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ITMD 525 – DATA MINING FINAL PROJECT

Credit Card Transaction Categorization using Text Analytics

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1. INTRODUCTION

- Text Analytics a.k.a. Text Mining refers to the process of deriving high-quality information from text.
- Text Mining usually involves parsing of input text data to find out meaningful patterns and interpreting those patterns as a form of an output.
- Areas where text mining is implemented is Text Categorization, Sentiment Analysis, Text Clustering, Document Summarizing and many more.
- In this project, we have used text mining for Categorization of Credit Card Transactions.

2. OBJECTIVES & APPLICATIONS

- **Objectives**
  - Carry out text mining on transaction description to identify word patterns belonging to different categories
  - Using the text patterns, bucket the credit card transaction data in 38 different categories.
- **Applications**
  - A user would be able to view their spending in an understandable format.
  - A bank would be able to analyze the expenses in every category and come up with different credit card offers or cash back rewards system.

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3. SNAPSHOT OF THE DATASET

- Creditdata_Category

DESCRIPTION	LEDGER_ENTRY	PROPOSED_CATEGORY
DIVERSIFIED VENDING LLC WALLINGFORD CT	debit	Groceries
NATIONAL CAR TOLLS	debit	Travel
FORSBERG FINE WINE & S CHARLESTON SC XXXXX USA	debit	Groceries
Interest on Purchases	debit	Service Charges/Fees
OFFUTT NEW MAIN STORE	debit	Personal/Family

- Train Dataset
- Observations: 501,449.
- Categories assigned manually.

- CreditCard_Actual

DESCRIPTION	TRANSACTION_DATE	AMOUNT	TYPE	Category
STOP & SHOP #569 OYSTER BAY NY	7/29/2014	86.3	debit	
NTTA CUST SVC ONLINE PLANO TX	1/30/2014	34.43	debit	
NETFLIX.COM XXXXXXXXXX CA	2/12/2015	7.99	debit	
PRESIDENT OFFICE 00-08 BROOKLYN	11/10/2014	20	debit	
WHOLEFDS RMD XXXXX 0REDMOND XXXXXXXXXXX	1/2/2015	98.42	debit	

- Test Dataset
- Observations: 500,001.
- Using the train dataset, assign the categories.

4. CHALLENGES & APPROACH

- **Challenges**
  - Tackle parts of speech present in transaction description to identify patterns
  - Inconsistent data having spelling mistakes
  - We have "Other Expenses" as a category which contains transactions that do not fall under any of the major categories.
  - Identical terms falling under different categories

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4. CHALLENGES & APPROACH

- **Approach**
  - We extract only NOUNS from every transaction description and eliminate different parts of speech, locations, English stop words, zip codes and abbreviations.
  - Miscellaneous nouns present in the same transaction description of the training data set are associated with the category to form different rules.
  - The transaction description of the test dataset is parsed against these rules to predict the category of the transactions present in the test data.
  - To associate a transaction to a specific category, probability of the associated rule to each category is calculated and the category with the highest probability value is predicted as the associated transaction.

5. IMPLEMENTATION

- Text Mining module of SAS Enterprise Miner is used to create a transformation to achieve this objective.
- Different nodes of this module used in the system are:
  - File Import – Import the file (.xlsx/.sas7bdat)
  - Text Parsing – Extract nouns and eliminate other parts of speech
  - Text Filter – Weigh the terms using Mutual Information and TF.IDF
  - Text Rule Builder – Build rules to identify different text patterns
  - Score Node – Generates a score for transaction w.r.t. every category

