



# Customer Churn Analytics using Microsoft R Open

Malaysia R User Group Meet Up  
16<sup>th</sup> February 2017  
Poo Kuan Hoong



<https://github.com/kuanhoong/churn-r>

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# Agenda

- Introduction
- Customer Churn Analytics
- Machine Learning Framework
- Microsoft R Open and Visual Studio
- Model Performance Comparison
- Demo

# Malaysia R User Group (MyRUG)

- The Malaysia R User Group (MyRUG) was formed on June 2016.
- It is a diverse group that come together to discuss anything related to the R programming language.
- The main aim of MyRUG is to provide members ranging from beginners to R professionals and experts to share and learn about R programming and gain competency as well as share new ideas or knowledge.

# Malaysia R User Group - (myRUG)

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Kuala Lumpur,  
Malaysia

Founded Jun 5, 2016

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The R User Group Malaysia is a diverse group that come together to discuss anything related to the R programming language.



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# Malaysia R User Group

MyRUG





# Introduction

- **Customer churn** can be defined simply as the rate at which a company is losing its customers
- Imagine the business as a bucket with holes, the water flowing from the top is the growth rate, while the holes at the bottom is **churn**
- While a certain level of churn is unavoidable, it is important to keep it under control, as high churn rate can potentially kill your business









## Data Scientists Quick Apply

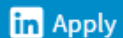
PositiveLinks Asia

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### Job description

We are looking for data science and analytics candidates with the following experience:


- Experts in Python, SQL and R.
- Experienced in working with large data sets with the aim of developing predictive models.
- Have carried statistical modeling, analytics modeling, customer segmentation and profiling, social network analysis and customer insights.
- Have contributed to the marketing campaign strategically and tactically through the use of various models (descriptive, predictive, optimisation).
- Knowledge of Hadoop and Spark would be beneficial.



## Data Scientist Quick Apply

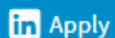
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### Job description

#### Responsibilities

- Designs experiments, test hypotheses, and build models.
- Build, maintain, and improve on multiple real-time decision systems.
- Leads discovery processes with stakeholders to identify the business requirements and the expected outcomes.
- Works with and alongside business analysts by suggesting other products of interest to the client.
- Models and frames business scenarios that are meaningful and which impact on critical business processes and/or decisions.
- Identifies what data is available and relevant, including internal and external data sources, leveraging new data collection processes such as smart meters and geo-location information or social media.
- Collaborates with subject matter experts to select the relevant sources of information.
- Makes strategic recommendations on data collection, integration and retention requirements incorporating business requirements and knowledge of best practices.

digi

Data Scientist, BIRS  
Digi Telecommunications Sdn Bhd

### Job Description

#### JOB SUMMARY

This individual will be the expert modeler in the data science and modeling team and have deep knowledge of machine learning, data mining and statistical analyses.

#### KEY RESPONSIBILITIES

- Hands on building models utilizing the various analytical techniques.
- Engage regularly with the campaign mgt team to come up with new and innovative campaigns.
- Develop predictive models (e.g. Churn Prediction model, Next Best offer model, Market Basket analysis) to leverage existing information assets for optimal Marketing activity.
- Develop descriptive models (e.g. behavioural segmentation, lifetime value model, social network analysis) to enhance customer insights.
- Develop optimization models (e.g. network optimization, campaign optimization) to enhance return on investment.
- Capitalize opportunities for revenue enhancement through targeted campaigns by development of:
  - Behavioral analytics, measurement and modelling
  - Customer and Audience segmentation, clustering and profiling
  - Geo/demographic attribution and segmentation

# Churn analytics

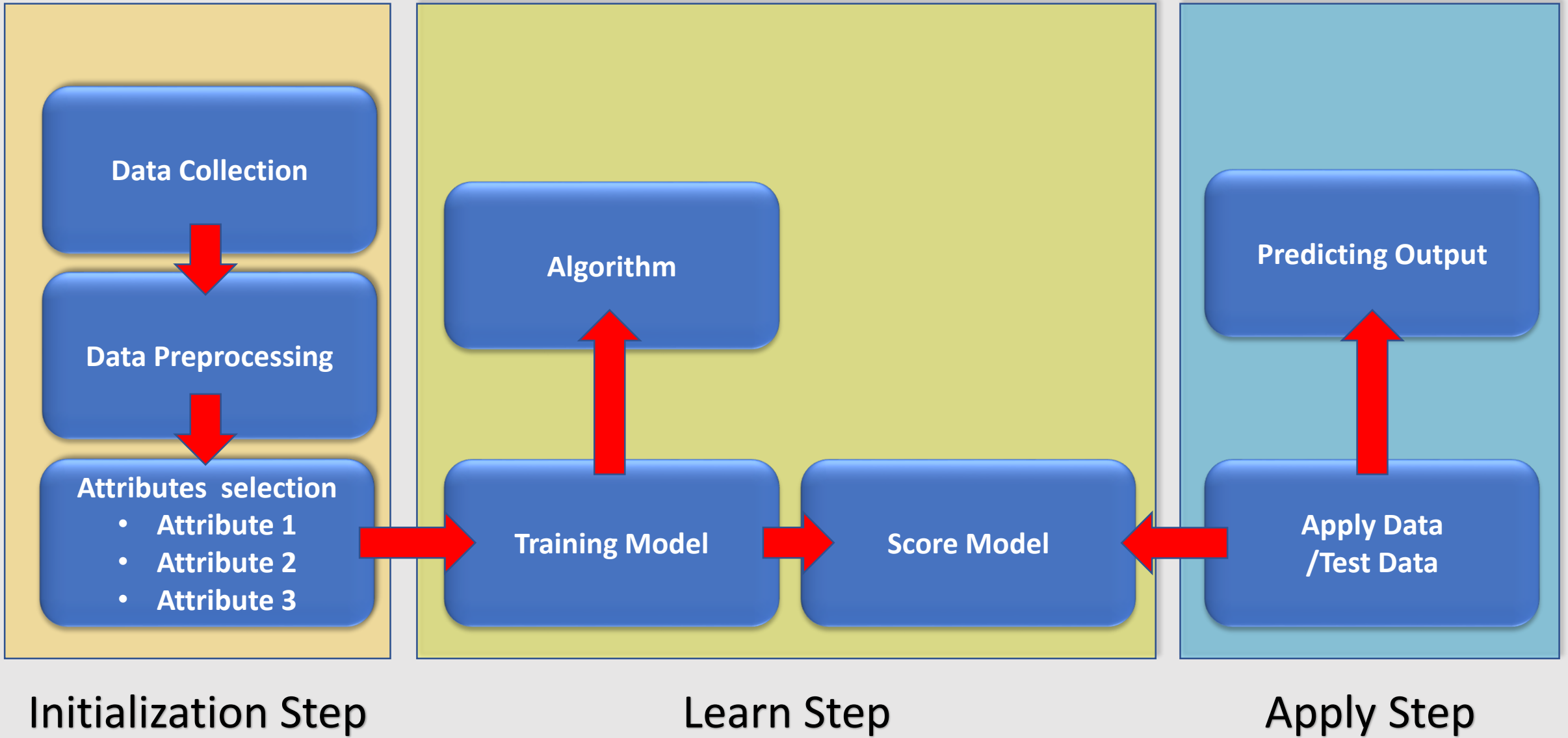
- Predicting who will switch mobile operator

