

Predict Telecom User Churn via Logit Model

Marketing Analytics | Group Project

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Our Team



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Data Overview

7043

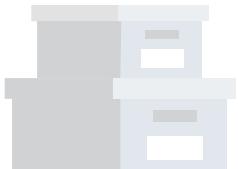
rows

(Customers)

21

columns

(Features)



What kind of data it includes?



Churn

Whether the customer churned or not



Services Signed

Phone, Multiple Lines, Internet, Online Security, Online Backup, Device Protection, Tech Support, Streaming



Account Info

Customer Tenure, Contract Term, Payment Method, Paperless Billing, Monthly Charges, Total Charges

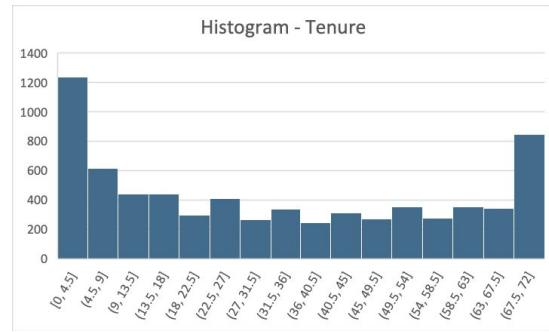
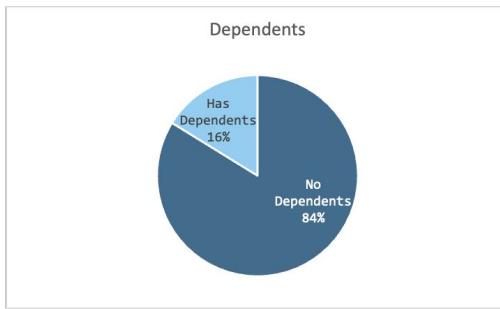
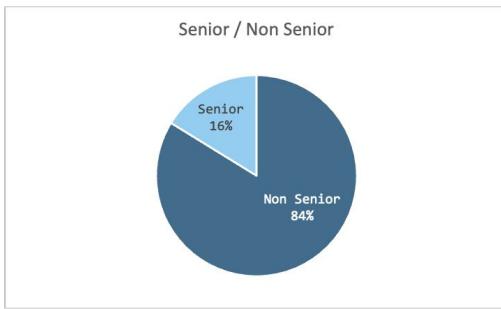
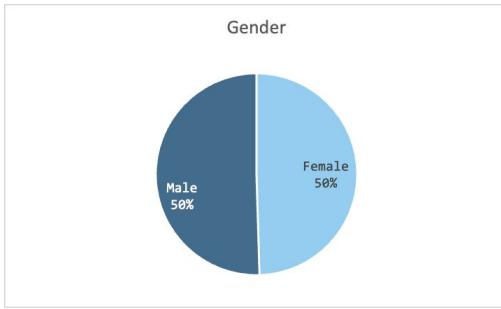


