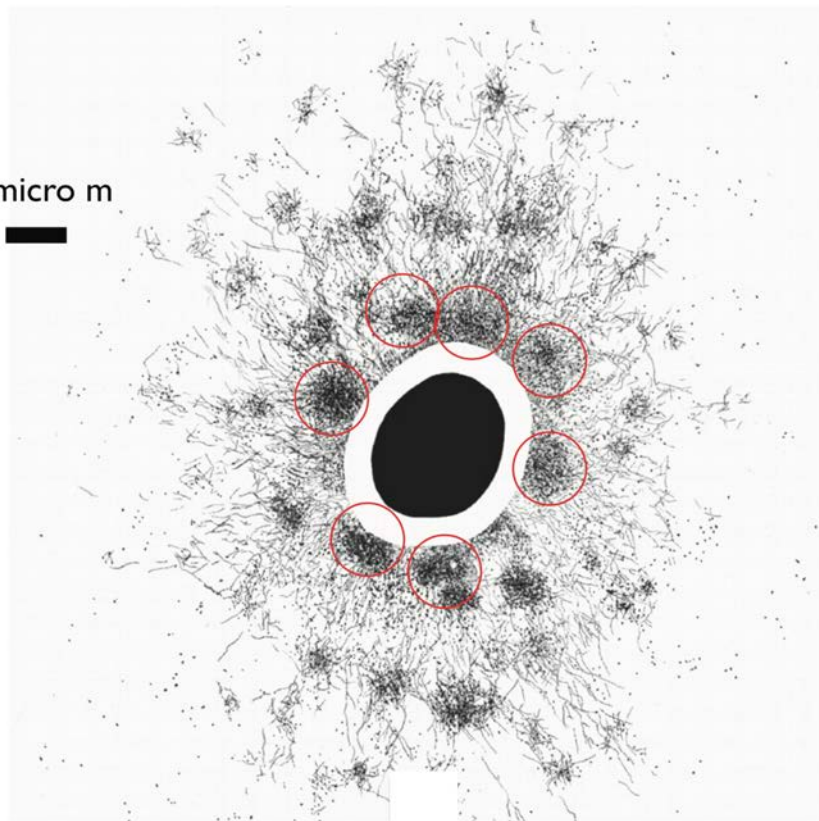
II. Repeatability of results



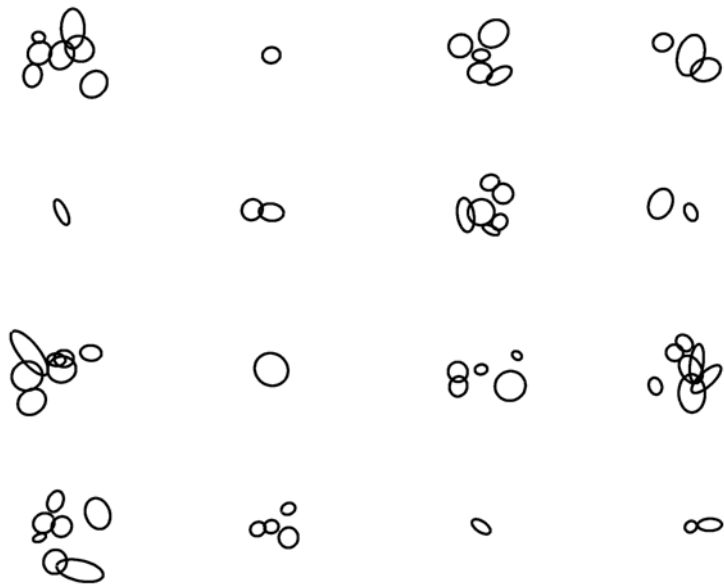
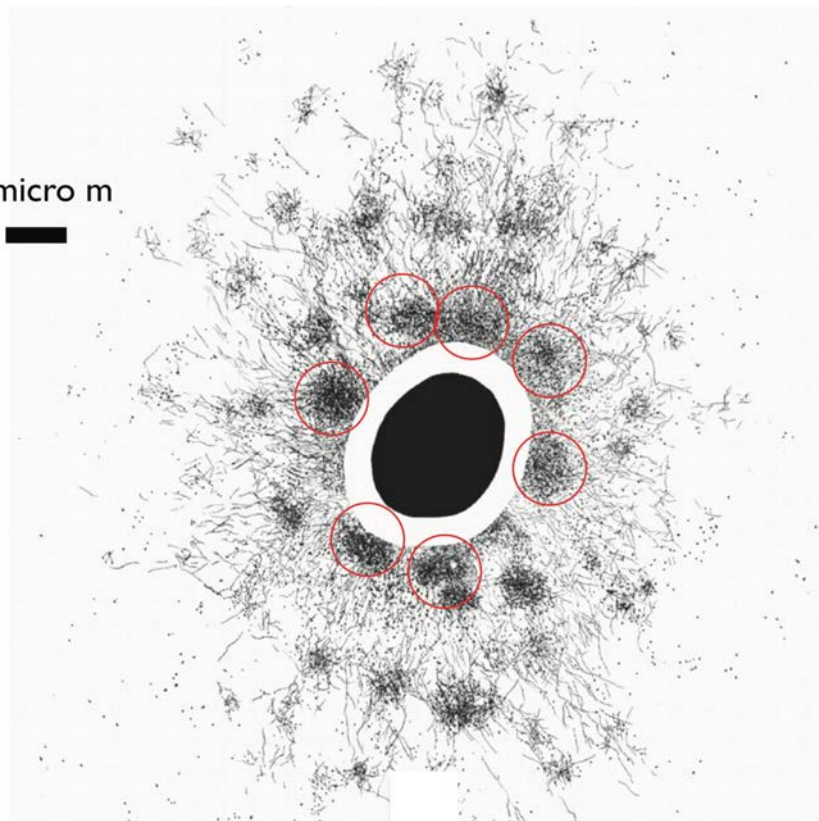
III. Resistance to **damage**



