Data Science Final Report

第七組
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Content

- Introduction
- EDA
- Dealing With Missing Value
- Model Evaluation

INTRODUCTION

Data Description

- *Data 來源：IEEE-CIS Fraud Detection*
- *Goal：we want to detect fraud from customer transactions，and prevent them.*

Categorical Features

ProductCD
card1 - card6
addr1, addr2
P_emaildomain
R_emaildomain
M1 - M9
DeviceType
DeviceInfo
id_12 - id_38

Model Tried

Null model
LightGBM Regressor
KNN
SVM

EXPLORATORY DATA ANALYSIS

Data Description

Target Variable

- 'isFraud'
- The binary target is isFraud.
  - 0 means not Fraud
  - 1 means is Fraud

Data Description

Transaction Table

- *TransactionDT*: timedelta from a given reference datetime (not an actual timestamp)
- TransactionAMT: transaction payment amount in USD
- ProductCD: product code, the product for each transaction
- card1 - card6: payment card information, such as card type, card category, issue bank, country, etc.
- addr: address
- dist: distanceP_ and (R__)
- emaildomain: purchaser and recipient email domain
- C1-C14: counting, such as how many addresses are found to be associated with the payment card, etc. The actual meaning is masked.
- D1-D15: timedelta, such as days between previous transaction, etc.
- M1-M9: match, such as names on card and address, etc.
- Vxxx: Vesta engineered rich features, including ranking, counting, and other entity relations."Our team finished projects one week earlier on average last year thanks to TaskWhiz."

Data Description

Identity Table

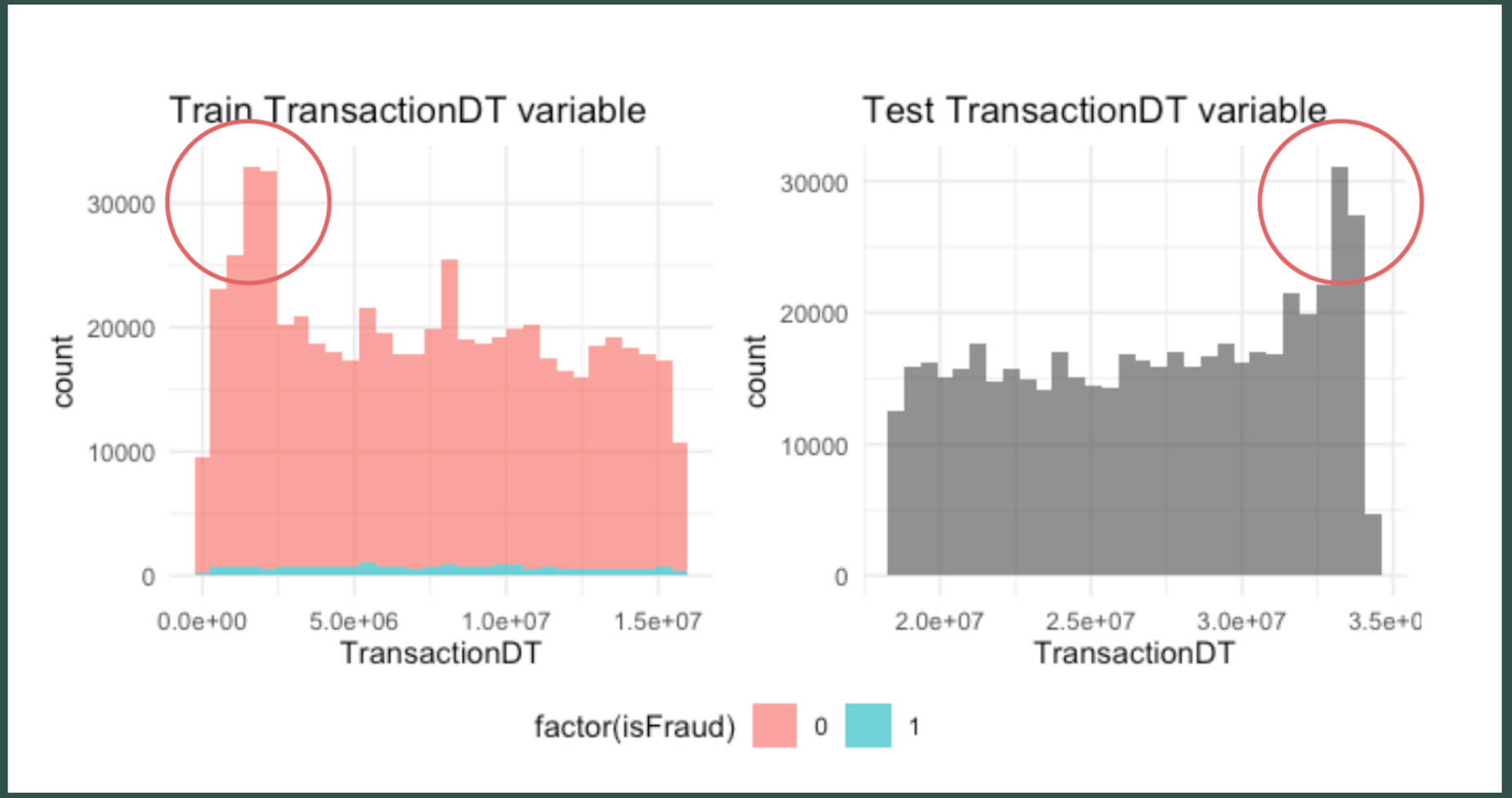
Variables in this table are identity information – network connection information (IP, ISP, Proxy, etc) and digital signature (UA/browser/os/version, etc) associated with transactions.