Demographics

Gender, Senior Citizen/Non-Senior Citizen, Partners and Dependents



Descriptive Analysis





Raw Data

WA_Fn-UseC_-Telco-Customer-Churn

customerID	gender	SeniorCitizen	Partner	Dependents	tenure	PhoneService	MultipleLines	InternetService	OnlineSecurity	OnlineBackup	DeviceProtection	TechSupport	StreamingTV	StreamingMovies	Contract	PaperlessBilling	PaymentMethod	MonthlyCharges	TotalCharges	Churn
7550-WHVEG	Female	0	Yes	No	1	No	No phone service	DSL	No	Yes	No	No	No	No	Month-to-month	Yes	Electronic check	29.85	29.85	No
5575-GNVED	Male	0	No	No	34	Yes	No	DSL	Yes	No	Yes	No	No	No	One year	No	Mailed check	56.95	1889.5	No
3668-QPYBK	Male	0	No	No	2	Yes	No	DSL	Yes	Yes	No	No	No	No	Month-to-month	Yes	Mailed check	53.85	108.15	Yes
7795-FOCW	Male	0	No	No	45	No	No phone service	DSL	Yes	No	Yes	Yes	No	No	One year	No	Bank transfer (automatic)	42.3	1840.75	No
9237-HQTU	Female	0	No	No	2	Yes	No	Fiber optic	No	No	No	No	No	No	Month-to-month	Yes	Electronic check	70.7	151.65	Yes
9305-CDSKC	Female	0	No	No	8	Yes	Yes	Fiber optic	No	No	Yes	No	Yes	No	Month-to-month	Yes	Electronic check	99.65	820.5	Yes
1452-KIOVK	Male	0	No	Yes	22	Yes	Yes	Fiber optic	No	Yes	No	No	Yes	No	Month-to-month	Yes	Credit card (automatic)	89.1	1949.4	No
6713-OKOMC	Female	0	No	No	10	No	No phone service	DSL	Yes	No	No	No	No	No	Month-to-month	No	Mailed check	29.75	301.9	No
7892-POOKP	Female	0	Yes	No	28	Yes	Yes	Fiber optic	No	No	Yes	Yes	Yes	No	Month-to-month	Yes	Electronic check	104.8	3046.05	Yes
6388-TABGU	Male	0	No	Yes	62	Yes	No	DSL	Yes	Yes	No	No	No	No	One year	No	Bank transfer (automatic)	56.15	3487.95	No
9763-GRSKD	Male	0	Yes	Yes	13	Yes	No	DSL	Yes	No	No	No	No	No	Month-to-month	Yes	Mailed check	49.95	587.45	No
7469-LKBCI	Male	0	No	No	16	Yes	No	No	No internet service	Two year	No	Credit card (automatic)	18.95	326.8	No					
8091-TTAX	Male	0	Yes	No	58	Yes	Yes	Fiber optic	No	No	Yes	No	Yes	Yes	One year	No	Credit card (automatic)	100.35	5681.1	No
0280-XJEX	Male	0	No	No	49	Yes	Yes	Fiber optic	No	Yes	Yes	No	Yes	Yes	Month-to-month	Yes	Bank transfer (automatic)	103.7	5036.3	Yes
5129-JLPIS	Male	0	No	No	25	Yes	No	Fiber optic	Yes	No	Yes	Yes	Yes	Yes	Month-to-month	Yes	Electronic check	105.5	2686.05	No
3655-SNOYZ	Female	0	Yes	Yes	69	Yes	Yes	Fiber optic	Yes	Yes	Yes	Yes	Yes	Yes	Two year	No	Credit card (automatic)	113.25	7895.15	No
8191-XWSZG	Female	0	No	No	52	Yes	No	No	No internet service	One year	No	Mailed check	20.65	1022.95	No					
9950-WOFKT	Male	0	No	Yes	71	Yes	Yes	Fiber optic	Yes	No	Yes	No	Yes	Yes	Two year	No	Bank transfer (automatic)	106.7	7382.25	No
4190-MFLUW	Female	0	Yes	Yes	10	Yes	No	DSL	No	No	Yes	No	No	No	Month-to-month	No	Credit card (automatic)	55.2	528.35	Yes
4183-MYFRB	Female	0	No	No	21	Yes	No	Fiber optic	No	Yes	Yes	No	No	Yes	Month-to-month	Yes	Electronic check	90.05	1862.9	No
8779-QRDVM	Male	1	No	No	1	No	No phone service	DSL	No	No	No	No	Yes	No	Month-to-month	Yes	Electronic check	39.65	39.65	Yes
1680-VDCWW	Male	0	Yes	No	12	Yes	No	No	No internet service	One year	No	Bank transfer (automatic)	19.8	202.25	No					
1066-JKSGK	Male	0	No	No	1	Yes	No	No	No internet service	Month-to-month	No	Mailed check	20.15	20.15	Yes					
3638-WEABW	Female	0	Yes	No	58	Yes	Yes	DSL	No	Yes	No	Yes	No	No	Two year	Yes	Credit card (automatic)	59.9	3505.1	No
6322-HRPF	Female	0	Yes	Yes	49	Yes	No	DSL	Yes	Yes	No	Yes	No	No	Month-to-month	No	Credit card (automatic)	59.6	2970.3	No
6865-JZNKO	Female	0	No	No	30	Yes	No	DSL	Yes	Yes	No	No	No	No	Month-to-month	Yes	Bank transfer (automatic)	55.3	1530.6	No
6467-CHFZW	Male	0	Yes	Yes	47	Yes	Yes	Fiber optic	No	Yes	No	No	Yes	Yes	Month-to-month	Yes	Electronic check	99.35	4749.15	Yes
8665-UTDHZ	Male	0	Yes	Yes	1	No	No phone service	DSL	No	Yes	No	No	No	No	Month-to-month	No	Electronic check	30.2	30.2	Yes
5246-YQJUN	Male	0	Yes	No	72	Yes	Yes	DSL	Yes	Yes	Yes	Yes	Yes	Yes	Two year	Yes	Credit card (automatic)	90.25	6369.45	No
8773-HHNUOZ	Female	0	No	Yes	17	Yes	No	DSL	No	No	No	Yes	Yes	Yes	Month-to-month	Yes	Mailed check	64.7	1093.1	Yes
3841-NFECX	Female	1	Yes	No	71	Yes	Yes	Fiber optic	Yes	Yes	Yes	Yes	No	No	Two year	Yes	Credit card (automatic)	96.35	6766.95	No
4929-JXHWV	Male	1	Yes	No	2	Yes	No	Fiber optic	No	No	Yes	No	Yes	Yes	Month-to-month	Yes	Credit card (automatic)	95.5	181.65	No
6827-TEAUQ	Female	0	Yes	Yes	27	Yes	No	DSL	Yes	Yes	Yes	Yes	No	No	One year	No	Mailed check	66.15	1874.45	No
7310-EQHZ	Male	0	No	No	1	Yes	No	No	No internet service	Month-to-month	No	Bank transfer (automatic)	20.2	20.2	No					
3413-EMMZE	Male	1	No	No	1	Yes	No	DSL	No	No	No	No	No	No	Month-to-month	No	Bank transfer (automatic)	45.25	45.25	No
6234-RAAPL	Female	0	Yes	Yes	72	Yes	Yes	Fiber optic	Yes	Yes	No	Yes	Yes	No	Two year	No	Bank transfer (automatic)	99.9	7251.7	No
6047-YHPVI	Male	0	No	No	5	Yes	No	Fiber optic	No	No	No	No	No	No	Month-to-month	Yes	Electronic check	69.7	316.9	Yes
6572-ADKRS	Female	0	No	No	46	Yes	No	Fiber optic	No	No	Yes	No	No	No	Month-to-month	Yes	Credit card (automatic)	74.8	3548.3	No
5380-WJKOV	Male	0	No	No	34	Yes	Yes	Fiber optic	No	Yes	Yes	No	Yes	Yes	Month-to-month	Yes	Electronic check	106.35	3549.25	Yes