500 micro m

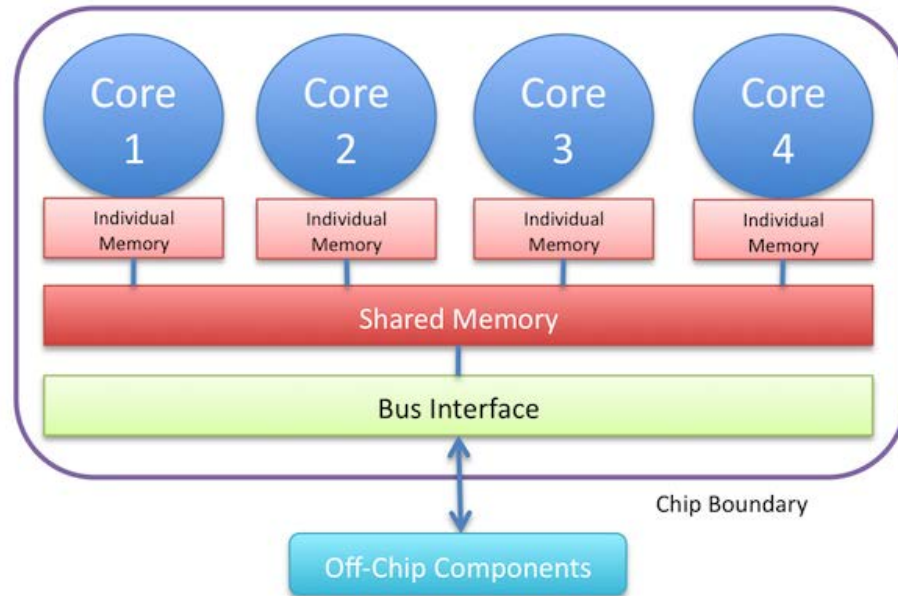


500 micro m

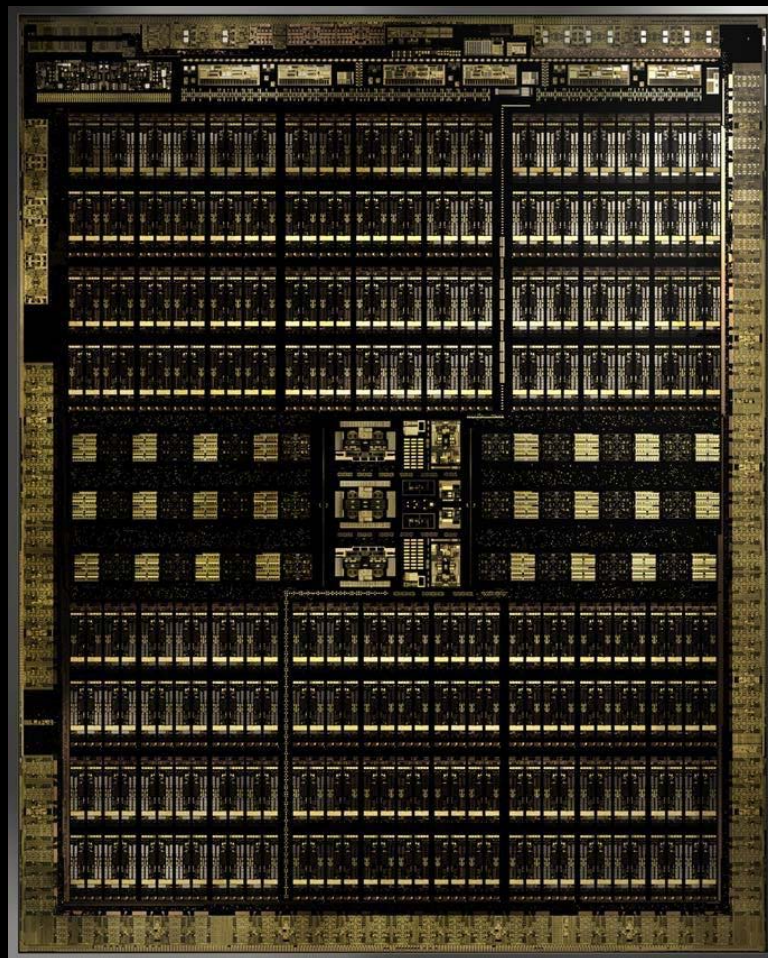




Multi-core Processor











<https://www.nvidia.com/en-us/data-center/tesla-v100/>

2

Fraud Detection

A simplified view of fraud detection





Repeated transaction at same merchant

Authorisations: 30 rows 1 - 19 of 19 Refresh

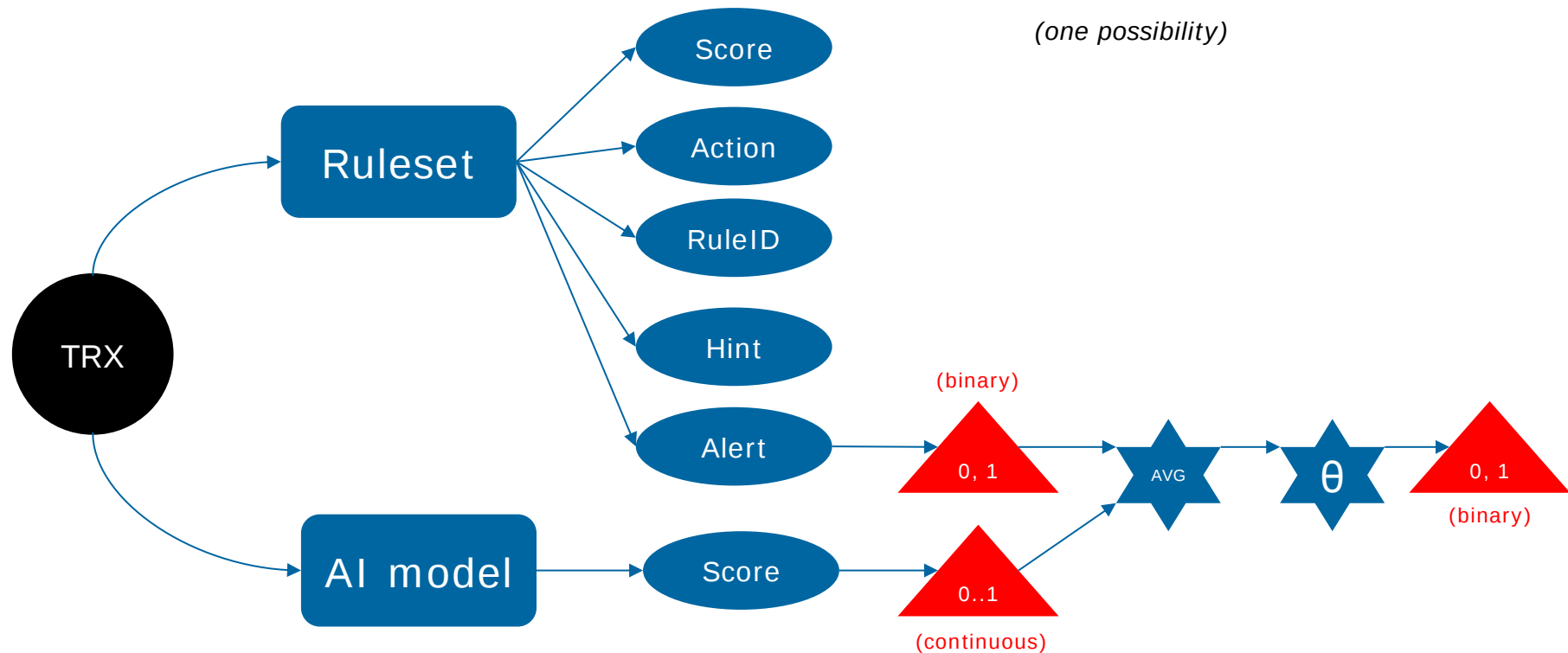
Fraud Mark	TrxType	Risk Score	Hints	TrxHostDateTime	System Amount	System Currency
-	118	35	[...]	2018-05-22 13:13:51	1,000.00	CHF
-	118	35	[...]	2018-05-22 13:13:18	1,600.00	CHF
-	118	35	[...]	2018-05-22 13:10:44	1,600.00	CHF
-	118	35	[...]	2018-05-22 13:09:55	1,600.00	CHF
-	118	35	[...]	2018-05-22 13:09:43	1,600.00	CHF
-	118					
-	118					
-	118					
-	117	25	[...]	2018-05-22 08:56:35	1.00	CHF
-	118	35	[...]	2018-05-21 18:22:22	2.00	CHF
-	117	25	[...]	2018-05-21 17:19:57	1.00	CHF
-	117	25	[...]	2018-05-21 17:19:27	1.00	CHF
-	117	35	[...]	2018-05-20 18:40:05	100.00	CHF
-	142	80	[...]	2018-05-20 11:41:34	25.00	CHF
-	142	45	[...]	2018-05-20 11:19:54	25.00	CHF
-	142	45	[...]	2018-05-20 11:18:26	25.00	CHF
-	142	45	[...]	2018-05-20 11:11:09	150.00	CHF
-	142	35	[...]	2018-05-20 11:03:00	150.00	CHF
-	142	35	[...]	2018-05-20 10:49:23	150.00	CHF

Hints
New account | Lots of transactions at the same merchant within a short time | Repeated Trx at paysafecard

authorizations →

↑ TIME

Combining rules and AI models



3

Machine Learning

	Classification error (%)
Typical human	3.0
Typical doctor	1.0
Experienced doctor	0.7
Team of experienced doctors	0.5

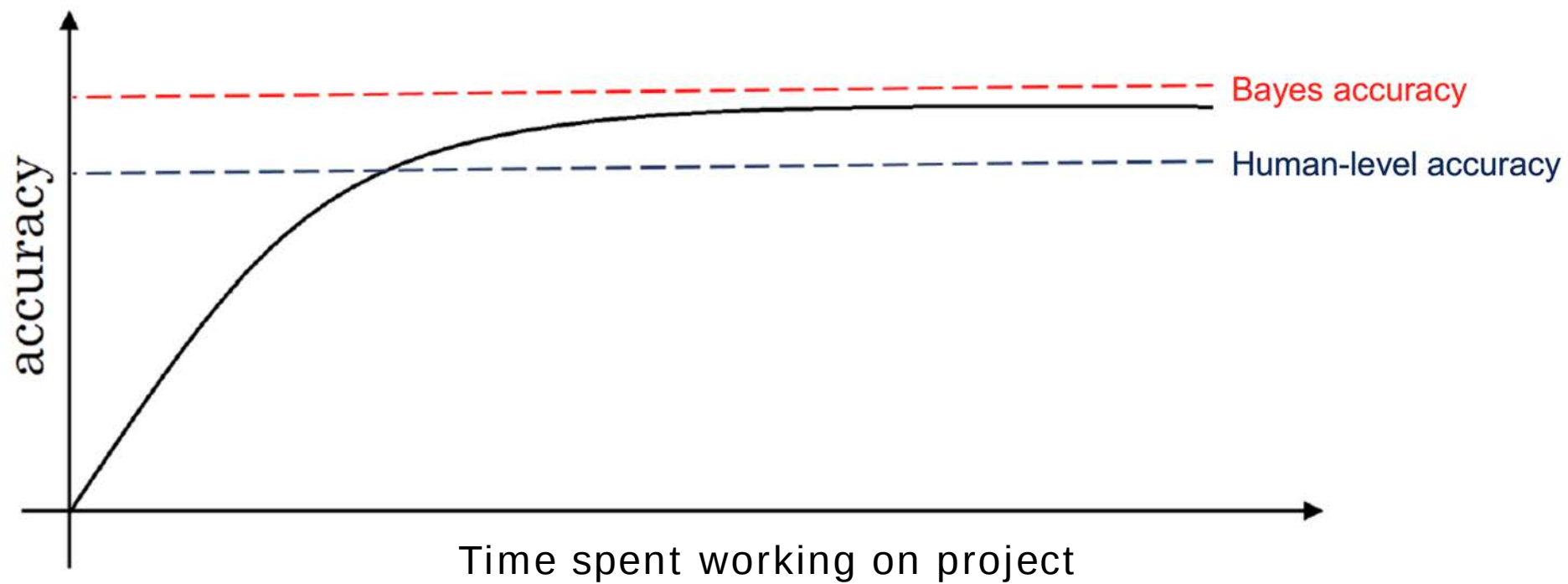


FIG. 35-5 Hairline fissure fracture of metatarsal III at the junction of the proximal one-third and middle one-third: (A) dorsal-plantar view; (B) medial-lateral view.

	Classification error (%)
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Team of experienced doctors	0.5



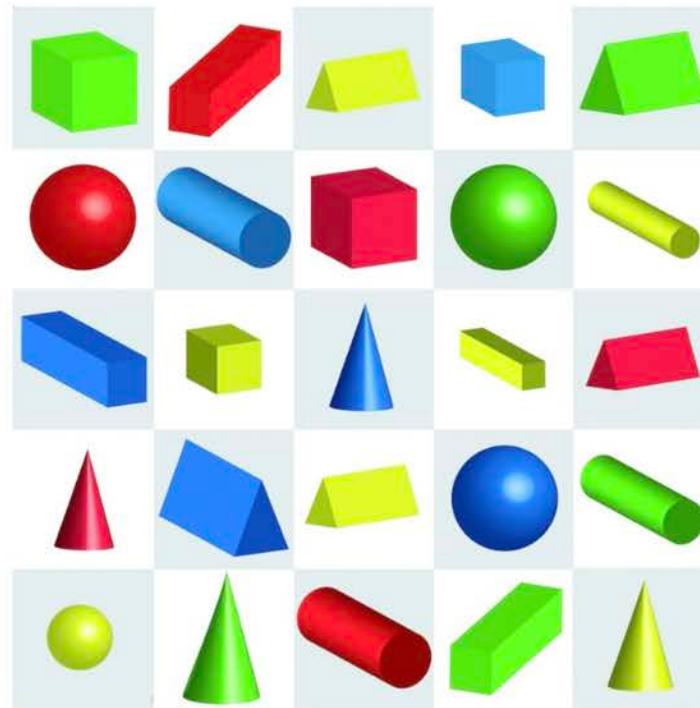
FIG. 35-5 Hairline fissure fracture of metatarsal III at the junction of the proximal one-third and middle one-third: (A) dorsal-plantar view; (B) medial-lateral view.