Target Variable

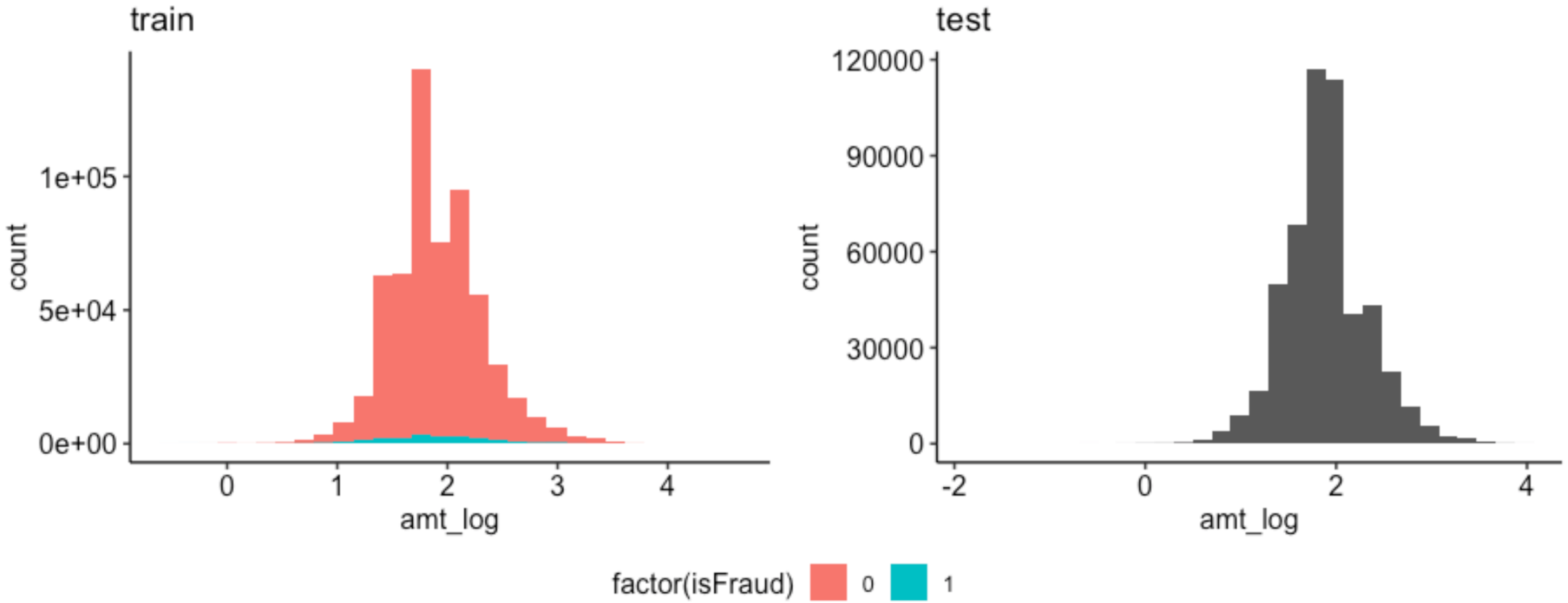
The dataset is *imbalanced*, most transactions are non-fraud： might “overfit”

