Naive Bayes Agency Data Predictive Model

Frank Neugebauer

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# Agency Data Simple Naive Bayes Predictive Model

Agency data intuitively has value to an agency and potentially to agent’s carrier partner(s). One way to gain value from that data - which exists within agency management systems - is to create one or more predictive models. Gaining insight from predictive modeling using agency data is the fundamental nature of this effort.

**Epilogue** It’s clear that predictive modelling with agency has value. The contents of this analysis are a single perspective of such an effort, although subsequently, at least one other perspective is presented to give the reader a glimpse into how varied this analysis could potentially be.

This uses a largely unaltered simple Naive Bayes model to set a baseline for subsequent predictive models, which can be created using other algorithms.

# Read the original data set  
agency\_data\_orig <- read.xlsx('./data/AgencyData\_clean.xlsx', sheetIndex=1, stringsAsFactors=T)

## Data Setup

There are a couple of irrelevant attributes from the original set. Get rid of those and then setup the train and test data sets.

# Trim the phat - i.e., data that's irrelevant  
agency\_data\_used <- agency\_data\_orig[c(-1, -4)]  
str(agency\_data\_used)

## 'data.frame': 2376 obs. of 12 variables:  
## $ account\_type : Factor w/ 2 levels "Commercial","Personal": 2 2 2 2 2 2 2 2 2 2 ...  
## $ assigned\_agent : Factor w/ 6 levels "Boehm, Sebastian",..: 6 2 2 6 6 6 6 6 6 6 ...  
## $ lob : Factor w/ 20 levels "Auto (Commercial)",..: 10 10 2 10 2 2 10 7 2 2 ...  
## $ master\_company : Factor w/ 20 levels "Aimonetti Insurance",..: 9 9 9 9 9 9 9 11 9 9 ...  
## $ effective\_date : Date, format: "2014-10-07" "2014-10-06" ...  
## $ policy\_term : Factor w/ 3 levels "12 Months","6 Months",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ policy\_type : Factor w/ 2 levels "Commercial","Personal": 2 2 2 2 2 2 2 2 2 2 ...  
## $ annual\_premium : num 291 868 1239 789 1648 ...  
## $ written\_premium : num 291 868 1239 789 1648 ...  
## $ rating\_state : Factor w/ 8 levels "FL","ND","NV",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ status : Factor w/ 2 levels "Active","Inactive": 2 2 2 2 2 2 2 2 2 2 ...  
## $ transaction\_type: Factor w/ 13 levels "Cancel Conf",..: 13 13 13 13 13 13 13 5 13 13 ...

# Setup train and test data, 70% / 30%  
train\_ad <- sample\_frac(agency\_data\_used, 0.7)  
sid <- as.numeric(rownames(train\_ad)) # because rownames() returns character  
test\_ad <- agency\_data\_used[-sid,]

## Build the Model

This step is set aside because with a big data set, it would be slow or put into a distributed system. This model is using transaction\_type as the target variable. In simple terms, the model is making predictions for the various transaction types given other conditions, such as the line of business.

For example, can the model predict the likelihood of a renewal for a personal auto policy (it can go deeper than that, but it’s a good illustration of the principle).

nb\_model <- naiveBayes(transaction\_type~., data=train\_ad)

## Conditional Probabilities

The model creates the conditional probabilities based on the training data. This output shows those, which is interesting unto itself.