The deep learning game

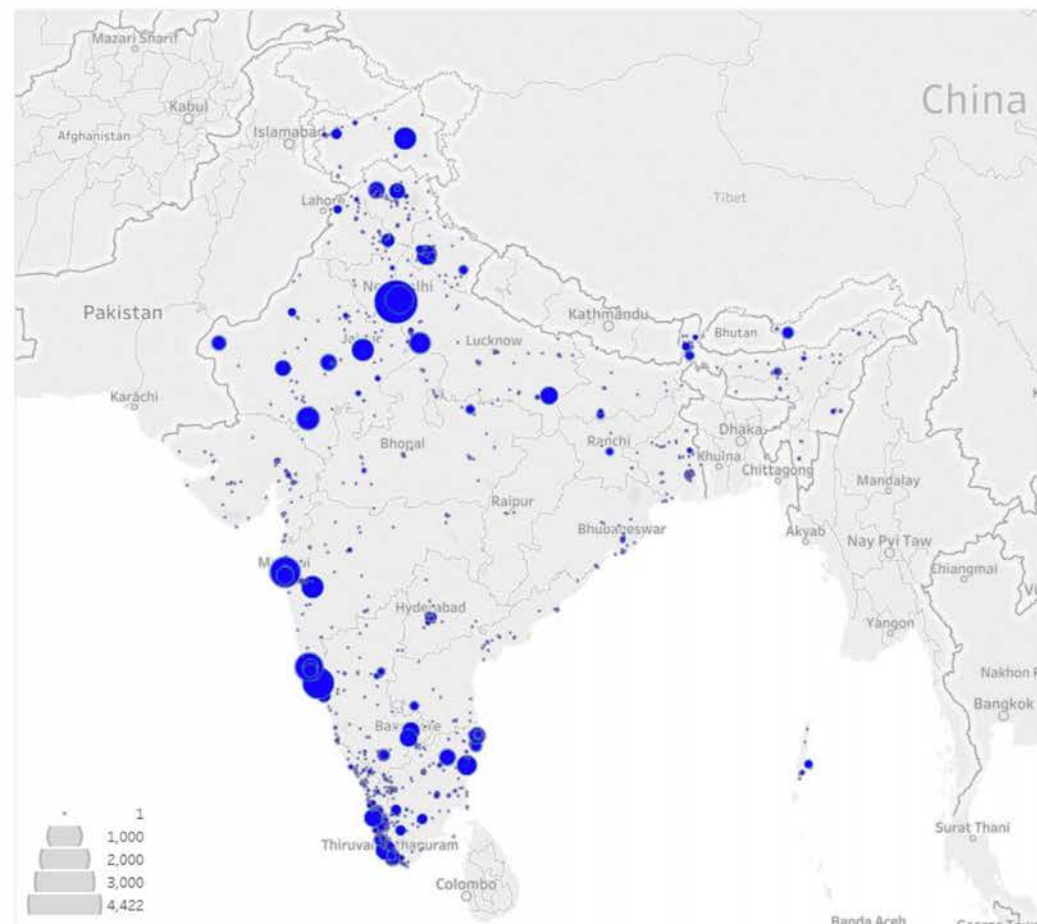
- **Goal:** classify images into two categories
 - “Positive”
 - “Negative”
- **The catch:**
You won't be told the category names

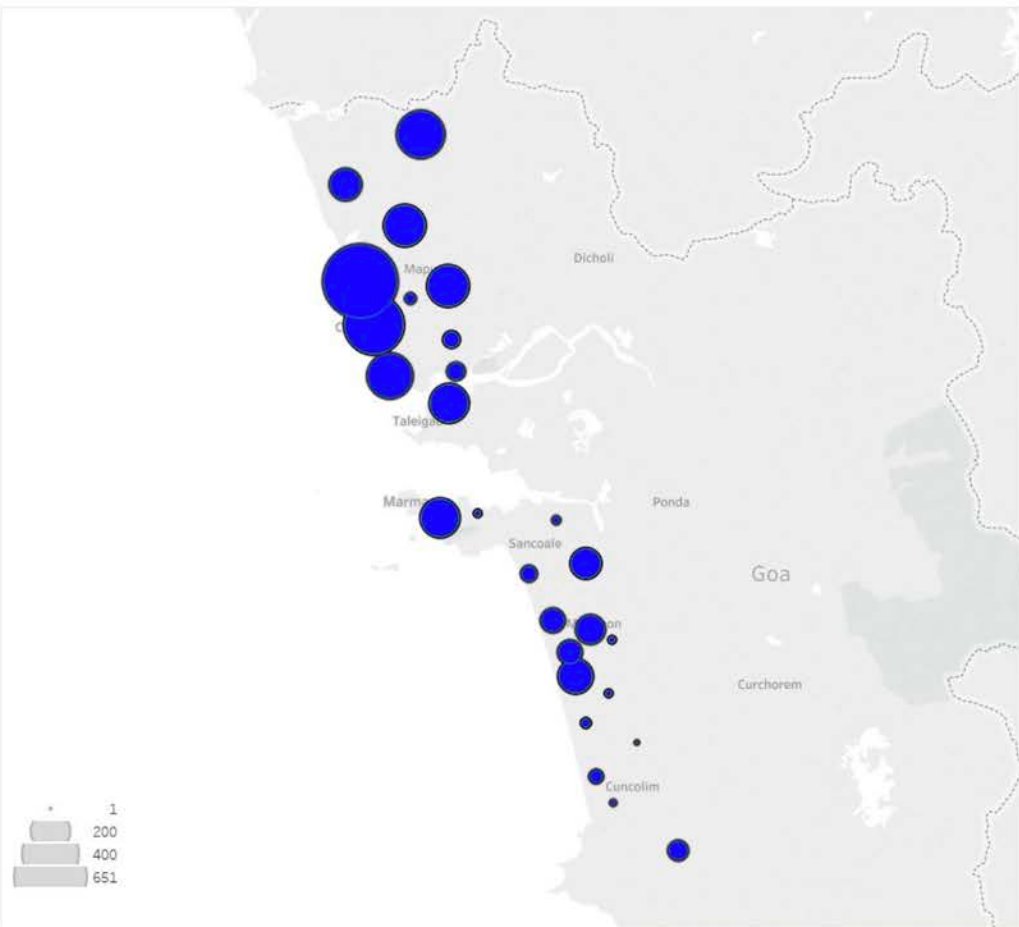
What are possible categories for these images?

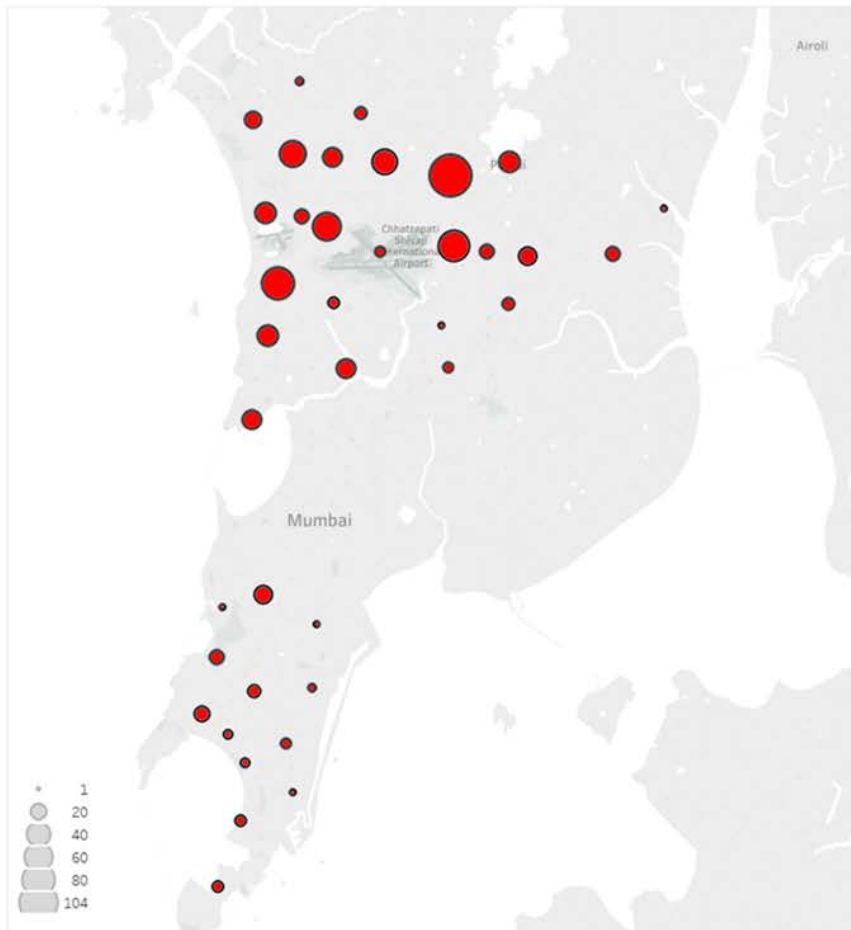
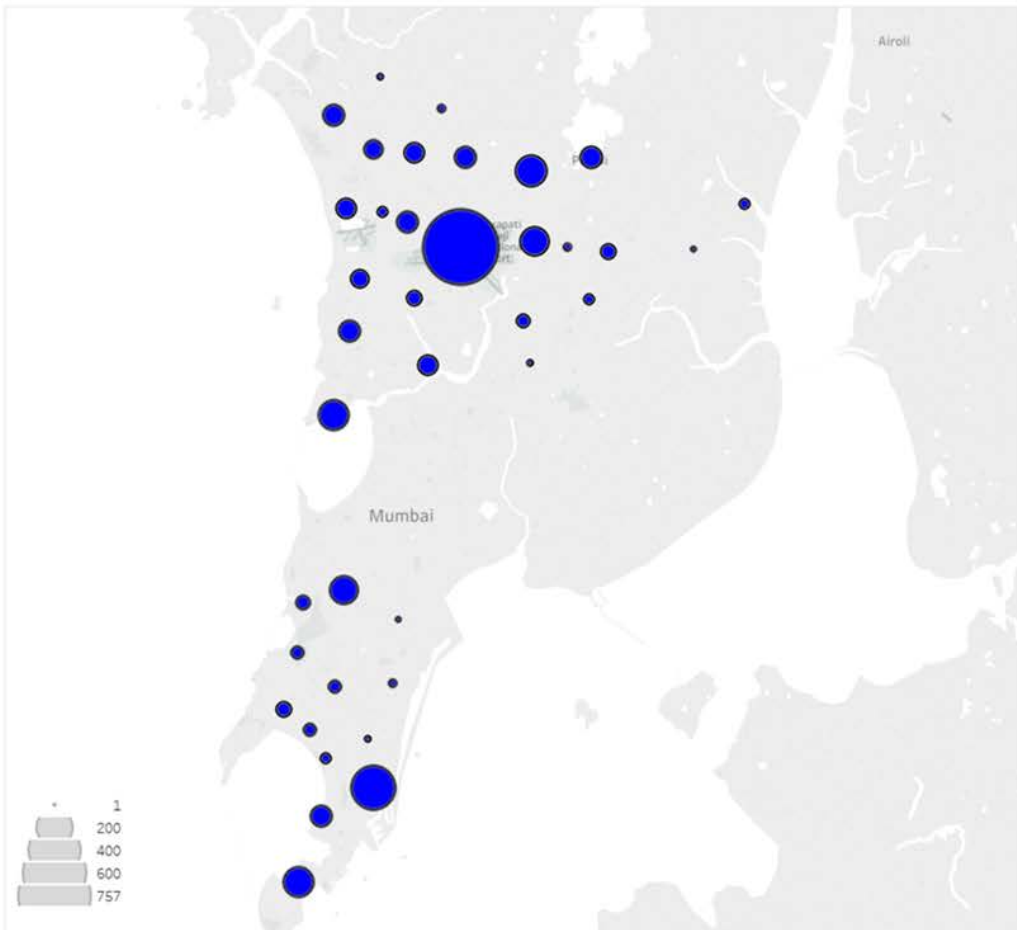