Cleaned Data

customerID	Gender	Married	SeniorCitizen	Partner	yes	Dependents	tenure	Phone service	Multiple Lines	Single Line	Internet_Yes	DSL	Internet_Fiberoptic	OnlineSecurity	OnlineBackup	DeviceProtection	TechSupport	StreamingTV	StreamingMovies	Contract_1 yr	Contract_2 yr	PaperlessBilling	PaymentMethod_Mail	PaymentMethod_Bill	PaymentMethod_ElectronicBill	MonthlyChurn	TotalChurn	Churn
3640-PHOKK	0	0	0	0	0	31	1	0	0	1	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	89.9	2805.90	1
2267-WTFYD	0	0	1	0	0	57	1	1	0	0	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	94	5436.95	0
1664-JBPZT	1	0	0	0	0	27	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	49	1291.35	0
0927-CNGRH	1	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	19.55	0
1169-SAOCU	1	0	0	0	0	49	1	1	0	0	1	0	1	1	1	1	1	1	1	0	1	0	0	1	0	106.65	5168.10	0
7402-PVWUJ	0	0	0	1	0	53	1	1	0	0	1	0	0	0	0	0	1	1	1	0	1	1	0	0	91.15	4862.50	0	
1173-XZPWF	0	0	0	0	0	11	1	1	0	0	1	0	0	0	1	0	1	1	0	0	0	1	1	0	0	89.2	990.30	0
5849-ASHZJ	1	0	0	0	1	27	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	20.05	552.90	0
5327-XOKKY	1	1	1	0	0	72	1	1	0	1	0	0	0	1	0	1	1	1	0	1	1	0	0	0	0	73.45	5329.00	0
7665-NKLAV	0	0	1	1	0	36	0	0	0	1	0	1	0	1	1	0	0	0	1	0	0	0	0	0	0	40.65	1547.35	0
1449-XCEMT	1	0	0	0	0	3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	19.8	58.15	1
1384-RCXUW	1	0	0	0	0	16	1	1	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	80.55	1248.90	0
9173-IVZPV	0	0	1	1	0	53	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	20.9	1146.05	0
6815-ABFQF	1	0	0	1	0	56	1	1	0	0	1	0	1	0	1	1	1	1	1	0	1	1	0	0	0	107.25	6033.30	0
9658-WVUFB	0	0	0	0	0	17	1	1	0	0	1	1	1	0	0	0	1	0	0	0	1	1	0	0	94.4	1617.50	1	
8347-GDTMP	0	0	1	0	0	64	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	19.45	1225.65	0	
1355-KUSBG	0	0	1	1	0	7	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	48.8	349.80	0	
0619-OUYUR	1	0	1	0	0	72	1	1	0	1	0	1	1	1	1	1	1	1	0	1	1	0	0	0	111.9	8071.05	0	
4508-OEBEY	1	0	1	0	0	31	1	0	1	1	0	1	1	1	1	1	1	1	1	0	1	0	0	0	75.5	2424.45	0	
4010-YLMVT	0	0	0	0	0	56	1	1	0	0	1	1	1	0	0	1	1	1	0	0	1	0	0	0	106.6	5893.95	0	
4418-LZMSV	1	0	1	1	0	13	1	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0	1	61.8	750.10	0		
1029-QFBEN	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	19.55	1		
9933-QRGTK	0	0	1	0	0	60	1	0	1	0	1	1	0	0	1	1	1	1	0	1	1	0	0	0	97.2	5611.75	0	
3898-GUVTG	0	1	0	0	0	45	1	1	0	0	1	1	1	1	0	1	0	0	0	0	1	0	0	0	97.05	4385.05	0	
7640-GRWVZ	0	0	0	0	0	1	1	0	1	0	1	0	1	1	0	1	1	1	0	1	1	0	0	0	69.2	670.00	1	
0800-DHJBD	0	0	0	0	0	52	1	1	0	1	0	1	1	1	1	1	1	1	0	1	0	0	0	0	0	370.65	0	0
6576-KRMHW	1	0	0	0	0	33	1	0	1	1	0	1	1	1	1	1	0	1	0	1	0	0	0	0	93.4	393.30	0	
5716-EZKZN	0	0	1	1	0	65	1	1	0	0	1	1	1	1	0	1	1	1	0	1	1	0	0	0	99.05	6416.70	0	
2348-KCJLT	0	0	0	1	0	44	1	0	1	1	0	1	1	1	1	0	0	1	1	0	1	1	0	0	61.5	2722.20	0	
5184-EJEGL	1	0	0	0	0	9	1	0	1	1	0	1	1	1	1	1	0	0	1	1	0	1	0	0	69.5	653.25	0	
4550-EVNNY	0	0	0	1	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	69.65	69.65	1	
5438-QMDQL	0	1	0	0	19	1	0	1	1	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	59.8	1130.85	0	
1497-NVNGY	1	1	0	0	19	1	0	1	1	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	66.4	1286.05	0	
0107-YHINA	1	0	0	1	0	3	1	1	0	0	1	0	1	1	1	1	1	1	0	1	1	0	0	0	99.75	99.75	1	
2111-DWVHN	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	21.1	21.10	0	
5268-DSMNC	0	1	1	0	62	1	1	0	0	1	0	1	1	1	0	1	0	1	0	1	0	0	0	0	97.95	5936.55	0	
2446-ZKVAF	1	0	1	0	18	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	56.8	1074.65	0	
5906-DVAPM	0	0	1	1	55	1	1	0	1	0	1	1	1	0	1	1	1	1	0	1	0	0	0	0	75	4213.90	0	
3340-QBFM	1	1	1	0	36	1	0	1	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	54.1	1992.85	0	
7198-GLXTC	1	0	0	0	2	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	79	143.65	1	
5919-TMRGD	0	0	0	1	1	0	1	0	1	0	1	0	0	0	1	0	0	0	1	0	1	0	0	0	79.35	79.35	1	
3892-NXAZG	1	0	1	1	72	1	1	0	0	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	114.05	8289.20	0	
5902-WBLSE	0	0	1	1	70	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	20.15	1411.20	0	
1945-XISKS	0	0	1	0	67	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	19.65	1335.20	0	
3786-WWVRF	0	1	1	0	72	1	1	0	0	1	1	1	0	0	1	1	1	1	0	1	0	0	0	0	106.85	7677.40	0	
2710-WVYVG	0	0	0	0	3	1	0	1	1	0	1	1	1	0	1	0	1	0	1	0	1	0	0	0	71.1	213.35	0	
0365-BZUWY	1	0	0	1	17	1	1	0	0	1	0	1	1	0	1	1	1	0	0	1	1	0	0	0	102.55	1742.50	0	
8203-XJRC	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	20.25	20.25	0	
5304-EFLP	1	1	0	0	72	1	1	0	0	1	0	1	1	1	1	1	1	1	1	0	1	0	0	0	111.65	8022.85	0	
9367-WKLCH	1	0	0	0	8	1	1	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	84.5	662.65	1	
5088-QJRLC	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	20.65	20.65	0	
16862-QMGBDM	1	0	0	0	37	1	0	1	0	1	0	1	0	0	0	1	1	1	0	0	1	0	0	0	96.3	3646.0	0	
5385-SURI	1	1	1	0	52	1	1	0	0	1	1	0	1	1	0	1	1	1	0	0	1	1	0	0	104.2	5568.35	1	
3647-QMGDH	1	0	0	1	22	1	0	1	0	1	0	0	0	1	1	1	1	1	0	0	1	1	0	0	94.7	1914.90	1	
0380-ZCSBI	1	0	0	0	10	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	198.70	0	
8042-JVNHF	1	0	0	0	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	71.35	71.35	1	