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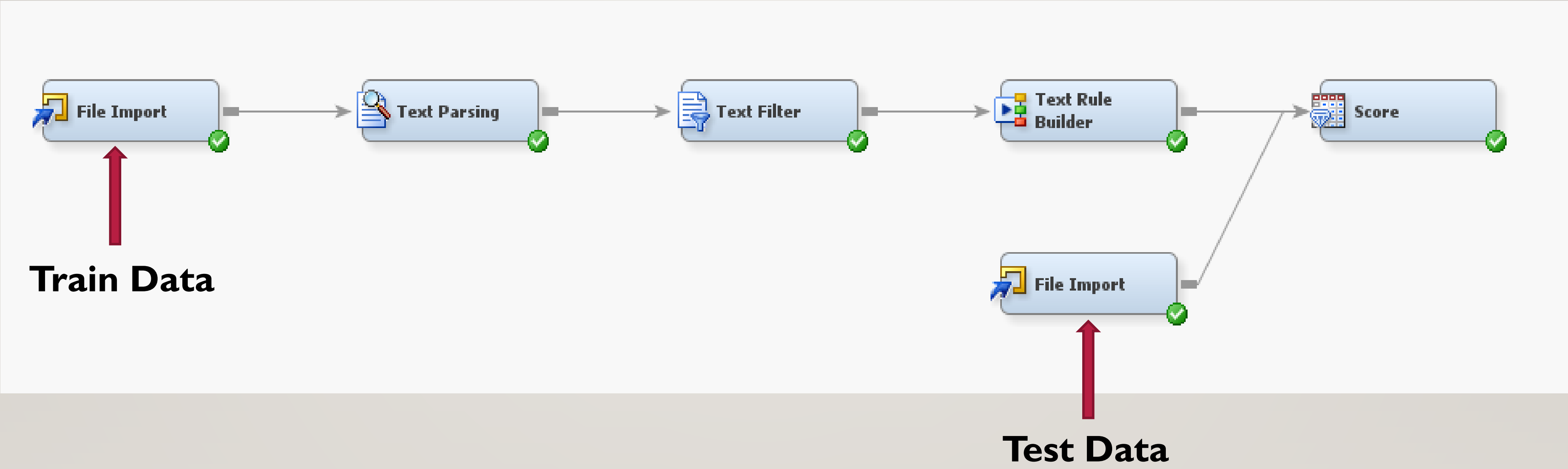
5. IMPLEMENTATION

- The transformation created using these components is below:



5. IMPLEMENTATION

- To achieve highest accuracy, we split the train data in 2 parts (80% train – 20% test).
- Eliminate all transactions that fall under "Other Expenses" category.
- Document Term Matrix is formed by assigning Mutual Information weights for each term associated with documents.