4

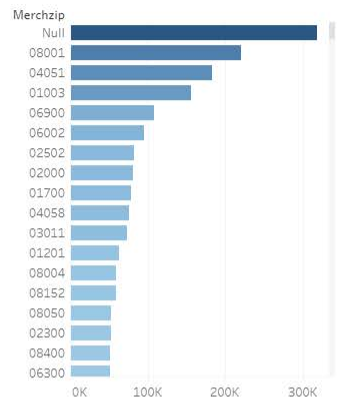
Data visualization
and
feature engineering



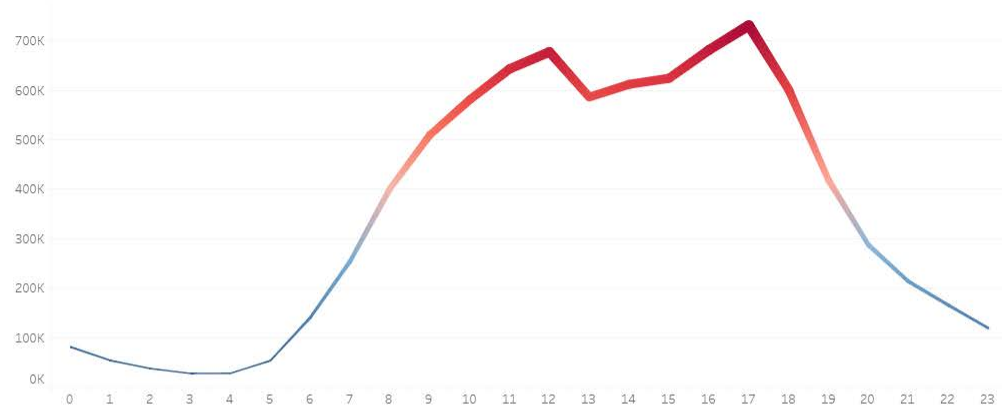




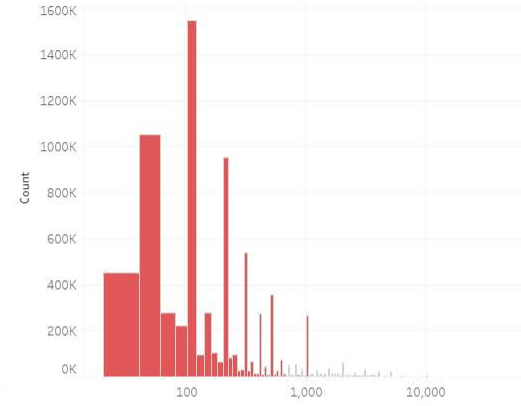
TRX by ZIP



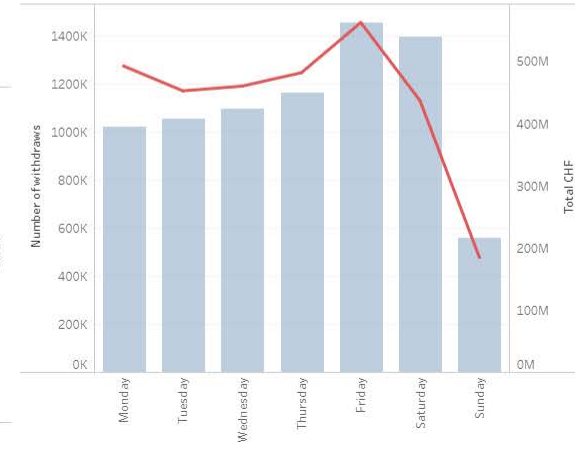
Number of Transactions vs Hour of Day



Histogram of Total CHF (horizontal axis)



Number of withdrawals, Total CHF per Day, in Switzerland



Number of Withdrawals by Weekday, Calendar Week (Local terminal time)