Target metric



Churn

Whether the customer churned or not



Services Signed

Phone, Multiple Lines, Internet, Online Security, Online Backup, Device Protection, Tech Support, Streaming



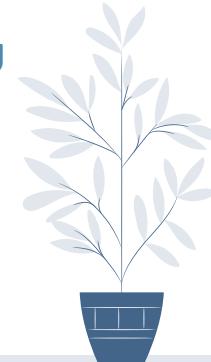
Account Info

Customer Tenure, Contract Term, Payment Method, Paperless Billing, Monthly Charges, Total Charges



Demographics

Gender, Senior Citizen/Non-Senior Citizen, Partners and Dependents



Analysis Strategy



Goal

To predict who is going to quit our service & raise segmentation suggestion

Independent Variables

Features: demographics, account info, services signed

Model

Logistic Regression

Dependent Variable

Churned or Not (binary)

Splitting the dataset

1

Assign each observation with a random number



2

Pick out observations with 70% biggest random numbers as the training set



3

Set the remaining 30% observations as hold-out set



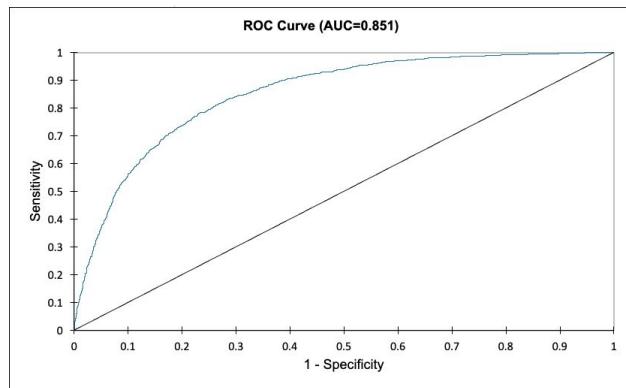
- Training set: 70% (4930 rows)
- Testing set: 30% (2113 rows)