Intuitively, it may appear that this is simple math - e.g., if there were 100 transactions and 40 of them were renewals, then the probability should be 40%. However, this model is multi-factored, which means a more accurate way of considering it is, given the line of business was personal auto, there’s some non-obvious probability that a renwal will occur. That’s the kind of probabilities being reported here.

nb\_model$tables$assigned\_agent

## assigned\_agent  
## Y Boehm, Sebastian Doyle, Walter Insurance, Nichersen  
## Cancel Conf 0.120115774 0.445730825 0.057887120  
## Cancel Req 0.000000000 0.500000000 0.000000000  
## Cancel/DNR 0.200000000 0.000000000 0.800000000  
## DB Synch 0.000000000 0.250000000 0.500000000  
## New Business 0.083333333 0.380952381 0.011904762  
## Non-Renewal 0.000000000 0.000000000 0.000000000  
## Policy Change 0.140109890 0.335164835 0.008241758  
## Re-Issue 0.000000000 0.000000000 0.000000000  
## Reinstate 0.083333333 0.291666667 0.020833333  
## Renew Quote   
## Renewal 0.278735632 0.344827586 0.000000000  
## Renewal Re-Quote 0.000000000 0.000000000 0.000000000  
## Rewrite 0.153846154 0.307692308 0.000000000  
## assigned\_agent  
## Y Padberg, Tracy Rohan, Elwood Tremblay, Deena  
## Cancel Conf 0.010130246 0.010130246 0.356005789  
## Cancel Req 0.000000000 0.166666667 0.333333333  
## Cancel/DNR 0.000000000 0.000000000 0.000000000  
## DB Synch 0.250000000 0.000000000 0.000000000  
## New Business 0.172619048 0.083333333 0.267857143  
## Non-Renewal 0.000000000 0.000000000 1.000000000  
## Policy Change 0.126373626 0.063186813 0.326923077  
## Re-Issue 0.000000000 0.000000000 1.000000000  
## Reinstate 0.020833333 0.166666667 0.416666667  
## Renew Quote   
## Renewal 0.005747126 0.011494253 0.359195402  
## Renewal Re-Quote 0.000000000 0.000000000 1.000000000  
## Rewrite 0.000000000 0.000000000 0.538461538