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	customerI	gender	SeniorCiti	Partner	Dependen	tenure	PhoneServ	MultipleLi	InternetSe	OnlineSec	OnlineBac	DevicePro	TechSupp	Streaming	Streaming	Contract	Paperless	PaymentM	MonthlyCl	TotalChar	Churn
2	7590-VHV	Female	0	Yes	No	1	No	No phone	DSL	No	Yes	No	No	No	No	Month-to	Yes	Electronic	29.85	29.85	No
3	5575-GNV	Male	0	No	No	34	Yes	No	DSL	Yes	No	Yes	No	No	No	One year	No	Mailed ch	56.95	1889.5	No
4	3668-QPY	Male	0	No	No	2	Yes	No	DSL	Yes	Yes	No	No	No	No	Month-to	Yes	Mailed ch	53.85	108.15	Yes
5	7795-CFO	Male	0	No	No	45	No	No phone	DSL	Yes	No	Yes	Yes	No	No	One year	No	Bank trans	42.3	1840.75	No
6	9237-HQI	Female	0	No	No	2	Yes	No	Fiber opti	No	No	No	No	No	No	Month-to	Yes	Electronic	70.7	151.65	Yes
7	9305-CDSI	Female	0	No	No	8	Yes	Yes	Fiber opti	No	No	Yes	No	Yes	Yes	Month-to	Yes	Electronic	99.65	820.5	Yes
8	1452-KIOV	Male	0	No	Yes	22	Yes	Yes	Fiber opti	No	Yes	No	No	Yes	No	Month-to	Yes	Credit car	89.1	1949.4	No
9	6713-OKC	Female	0	No	No	10	No	No phone	DSL	Yes	No	No	No	No	No	Month-to	No	Mailed ch	29.75	301.9	No
10	7892-POC	Female	0	Yes	No	28	Yes	Yes	Fiber opti	No	No	Yes	Yes	Yes	Yes	Month-to	Yes	Electronic	104.8	3046.05	Yes
11	6388-TAB	Male	0	No	Yes	62	Yes	No	DSL	Yes	Yes	No	No	No	No	One year	No	Bank trans	56.15	3487.95	No
12	9763-GRSI	Male	0	Yes	Yes	13	Yes	No	DSL	Yes	No	No	No	No	No	Month-to	Yes	Mailed ch	49.95	587.45	No
13	7469-LKBC	Male	0	No	No	16	Yes	No	No	No interne	No interne	No interne	No interne	No interne	No interne	Two year	No	Credit car	18.95	326.8	No
14	8091-TTV	Male	0	Yes	No	58	Yes	Yes	Fiber opti	No	No	Yes	No	Yes	Yes	One year	No	Credit car	100.35	5681.1	No
15	0280-XJGE	Male	0	No	No	49	Yes	Yes	Fiber opti	No	Yes	Yes	No	Yes	Yes	Month-to	Yes	Bank trans	103.7	5036.3	Yes
16	5129-JLPI	Male	0	No	No	25	Yes	No	Fiber opti	Yes	No	Yes	Yes	Yes	Yes	Month-to	Yes	Electronic	105.5	2686.05	No
17	3655-SNQ	Female	0	Yes	Yes	69	Yes	Yes	Fiber opti	Yes	Yes	Yes	Yes	Yes	Yes	Two year	No	Credit car	113.25	7895.15	No
18	8191-XWS	Female	0	No	No	52	Yes	No	No	No interne	No interne	No interne	No interne	No interne	No interne	One year	No	Mailed ch	20.65	1022.95	No
19	9959-WOI	Male	0	No	Yes	71	Yes	Yes	Fiber opti	Yes	No	Yes	No	Yes	Yes	Two year	No	Bank trans	106.7	7382.25	No
20	4190-MFL	Female	0	Yes	Yes	10	Yes	No	DSL	No	No	Yes	Yes	No	No	Month-to	No	Credit car	55.2	528.35	Yes

# Customer churn - who do customers change operators?

- The top 3 reasons why subscribers change providers:
  - They want a new handset
  - They believe they pay too much for calls/data
  - Providers do not offer additional loyalty benefits

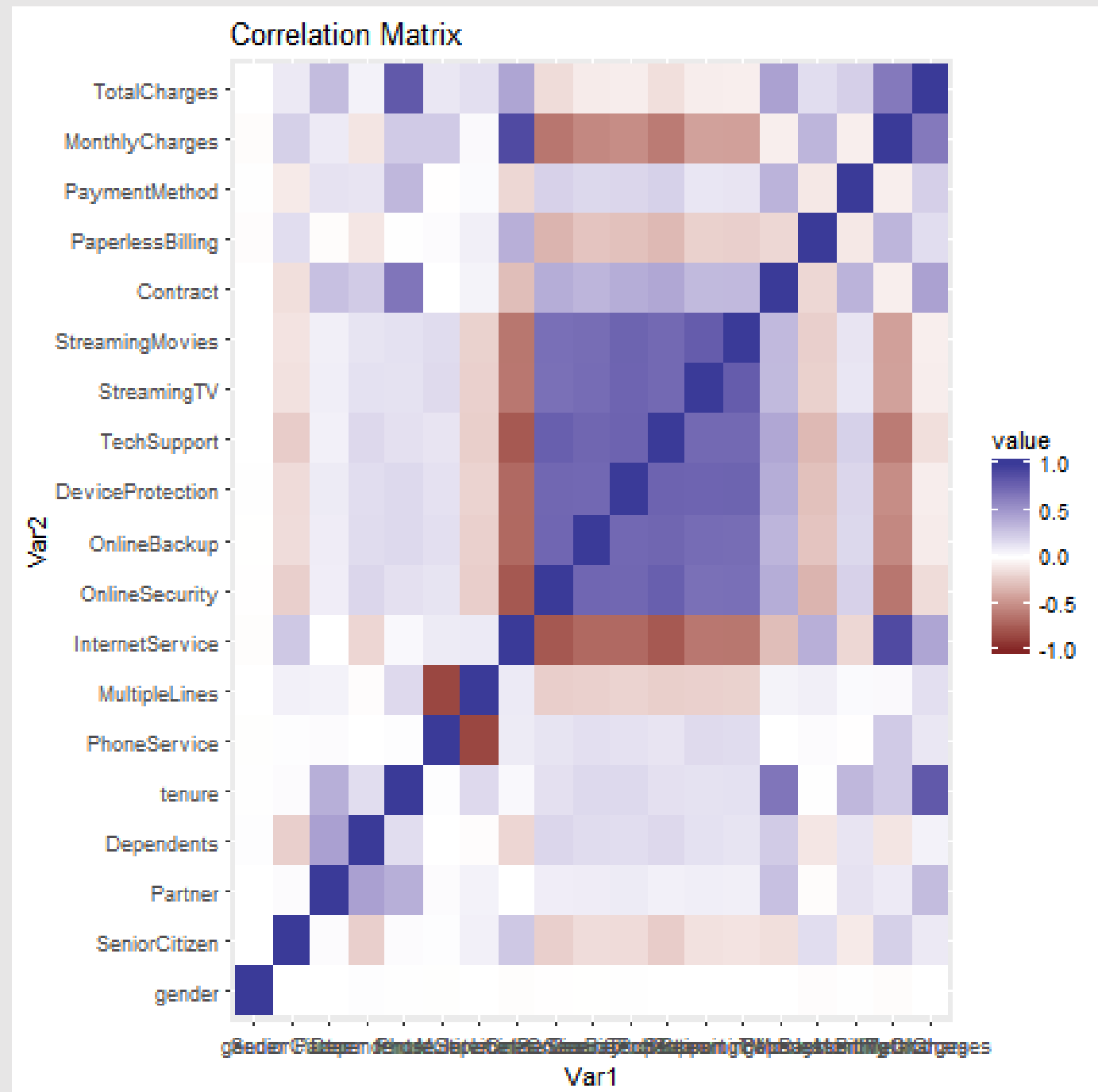




# Machine Learning Framework

# Correlation Matrix

- **correlation matrix**, which is used to investigate the dependence between multiple variables at the same time.