MonthlyCharg	TotalCharges	Churn	Random Number
115.65	5125.50	0	0.999913987
95.9	827.45	0	0.999877173
98.05	3082.10	0	0.99981132
89.2	346.20	1	0.999687913
68.9	1370.35	0	0.999679216
19.5	159.35	0	0.999416451
75	632.95	1	0.999350877
51.35	262.30	0	0.999215345
114.85	8317.95	0	0.99920602
20.15	165.50	0	0.99915399
20.55	1252.00	0	0.998787094
78.65	1663.75	0	0.998786518
104.95	7544.30	0	0.998589771
45.05	523.10	0	0.99851857
19.95	1322.85	0	0.998478723
56.15	1439.35	0	0.998444162
67.4	3306.85	0	0.997745128
45.15	45.15	0	0.997676246
112.95	6465.00	1	0.997647795
90.05	4137.20	0	0.997557975
69.8	134.70	1	0.997536087
91.8	5960.50	0	0.997349931
102.4	6444.05	0	0.997040892
19.95	170.90	0	0.996899637
112.25	8041.65	0	0.996744316
109.1	4454.25	0	0.996733807
44.6	641.25	0	0.996710147

Analysis Results

Model parameters (Variable Churn):

Source	Value	Standard error	Wald Chi-Square	Pr > Chi ²	Wald Lower bound	Wald Upper bound	Odds ratio	Odds ratio Lower	Odds ratio Upper
Intercept	-0.856	0.255	11.241	0.001	-1.357	-0.356			
Gender(Male = 1)	0.004	0.078	0.002	0.961	-0.149	0.157	1.004	0.861	1.170
SeniorCitizen	0.227	0.102	4.974	0.026	0.028	0.427	1.255	1.028	1.532
Partner(yes = 1)	-0.030	0.095	0.100	0.752	-0.216	0.156	0.971	0.806	1.169
Dependents(yes = 1)	-0.171	0.109	2.451	0.117	-0.385	0.043	0.843	0.681	1.044
tenure	-0.062	0.008	66.309	<0.0001	-0.077	-0.047	0.940	0.926	0.954
Phone service(Yes = 1)	-2.369	0.781	9.194	0.002	-3.900	-0.838	0.094	0.020	0.433
Multiple Line	3.600	0.213	285.835	<0.0001	3.183	4.018	36.613	24.120	55.579
Single Line	3.046	0.000							
Internet-DSL	2.328	0.971	5.742	0.017	0.424	4.231	10.253	1.528	68.819
Internet-Fiber optic	4.572	1.920	5.669	0.017	0.808	8.336	96.725	2.244	4169.318
OnlineSecurity	-0.187	0.217	0.744	0.388	-0.612	0.238	0.829	0.542	1.269
OnlineBackup	0.126	0.211	0.359	0.549	-0.287	0.539	1.135	0.751	1.715
DeviceProtection	0.198	0.212	0.870	0.351	-0.218	0.614	1.219	0.804	1.848
TechSupport	-0.055	0.217	0.063	0.801	-0.481	0.371	0.947	0.618	1.450
StreamingTV	0.664	0.393	2.850	0.091	-0.107	1.434	1.942	0.899	4.197
StreamingMovies	0.824	0.393	4.407	0.036	0.055	1.594	2.280	1.056	4.921
Contract-1 year	-0.569	0.131	18.837	<0.0001	-0.826	-0.312	0.566	0.438	0.732
Contract-2 years	-1.199	0.209	33.016	<0.0001	-1.608	-0.790	0.301	0.200	0.454
PaperlessBilling	0.319	0.090	12.647	0.000	0.143	0.495	1.376	1.154	1.641
PaymentMethod-E check	0.306	0.118	6.718	0.010	0.075	0.537	1.358	1.077	1.712
PaymentMethod-mail check	-0.052	0.141	0.135	0.714	-0.327	0.224	0.950	0.721	1.251
PaymentMethod-auto bank	0.029	0.137	0.044	0.834	-0.240	0.297	1.029	0.787	1.346
MonthlyCharges	-0.058	0.038	2.302	0.129	-0.133	0.017	0.944	0.875	1.017
TotalCharges	0.000	0.000	14.111	0.000	0.000	0.000	1.000	1.000	1.000



ROC Curve

Robustness Check

Apply the coefficient to predict if individuals in testing set are going to churn or not