TransactionDT

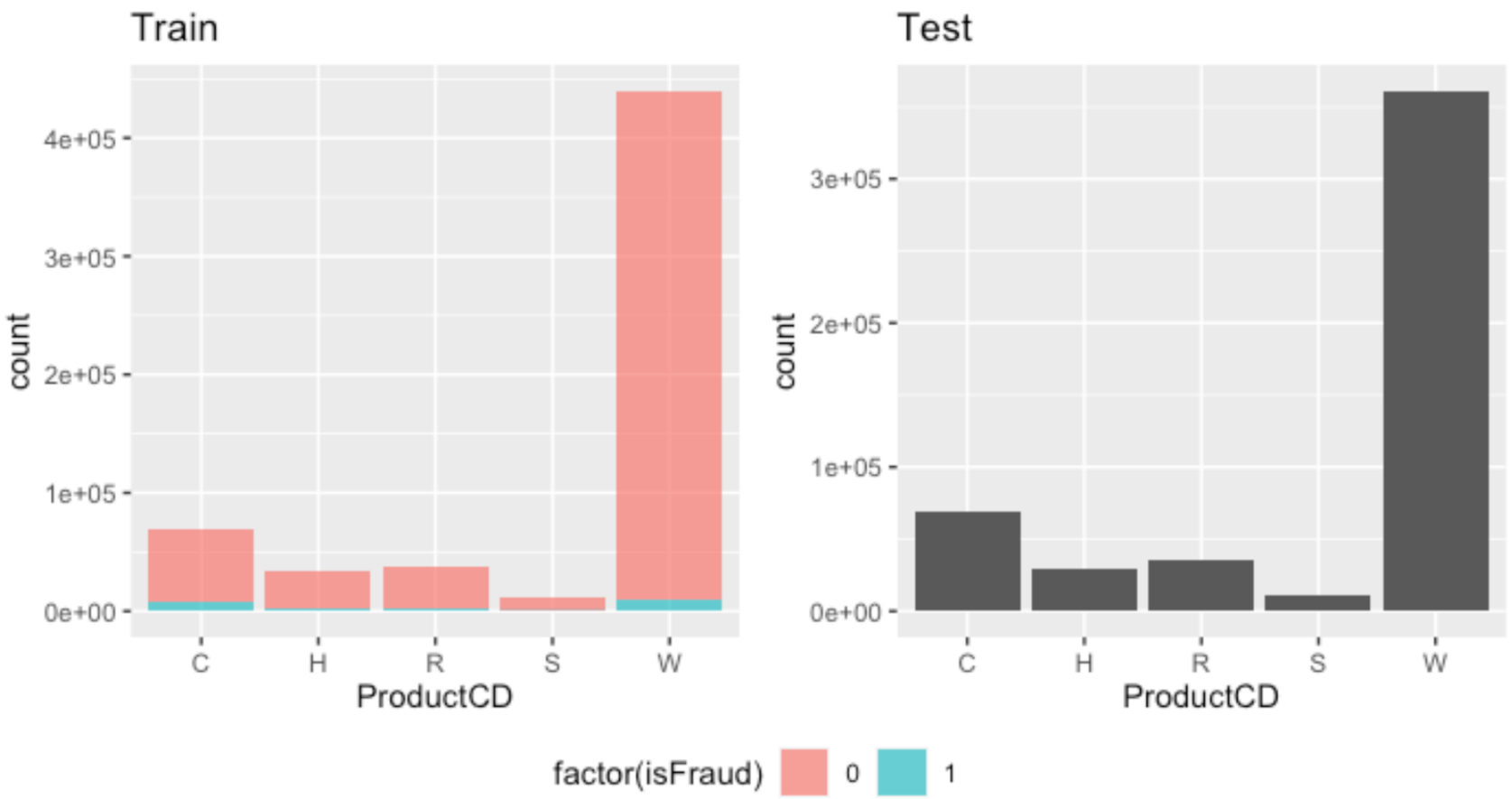
minimum and maximum values



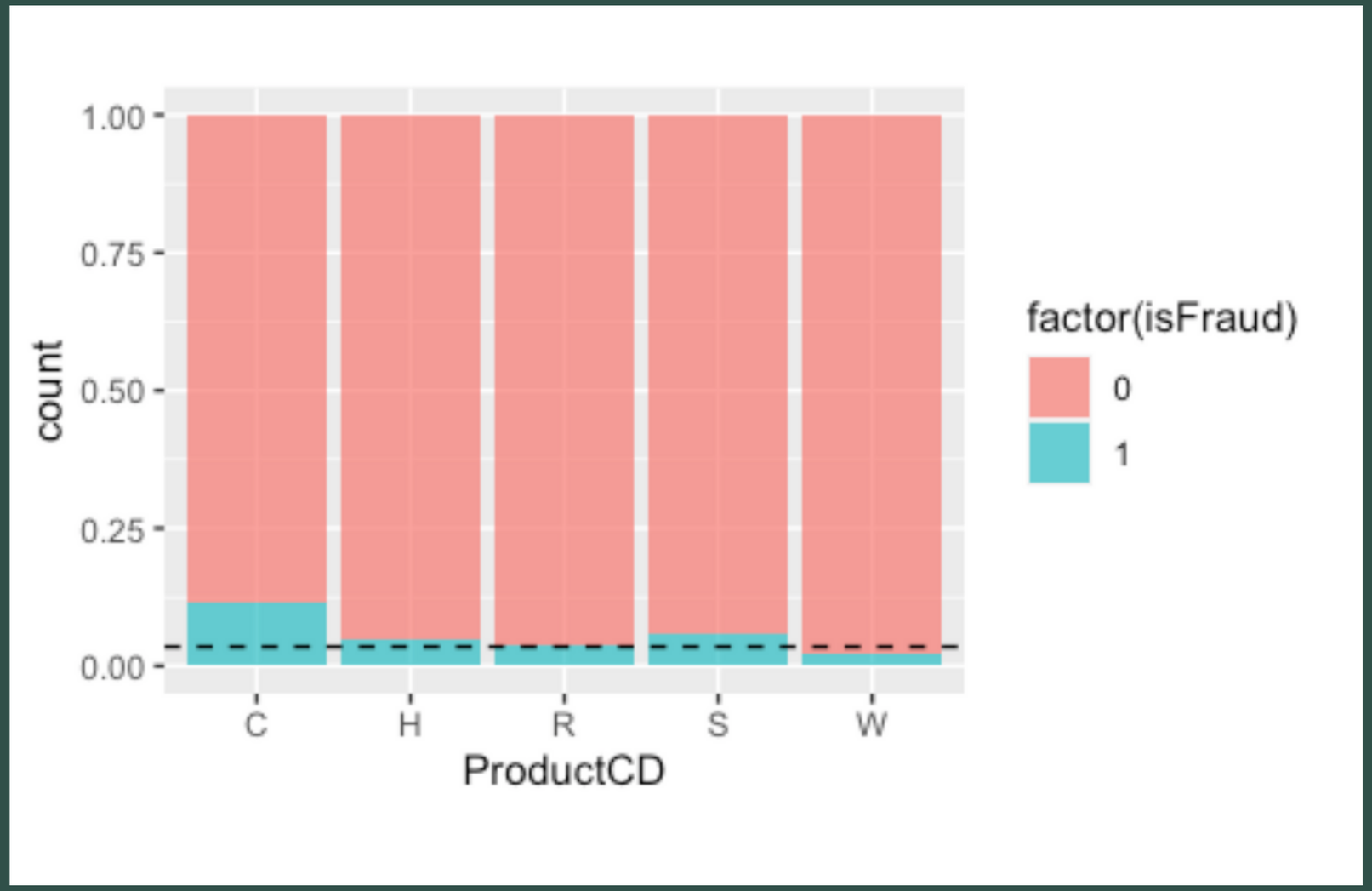
TransactionAMT



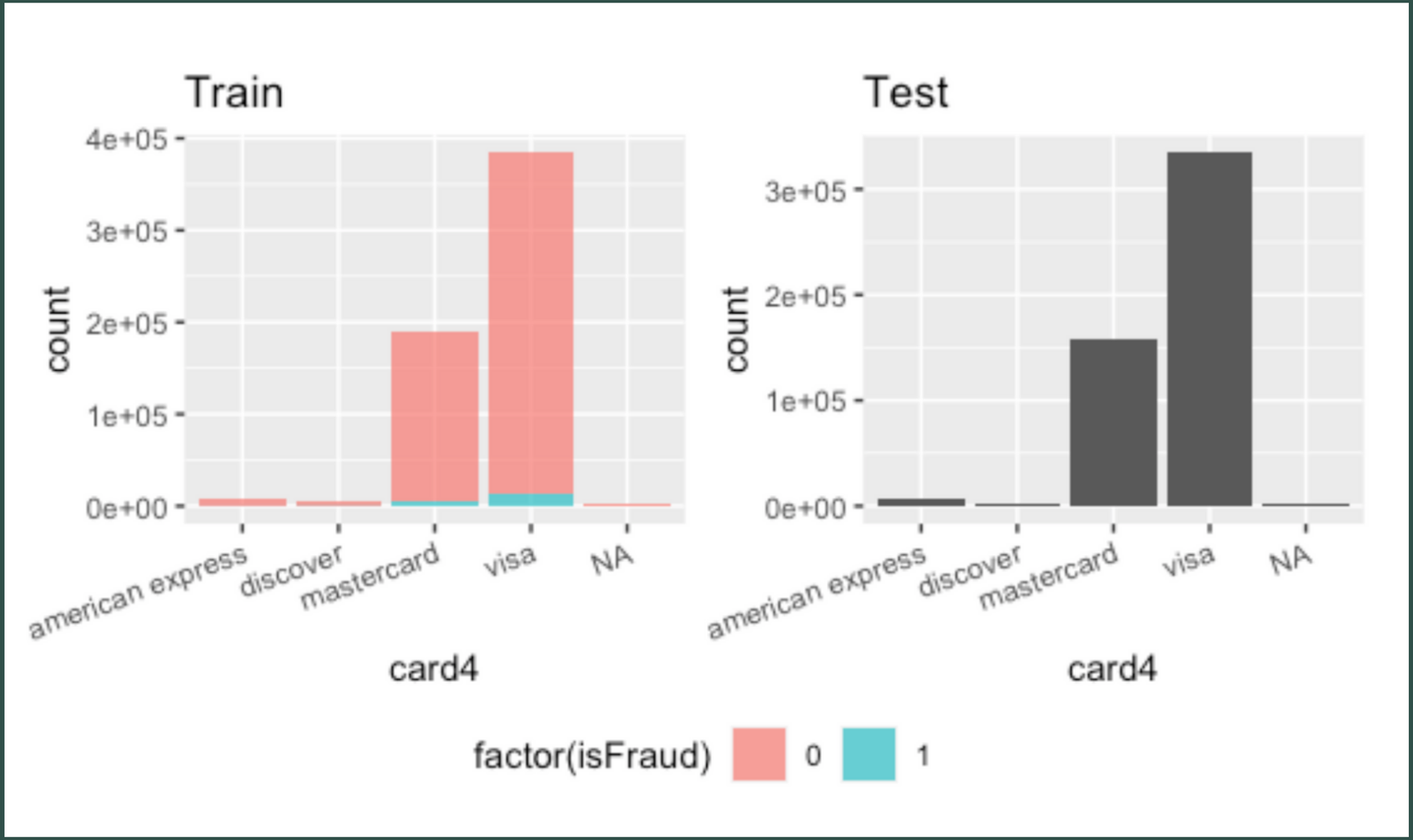
ProductCD


Train
Test
count
4e+05
3e+05
2e+05
1e+05
0e+00
C
H
R
S
W
ProductCD
factor(isFraud)
0
1