Terms

Term	Role	Attribute	Status	Weight	Imported Frequency	Freq	Number of Imported Documents	# Docs	Rank	Parent/Child Status	Parent ID
com	Noun	Alpha	Drop	0.000	25199	25199	21432	21432	1		35917
+ amazon	Noun	Alpha	Keep	0.738	11153	11153	11079	11079	2+		23026
+ store	Noun	Alpha	Keep	0.880	9578	9578	9276	9276	3+		7306
s	Noun	Alpha	Drop	0.000	9348	9348	9260	9260	4		35893
interest	Noun	Alpha	Keep	1.171	8283	8283	8081	8081	5		15688
wal-mart	Noun	Mixed	Keep	0.814	5501	5501	5501	5501	6		21622
+ bill	Noun	Alpha	Keep	0.861	5128	5128	5119	5119	7+		10900
oil	Noun	Alpha	Keep	1.083	4896	4896	4896	4896	8		11980
target	Noun	Alpha	Keep	0.814	4615	4615	4615	4615	9		18856
shell	Noun	Alpha	Keep	1.083	4408	4408	4407	4407	10		11891
+ cafe	Noun	Alpha	Keep	0.638	4341	4341	4335	4335	11+		26690
shell oil	Noun Group	Alpha	Keep	1.083	4218	4218	4218	4218	12		30549
+ fee	Noun	Alpha	Keep	1.587	4032	4032	3993	3993	13+		9239
+ restaurant	Noun	Alpha	Keep	0.644	3974	3974	3939	3939	14+		1879
+ apple	Noun	Alpha	Keep	1.095	3671	3671	3646	3646	15+		3456
depot	Noun	Alpha	Keep	1.429	3644	3644	3644	3644	16		30576
+ pharmacy	Noun	Alpha	Keep	1.404	3613	3613	3589	3589	17+		12668
+ market	Noun	Alpha	Keep	0.888	3274	3274	3269	3269	18+		10840
apple itunes store xxx...	Noun Group	Mixed	Keep	1.149	2670	2670	2670	2670	19		28500
amazon.com	Noun	Mixed	Keep	0.814	2663	2663	2663	2663	20		17270
+ payment	Noun	Alpha	Keep	1.214	2348	2348	2348	2348	21+		4730
+ food	Noun	Alpha	Keep	0.724	2320	2320	2316	2316	22+		23109
+ fuel	Noun	Alpha	Keep	0.888	2261	2261	2236	2236	23+		16001
+ pizza	Noun	Alpha	Keep	0.645	2221	2221	2219	2219	24+		29294
+ subway	Noun	Alpha	Keep	0.647	2193	2193	2192	2192	25+		1314
+ pa	Noun	Alpha	Keep	0.711	2184	2184	2183	2183	26+		18955
+ city	Noun	Alpha	Keep	0.602	2168	2168	2148	2148	27+		4857
+ service	Noun	Alpha	Keep	1.126	2132	2132	2005	2005	28+		21193
foreign tran chg	Noun Group	Alpha	Keep	1.171	2002	2002	2002	2002	29		5067
chevron	Noun	Alpha	Keep	1.083	1984	1984	1976	1976	30		1316
+ park	Noun	Alpha	Keep	0.685	2037	2037	1967	1967	31+		29010
+ shop	Noun	Alpha	Keep	1.146	1970	1970	1965	1965	32+		12033
+ trader	Noun	Alpha	Keep	0.922	1959	1959	1959	1959	33+		7781
joe	Noun	Alpha	Keep	0.917	1956	1956	1955	1955	34		21572
+ trader joe	Noun Group	Alpha	Keep	0.928	1932	1932	1932	1932	35+		8891
supercenter	Noun	Alpha	Keep	0.814	1915	1915	1915	1915	36		30058
+ charge	Noun	Alpha	Keep	1.169	2044	2044	1842	1842	37+		29353
+ ma	Noun	Alpha	Keep	1.000	1727	1727	1726	1726	38+		5807
fort	Noun	Alpha	Keep	0.747	1756	1756	1688	1688	39		7650
c	Noun	Alpha	Drop	0.000	1684	1684	1623	1623	40		35890
grill	Noun	Alpha	Keep	0.646	1602	1602	1601	1601	41		8006
+ burger	Noun	Alpha	Keep	0.647	1567	1567	1565	1565	42+		5024
+ hill	Noun	Alpha	Keep	1.152	1571	1571	1541	1541	43+		20074
+ taco	Noun	Alpha	Keep	0.647	1527	1527	1524	1524	44+		19126
+ lake	Noun	Alpha	Keep	0.438	1487	1487	1445	1445	45+		5478
membership	Noun	Alpha	Keep	2.076	1426	1426	1423	1423	46		10526
chipotle	Noun	Alpha	Keep	0.648	1422	1422	1422	1422	47		24579
+ king	Noun	Alpha	Keep	0.472	1365	1365	1361	1361	48+		20401
+ beach	Noun	Alpha	Keep	0.362	1317	1317	1285	1285	49+		8251
transaction	Noun	Alpha	Keep	1.162	1270	1270	1268	1268	50		22226
taxi	Noun	Alpha	Keep	1.210	1238	1238	1235	1235	51		21033
+ island	Noun	Alpha	Keep	0.957	1234	1234	1230	1230	52+		11100
+ la	Noun	Alpha	Keep	0.301	1202	1202	1178	1178	53+		22076
+ car	Noun	Alpha	Keep	0.879	1182	1182	1170	1170	54+		16596

5. IMPLEMENTATION

Rules Obtained

Target Value	Rule #	Rule	Precision	Recall	F1 score	True Positive/Total
POSTAGE/SHIPPING	1258	horseshoe	[illegible]	[illegible]	[illegible]	[illegible]
POSTAGE/SHIPPING	1259	new hyde parkny	80.38%	6.83%	12.58%	2/17
POSTAGE/SHIPPING	1260	north myrtle sc	79.72%	6.87%	12.64%	1/8
POSTAGE/SHIPPING	1261	new brunswicknj	78.34%	6.91%	12.70%	1/8
POSTAGE/SHIPPING	1262	hero	77.73%	6.95%	12.76%	1/8
POSTAGE/SHIPPING	1263	fond	76.79%	6.99%	12.81%	1/8
POSTAGE/SHIPPING	1264	satellite	74.68%	7.07%	12.92%	2/19
POSTAGE/SHIPPING	1265	office & ~depot	74.68%	7.07%	12.92%	52/408
RENT	1266	u-haul	100.0%	46.59%	63.56%	198/198
RENT	1267	extra space stora	100.0%	55.06%	71.02%	36/36
RENT	1268	rental & purchase	100.0%	60.71%	75.55%	24/24
RENT	1269	(800)528-0463	100.0%	63.29%	77.52%	11/11
RENT	1270	extra space stor	100.0%	65.65%	79.26%	10/10
RENT	1271	extra space storage	100.0%	67.06%	80.28%	6/6
RENT	1272	household	99.31%	67.53%	80.39%	2/4
RENT	1273	mini	99.31%	67.53%	80.39%	4/24