nb\_model$tables$lob

## lob  
## Y Auto (Commercial) Auto (Personal) BOP Liability  
## Cancel Conf 0.010130246 0.717800289 0.001447178  
## Cancel Req 0.166666667 0.666666667 0.000000000  
## Cancel/DNR 0.000000000 1.000000000 0.000000000  
## DB Synch 0.000000000 1.000000000 0.000000000  
## New Business 0.023809524 0.214285714 0.005952381  
## Non-Renewal 0.000000000 1.000000000 0.000000000  
## Policy Change 0.010989011 0.695054945 0.000000000  
## Re-Issue 0.000000000 1.000000000 0.000000000  
## Reinstate 0.020833333 0.583333333 0.000000000  
## Renew Quote   
## Renewal 0.020114943 0.571839080 0.000000000  
## Renewal Re-Quote 0.000000000 1.000000000 0.000000000  
## Rewrite 0.000000000 0.730769231 0.000000000  
## lob  
## Y BOP Property Business Owners Policy Commercial Prpty  
## Cancel Conf 0.001447178 0.004341534 0.000000000  
## Cancel Req 0.000000000 0.000000000 0.000000000  
## Cancel/DNR 0.000000000 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000 0.000000000  
## New Business 0.000000000 0.029761905 0.005952381  
## Non-Renewal 0.000000000 0.000000000 0.000000000  
## Policy Change 0.000000000 0.002747253 0.000000000  
## Re-Issue 0.000000000 0.000000000 0.000000000  
## Reinstate 0.000000000 0.000000000 0.000000000  
## Renew Quote   
## Renewal 0.000000000 0.008620690 0.002873563  
## Renewal Re-Quote 0.000000000 0.000000000 0.000000000  
## Rewrite 0.000000000 0.000000000 0.000000000  
## lob  
## Y Dwelling fire Flood Genl Liability Homeowners  
## Cancel Conf 0.015918958 0.000000000 0.015918958 0.222865412  
## Cancel Req 0.166666667 0.000000000 0.000000000 0.000000000  
## Cancel/DNR 0.000000000 0.000000000 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000 0.000000000 0.000000000  
## New Business 0.065476190 0.000000000 0.041666667 0.476190476  
## Non-Renewal 0.000000000 0.000000000 0.000000000 0.000000000  
## Policy Change 0.024725275 0.002747253 0.000000000 0.239010989  
## Re-Issue 0.000000000 0.000000000 0.000000000 0.000000000  
## Reinstate 0.041666667 0.000000000 0.020833333 0.312500000  
## Renew Quote   
## Renewal 0.014367816 0.000000000 0.034482759 0.324712644  
## Renewal Re-Quote 0.000000000 0.000000000 0.000000000 0.000000000  
## Rewrite 0.000000000 0.000000000 0.000000000 0.269230769  
## lob  
## Y Inland marine (comm) Inland Marine (pers)  
## Cancel Conf 0.000000000 0.001447178  
## Cancel Req 0.000000000 0.000000000  
## Cancel/DNR 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000  
## New Business 0.000000000 0.000000000  
## Non-Renewal 0.000000000 0.000000000  
## Policy Change 0.000000000 0.000000000  
## Re-Issue 0.000000000 0.000000000  
## Reinstate 0.000000000 0.000000000  
## Renew Quote   
## Renewal 0.002873563 0.005747126  
## Renewal Re-Quote 0.000000000 0.000000000  
## Rewrite 0.000000000 0.000000000  
## lob  
## Y Personal Liability Professional Liab Renters  
## Cancel Conf 0.000000000 0.000000000 0.000000000  
## Cancel Req 0.000000000 0.000000000 0.000000000  
## Cancel/DNR 0.000000000 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000 0.000000000  
## New Business 0.005952381 0.011904762 0.011904762  
## Non-Renewal 0.000000000 0.000000000 0.000000000  
## Policy Change 0.000000000 0.000000000 0.000000000  
## Re-Issue 0.000000000 0.000000000 0.000000000  
## Reinstate 0.000000000 0.000000000 0.000000000  
## Renew Quote   
## Renewal 0.000000000 0.000000000 0.000000000  
## Renewal Re-Quote 0.000000000 0.000000000 0.000000000  
## Rewrite 0.000000000 0.000000000 0.000000000  
## lob  
## Y Signs Umbrella - Comm Umbrella - Personal  
## Cancel Conf 0.000000000 0.001447178 0.005788712  
## Cancel Req 0.000000000 0.000000000 0.000000000  
## Cancel/DNR 0.000000000 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000 0.000000000  
## New Business 0.000000000 0.005952381 0.077380952  
## Non-Renewal 0.000000000 0.000000000 0.000000000  
## Policy Change 0.002747253 0.000000000 0.019230769  
## Re-Issue 0.000000000 0.000000000 0.000000000  
## Reinstate 0.000000000 0.000000000 0.020833333  
## Renew Quote   
## Renewal 0.000000000 0.000000000 0.011494253  
## Renewal Re-Quote 0.000000000 0.000000000 0.000000000  
## Rewrite 0.000000000 0.000000000 0.000000000  
## lob  
## Y Watercraft (small boat) Workers comp  
## Cancel Conf 0.000000000 0.001447178  
## Cancel Req 0.000000000 0.000000000  
## Cancel/DNR 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000  
## New Business 0.023809524 0.000000000  
## Non-Renewal 0.000000000 0.000000000  
## Policy Change 0.002747253 0.000000000  
## Re-Issue 0.000000000 0.000000000  
## Reinstate 0.000000000 0.000000000  
## Renew Quote   
## Renewal 0.002873563 0.000000000  
## Renewal Re-Quote 0.000000000 0.000000000  
## Rewrite 0.000000000 0.000000000