# Microsoft R Open

- [Microsoft R Open](#), formerly known as Revolution R Open (RRO), is the enhanced distribution of R from Microsoft Corporation.
- It is a complete open source platform for statistical analysis and data science.

## Key enhancement

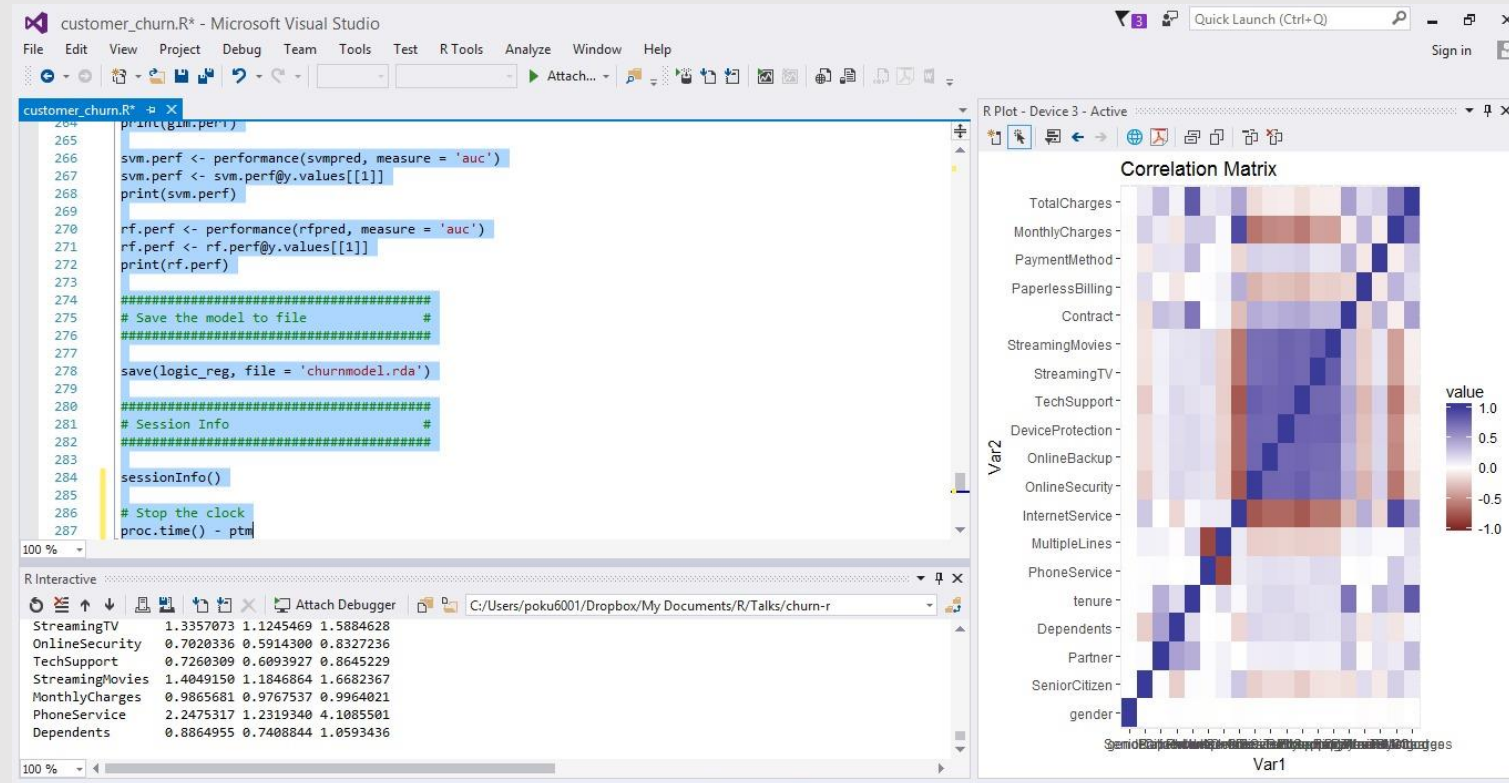
- Multi-threaded math libraries that brings multi-threaded computations to R.
- A high-performance default CRAN repository that provide a consistent and static set of packages to all Microsoft R Open users.
- The checkpoint package that make it easy to share R code and replicate results using specific R package versions.