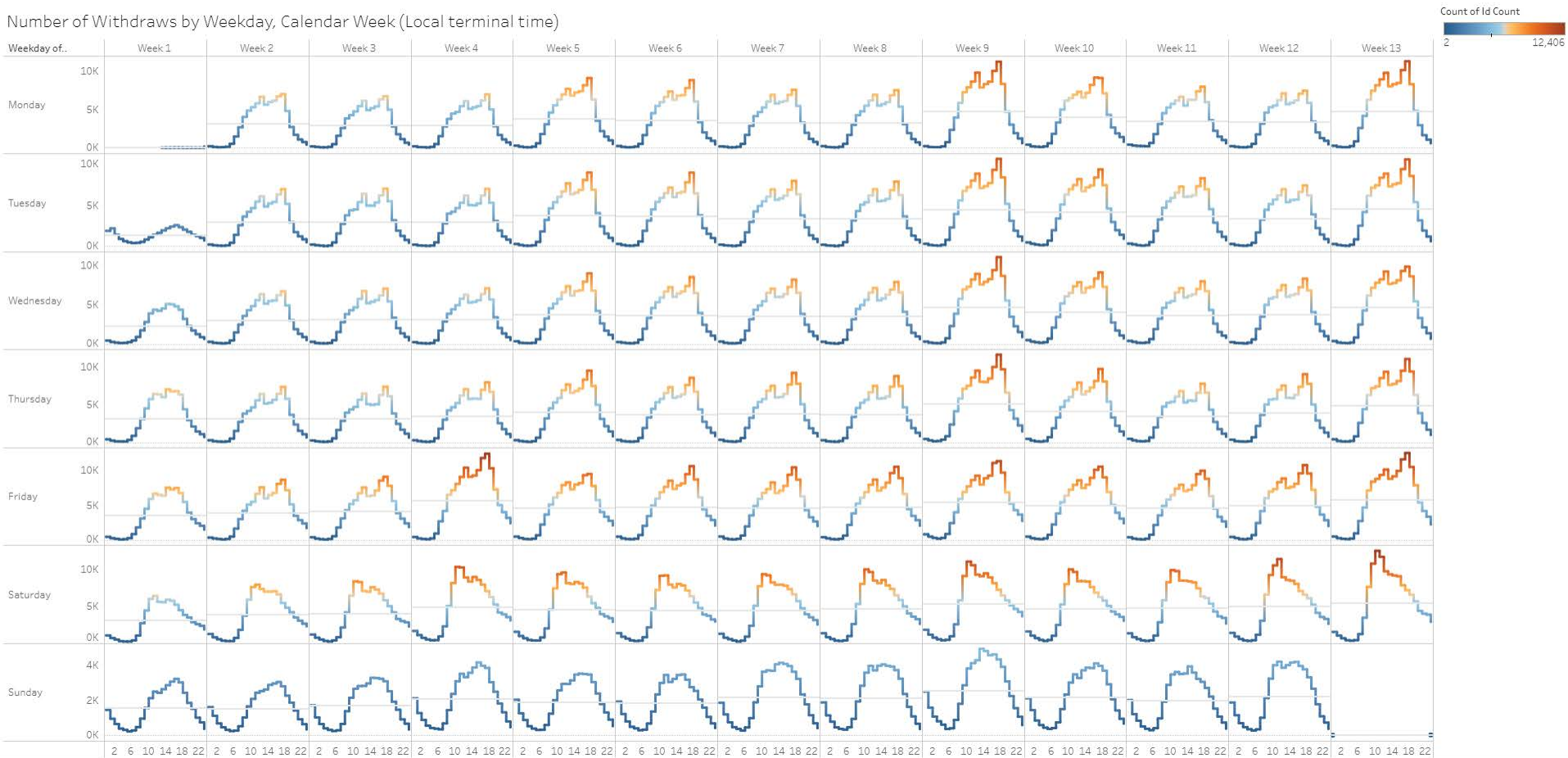


Tableau Demo



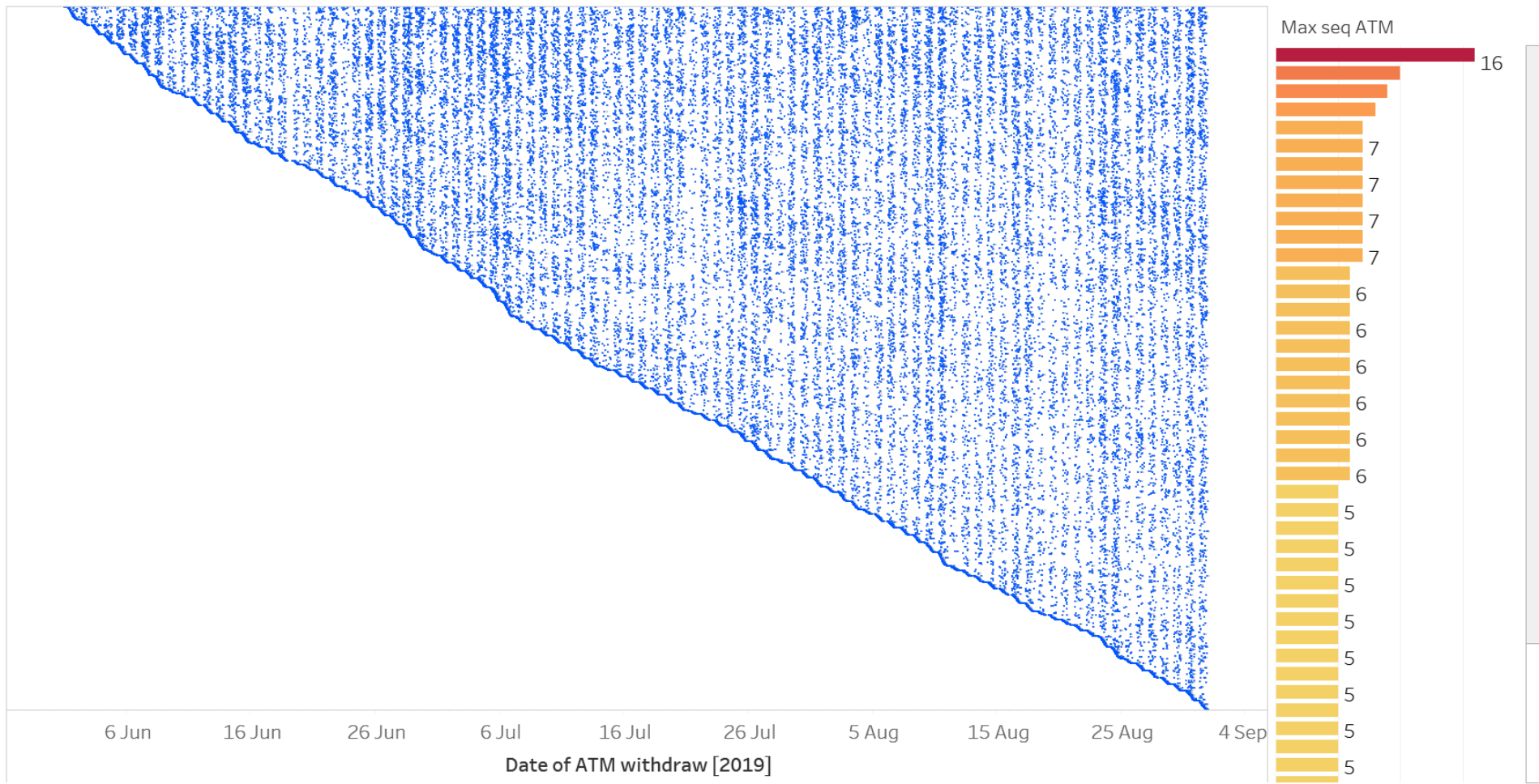
Max seq ATM



21 23 01 03 05 07 09 11 13 15 17 19 21 23 01

Date of ATM withdraw [24 July 2019]

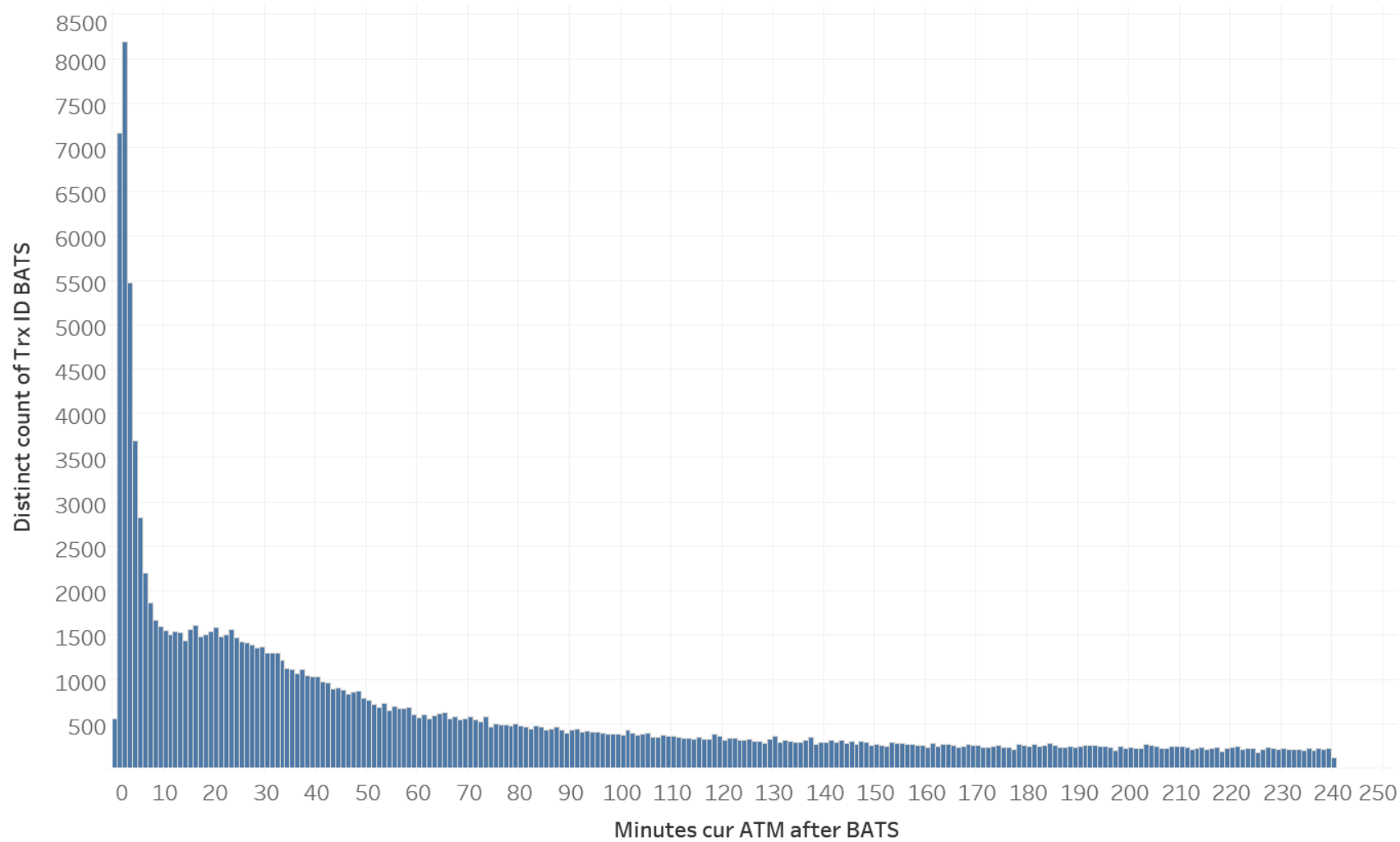




Date BATS	Name BATS	Date cur ATM	Minutes cur ..	Name cur ATM	Amount cur ..	
11:36:11 (07.06.19)	SBB DIETIKON	11:39:17 (07.06.19)	3	UBS Dietikon	200	1
		11:41:05 (07.06.19)	5	UBS Dietikon	80	2
		11:41:52 (07.06.19)	5	UBS Dietikon	80	3
		11:42:39 (07.06.19)	6	UBS Dietikon	90	4
		11:43:54 (07.06.19)	7	UBS Dietikon	50	5
11:46:04 (07.06.19)	SBB LANDQUART	11:59:16 (07.06.19)	13	Bahnhof SBB	20	1
		11:59:49 (07.06.19)	13	Bahnhof SBB	20	2
		12:01:20 (07.06.19)	15	GRKB CHUR-BHOF-UNT	20	3
		12:02:01 (07.06.19)	16	GRKB CHUR-BHOF-UNT	300	4
		12:06:46 (07.06.19)	20	Bahnhof SBB	200	5
16:05:37 (07.06.19)	SBB ZUG	16:11:28 (07.06.19)	6	ZGKB BAHNHOF	60	1
		16:12:08 (07.06.19)	7	ZGKB BAHNHOF	60	2
		16:13:00 (07.06.19)	8	ZGKB BAHNHOF	60	3
		16:13:44 (07.06.19)	8	ZGKB BAHNHOF	60	4
		16:14:27 (07.06.19)	9	ZGKB BAHNHOF	60	5
		16:15:21 (07.06.19)	10	ZGKB BAHNHOF	150	6
		16:16:14 (07.06.19)	11	ZGKB BAHNHOF	Null	7
		00:11:52 (09.06.19)	SBB AARAU	00:48:04 (09.06.19)	37	Baloise Bank SOBA
		02:22:59 (09.06.19)	131	RBB SBB OLTEN	50	2
		02:26:22 (09.06.19)	135	RBB SBB OLTEN	200	3

Agreement	Number of Countries
Paris Agreement	16
Other Agreement 1	7
Other Agreement 2	7
Other Agreement 3	7
Other Agreement 4	7
Other Agreement 5	7
Other Agreement 6	7
Other Agreement 7	7
Other Agreement 8	7
Other Agreement 9	7

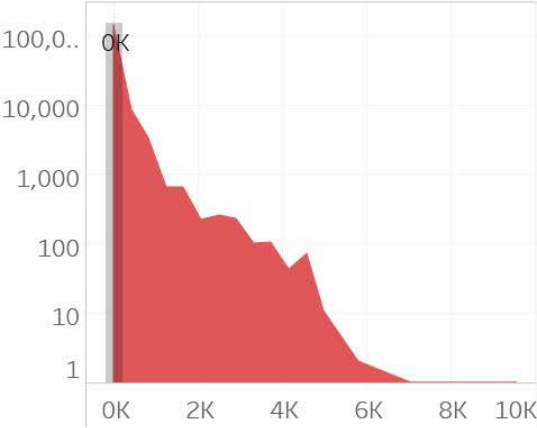
Time between BATS and first ATM



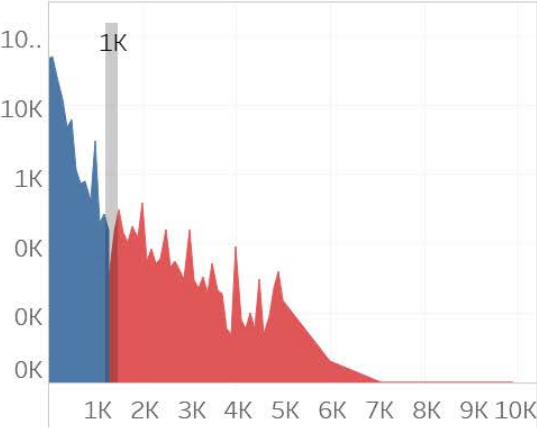
Interactive Rule Generation Dashboard: Ticket machine (BATS) followed by one or multiple ATM withdrawals