6. ANALYSIS

- Accuracy is determined using the following parameters:
  - Generalization Error – Determines the predicted probability for rules on untrained data

$$I[f_n] = \int_{X\times Y} V(f_n(x), y)\rho(x, y)dxdy,$$

$$I_S[f_n] = \frac{1}{n}\sum_{i=1}^{n} V(f_n(x_i), y_i)$$

$$G = I[f_n] - I_S[f_n]$$

  - Purity of rules – Higher values result in fewer, purer rules. Lower values cover more instances
  - Exhaustiveness – Controls the number of terms formed as a conjunction with the existing rule using AND (&) operator

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6. ANALYSIS

- **Configuration #1**

Generalization Error	Purity of Rules	Exhaustiveness
Medium	Medium	Low

Target	Target Label	Fit Statistics	Statistics Label	Train	Validation	Test
PROPOSED C...	PROPOSED C...	ASE	Average Squared Error	0.01338	.	.
PROPOSED C...	PROPOSED C...	DIV	Divisor for ASE	7657325	.	.
PROPOSED C...	PROPOSED C...	MAX	Maximum Absolute Error	0.964784	.	.
PROPOSED C...	PROPOSED C...	NOBS	Sum of Frequencies	306293	.	.
PROPOSED C...	PROPOSED C...	RASE	Root Average Squared Error	0.115674	.	.
PROPOSED C...	PROPOSED C...	SSE	Sum of Squared Errors	102458.2	.	.
PROPOSED C...	PROPOSED C...	DISF	Frequency of Classified Cases	306293	.	.
PROPOSED C...	PROPOSED C...	MISC	Misclassification Rate	0.374181	.	.
PROPOSED C...	PROPOSED C...	WRONG	Number of Wrong Classifications	114609	.	.

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6. ANALYSIS

- **Configuration #2**

Generalization Error	Purity of Rules	Exhaustiveness
Very Low	Low	Low

Target	Target Label	Fit Statistics	Statistics Label	Validation	Test	Train
PROPOSED CAT...	PROPOSED CAT...	ASE	Average Squared Error	.	.	0.013206
PROPOSED CAT...	PROPOSED CAT...	DIV	Divisor for ASE	.	.	7657325
PROPOSED CAT...	PROPOSED CAT...	MAX	Maximum Absolute Error	.	.	0.971622
PROPOSED CAT...	PROPOSED CAT...	NOBS	Sum of Frequencies	.	.	306293
PROPOSED CAT...	PROPOSED CAT...	RASE	Root Average Squared Error	.	.	0.114916
PROPOSED CAT...	PROPOSED CAT...	SSE	Sum of Squared Errors	.	.	101120.7
PROPOSED CAT...	PROPOSED CAT...	DISF	Frequency of Classified Cases	.	.	306293
PROPOSED CAT...	PROPOSED CAT...	MISC	Misclassification Rate	.	.	0.373858
PROPOSED CAT...	PROPOSED CAT...	WRONG	Number of Wrong Classifications	.	.	114510

6. ANALYSIS

- **Configuration #3**

Generalization Error	Purity of Rules	Exhaustiveness
Very Low	Medium	Low

Target	Target Label	Fit Statistics	Statistics Label	Train	Validation	Test
PROPOSED CA...	PROPOSED CA...	ASE	Average Squared ...	0.013284	.	.
PROPOSED CA...	PROPOSED CA...	DIV	Divisor for ASE	7657325	.	.
PROPOSED CA...	PROPOSED CA...	MAX	Maximum Absolut...	0.970906	.	.
PROPOSED CA...	PROPOSED CA...	NOBS	Sum of Frequencies	306293	.	.
PROPOSED CA...	PROPOSED CA...	RASE	Root Average Squ...	0.115257	.	.
PROPOSED CA...	PROPOSED CA...	SSE	Sum of Squared E...	101722	.	.
PROPOSED CA...	PROPOSED CA...	DISF	Frequency of Clas...	306293	.	.
PROPOSED CA...	PROPOSED CA...	MISC	Misclassification ...	0.37406	.	.
PROPOSED CA...	PROPOSED CA...	WRONG	Number of Wrong ...	114572	.	.