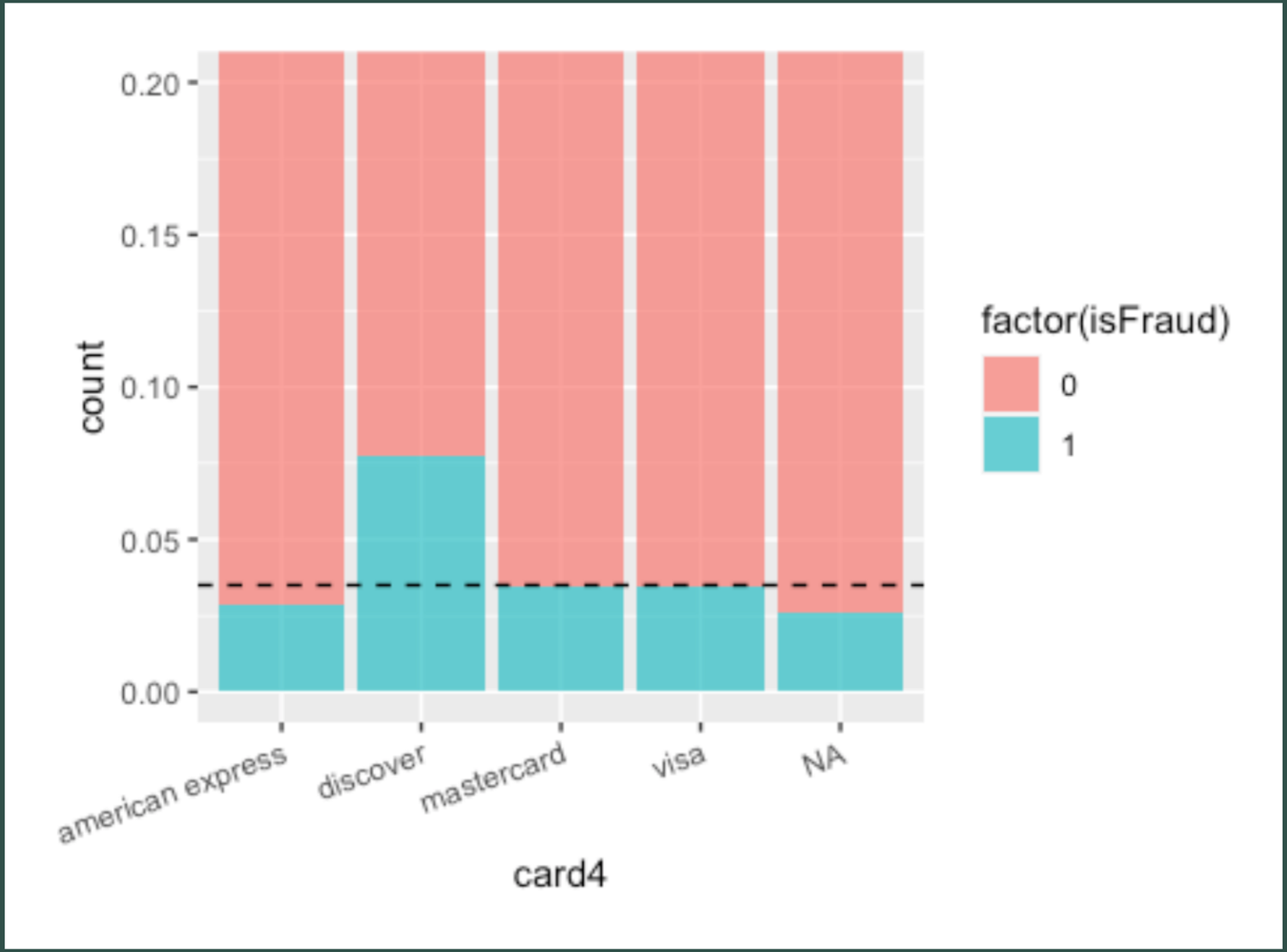
ProductCD



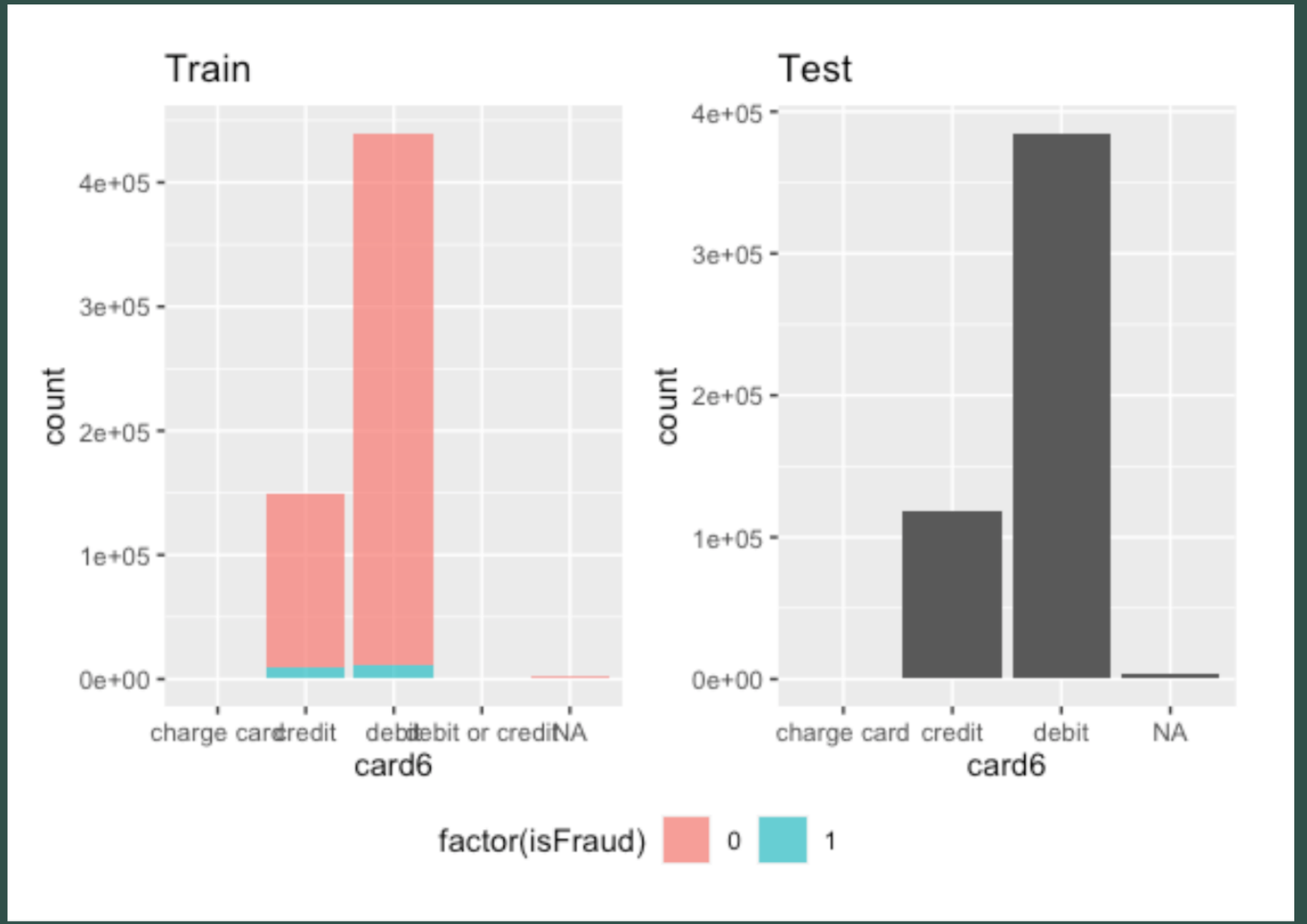
Card 4


Train
Test
count
4e+05
3e+05
2e+05
1e+05
0e+00
american express
discover
mastercard
visa
NA
card4
factor(isFraud)
0
1

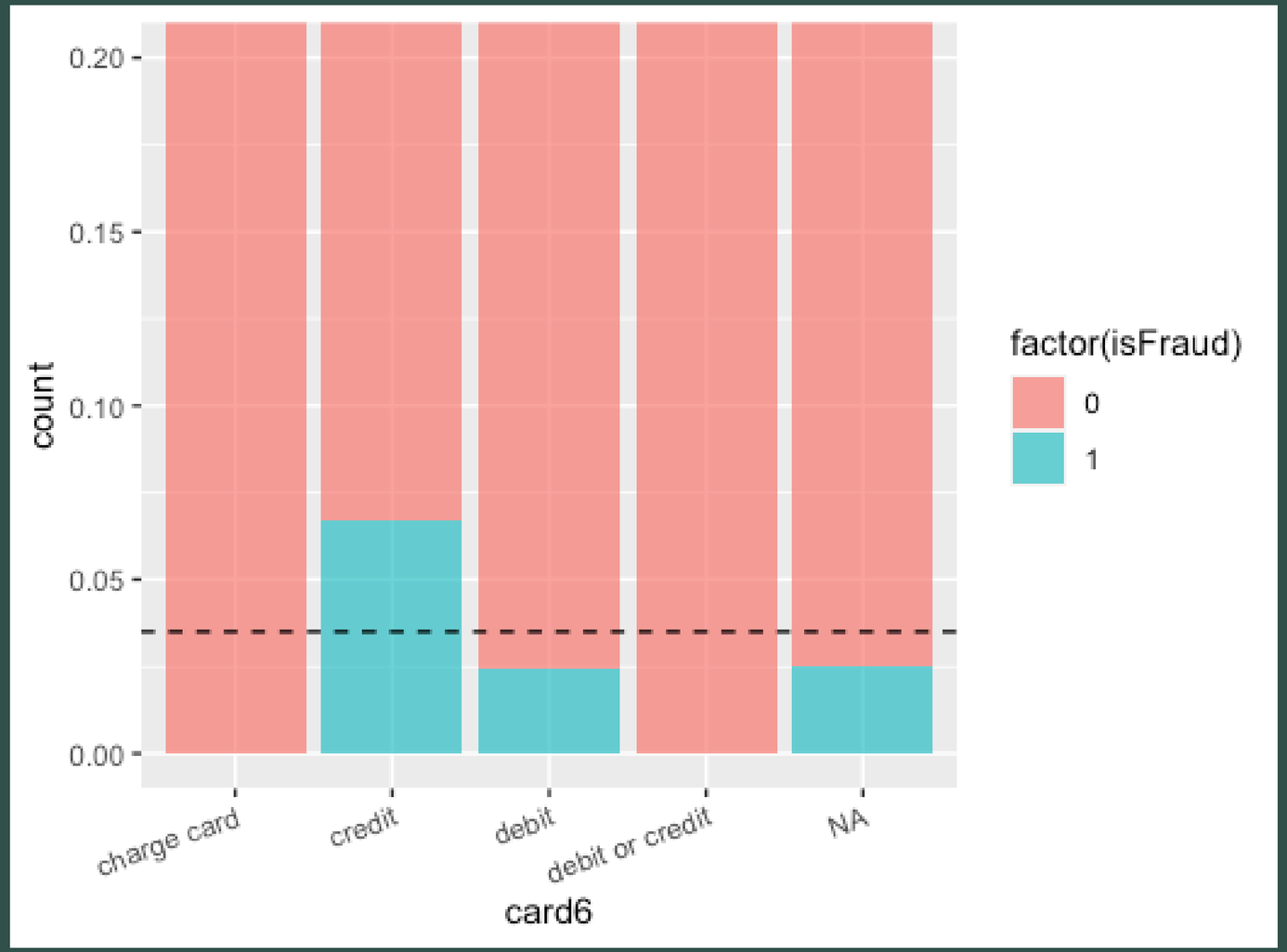
Card 4


0.20
0.15
0.10
0.05
0.00
count
american express
discover
mastercard
visa
NA
card4
factor(isFraud)
0
1

Card 6


Train
Test
count
4e+05
3e+05
2e+05
1e+05
0e+00
charge card
credit
debit
debit or credit
NA
card6
factor(isFraud)
0
1

Card 6


0.20
0.15
0.10
0.05
0.00
count
charge card
credit
debit
debit or credit
NA
card6
factor(isFraud)
0
1

DEALING WITH MISSING VALUE

Missing Rate

- missing values in the most of the columns.
- data full of missing values = low complete_rate

skim_variable	n_missing	complete_rate
V138	508595	0.139
V139	508595	0.139
V140	508595	0.139
V141	508595	0.139
V142	508595	0.139
V143	508589	0.139
V144	508589	0.139
V145	508589	0.139
V146		
V147		
V148		