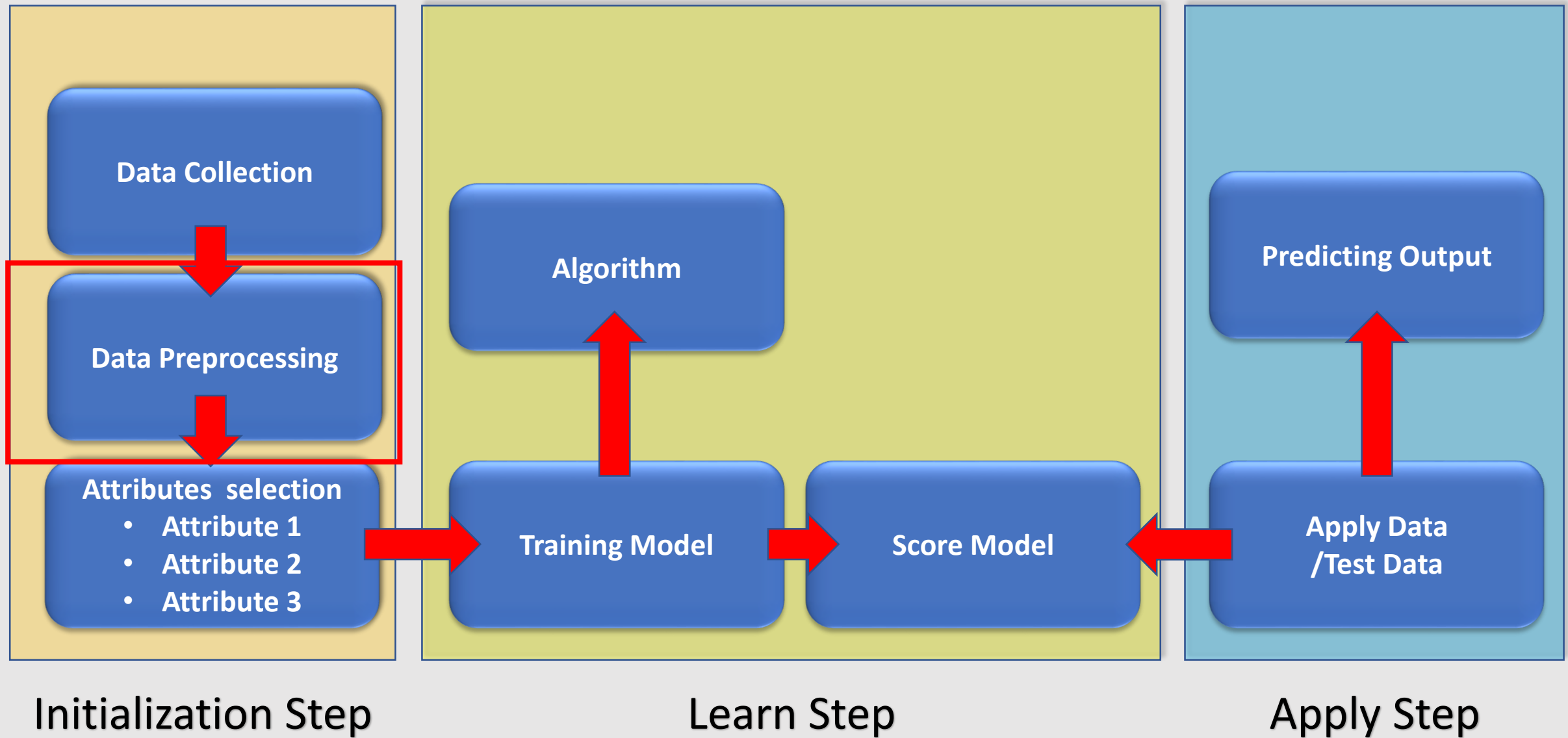
# R Tools for Visual Studio

- Turn Visual Studio into a powerful R development environment
- [Download R Tools for Visual Studio](#)



# R Tools for Visual Studio

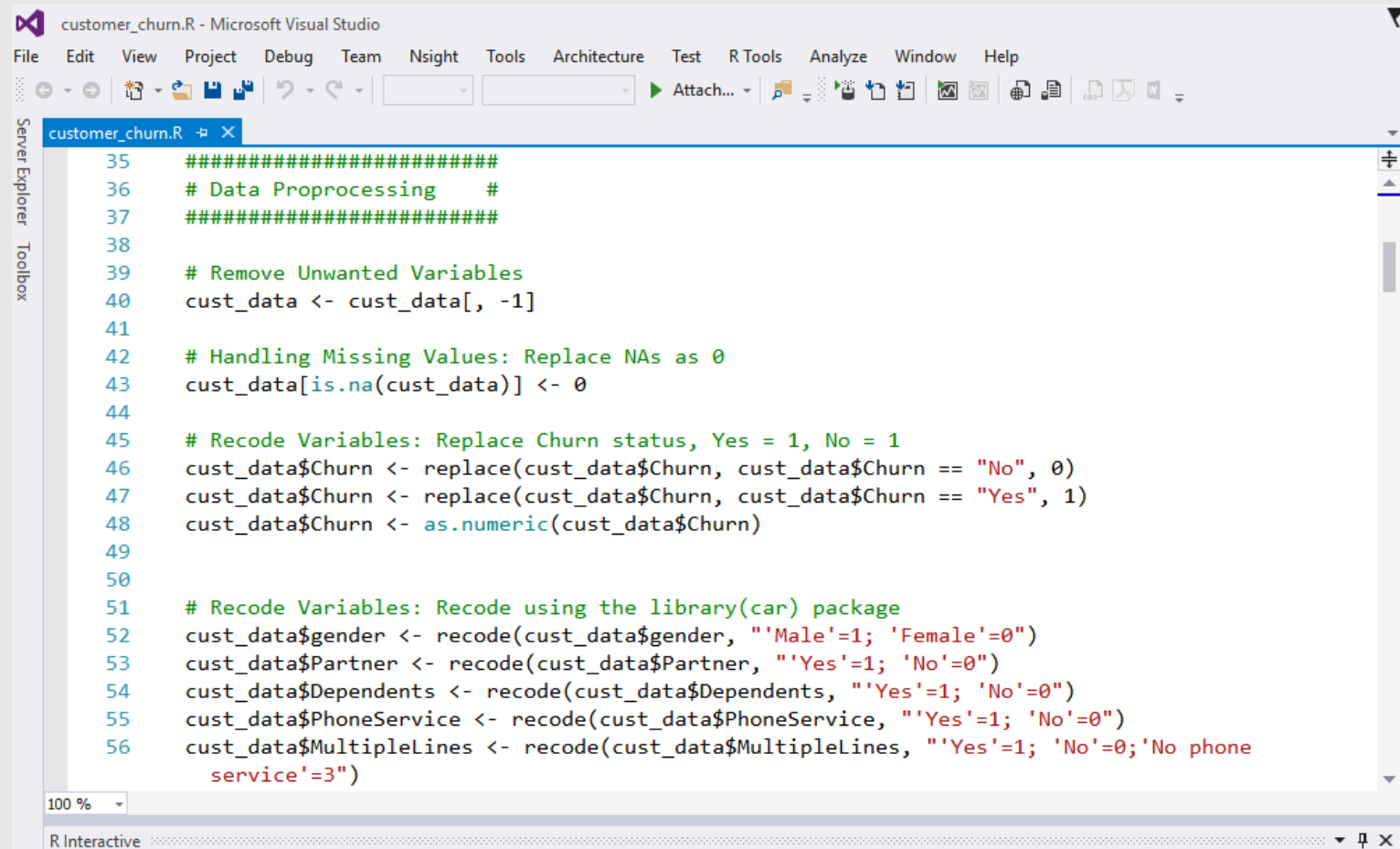
- Visual Studio IDE
- Intellisense
- Enhanced multi-threaded math libs, cluster scale computing, and a high performance CRAN repo with checkpoint capabilities.
- Learn more about R Tools from here:  
<https://microsoft.github.io/RTVS-docs/>