(1) Click distributions to set a thresholds (2) Use parameter menu to fine-tune (3) See all resulting alerts (4) See alerts on distributions

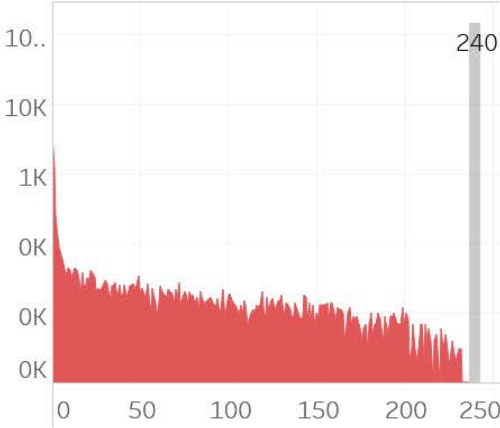
Minimum ATM withdraw amount for case



Maximum ATM withdraw amount for case



Minutes from prev withdraw to current



Alerts

1,029 alerts for 1 repeated ATM trx

92 alerts for 2 repeated ATM trx

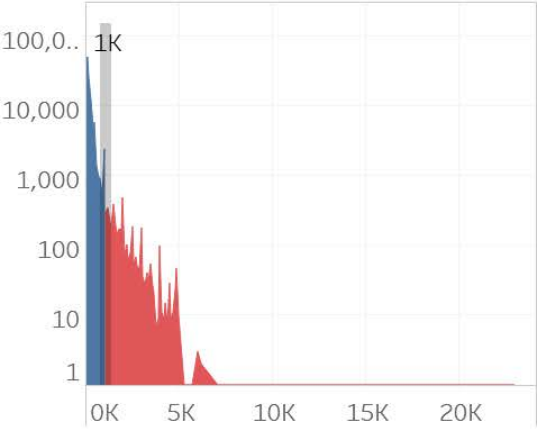
7 alerts for 3 repeated ATM trx

1 alerts for 4 repeated ATM trx

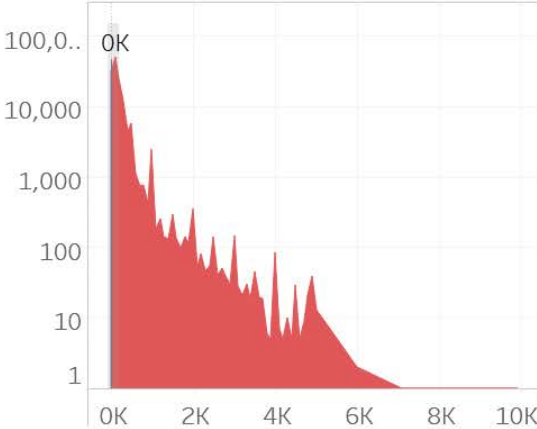
1 alerts for 5 repeated ATM trx

1 alerts for 6 repeated ATM trx

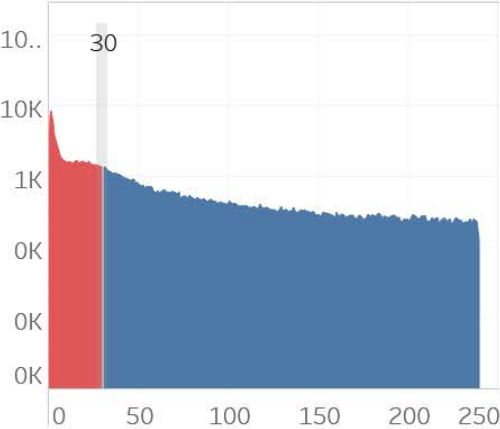
Cumulative ATM amount withdrawn in case



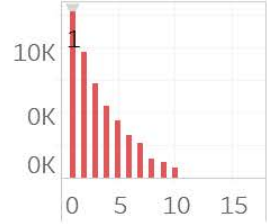
Current ATM withdraw amount



Minutes from BATS transaction to current



Repeated ATM trx



Interactive Rule Generation Dashboard: Ticket machine (BATS) followed by one or multiple ATM withdrawals

(1) Click distributions to set a thresholds (2) Use parameter menu to fine-tune (3) See all resulting alerts (4) See alerts on distributions

Alerted ATM withdrawals

including minutes after BATS and Amount (for the selected alert category)

Date BATS	Name BATS	Date cur ATM	Minut..	Name cur ATM	
05:27:56 (01.06.19)	Schweiz. Bundesbahn	05:44:24 (01.06.19)	17	RB BERN_SBB	4,000
08:15:06 (01.06.19)	SBB UZWIL	08:17:12 (01.06.19)	2	RB UZWIL-BAHNHOF	2,000
08:15:29 (01.06.19)	SBB UZWIL	08:19:23 (01.06.19)	4	RB UZWIL-BAHNHOF	4,000
09:13:36 (01.06.19)	BAEUMLIWEG BILLE..	09:28:33 (01.06.19)	15	UBS Winterthur	2,000
09:16:19 (01.06.19)	SBB St. gallen	09:22:03 (01.06.19)	6	CS SG Leonh 33/2	1,600
09:20:06 (01.06.19)	BACHTELSTRASSE BI..	09:36:44 (01.06.19)	16	UBS Winterthur	1,700
10:07:02 (01.06.19)	Schweiz. Bundesbahn	10:21:30 (01.06.19)	14	CS GRENCHEN_2	1,950
10:24:27 (01.06.19)	VBSG Busse	10:31:24 (01.06.19)	7	SGKB SG-Bruggen 3/rechts	1,880
10:58:12 (01.06.19)	VBZ ZURICH Verkehr..	11:22:36 (01.06.19)	24	CS ZH-SOCAR-TRIEMLI	1,800
11:17:07 (01.06.19)	VBZ DIETIKON BIRM..	11:26:09 (01.06.19)	9	UBS Dietikon	3,000
12:21:22 (01.06.19)	SBB DIETIKON	12:25:20 (01.06.19)	4	CS DIETIKON_2	1,800
13:13:05 (01.06.19)	SBB DUEBENDORF	13:43:10 (01.06.19)	30	CS ZH_SHOPVILLE_3	1,500
15:04:47 (01.06.19)	SBB ZUERICH OERLI..	15:11:58 (01.06.19)	7	UBS Zuerich Oerlikon	2,000
16:09:46 (01.06.19)	VBZ PARADEPLATZ	16:18:14 (01.06.19)	9	UBS Zuerich Paradeplatz	1,400
16:10:50 (01.06.19)	VBZ PARADEPLATZ	16:18:14 (01.06.19)	8	UBS Zuerich Paradeplatz	1,400
16:14:32 (01.06.19)	VBZ PARADEPLATZ	16:18:14 (01.06.19)	4	UBS Zuerich Paradeplatz	1,400
16:41:14 (01.06.19)	CFF MORGES	16:58:52 (01.06.19)	17	UBS Morges	3,000
09:22:30 (02.06.19)	SBB BIEL/BIENNE	09:43:06 (02.06.19)	21	BEKB BIEL-METT	2,280
11:25:53 (02.06.19)	Schweiz. Bundesbahn	11:28:34 (02.06.19)	3	UBS Bern SBB Hauptbahnhof	4,000
		11:29:43 (02.06.19)	4	UBS Bern SBB Hauptbahnhof	200
11:38:00 (02.06.19)	SBB MENDRISIO FFS	11:53:46 (02.06.19)	15	BR STABIO 3	3,000
11:46:37 (02.06.19)	SBB FRAUENFELD	11:51:13 (02.06.19)	5	Thurgauer Kantonalbank Frauenfeld	3,260
15:18:45 (02.06.19)	SBB BASEL HB	15:45:32 (02.06.19)	27	UBS Basel Lysbuechel	1,500
		15:46:59 (02.06.19)	28	UBS Basel Lysbuechel	1,500
15:30:41 (02.06.19)	Bahnhof Sued Parking	15:45:32 (02.06.19)	15	UBS Basel Lysbuechel	1,500
		15:46:59 (02.06.19)	16	UBS Basel Lysbuechel	1,500
16:07:06 (02.06.19)	Schweiz. Bundesbahn	16:32:18 (02.06.19)	25	UBS Geneva CFF	1,950

Alerts

1,029 alerts for
1 repeated ATM trx

92 alerts for
2 repeated ATM trx

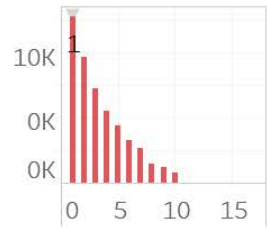
7 alerts for
3 repeated ATM trx

1 alerts for
4 repeated ATM trx

1 alerts for
5 repeated ATM trx

1 alerts for
6 repeated ATM trx

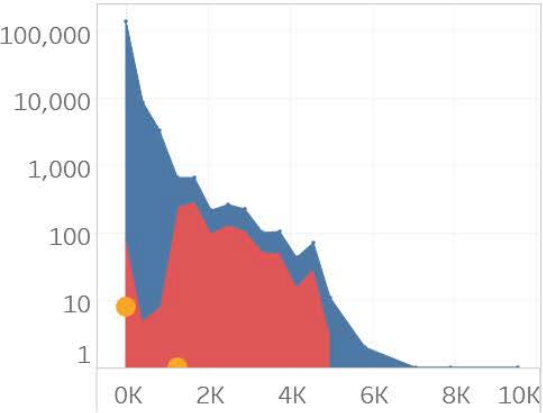
Repeated ATM trx



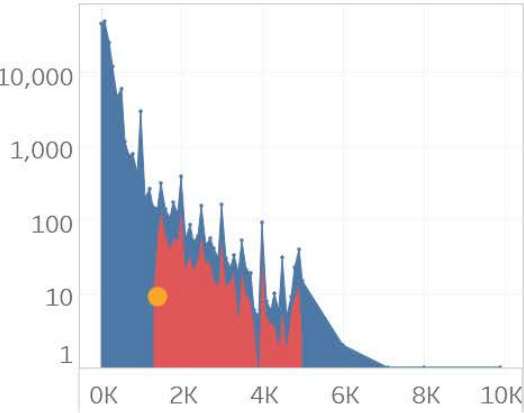
Interactive Rule Generation Dashboard: Ticket machine (BATS) followed by one or multiple ATM withdrawals