	Variable	MissPercentage
	<fct>	<dbl>
id_24	id_24	99.19616
id_25	id_25	99.13096
id_07	id_07	99.12707
id_08	id_08	99.12707
id_21	id_21	99.12639
id_26	id_26	99.12572
id_22	id_22	99.12470
id_23	id_23	99.12470
id_27	id_27	99.12470

Different type of the columns

Two types of column in the data:

- Category columns
- Numeric columns

```
# Get the categorical and numeric columns
category_columns = [
    'ProductCD', 'card1', 'card2', 'card3', 'card4', 'card5', 'card6',
                 'addr1', 'addr2', 'P_emaildomain', 'R_emaildomain', 'DeviceType', 'DeviceInfo',
                 'M1','M2','M3','M4','M5','M6','M7','M8','M9',"id_12",
                 "id_13","id_14","id_15","id_16","id_17","id_19","id_20",
                 "id_28","id_29","id_30","id_31","id_32","id_33",
                 "id_34","id_35","id_36","id_37","id_38"]
```

Fill NA in Numeric columns

NA imputation：

- KNN imputation
  - Error in knnImputation in r: Not sufficient complete cases for computing neighbors [closed]
- MICE imputation
- give mean, median and mode to fill NA

	V219	V206	V50	V292	V170	V101	V191	V120	V258	V84	...	V192	V151	V254	V30	V155	V283	D1	V338	C11	V328
0	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	...	1.0	1.0	1.0	0.0	1.0	1.0	14.0	0.0	2	0.0
1	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	...	1.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0	1	0.0
2	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	...	1.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0	1	0.0
3	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0	...	1.0	1.0	1.0	0.0	1.0	0.0	112.0	0.0	1	0.0
4	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	...	1.0	49.0	1.0	0.0	0.0	1.0	0.0	0.0	1	0.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
590535	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	...	1.0	1.0	1.0	1.0	1.0	1.0	29.0	0.0	1	0.0
590536	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	...	1.0	1.0	1.0	0.0	1.0	1.0	0.0	0.0	1	0.0
590537	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	...	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	1	0.0
590538	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	...	1.0	1.0	1.0	0.0	1.0	7.0	22.0	0.0	1	0.0
590539	0.0	0.0	0.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0	...	1.0	1.0	1.0	1.0	1.0	2.0	0.0	0.0	1	0.0

590540 rows × 384 columns

Memory Reduction

- Some float64, int64 column take too much memory
- but some columns can be int8 or int16.
- Do downcasting!

```
train.memory_usage().sum()
```

```
2223973768
```

```
train.memory_usage().sum()
```

```
1071239688
```

```
TransactionID      float64
isFraud              int64
TransactionDT      float64
TransactionAmt     float64
ProductCD           object
                      ...
V2_isna               bool
V15_isna              bool
V94_isna              bool
V147_isna             bool
V312_isna             bool
Length: 791, dtype: object
```

Fill NA in Category columns

- Encoding：convert string to numeric
  - Label encoding
  - one hot encoding
- we have columns with very high cardinality, so we choose LABEL ENCODING!
- Two thing that we need to deal with：
  - Missing value
  - Unknown value

	ProductCD	card1	card2	card3	card4	card5	card6	addr1	addr2	P_emaildomain	...	id_29	id_30	id_31	id_32	id_33	id_34	id_35	id_36	id_37	id_38
0	4	10095	500	42	1	38	1	166	62	31	...	2	74	96	4	260	4	2	2	2	2
1	4	1372	303	42	2	2	1	173	62	16	...	2	74	96	4	260	4	2	2	2	2
2	4	2833	389	42	4	58	2	178	62	36	...	2	74	96	4	260	4	2	2	2	2
3	4	13341	466	42	2	14	2	282	62	54	...	2	74	96	4	260	4	2	2	2	2
4	1	2712	413	42	2	2	1	241	62	16	...	1	7	124	3	164	3	1	0	1	1
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
590535	4	4305	500	42	4	108	2	132	62	31	...	2	74	96	4	260	4	2	2	2	2
590536	4	7354	124	42	2	106	2	78	62	16	...	2	74	96	4	260	4	2	2	2	2
590537	4	8621	494	42	2	106	2	98	62	16	...	2	74	96	4	260	4	2	2	2	2
590538	4	5297	380	42	2	106	2	219	62	2	...	2	74	96	4	260	4	2	2	2	2
590539	4	10950	69	42	2	2	1	151	62	16	...	2	74	96	4	260	4	2	2	2	2

590540 rows × 41 columns

MODEL EVALUATION

Model

- Naive Bayes
- KNN
- LGB
- null model: give random prob.
  - for comparison
  - negetive : positive = 0.97 : 0.03

Evaluation

- without cross validation

	knn	naive bayes	null model	lgb
accuracy	0.961	0.744	0.923	**0.982**
precision	0	0.982	0.032	0.772
sensitivity	0	**0.78**	0.234	0.033
specificity	0.962	0.615	**0.998**	0.969
f1	0	0.869	0.36	0.033

Performance

model	AUC score from kaggle
LGB	0.892
Naive Bayes	0.746
null model	0.5
KNN	0.5

SHINY

https://sourlab.shinyapps.io/datascience/

What's the problem?

An error has occurred

The application failed to start: exited normally with code 137, signal 9 (SIGKILL)

LOGS

```
2021-01-11T15:55:30.454277+00:00 shinyapps[system]: Out of memory!
2021-01-11T15:55:37.385770+00:00 shinyapps[system]: Out of memory!
2021-01-11T15:57:13.862446+00:00 shinyapps[system]: Out of memory!
2021-01-11T15:58:22.374907+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:02:11.703267+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:03:08.180247+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:08:55.741235+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:11:10.707325+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:15:17.140324+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:15:39.592174+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:17:06.037234+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:17:22.004832+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:29:40.242106+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:29:52.377532+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:34:50.398618+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:40:58.575547+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:41:11.185870+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:41:17.893742+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:42:05.304995+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:42:41.824297+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:43:39.551810+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:49:39.991687+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:55:14.405872+00:00 shinyapps[system]: Out of memory!
2021-01-11T16:58:49.929991+00:00 shinyapps[system]: Out of memory!
2021-01-11T17:00:04.099779+00:00 shinyapps[system]: Out of memory!
2021-01-11T19:05:11.397143+00:00 shinyapps[system]: Out of memory!
```

What we have tried?