nb\_model$tables$master\_company

## master\_company  
## Y Aimonetti Insurance Beaulah General Agency  
## Cancel Conf 0.350217077 0.000000000  
## Cancel Req 0.833333333 0.000000000  
## Cancel/DNR 0.200000000 0.000000000  
## DB Synch 0.750000000 0.000000000  
## New Business 0.125000000 0.005952381  
## Non-Renewal 0.000000000 0.000000000  
## Policy Change 0.348901099 0.000000000  
## Re-Issue 1.000000000 0.000000000  
## Reinstate 0.291666667 0.000000000  
## Renew Quote   
## Renewal 0.310344828 0.002873563  
## Renewal Re-Quote 1.000000000 0.000000000  
## Rewrite 0.038461538 0.000000000  
## master\_company  
## Y Beaulah Insurance Beyer Strategic Insurance  
## Cancel Conf 0.078147612 0.046309696  
## Cancel Req 0.000000000 0.000000000  
## Cancel/DNR 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000  
## New Business 0.023809524 0.053571429  
## Non-Renewal 0.000000000 0.000000000  
## Policy Change 0.068681319 0.043956044  
## Re-Issue 0.000000000 0.000000000  
## Reinstate 0.020833333 0.041666667  
## Renew Quote   
## Renewal 0.080459770 0.037356322  
## Renewal Re-Quote 0.000000000 0.000000000  
## Rewrite 0.115384615 0.000000000  
## master\_company  
## Y Borer Group, LLC Brakus Fire & Casualty  
## Cancel Conf 0.004341534 0.001447178  
## Cancel Req 0.000000000 0.000000000  
## Cancel/DNR 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000  
## New Business 0.089285714 0.000000000  
## Non-Renewal 0.000000000 0.000000000  
## Policy Change 0.043956044 0.000000000  
## Re-Issue 0.000000000 0.000000000  
## Reinstate 0.020833333 0.000000000  
## Renew Quote   
## Renewal 0.000000000 0.000000000  
## Renewal Re-Quote 0.000000000 0.000000000  
## Rewrite 0.153846154 0.000000000  
## master\_company  
## Y Breitenberg Insurance DuBuque Insurance  
## Cancel Conf 0.169319826 0.095513748  
## Cancel Req 0.000000000 0.000000000  
## Cancel/DNR 0.600000000 0.000000000  
## DB Synch 0.250000000 0.000000000  
## New Business 0.095238095 0.184523810  
## Non-Renewal 1.000000000 0.000000000  
## Policy Change 0.068681319 0.142857143  
## Re-Issue 0.000000000 0.000000000  
## Reinstate 0.041666667 0.187500000  
## Renew Quote   
## Renewal 0.189655172 0.025862069  
## Renewal Re-Quote 0.000000000 0.000000000  
## Rewrite 0.000000000 0.153846154  
## master\_company  
## Y Friesen Insurance Helen Herman Group Hui Insurance  
## Cancel Conf 0.044862518 0.005788712 0.017366136  
## Cancel Req 0.000000000 0.000000000 0.166666667  
## Cancel/DNR 0.000000000 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000 0.000000000  
## New Business 0.005952381 0.000000000 0.202380952  
## Non-Renewal 0.000000000 0.000000000 0.000000000  
## Policy Change 0.060439560 0.002747253 0.057692308  
## Re-Issue 0.000000000 0.000000000 0.000000000  
## Reinstate 0.083333333 0.000000000 0.104166667  
## Renew Quote   
## Renewal 0.071839080 0.002873563 0.037356322  
## Renewal Re-Quote 0.000000000 0.000000000 0.000000000  
## Rewrite 0.346153846 0.000000000 0.076923077  
## master\_company  
## Y Kilback Excess & Surplus Roderick Insurance  
## Cancel Conf 0.000000000 0.005788712  
## Cancel Req 0.000000000 0.000000000  
## Cancel/DNR 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000  
## New Business 0.023809524 0.065476190  
## Non-Renewal 0.000000000 0.000000000  
## Policy Change 0.000000000 0.071428571  
## Re-Issue 0.000000000 0.000000000  
## Reinstate 0.000000000 0.020833333  
## Renew Quote   
## Renewal 0.000000000 0.080459770  
## Renewal Re-Quote 0.000000000 0.000000000  
## Rewrite 0.000000000 0.000000000  
## master\_company  
## Y Ryan Hyatt Insurance Schimel Mutual Insurance  
## Cancel Conf 0.005788712 0.021707670  
## Cancel Req 0.000000000 0.000000000  
## Cancel/DNR 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000  
## New Business 0.011904762 0.035714286  
## Non-Renewal 0.000000000 0.000000000  
## Policy Change 0.002747253 0.000000000  
## Re-Issue 0.000000000 0.000000000  
## Reinstate 0.020833333 0.020833333  
## Renew Quote   
## Renewal 0.000000000 0.045977011  
## Renewal Re-Quote 0.000000000 0.000000000  
## Rewrite 0.000000000 0.000000000  
## master\_company  
## Y Schuppe Group Simonis Insurance Spinka West Insurance  
## Cancel Conf 0.059334298 0.053545586 0.031837916  
## Cancel Req 0.000000000 0.000000000 0.000000000  
## Cancel/DNR 0.200000000 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000 0.000000000  
## New Business 0.047619048 0.011904762 0.005952381  
## Non-Renewal 0.000000000 0.000000000 0.000000000  
## Policy Change 0.065934066 0.002747253 0.005494505  
## Re-Issue 0.000000000 0.000000000 0.000000000  
## Reinstate 0.000000000 0.020833333 0.020833333  
## Renew Quote   
## Renewal 0.068965517 0.008620690 0.017241379  
## Renewal Re-Quote 0.000000000 0.000000000 0.000000000  
## Rewrite 0.115384615 0.000000000 0.000000000  
## master\_company  
## Y Streich Group Insurance Sultan Insurance  
## Cancel Conf 0.008683068 0.000000000  
## Cancel Req 0.000000000 0.000000000  
## Cancel/DNR 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000  
## New Business 0.005952381 0.005952381  
## Non-Renewal 0.000000000 0.000000000  
## Policy Change 0.013736264 0.000000000  
## Re-Issue 0.000000000 0.000000000  
## Reinstate 0.104166667 0.000000000  
## Renew Quote   
## Renewal 0.020114943 0.000000000  
## Renewal Re-Quote 0.000000000 0.000000000  
## Rewrite 0.000000000 0.000000000