# Machine Learning Framework

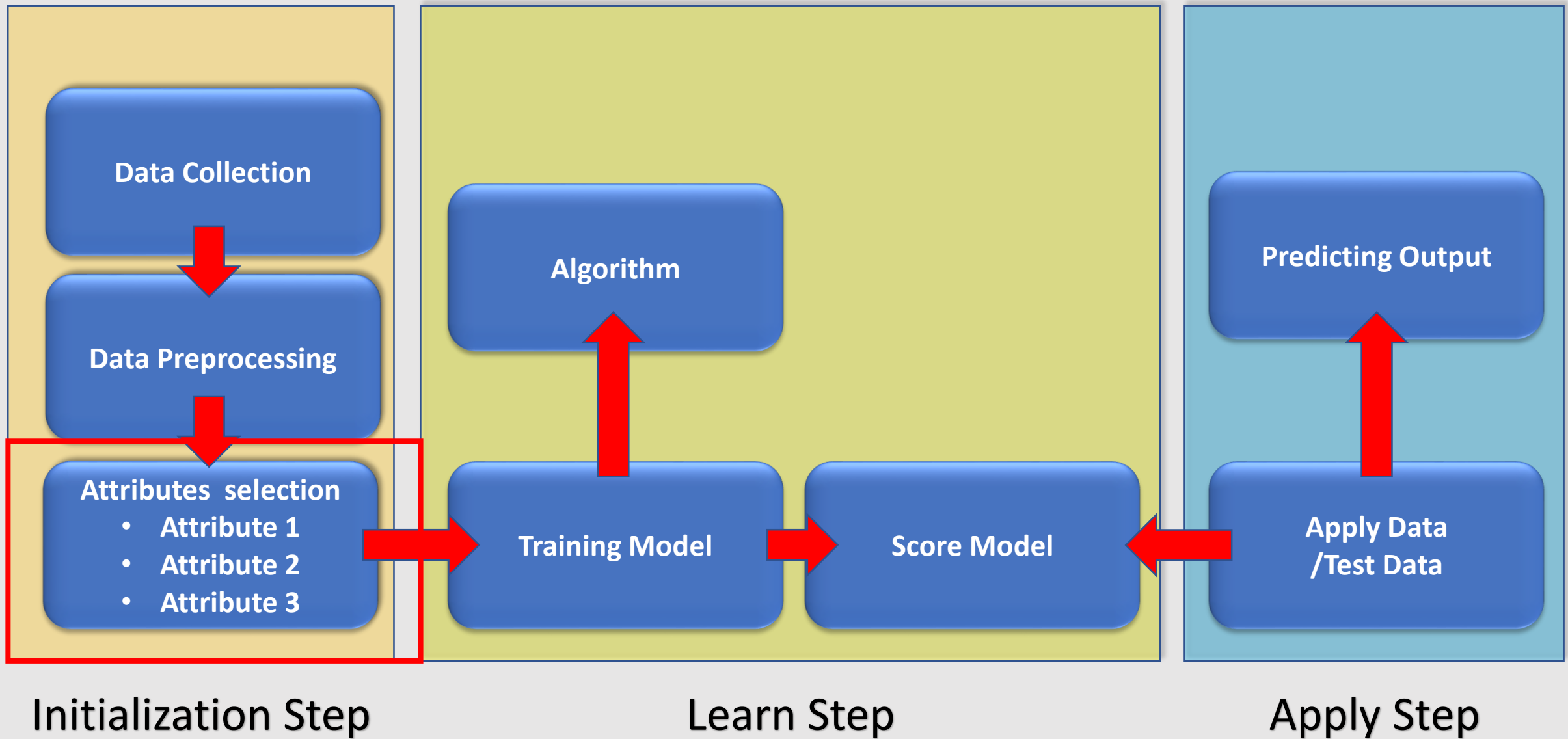
# Data Preprocessing

- Assign missing values as zero
- Detect outliers
- Remove unwanted variables
- Recode variables
- Convert categorical variables



The screenshot shows the Microsoft Visual Studio interface with a file named 'customer\_churn.R' open. The code is written in R and focuses on data preprocessing. It includes comments for each step: removing unwanted variables, handling missing values, and recoding categorical variables. The 'car' package is used for recoding. The code is as follows:

```
35 #####
36 # Data Preprocessing #
37 #####
38
39 # Remove Unwanted Variables
40 cust_data <- cust_data[, -1]
41
42 # Handling Missing Values: Replace NAs as 0
43 cust_data[is.na(cust_data)] <- 0
44
45 # Recode Variables: Replace Churn status, Yes = 1, No = 0
46 cust_data$Churn <- replace(cust_data$Churn, cust_data$Churn == "No", 0)
47 cust_data$Churn <- replace(cust_data$Churn, cust_data$Churn == "Yes", 1)
48 cust_data$Churn <- as.numeric(cust_data$Churn)
49
50
51 # Recode Variables: Recode using the library(car) package
52 cust_data$gender <- recode(cust_data$gender, "'Male'=1; 'Female'=0")
53 cust_data$Partner <- recode(cust_data$Partner, "'Yes'=1; 'No'=0")
54 cust_data$Dependents <- recode(cust_data$Dependents, "'Yes'=1; 'No'=0")
55 cust_data$PhoneService <- recode(cust_data$PhoneService, "'Yes'=1; 'No'=0")
56 cust_data$MultipleLines <- recode(cust_data$MultipleLines, "'Yes'=1; 'No'=0; 'No phone
  service'=3")
```



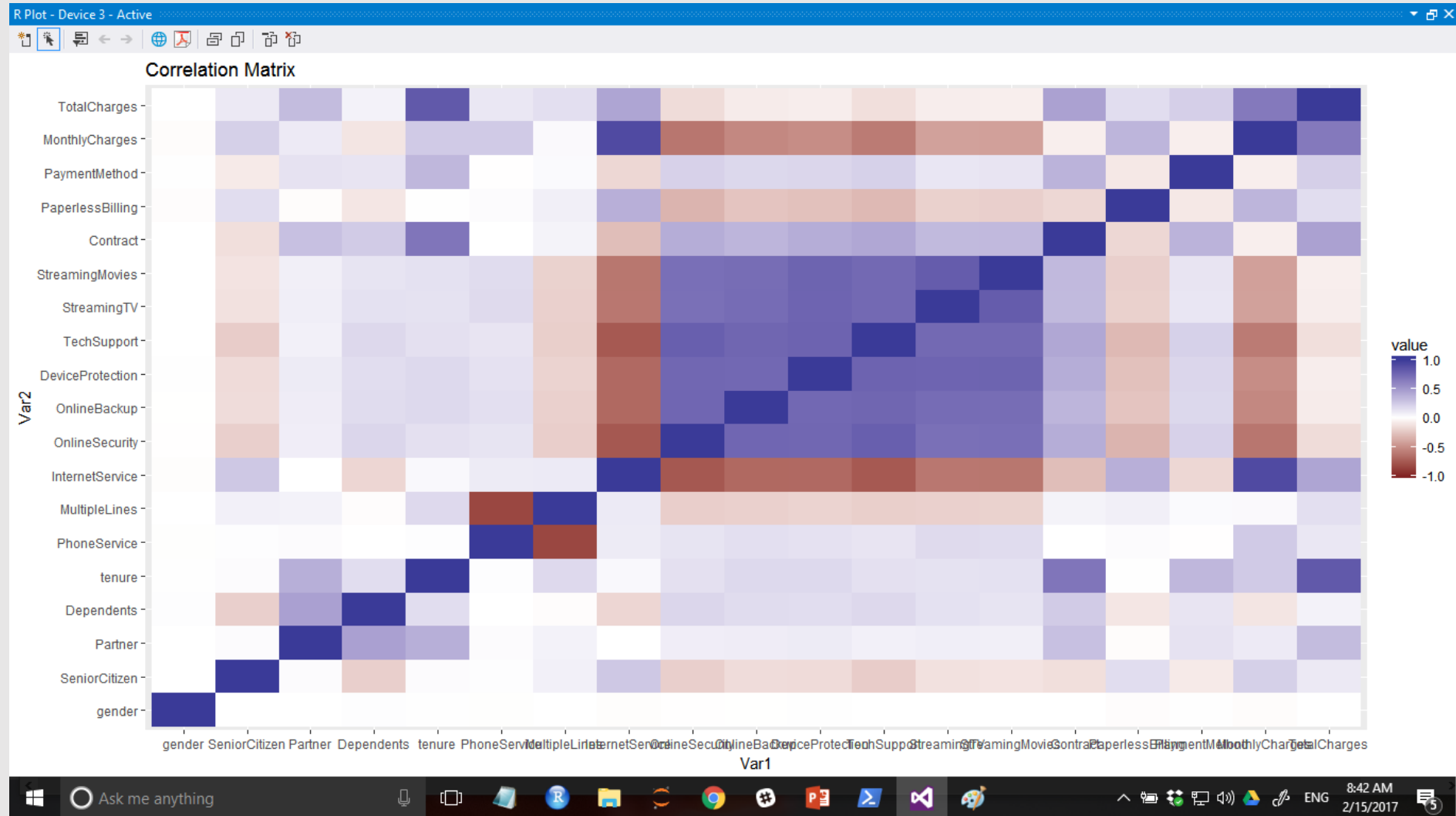
# Machine Learning Framework

# Features selection

- The process of selecting a subset of relevant features (variables, predictors) for use in model construction.
- Feature selection techniques are used for three reasons:
  - simplification of models to make them easier to interpret by researchers/users,
  - shorter training times,
  - enhanced generalization by reducing overfitting