- reduce dataset: from 3millions to 500
- reduce the feature image
- turn png to jpeg

However,
shiny still be out of memory :(

https://reurl.cc/Ag1QrK

Data Introduction

http://127.0.0.1:4352 | Open in Browser

IEEE CIS fraud detection

homepage | transction | identity | transaction structure | identity structure | isFraud | model result plot | model result table

IEEE CIS fraud detection

IEEE-CIS works across a variety of AI and machine learning areas, including deep neural networks, fuzzy systems, evolutionary computation, and swarm intelligence. Today they're partnering with the world's leading payment service company, Vesta Corporation, seeking the best solutions for fraud prevention industry, and now you are invited to join the challenge.

This competition is a binary classification problem - i.e. our target variable is a binary attribute (Is the user making the click fraudlent or not?) and our goal is to classify users into "fraudlent" or "not fraudlent" as well as possible.

Data

In this competition you are predicting the probability that an online transaction is fraudulent, as denoted by the binary target `isFraud`.

The data is broken into two files **identity** and **transaction**, which are joined by `TransactionID`.

Note: Not all transactions have corresponding identity information.

Categorical Features - Transaction

- `ProductCD`
- `card1` - `card6`
- `addr1`, `addr2`
- `P_emaildomain`
- `R_emaildomain`
- `M1` - `M9`

Categorical Features - Identity

- `DeviceType`
- `DeviceInfo`
- `id_12` - `id_38`

Files

- train_{transaction, identity}.csv - the training set
- test_{transaction, identity}.csv - the test set (you must predict the `isFraud` value for these observations)
- sample_submission.csv - a sample submission file in the correct format

Model Tried

Data Preview

http://127.0.0.1:4352 | Open in Browser

IEEE CIS fraud detection

homepage | transction | identity | transaction structure | identity structure | isFraud | model result plot | model result table

Show 5 entries Search:

	X.1	X	TransactionID	isFraud	TransactionDT	TransactionAmt	ProductCD	card1	card2	card3	card
191	191	191	2987190	0	89565	32.325	0	3454	165	73	
201	201	201	2987200	0	89666	34	4	9044	167	42	
310	310	310	2987309	0	91339	25.95	4	771	10	42	
104	104	104	2987103	0	88184	47.95	4	13533	446	42	
200	200	200	2987199	0	89665	19.455	0	11593	444	73	

Showing 1 to 5 of 50 entries Previous 1 2 3 4 5 ... 10 Next

Data Preview

http://127.0.0.1:4352 | Open in Browser

IEEE CIS fraud detection

homepage | transction | identity | transaction structure | identity structure | isFraud | model result plot | model result table

Show 5 entries Search:

	X	TransactionID	id_01	id_02	id_03	id_04	id_05	id_06	id_07	id_08	id_09	id_10	id_
133	133	2987504	-5	78385			0	0					
316	316	2988204	-5	127122			0	0					
496	496	2989451	-10	19389	0	0	0	0			0	0	
202	202	2987683	-5	30602			0	-12			0	0	95.0800018310
182	182	2987620	0	9297	0	0	0	-9			0	0	

Showing 1 to 5 of 50 entries

Previous 1 2 3 4 5 ... 10 Next

Data Structure

http://127.0.0.1:4352 | Open in Browser

IEEE CIS fraud detection

homepage | transction | identity | transaction structure | identity structure | isFraud | model result plot | model result table

```
'data.frame':   500 obs. of  436 variables:
 $ X.1           : int  1 2 3 4 5 6 7 8 9 10 ...
 $ X             : int  1 2 3 4 5 6 7 8 9 10 ...
 $ TransactionID : int  2987000 2987001 2987002 2987003 2987004 2987005 2987006 2987007 2987008 2987009 .
 $ isFraud       : int  0 0 0 0 0 0 0 0 0 0 ...
 $ TransactionDT : int  86400 86401 86469 86499 86506 86510 86522 86529 86535 86536 ...
 $ TransactionAmt: num  68.5 29 59 50 50 ...
 $ ProductCD     : int  4 4 4 4 1 4 4 4 1 4 ...
 $ card1         : int  10095 1372 2833 13341 2712 3816 8827 9143 1412 12782 ...
 $ card2         : int  500 303 389 466 413 454 259 389 0 10 ...
 $ card3         : int  42 42 42 42 42 42 42 42 42 42 ...
 $ card4         : int  1 2 4 2 2 4 4 4 4 2 ...
 $ card5         : int  38 2 58 14 2 108 58 108 108 106 ...
 $ card6         : int  1 1 2 2 1 2 2 2 2 2 ...
 $ addr1         : int  166 173 178 282 241 132 17 173 183 78 ...
 $ addr2         : int  62 62 62 62 62 62 62 62 62 62 ...
 $ dist1         : int  19 8 287 8 8 36 0 8 8 19 ...
 $ dist2         : int  37 37 37 37 37 37 37 37 37 37 ...
 $ P_emaildomain : int  31 16 36 54 16 16 54 29 1 54 ...
 $ R_emaildomain : int  31 31 31 31 31 31 31 31 31 31 ...
 $ C1            : int  1 1 1 2 1 1 1 1 1 2 ...
 $ C2            : int  1 1 1 5 1 1 1 1 1 2 ...
 $ C3            : int  0 0 0 0 0 0 0 0 0 0 ...
 $ C4            : int  0 0 0 0 0 0 0 0 0 0 ...
 $ C5            : int  0 0 0 0 0 0 0 0 0 0 ...
 $ C6            : int  1 1 1 4 1 1 1 1 1 3 ...
 $ C7            : int  0 0 0 0 0 0 0 0 0 0 ...
 $ C8            : int  0 0 0 0 1 0 0 0 1 0 ...
 $ C9            : int  1 0 1 1 0 1 1 0 0 3 ...
 $ C10           : int  0 0 0 0 1 0 0 0 1 0 ...
 $ C11           : int  2 1 1 1 1 1 1 1 1 1 ...
 $ C12           : int  0 0 0 0 0 0 0 0 0 0 ...
 $ C13           : int  1 1 1 25 1 1 1 1 1 12 ...
 $ C14           : int  1 1 1 1 1 1 1 1 1 2 ...
 $ D1            : int  14 0 0 112 0 0 0 0 0 61 ...
 $ D2            : int  97 97 97 112 97 97 97 97 97 61 ...
 $ D3            : int  13 8 8 0 8 8 8 8 8 30 ...
```