#nb\_model$tables$effective\_date # bin this  
nb\_model$tables$policy\_term

## policy\_term  
## Y 12 Months 6 Months 7 Months  
## Cancel Conf 0.534008683 0.465991317 0.000000000  
## Cancel Req 0.333333333 0.666666667 0.000000000  
## Cancel/DNR 0.200000000 0.800000000 0.000000000  
## DB Synch 0.500000000 0.500000000 0.000000000  
## New Business 0.964285714 0.029761905 0.005952381  
## Non-Renewal 1.000000000 0.000000000 0.000000000  
## Policy Change 0.854395604 0.145604396 0.000000000  
## Re-Issue 1.000000000 0.000000000 0.000000000  
## Reinstate 0.791666667 0.208333333 0.000000000  
## Renew Quote   
## Renewal 0.752873563 0.247126437 0.000000000  
## Renewal Re-Quote 0.000000000 1.000000000 0.000000000  
## Rewrite 0.961538462 0.038461538 0.000000000

nb\_model$tables$policy\_type

## policy\_type  
## Y Commercial Personal  
## Cancel Conf 0.03907381 0.96092619  
## Cancel Req 0.33333333 0.66666667  
## Cancel/DNR 0.00000000 1.00000000  
## DB Synch 0.00000000 1.00000000  
## New Business 0.12500000 0.87500000  
## Non-Renewal 0.00000000 1.00000000  
## Policy Change 0.02472527 0.97527473  
## Re-Issue 0.00000000 1.00000000  
## Reinstate 0.06250000 0.93750000  
## Renew Quote   
## Renewal 0.06896552 0.93103448  
## Renewal Re-Quote 0.00000000 1.00000000  
## Rewrite 0.00000000 1.00000000