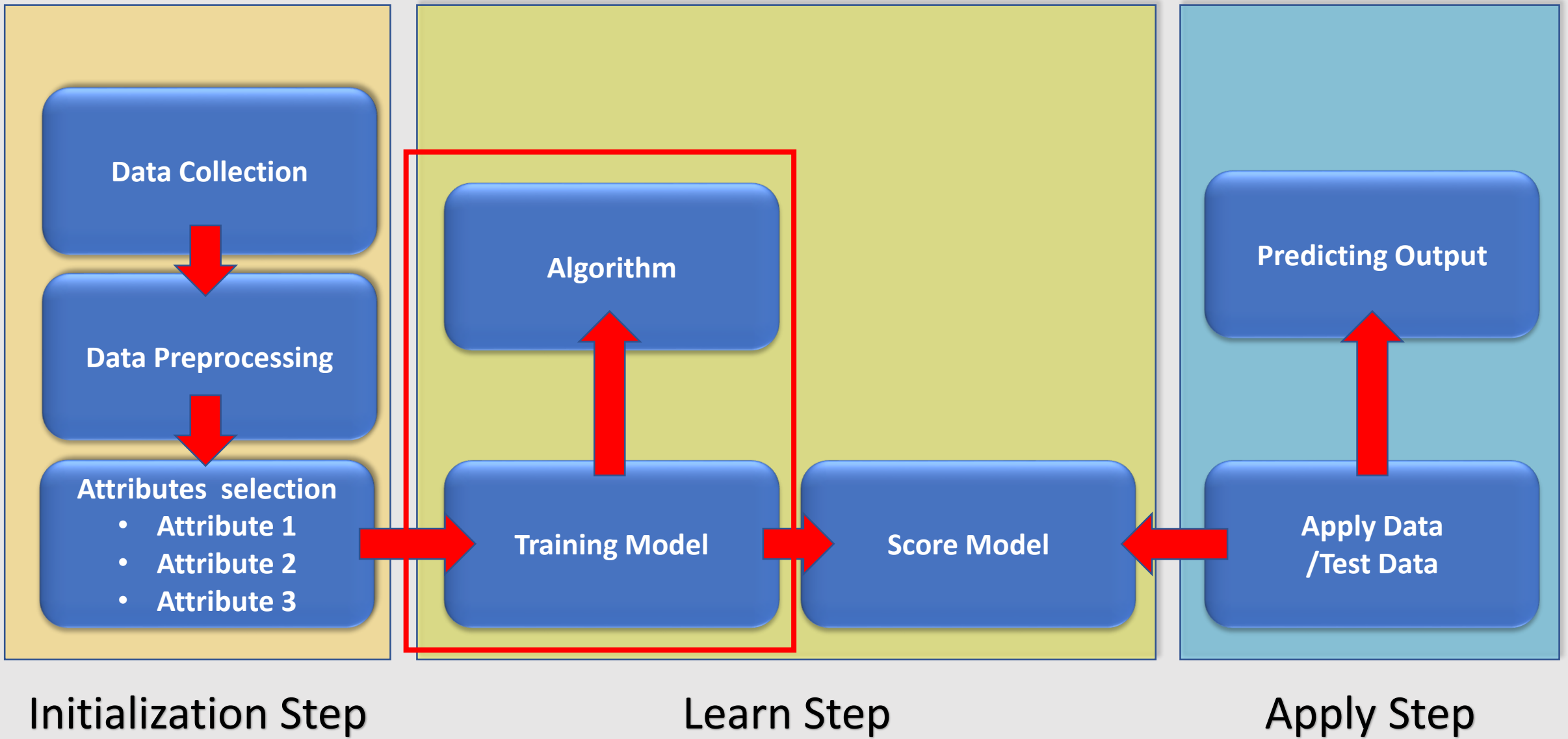


# Correlation Matrix



# Models Performance Comparison

- Logistic Regression
  - is a regression model where the dependent variable (DV) is categorical.
- Support Vector Machine
  - SVM is a supervised learning model with associated learning algorithms that analyze data used for classification and regression analysis.
- RandomForest
  - is an ensemble learning method for classification, regression and other tasks, that operate by constructing a multitude of decision trees at training time and outputting the class that is the mode of the classes (classification) or mean prediction (regression) of the individual trees.