Threshold: 0.5

Observation	Churn	threshold		0.50 Count:	308		156		1373		276		
		Pr(0)	Pr(1)		Pred	TP	FP	TN	FN	TP	FP	TN	FN
PredObs1	1	0.412	0.588	1	1	0	0	0	0	0	0	0	0
PredObs2	0	0.721	0.279	0	0	0	0	1	0	0	0	0	0
PredObs3	0	0.810	0.190	0	0	0	0	0	1	0	0	0	0
PredObs4	0	0.830	0.170	0	0	0	0	0	1	0	0	0	0
PredObs5	0	0.782	0.218	0	0	0	0	0	1	0	0	0	0
PredObs6	0	0.781	0.219	0	0	0	0	0	1	0	0	0	0
PredObs7	0	0.290	0.710	1	0	0	1	0	0	0	0	0	0
PredObs8	0	0.973	0.027	0	0	0	0	0	1	0	0	0	0
PredObs9	0	0.965	0.035	0	0	0	0	0	1	0	0	0	0
PredObs10	0	0.983	0.017	0	0	0	0	0	1	0	0	0	0
PredObs11	1	0.773	0.227	0	0	0	0	0	0	0	1	0	0
PredObs12	0	0.480	0.520	1	0	0	1	0	0	0	0	0	0
PredObs13	0	0.997	0.003	0	0	0	0	0	1	0	0	0	0
PredObs14	0	0.772	0.228	0	0	0	0	0	1	0	0	0	0
PredObs15	1	0.459	0.541	1	1	0	0	0	0	0	0	0	0
PredObs16	0	0.998	0.002	0	0	0	0	1	0	0	0	0	0
PredObs17	0	0.586	0.414	0	0	0	0	0	1	0	0	0	0
PredObs18	0	0.947	0.053	0	0	0	0	0	1	0	0	0	0
PredObs19	0	0.940	0.060	0	0	0	0	0	1	0	0	0	0
PredObs20	0	0.745	0.255	0	0	0	0	0	1	0	0	0	0
PredObs21	0	0.870	0.130	0	0	0	0	0	1	0	0	0	0
PredObs22	1	0.805	0.195	0	0	0	0	0	0	1	0	0	0
PredObs23	0	0.926	0.074	0	0	0	0	0	1	0	0	0	0
PredObs24	0	0.660	0.340	0	0	0	0	0	1	0	0	0	0
PredObs25	1	0.276	0.724	1	1	0	0	0	0	0	0	0	0
PredObs26	0	0.971	0.029	0	0	0	0	1	0	0	0	0	0

		Prediction	
		1	0
Actual	1	308	276
	0	156	1373

Accuracy: 79.56%

$$\frac{TP + TN}{TP + FP + TN + FN}$$

Precision: 66.38%

$$\frac{TP}{TP + FP}$$

Recall: 52.74%

$$\frac{TP}{TP + FN}$$

F1 Measure: 58.78%

$$\frac{2 \times Precision \times Recall}{Precision + Recall}$$

Step further — Segmentation?

Model parameters (Variable Churn):

Source	Value	Standard error	Wald Chi-Square	Pr > Chi ²	W:
Intercept	-0.856	0.255	11.241	0.001	
Gender(Male = 1)	0.004	0.078	0.002	0.961	
SeniorCitizen	0.227	0.102	4.974	0.026	
Partner(yes = 1)	-0.030	0.095	0.100	0.752	
Dependents(yes = 1)	-0.171	0.109	2.451	0.117	
tenure	-0.062	0.008	66.309	<0.0001	
Phone service(Yes = 1)	-2.369	0.781	9.194	0.002	
Multiple Line	3.600	0.213	285.835	<0.0001	
Single Line	3.046	0.000			
Internet-DSL	2.328	0.971	5.742	0.017	
Internet-Fiber optic	4.572	1.920	5.669	0.017	
OnlineSecurity	-0.187	0.217	0.744	0.388	
OnlineBackup	0.126	0.211	0.359	0.549	
DeviceProtection	0.198	0.212	0.870	0.351	
TechSupport	-0.055	0.217	0.063	0.801	
StreamingTV	0.664	0.393	2.850	0.091	
StreamingMovies	0.824	0.393	4.407	0.036	
Contract-1 year	-0.569	0.131	18.837	<0.0001	
Contract-2 years	-1.199	0.209	33.016	<0.0001	
PaperlessBilling	0.319	0.090	12.647	0.000	
PaymentMethod-E check	0.306	0.118	6.718	0.010	
PaymentMethod-mail check	-0.052	0.141	0.135	0.714	
PaymentMethod-auto bank	0.029	0.137	0.044	0.834	
MonthlyCharges	-0.058	0.038	2.302	0.129	
TotalCharges	0.000	0.000	14.111	0.000	



K-Means Clustering...

with dummy variables?

Simple subset with important variables...

not identifiable, or accessible, or stable

Step further — Segmentation!

Model parameters (Variable Churn):