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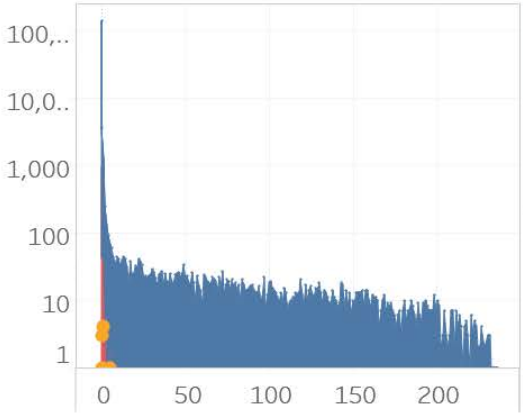
Minimum ATM withdraw amount for case



Maximum ATM withdraw amount for case



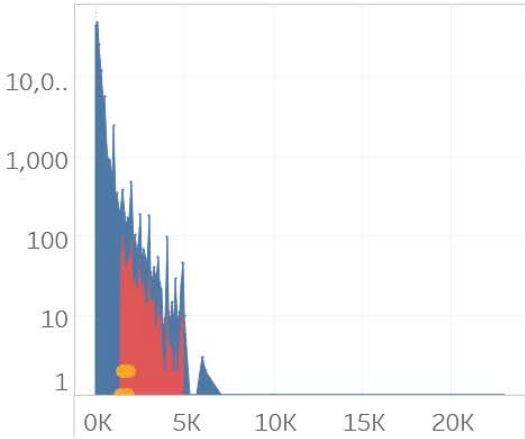
Minutes from prev withdraw to current



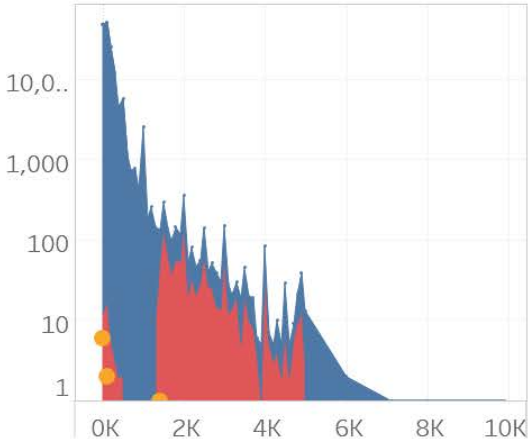
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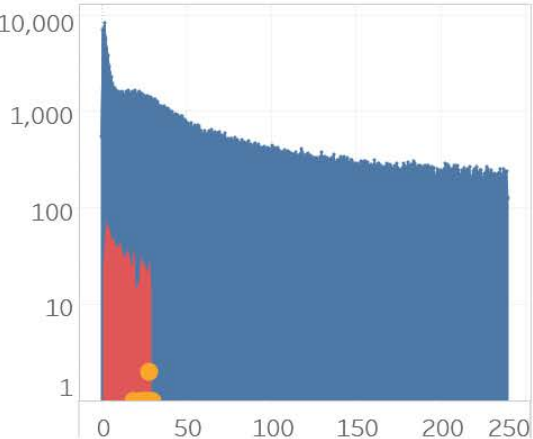
Cumulative ATM amount withdrawn in case



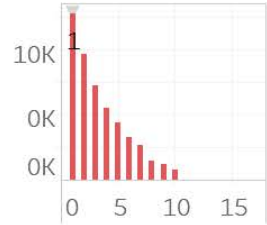
Current ATM withdraw amount



Minutes from BATS transaction to current

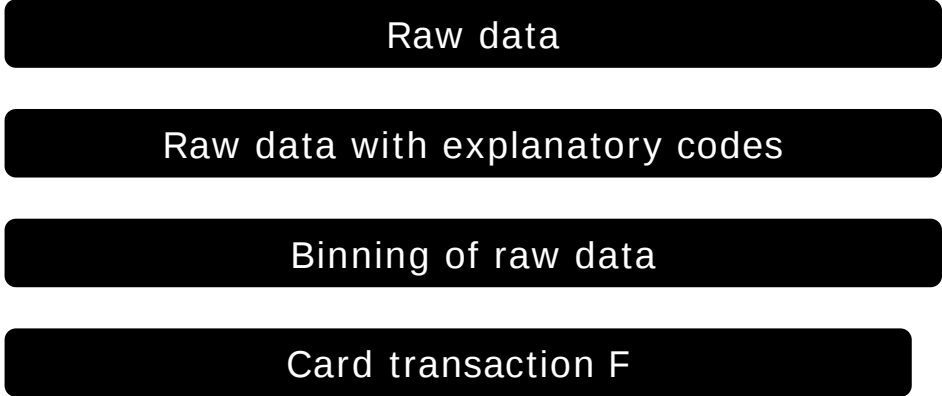


Repeated ATM trx



5

Model Results

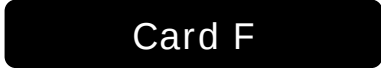


100

100

100

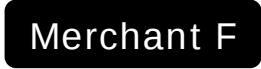
99.9



0.97



0.55

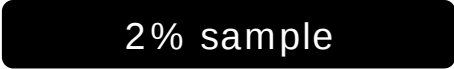


0.32



0.00

JOIN



2



0.00



0.00

ID_KEY_HASH ID_DATE ID_COUNT ID_REVISION ID_DATA_ID ID_MARK ID_UPDATE ACQUIRERID BCNR CARDBRAND CARDEXPIRYDATE
CARDPRODUCT CARDSEQNUMBER CARDSERVICECODE CHACTIVTERMLEVEL CVM EXTERNALVPNUMBER EXTREFNUMBER IND3DSECURE
INTERNALMANDID ISSCOUNTRY ISSPLATFORMID ISSRESPONSECODE MCC MERCHNAME MERCHZIP MERCHCITY MERCHREGIONCODE
MERCHCOUNTRYCODE MSGTYPEIND ORIGIN PAN_HASHPEM PEM_DE22 POSATTENDANCE POSCAPABILITY POSCARDPRESENT
POSCHPRESENT POSCOUNTRY POSLOCATIONIND POSLOCATIONPOSTCODEPOSPINENTRYCAP POSTRXSECURITY PROCCLASS
PROCESSINGTYPE RESPONSECODE SCHEMEBRAND SYSTEMAMOUNT SYSTEMCURRENCY SYSTEMEXPONENTTERMINALID TERMTYPE
TRXAMOUNT TRXCURRENCY TRXEXPONENT TRXHOSTDATETIME TRXTERMDATETIME TRXTYPE ZUFALLSZAHL_SPURZUFALLSZAHL_LAST
EVENTID EXTREFNUMBERHASH AUTH_UPDATE ISSMANDANTID MERCKEYHASH ON_INTDECLINELIST_AT
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TENANT_ID TENANT_NAMETENANT_REVISION ACTION ALERT CASECLASS HINTS RISKSCORE RULEID FRAUDMARK EMAILMARK
ON_GREYLISTCNP_AT ON_MONITORED CARDS_AT LOAD_TIME LOAD_SEQ RND

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TER_TRX_N TER_SYSTEMAMOUNT_AVG TER_TRX_BPT TER_SYSTEMAMOUNT_SUM TER_AMT_BPT MER_TRX_N MER_TRX_BPT
MER_SYSTEMAMOUNT_SUM MER_AMT_BPT CTR_N_TRX CTR_TRX_BPT CTR_SYSTEMAMOUNT_SUM CTR_AMT_BPT CLS_TRXCOUNTER
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TENANT_ID TENANT_NAMETENANT_REVISION ACTION ALERT CASECLASS HINTS RISKSCORE RULEID FRAUDMARK EMAILMARK
ON_GREYLISTCNP_AT ON_MONITORED CARDS_AT LOAD_TIME LOAD_SEQ RND

ID_TRX TRX_TRXHOSTDATETIME TRX_WDY TRX_HH_FRC TER TRX_HH_FRC_HST TRX_HH_FRC_TER_HST_DIFF TRX_HH_BIN
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TER_TRX_N TER_SYSTEMAMOUNT_AVG TER_TRX_BPT TER_SYSTEMAMOUNT_SUM TER_AMT_BPT MER_TRX_N MER_TRX_BPT
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CLS_TIMEDIFF CLS_AMOUNTCHF CLS_DIFFTOPREVAMT CLS_MAXAMT CLS_CNTTRX30MIN CLS_CNTTRX1D CLS_CNTTRX1H CLS_CNTTRX2H
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TENANT_ID TENANT_NAMETENANT_REVISION ACTION **ALERT** CASECLASS HINTS RISKSCORE RULEID **FRAUDMARK** EMAILMARK
ON_GREYLISTCNP_AT ON_MONITORED CARDS_AT LOAD_TIME LOAD_SEQ RND