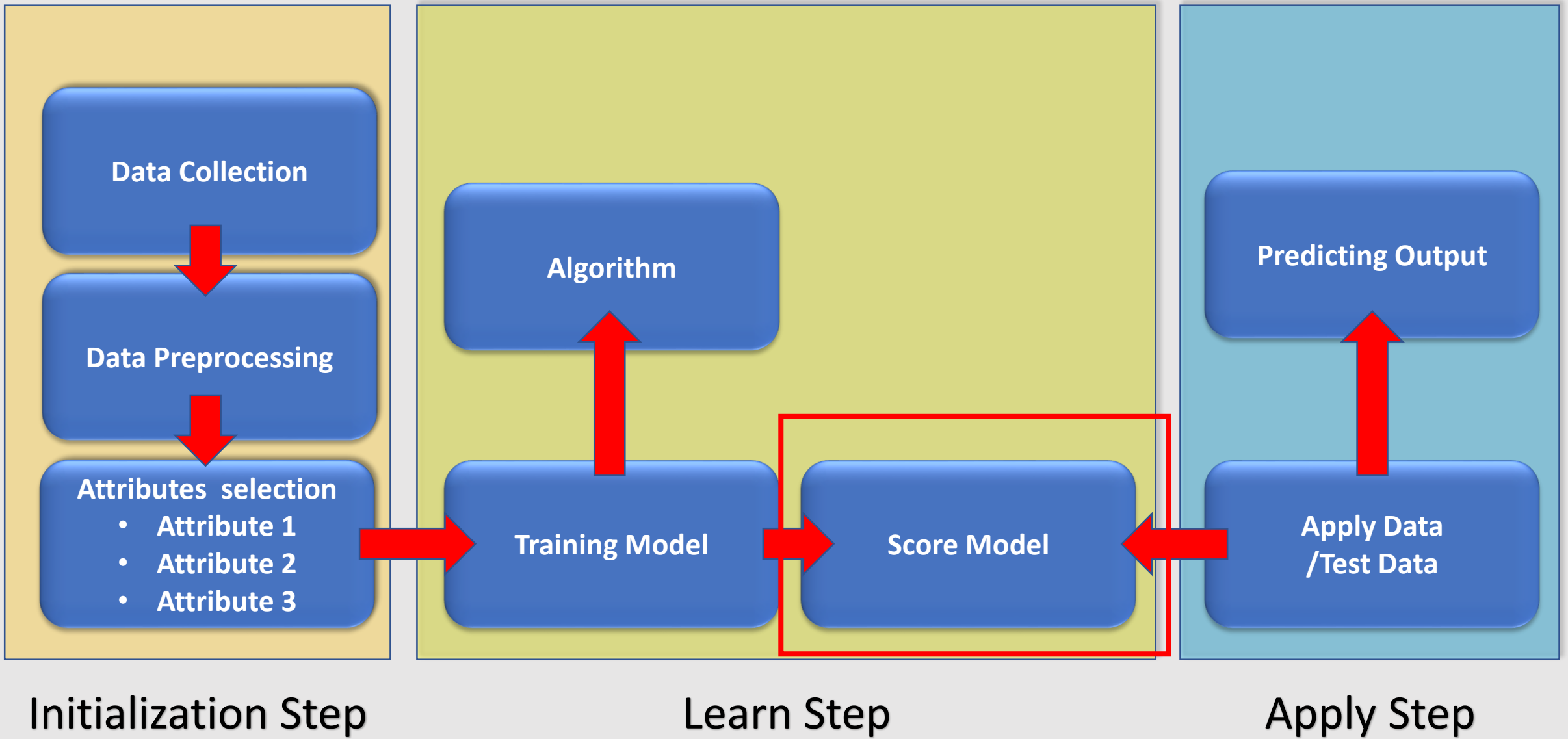


# Machine Learning Framework

# Training Model and Algorithm

- Split the data set into 80:20 using library(caret)
- Apply the algorithms: GLM, SVM and RF

```
customer_churn.R* X
87
88 #####
89 # Model Building #
90 #####
91
92 # For training and testing purpose,
93 # split the data to 80-20
94
95 library(caret)
96 set.seed(1234)
97 intrain <- createDataPartition(y = cust_data$Churn, p = 0.8, list = FALSE, times = 1)
98 training <- cust_data[intrain,]
99 testing <- cust_data[- intrain,]
100
101 #####
102 # Model 1: Logistic Regression Model #
103 #####
104
105 # Select the features to be used based on forward selection procedure
106 # Akaike information criterion (AIC = 2k - 2 log L) as the choice of
107 # metric. Lower AIC indicates better model
108
109 fullMod = glm(Churn ~ ., data = training, family = binomial)
110 summary(fullMod)
111 intMod <- glm(Churn ~ 1, data = training, family = binomial)
112 summary(intMod)
113 fwdSelection = stepAIC(intMod, scope = list(lower = formula(intMod), upper = formula(fullMod)),
```



# Machine Learning Framework

# Score Model

- Confusion Matrix: a table that is often used to describe the performance of a classification model (or "classifier") on a set of test data for which the true values are known.
  - **true positives (TP)**: These are cases in which we predicted yes (they have the disease), and they do churn.
  - **true negatives (TN)**: We predicted no, and they don't churn.
  - **false positives (FP)**: We predicted yes, but they don't actually churn. (Also known as a "Type I error.")
  - **false negatives (FN)**: We predicted no, but they actually do churn. (Also known as a "Type II error.")



# Confusion Matrix: Generalized Linear Model (glm)

n=1407	Predicted: NO	Predicted: YES	
Actual: NO	TN = 919 (0.653)	FP = 115 (0.082)	1034
Actual: YES	FN = 167 (0.119)	TP = 206 (0.146)	373
	1086	321	

Accuracy : 84.5%

# Confusion Matrix: Support Vector Machine (SVM)

n=1407	Predicted: NO	Predicted: YES	
Actual: NO	TN= 929 (0.660)	FP= 105 (0.075)	1034
Actual: YES	FN= 183 (0.130)	TP= 190 (0.135)	373
	1112	295	

Accuracy : 70.4%

# Confusion Matrix: RandomForest

n=1407	Predicted: NO	Predicted: YES	
Actual: NO	TN= 939 (0.667)	FP= 95 (0.068)	1034
Actual: YES	FN= 181 (0.129)	TP= 192 (0.136)	373
	1120	287	

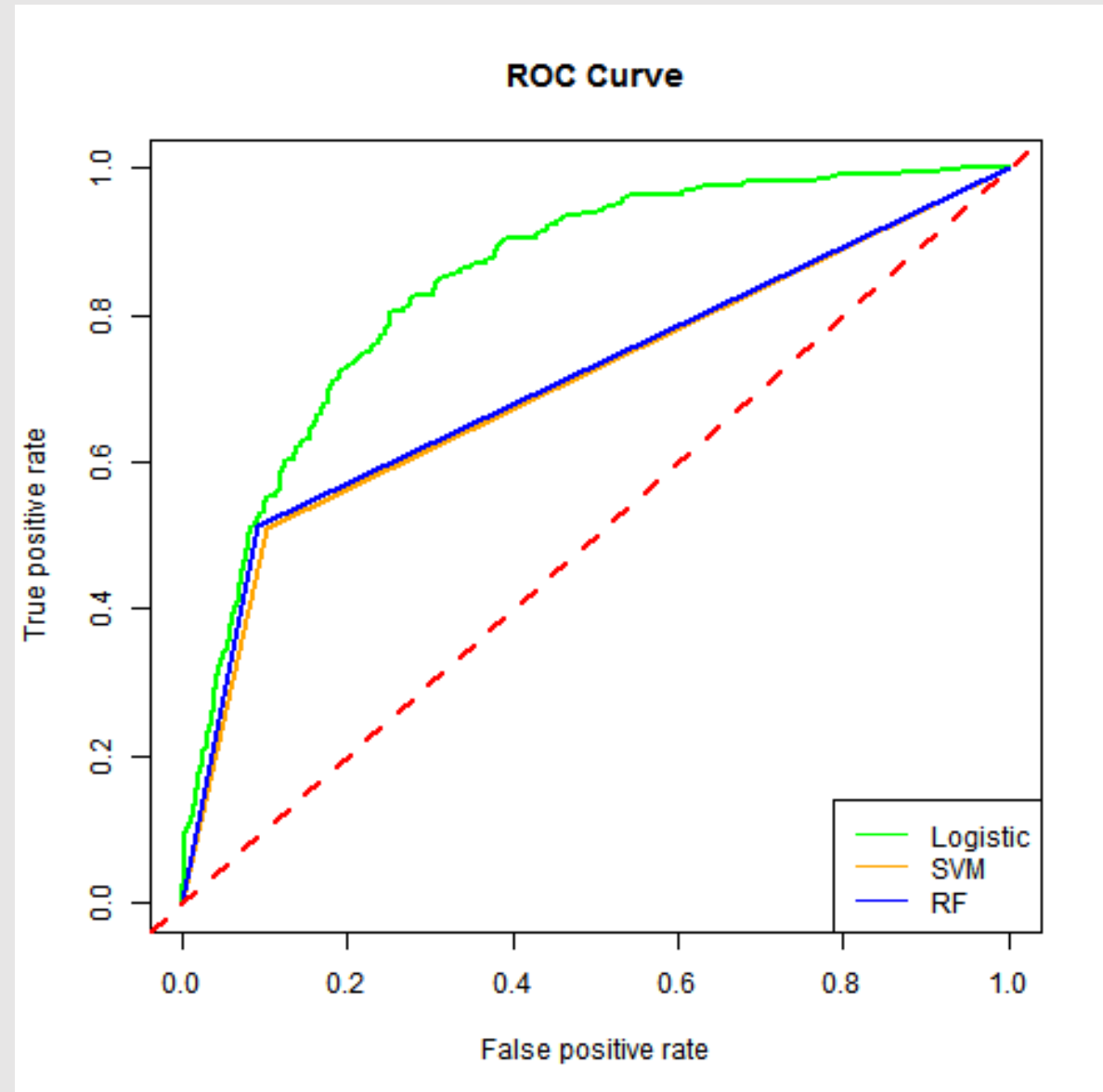
Accuracy : 71.1 %

# Receiver Operating Characteristic (ROC) curve

- ROC curve is a graphical plot that illustrates the performance of a binary classifier system as its discrimination threshold is varied. The curve is created by plotting the true positive rate (TPR) against the false positive rate (FPR) at various threshold settings.

# Models comparison

- ROC illustrates the performance of a binary classifier system as its discrimination threshold is varied.