DEMO

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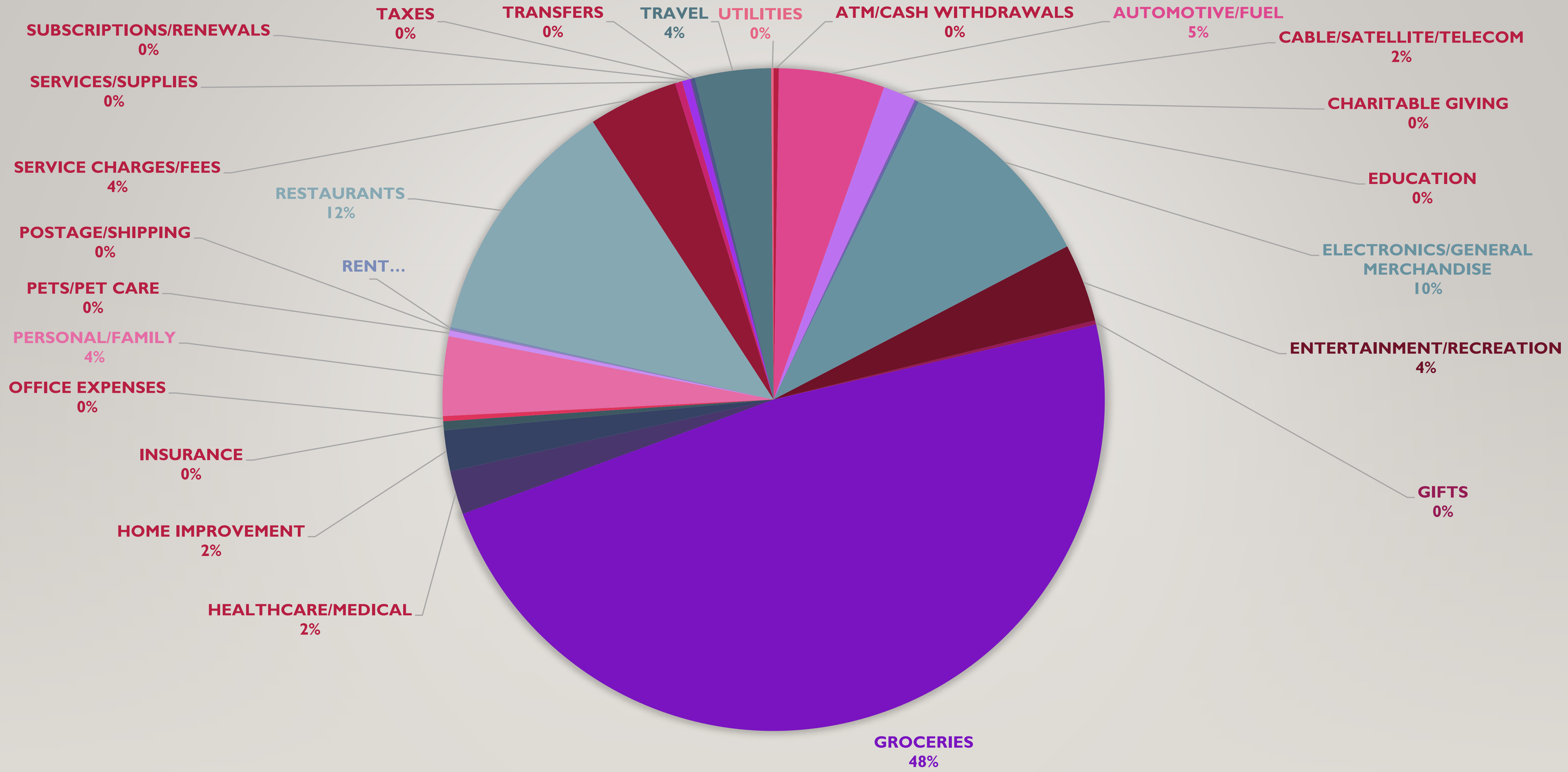
TAXES
0%
TRANSFERS
0%
TRAVEL
4%
UTILITIES
0%
ATM/CASH WITHDRAWALS
0%
AUTOMOTIVE/FUEL
5%
SUBSCRIPTIONS/RENEWALS
0%
CABLE/SATELLITE/TELECOM
2%
SERVICES/SUPPLIES
0%
CHARITABLE GIVING
0%
SERVICE CHARGES/FEES
4%
EDUCATION
0%
RESTAURANTS
12%
POSTAGE/SHIPPING
0%
ELECTRONICS/GENERAL MERCHANDISE
10%
RENT...
PETS/PET CARE
0%
PERSONAL/FAMILY
4%
ENTERTAINMENT/RECREATION
4%
OFFICE EXPENSES
0%
INSURANCE
0%
GIFTS
0%
HOME IMPROVEMENT
2%
HEALTHCARE/MEDICAL
2%
GROCERIES
48%

QUESTIONS

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