ID_TRX TRX_TRXHOSTDATETIME TRX_WDY TRX_HH_FRC TER TRX_HH_FRC_HST TRX_HH_FRC_TER_HST_DIFF TRX_HH_BIN
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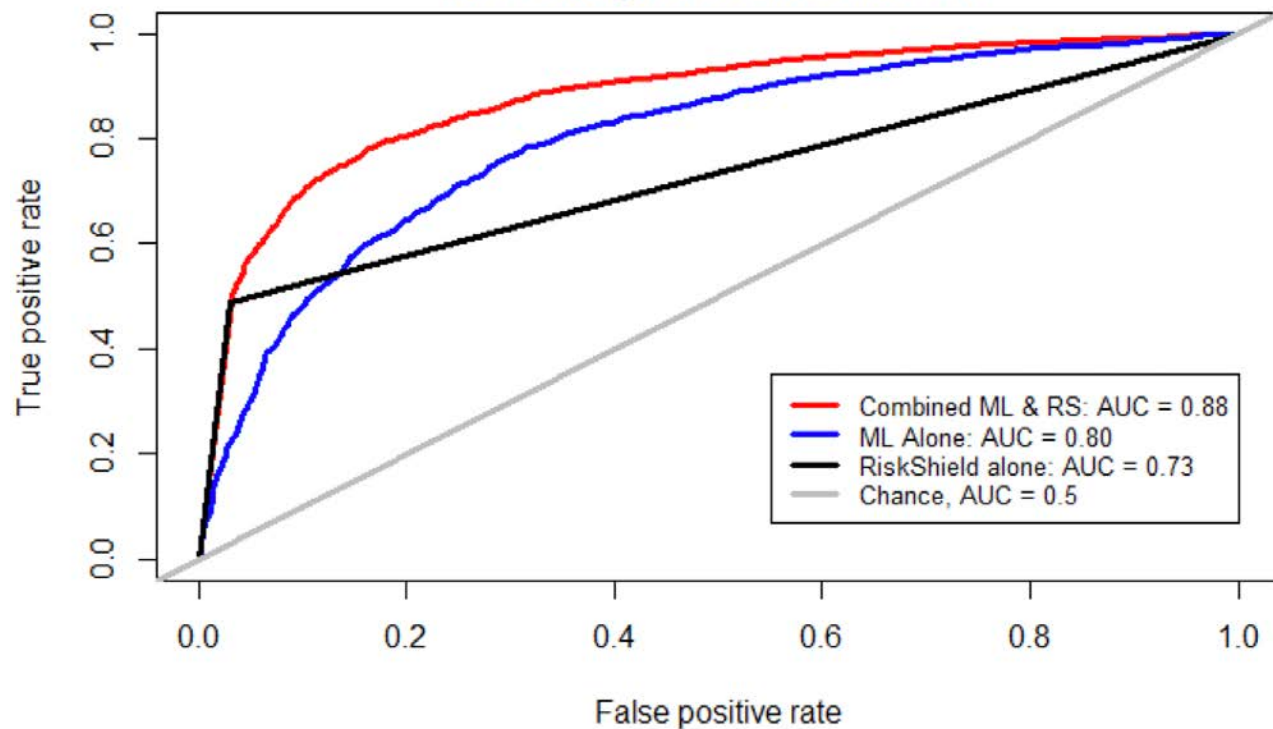
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ID_TRX TRX_TRXHOSTDATETIME TRX_WDY TRX_HH_FRC TER TRX_HH_FRC_HST TRX_HH_FRC_TER_HST_DIFF TRX_HH_BIN
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ROC Analysis for the 3 Models



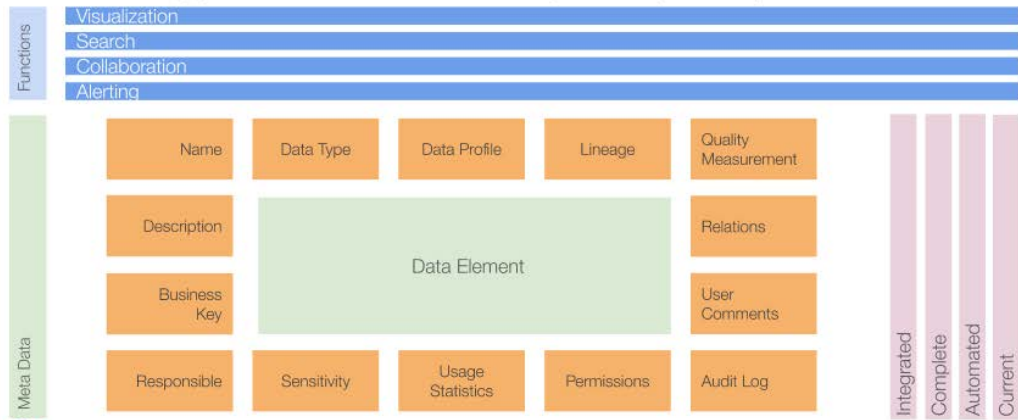
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Outlook

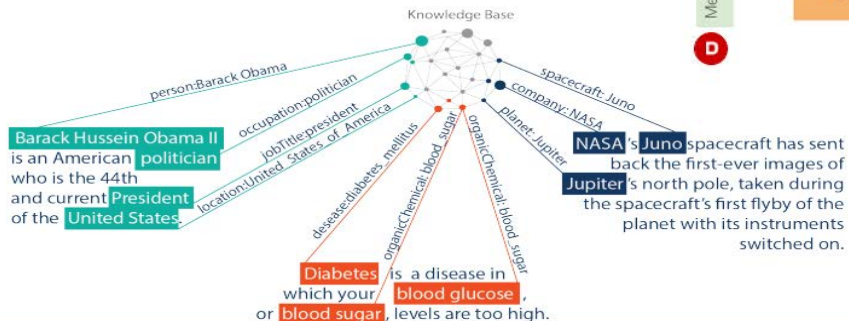
Enhance our organization of data

Data Catalog Overview

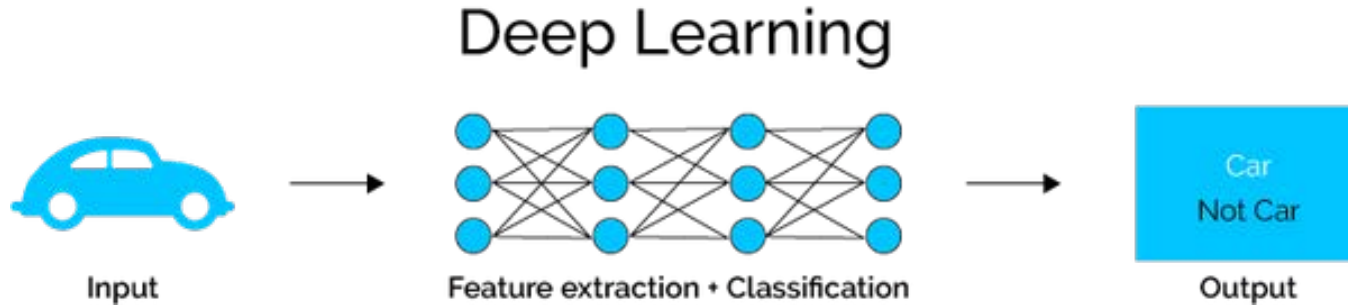
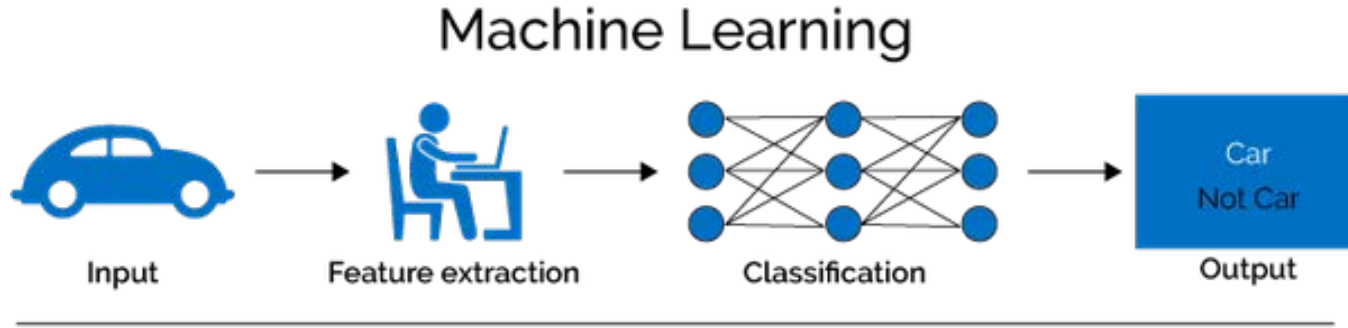
The data catalog provides all information on data (metadata) in one place.



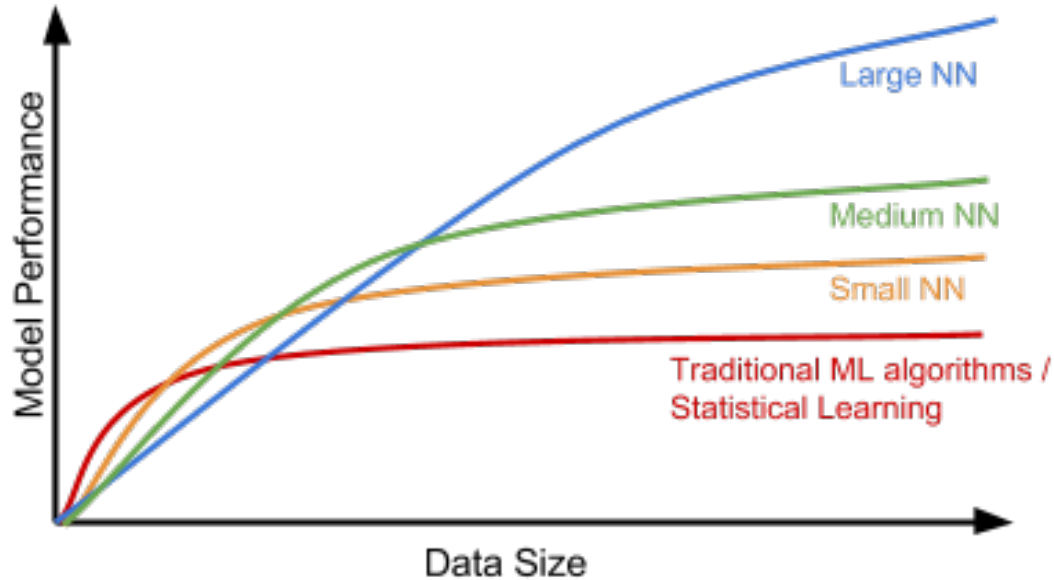
Simon Hefti, D ONE



What does the future hold?



Why is more data important?



Conclusions

- We have many challenges
 - Organization of data
 - Computing infrastructure
 - Innovation while ensuring security
 - Investing in infrastructure
- We also have numerous resources
 - Copious amounts of raw data
 - Expert colleagues
 - Professional tools



WL: my favorite position to-date by far



Thanks!



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