# Microsoft R Open vs R

```
[17] parallel_3.3.1      SparseM_1.74      RGtk2_2.20.31     stringr_1.1.0
[25] grid_3.3.1          nnet_7.3-12      survival_2.40-1   gdata_2.1.1
[33] scales_0.4.1        codetools_0.2-14 ModelMetrics_1.1.0 MASS_7.3-45
[41] labeling_0.3        quantreg_5.29    KernSmooth_2.23-15 stringi_1.1.2
>
> # Stop the clock
> proc.time() - ptm
  user system elapsed
750.81   4.59  758.04
> |
```

R

```
loaded via a namespace (and not attached):
 [1] Rcpp_0.12.9      nloptr_1.0.4     plyr_1.8.4       class_7.3-16
 [9] partykit_1.1-1   lme4_1.1-12      tibble_1.2       nlme_3.1-152
[17] parallel_3.3.2   SparseM_1.74     RGtk2_2.20.31    stringr_1.1.0
[25] stats4_3.3.2     grid_3.3.2       nnet_7.3-12      survival_2.40-1
[33] magrittr_1.5     scales_0.4.1     codetools_0.2-15 ModelMetrics_1.1.0
[41] colorspace_1.3-2 labeling_0.3      quantreg_5.29    KernSmooth_2.23-15
>
> # Stop the clock
> proc.time() - ptm
  user system elapsed
759.04   5.31  750.22
> |
```

Microsoft R Open

100 %

R Interactive

```
[19] RGtk2_2.20.31      stringr_1.1.0     caTools_1.17.1    gtools_3.5.0
[25] rtvs_1.0.0.0       stats4_3.3.2     grid_3.3.2        nnet_7.3-12
[31] minqa_1.2.4        Formula_1.2-1     reshape2_1.4.2    magrittr_1.5
[37] ModelMetrics_1.1.0 MASS_7.3-45       splines_3.3.2     assertthat_0.1
[43] labeling_0.3       quantreg_5.29    KernSmooth_2.23-15 stringi_1.1.2
  user system elapsed
769.02   3.16  770.47
```

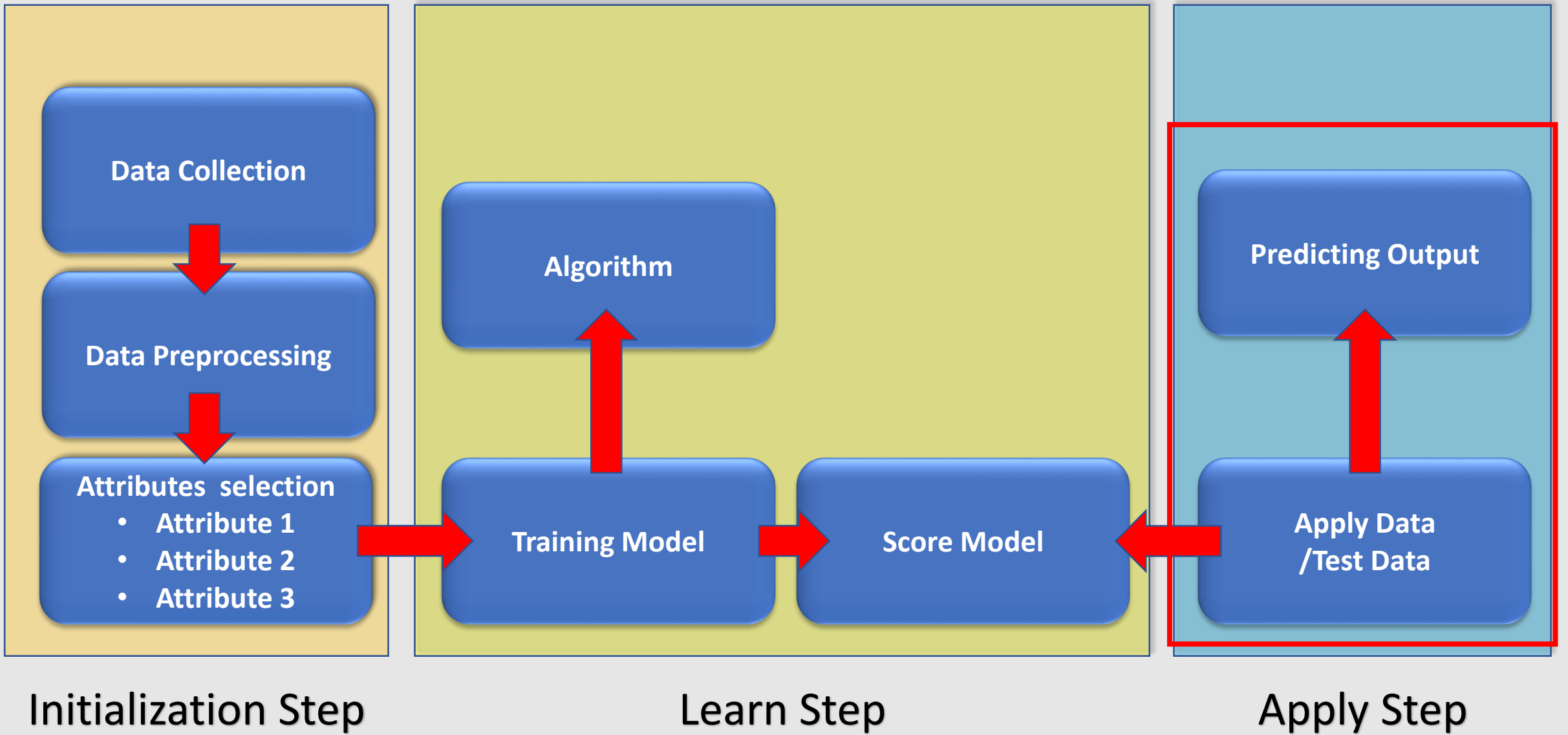
VS 2015

Console C:/Users/pokub001/Dropbox/My Documents/R/talks/chum-r/

```
[37] MASS_7.3-45       splines_3.3.2     assertthat_0.1    pbr_0.1.1
[41] colorspace_1.3-2  labeling_0.3      quantreg_5.29     KernSmooth_2.23-15
[45] stringi_1.1.2     lazyeval_0.2.0    munsell_0.4.3
>
> # Stop the clock
> proc.time() - ptm
  user system elapsed
783.30   3.77  783.80
> |
```

RStudio





# Machine Learning Framework

# Predict test data

- Based on the training model, select the best model to be used for test data prediction

```
load_model.R  X customer_churn.R*
44 #####
45 # load model #
46 #####
47 load('churnmodel.rda')
48
49 #logic_reg <- glm(Churn ~ Contract
50 #               + InternetService
51 #               + tenure
52 #               + PaperlessBilling
53 #               + TotalCharges
54 #               + MultipleLines
55 #               + PaymentMethod
56 #               + SeniorCitizen
57 #               + StreamingTV
58 #               + OnlineSecurity
59 #               + TechSupport
60 #               + StreamingMovies
61 #               + MonthlyCharges
62 #               + PhoneService
63 #               + Dependents
64
65 #for glm, requires to select the same variables used in training
66 cust_data1 <- cust_data1[,c
67   ("Contract", "InternetService", "tenure", "PaperlessBilling", "TotalCharges", "MultipleLines", "Pay
68    mentMethod", "SeniorCitizen", "StreamingTV", "OnlineSecurity", "TechSupport", "StreamingMovies", "M
69    onthlyCharges", "PhoneService", "Dependents", "Churn")]
67
```

# Thanks!

# Questions?



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DEMO