# create one for binned premium  
nb\_model$tables$rating\_state

## rating\_state  
## Y FL ND NV OK  
## Cancel Conf 0.995658466 0.001447178 0.000000000 0.000000000  
## Cancel Req 1.000000000 0.000000000 0.000000000 0.000000000  
## Cancel/DNR 1.000000000 0.000000000 0.000000000 0.000000000  
## DB Synch 1.000000000 0.000000000 0.000000000 0.000000000  
## New Business 0.988095238 0.000000000 0.005952381 0.000000000  
## Non-Renewal 1.000000000 0.000000000 0.000000000 0.000000000  
## Policy Change 0.989010989 0.000000000 0.000000000 0.008241758  
## Re-Issue 1.000000000 0.000000000 0.000000000 0.000000000  
## Reinstate 1.000000000 0.000000000 0.000000000 0.000000000  
## Renew Quote   
## Renewal 1.000000000 0.000000000 0.000000000 0.000000000  
## Renewal Re-Quote 1.000000000 0.000000000 0.000000000 0.000000000  
## Rewrite 1.000000000 0.000000000 0.000000000 0.000000000  
## rating\_state  
## Y OR UT WA WY  
## Cancel Conf 0.001447178 0.001447178 0.000000000 0.000000000  
## Cancel Req 0.000000000 0.000000000 0.000000000 0.000000000  
## Cancel/DNR 0.000000000 0.000000000 0.000000000 0.000000000  
## DB Synch 0.000000000 0.000000000 0.000000000 0.000000000  
## New Business 0.000000000 0.000000000 0.005952381 0.000000000  
## Non-Renewal 0.000000000 0.000000000 0.000000000 0.000000000  
## Policy Change 0.000000000 0.000000000 0.000000000 0.002747253  
## Re-Issue 0.000000000 0.000000000 0.000000000 0.000000000  
## Reinstate 0.000000000 0.000000000 0.000000000 0.000000000  
## Renew Quote   
## Renewal 0.000000000 0.000000000 0.000000000 0.000000000  
## Renewal Re-Quote 0.000000000 0.000000000 0.000000000 0.000000000  
## Rewrite 0.000000000 0.000000000 0.000000000 0.000000000

nb\_model$tables$status

## status  
## Y Active Inactive  
## Cancel Conf 0.000000000 1.000000000  
## Cancel Req 0.000000000 1.000000000  
## Cancel/DNR 0.000000000 1.000000000  
## DB Synch 0.250000000 0.750000000  
## New Business 0.898809524 0.101190476  
## Non-Renewal 1.000000000 0.000000000  
## Policy Change 0.942307692 0.057692308  
## Re-Issue 1.000000000 0.000000000  
## Reinstate 0.812500000 0.187500000  
## Renew Quote   
## Renewal 0.994252874 0.005747126  
## Renewal Re-Quote 0.000000000 1.000000000  
## Rewrite 0.730769231 0.269230769

Some important points about the conditional probabilities: 1. The conditional probabilities by assigned\_agent and transaction can help in workforce capacity planning. For example, if some agents are handling renewals more frequently, perhaps those agents need help.

1. master\_company data can be used similarly to how assigned\_agent is used in order to ensure companies with the most valuable business, or most frequently number of transactions, have the greatest amount of help.
2. For policy\_term there is something unexpected: virtually all New Business transactions are 12 month, whereas renewals are 76%/24% 12 to 6 month. Why?

## Make Predictions

As with the model, this step can take some real time with a large data set, so it’s segregated from processing / output.

nb\_predict <- predict(nb\_model, test\_ad)

## Show the Predictions

This is similar to the conditional probability, but applies it to show the actual predicted values. The points about conditional probabilities all apply for the predictions, but this is where number of transactions are shown. As such, this is a more valuable workforce capacity planning metric.