Source	Value	Standard error	Wald Chi-Square	Pr > Chi ²	Wald Lower bound	Wald Upper bound	Odds ratio	Odds ratio Lower	Odds ratio Upper
Intercept	-0.856	0.255	11.241	0.001	-1.357	-0.356			
Gender(Male = 1)	0.004	0.078	0.002	0.961	-0.149	0.157	1.004	0.861	1.170
SeniorCitizen	0.227	0.102	4.974	0.026	0.028	0.427	1.255	1.028	1.532
Partner(yes = 1)	-0.030	0.095	0.100	0.752	-0.216	0.156	0.971	0.806	1.169
Dependents(yes = 1)	-0.171	0.109	2.451	0.117	-0.385	0.043	0.843	0.681	1.044
tenure	-0.062	0.008	66.309	<0.0001	-0.077	-0.047	0.940	0.926	0.954
Phone service(Yes = 1)	-2.369	0.781	9.194	0.002	-3.900	-0.838	0.094	0.020	0.433
Multiple Line	3.600	0.213	285.835	<0.0001	3.183	4.018	36.613	24.120	55.579
Single Line	3.046	0.000							
Internet-DSL	2.328	0.971	5.742	0.017	0.424	4.231	10.253	1.528	68.819
Internet-Fiber optic	4.572	1.920	5.669	0.017	0.808	8.336	96.725	2.244	4169.318
OnlineSecurity	-0.187	0.217	0.744	0.388	-0.612	0.238	0.829	0.542	1.269
OnlineBackup	0.126	0.211	0.359	0.549	-0.287	0.539	1.135	0.751	1.715
DeviceProtection	0.198	0.212	0.870	0.351	-0.218	0.614	1.219	0.804	1.848
TechSupport	-0.055	0.217	0.063	0.801	-0.481	0.371	0.947	0.618	1.450
StreamingTV	0.664	0.393	2.850	0.091	-0.107	1.434	1.942	0.899	4.197
StreamingMovies	0.824	0.393	4.407	0.036	0.055	1.594	2.280	1.056	4.921
Contract-1 year	-0.569	0.131	18.837	<0.0001	-0.826	-0.312	0.566	0.438	0.732
Contract-2 years	-1.199	0.209	33.016	<0.0001	-1.608	-0.790	0.301	0.200	0.454
PaperlessBilling	0.319	0.090	12.647	0.000	0.143	0.495	1.376	1.154	1.641
PaymentMethod-E check	0.306	0.118	6.718	0.010	0.075	0.537	1.358	1.077	1.712
PaymentMethod-mail check	-0.052	0.141	0.135	0.714	-0.327	0.224	0.950	0.721	1.251
PaymentMethod-auto bank	0.029	0.137	0.044	0.834	-0.240	0.297	1.029	0.787	1.346
MonthlyCharges	-0.058	0.038	2.302	0.129	-0.133	0.017	0.944	0.875	1.017
TotalCharges	0.000	0.000	14.111	0.000	0.000	0.000	1.000	1.000	1.000

Easy-to-detect factors / Demographic features



SeniorCitizen is the only significant demographic feature



Subset the population into Senior & Non Senior

Senior Segment

Negative Coefficients

- Phone service
- Tech Support
- Contract - 1 year

Positive Coefficients

- Payment Method - Echeck
- Paperless Billing

Importance in Descending order

Model parameters (Variable Churn):									
Source	Value	Standard error	Wald Chi-Square	Pr > Chi ²	Wald Lower bound	Wald Upper bound	Odds ratio	Odds ratio Lower	Odds ratio Upper
Intercept	0.631	1.434	0.194	0.660	-2.180	3.441			
Gender(Male = 1)	-0.172	0.286	0.363	0.547	-0.733	0.389	0.842	0.480	1.475
Partner(yes = 1)	0.052	0.298	0.031	0.861	-0.532	0.636	1.054	0.587	1.890
Dependents(yes = 1)	-0.599	0.527	1.291	0.256	-1.633	0.434	0.549	0.195	1.544
tenure	-0.029	0.027	1.148	0.284	-0.081	0.024	0.972	0.922	1.024
Phone service(Yes = 1)	-5.943	2.728	4.745	0.029	-11.291	-0.596	0.003	0.000	0.551
Multiple Line	-0.970	0.740	1.717	0.190	-2.420	0.481	0.379	0.089	1.617
Single Line	0.000	0.000							
Internet-DSL	-5.850	3.490	2.810	0.094	-12.690	0.990	0.003	0.000	2.690
Internet-Fiber optic	-9.382	6.560	2.045	0.153	-22.239	3.475	0.000	0.000	32.303
OnlineSecurity	-0.931	0.724	1.652	0.199	-2.350	0.488	0.394	0.095	1.630
OnlineBackup	-1.134	0.722	2.467	0.116	-2.550	0.281	0.322	0.078	1.325
DeviceProtection	-0.756	0.708	1.140	0.286	-2.143	0.631	0.470	0.117	1.880
TechSupport	-1.813	0.750	5.841	0.016	-3.283	-0.343	0.163	0.038	0.710
StreamingTV	-2.085	1.379	2.286	0.131	-4.788	0.618	0.124	0.008	1.855
StreamingMovies	-1.437	1.338	1.153	0.283	-4.060	1.186	0.238	0.017	3.274
Contract-1 year	-1.511	0.546	7.660	0.006	-2.580	-0.441	0.221	0.076	0.644
Contract-2 years	-1.657	0.862	3.697	0.055	-3.346	0.032	0.191	0.035	1.033
PaperlessBilling	0.956	0.357	7.180	0.007	0.257	1.656	2.602	1.293	5.236
PaymentMethod-E chec	0.994	0.408	5.937	0.015	0.195	1.794	2.703	1.215	6.016
PaymentMethod-mail c	0.734	0.600	1.498	0.221	-0.442	1.911	2.084	0.643	6.757
PaymentMethod-auto b	0.511	0.522	0.959	0.328	-0.512	1.535	1.667	0.599	4.640
MonthlyCharges	0.201	0.130	2.418	0.120	-0.052	0.455	1.223	0.949	1.577
TotalCharges	0.000	0.000	0.000	0.983	-0.001	0.001	1.000	0.999	1.001