Data Structure

http://127.0.0.1:4352 | Open in Browser

IEEE CIS fraud detection

homepage | transction | identity | transaction structure | identity structure | isFraud | model result plot | model result table

```
'data.frame':   500 obs. of  42 variables:
 $ X            : int  1 2 3 4 5 6 7 8 9 10 ...
 $ TransactionID: int  2987004 2987008 2987010 2987011 2987016 2987017 2987022 2987038 2987040 2987048 ...
 $ id_01        : int  0 -5 -5 -5 0 -5 -15 0 -10 -5 ...
 $ id_02        : int  70787 98945 191631 221832 7460 61141 NA 31964 116098 257037 ...
 $ id_03        : int  NA NA 0 NA 0 3 NA 0 0 NA ...
 $ id_04        : int  NA NA 0 NA 0 0 NA 0 0 NA ...
 $ id_05        : int  NA 0 0 0 1 3 NA 0 0 0 ...
 $ id_06        : int  NA -5 0 -6 0 0 NA -10 0 0 ...
 $ id_07        : int  NA NA NA NA NA NA NA NA NA NA ...
 $ id_08        : int  NA NA NA NA NA NA NA NA NA NA ...
 $ id_09        : int  NA NA 0 NA 0 3 NA 0 0 NA ...
 $ id_10        : int  NA NA 0 NA 0 0 NA 0 0 NA ...
 $ id_11        : num  100 100 100 100 100 100 NA 100 100 100 ...
 $ id_12        : chr  "NotFound" "NotFound" "NotFound" "NotFound" ...
 $ id_13        : int  NA 49 52 52 NA 52 14 NA 52 52 ...
 $ id_14        : int  -480 -300 NA NA -300 -300 NA -300 NA NA ...
 $ id_15        : chr  "New" "New" "Found" "New" ...
 $ id_16        : chr  "NotFound" "NotFound" "Found" "NotFound" ...
 $ id_17        : int  166 166 121 225 166 166 NA 166 121 225 ...
 $ id_18        : int  NA NA NA NA 15 18 NA 15 NA NA ...
 $ id_19        : int  542 621 410 176 529 529 NA 352 410 484 ...
 $ id_20        : int  144 500 142 507 575 600 NA 533 142 507 ...
 $ id_21        : int  NA NA NA NA NA NA NA NA NA NA ...
 $ id_22        : int  NA NA NA NA NA NA NA NA NA NA ...
 $ id_23        : chr  "" "" "" "" ...
 $ id_24        : int  NA NA NA NA NA NA NA NA NA NA ...
 $ id_25        : int  NA NA NA NA NA NA NA NA NA NA ...
 $ id_26        : int  NA NA NA NA NA NA NA NA NA NA ...
 $ id_27        : chr  "" "" "" "" ...
 $ id_28        : chr  "New" "New" "Found" "New" ...
 $ id_29        : chr  "NotFound" "NotFound" "Found" "NotFound" ...
 $ id_30        : chr  "Android 7.0" "iOS 11.1.2" "" "" ...
 $ id_31        : chr  "samsung browser 6.2" "mobile safari 11.0" "chrome 62.0" "chrome 62.0" ...
 $ id_32        : int  32 32 NA NA 24 24 NA 32 NA NA ...
 $ id_33        : chr  "2220x1080" "1334x750" "" "" ...
 $ id_34        : chr  "match_status:2" "match_status:1" "" "" ...
```

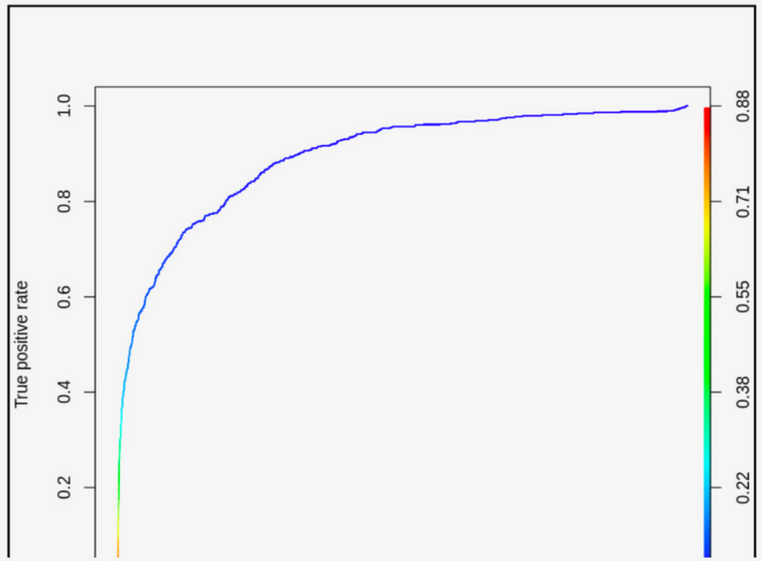
Model Result Plot

http://127.0.0.1:4352 | Open in Browser

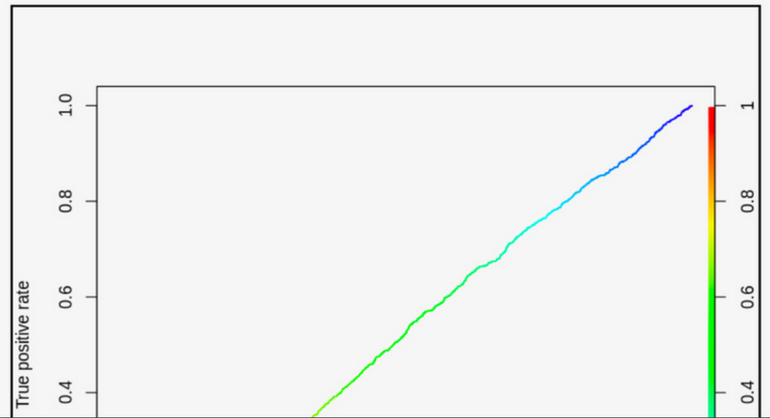
IEEE CIS fraud detection

homepage | transction | identity | transaction structure | identity structure | isFraud | model result plot | model result table

LGB
(1)AUC



Null
(1)AUC



Model Result Table

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model result table

Show 10 entries Search:

	model	accuracy	precision	sensitivity	speficity	recall	F1	kappa
1	KNN	0.9613	0	0	0.9615	0	0	-0.00059
2	Naviebayes	0.774	0.982	0.78	0.615	0.78	0.869	0.105
3	Null	0.9425	0.0314	0.234	0.998	0.235	0.36	0.3536
4	LGB	0.982	0.7716	0.033	0.969	0.0337	0.0325	0.0029

Showing 1 to 4 of 4 entries Previous 1 Next

Challenge

- huge datasets
- AUC score improved from 0.5 to 0.89

Reference

- https://www.kaggle.com/yoongkang/beginner-s-random-forest-example
- https://www.kaggle.com/yoongkang/beginner-memory-reduction-techniques
- https://www.kaggle.com/sunghun/ieee-fraud-detection-eda-step1#3.-transactionAmt
- https://www.kaggle.com/c/ieee-fraud-detection/discussion/101203