Non Senior Segment

Negative Coefficients

- Contract - 2 year
- Contract - 1 year
- Tenure

Positive Coefficients

- Payment Method - Echeck
- Paperless Billing

Importance in Descending order

Model parameters (Variable Churn):									
Source	Value	Standard error	Wald Chi-Square	Pr > Chi ²	Wald Lower bound	Wald Upper bound	Odds ratio	Odds ratio Lower	Odds ratio Upper
Intercept	-0.407	0.401	1.034	0.309	-1.192	0.378			
Gender(Male = 1)	-0.080	0.131	0.376	0.540	-0.337	0.177	0.923	0.714	1.193
Partner(yes = 1)	0.065	0.158	0.167	0.683	-0.246	0.375	1.067	0.782	1.456
Dependents(yes = 1)	-0.051	0.171	0.090	0.764	-0.387	0.284	0.950	0.679	1.329
tenure	-0.070	0.013	29.863	<0.0001	-0.095	-0.045	0.932	0.909	0.956
Phone service(Yes = 1)	0.421	1.340	0.099	0.753	-2.206	3.048	1.523	0.110	21.073
Multiple Line	0.104	0.366	0.081	0.775	-0.614	0.822	1.110	0.541	2.276
Single Line	-0.348	0.000							
Internet-DSL	1.777	1.666	1.137	0.286	-1.489	5.043	5.912	0.226	154.906
Internet-Fiber optic	3.470	3.291	1.112	0.292	-2.981	9.921	32.135	0.051	20347.699
OnlineSecurity	-0.104	0.362	0.082	0.775	-0.814	0.606	0.902	0.443	1.834
OnlineBackup	-0.034	0.363	0.009	0.925	-0.746	0.678	0.966	0.474	1.970
DeviceProtection	0.246	0.365	0.453	0.501	-0.470	0.962	1.279	0.625	2.617
TechSupport	-0.161	0.373	0.187	0.665	-0.893	0.570	0.851	0.410	1.768
StreamingTV	0.926	0.667	1.927	0.165	-0.381	2.233	2.524	0.683	9.330
StreamingMovies	0.450	0.680	0.437	0.508	-0.883	1.782	1.568	0.414	5.940
Contract-1 year	-0.744	0.207	12.869	0.000	-1.150	-0.337	0.475	0.317	0.714
Contract-2 years	-1.852	0.368	25.378	<0.0001	-2.572	-1.131	0.157	0.076	0.323
PaperlessBilling	0.293	0.148	3.922	0.048	0.003	0.584	1.341	1.003	1.792
PaymentMethod-E check	0.539	0.194	7.710	0.005	0.158	0.919	1.714	1.172	2.507
PaymentMethod-mail ch	0.145	0.228	0.408	0.523	-0.301	0.592	1.157	0.740	1.807
PaymentMethod-auto ba	0.192	0.231	0.690	0.406	-0.261	0.645	1.212	0.770	1.906
MonthlyCharges	-0.046	0.066	0.487	0.485	-0.174	0.083	0.955	0.840	1.086
TotalCharges	0.000	0.000	11.428	0.001	0.000	0.001	1.000	1.000	1.001

As professional marketing analysts...

	Senior	Non Senior
Insights	<ul style="list-style-type: none"><input type="checkbox"/> Have phone service & tech support less likely to churn<input type="checkbox"/> Have month-to-month contract most likely to churn<input type="checkbox"/> Paperless billing & pay with echeck more likely to churn	<ul style="list-style-type: none"><input type="checkbox"/> Have 2 year contract most unlikely to churn<input type="checkbox"/> Stay longer less likely to churn<input type="checkbox"/> Paperless billing & pay with echeck more likely to churn
Suggestions	<ul style="list-style-type: none"><input type="checkbox"/> Emphasize tech support service & encourage sign-ups<input type="checkbox"/> Pay more attention to senior users with monthly contract<input type="checkbox"/> Increase electronic payment service representatives	<ul style="list-style-type: none"><input type="checkbox"/> Promotion focus on advantages of long-term contract & troublesome of contract changes; take action when detecting plan shifts<input type="checkbox"/> Electronic payment service

Appendix



Dataset Source:

<https://www.kaggle.com/datasets/blastchar/telco-customer-churn>

a failed K-means cluster analysis

Cluster centroids:

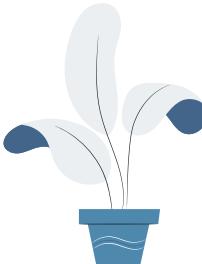
Cluster	tenure	MonthlyCharges	Sum of weights	Within-cluster variance	
1	10.519	32.524	1736.000	273.299	— Low Tenure Low Charges
2	14.865	80.950	2200.000	274.283	— Low Tenure High Charges
3	54.210	33.894	1150.000	388.102	— High Tenure Low Charges
4	58.603	93.299	1957.000	322.909	— High Tenure High Charges

Within each cluster, most of the coefficients (tenure & month charges) are not significant, showing they probably are not good measure.



Thank You!

Q & A



Happy Early Thanksgiving <3

us in msm finals