**However**, the numbers shown here are based on the size of the test set. If you want to actually simulate workforce capacity, you’ll need a sample that is similar to what you’ll expect in a year (a model like this one can be used to make that prediction).

table(nb\_predict, test\_ad$account\_type)

##   
## nb\_predict Commercial Personal  
## Cancel Conf 8 634  
## Cancel Req 3 1  
## Cancel/DNR 0 20  
## DB Synch 0 6  
## New Business 18 7  
## Non-Renewal 0 0  
## Policy Change 0 2  
## Re-Issue 0 0  
## Reinstate 1 11  
## Renew Quote 0 0  
## Renewal 0 1  
## Renewal Re-Quote 0 0  
## Rewrite 0 1

table(nb\_predict, test\_ad$assigned\_agent)

##   
## nb\_predict Boehm, Sebastian Doyle, Walter Insurance, Nichersen  
## Cancel Conf 83 271 40  
## Cancel Req 0 3 0  
## Cancel/DNR 1 0 19  
## DB Synch 0 1 5  
## New Business 2 16 0  
## Non-Renewal 0 0 0  
## Policy Change 2 0 0  
## Re-Issue 0 0 0  
## Reinstate 4 1 0  
## Renew Quote 0 0 0  
## Renewal 0 0 0  
## Renewal Re-Quote 0 0 0  
## Rewrite 0 0 0  
##   
## nb\_predict Padberg, Tracy Rohan, Elwood Tremblay, Deena  
## Cancel Conf 0 0 248  
## Cancel Req 0 0 1  
## Cancel/DNR 0 0 0  
## DB Synch 0 0 0  
## New Business 0 0 7  
## Non-Renewal 0 0 0  
## Policy Change 0 0 0  
## Re-Issue 0 0 0  
## Reinstate 0 1 6  
## Renew Quote 0 0 0  
## Renewal 0 0 1  
## Renewal Re-Quote 0 0 0  
## Rewrite 0 0 1

table(nb\_predict, test\_ad$lob)

##   
## nb\_predict Auto (Commercial) Auto (Personal) BOP Liability  
## Cancel Conf 5 464 0  
## Cancel Req 1 1 1  
## Cancel/DNR 0 20 0  
## DB Synch 0 5 0  
## New Business 0 0 1  
## Non-Renewal 0 0 0  
## Policy Change 0 1 0  
## Re-Issue 0 0 0  
## Reinstate 1 9 0  
## Renew Quote 0 0 0  
## Renewal 0 0 0  
## Renewal Re-Quote 0 0 0  
## Rewrite 0 1 0  
##   
## nb\_predict BOP Property Business Owners Policy Commercial Prpty  
## Cancel Conf 1 1 0  
## Cancel Req 0 0 0  
## Cancel/DNR 0 0 0  
## DB Synch 0 0 0  
## New Business 0 1 1  
## Non-Renewal 0 0 0  
## Policy Change 0 0 0  
## Re-Issue 0 0 0  
## Reinstate 0 0 0  
## Renew Quote 0 0 0  
## Renewal 0 0 0  
## Renewal Re-Quote 0 0 0  
## Rewrite 0 0 0  
##   
## nb\_predict Dwelling fire Flood Genl Liability Homeowners  
## Cancel Conf 3 0 2 158  
## Cancel Req 0 0 0 0  
## Cancel/DNR 0 0 0 0  
## DB Synch 0 0 0 0  
## New Business 1 0 14 4  
## Non-Renewal 0 0 0 0  
## Policy Change 0 0 0 1  
## Re-Issue 0 0 0 0  
## Reinstate 0 0 0 2  
## Renew Quote 0 0 0 0  
## Renewal 0 0 0 1  
## Renewal Re-Quote 0 0 0 0  
## Rewrite 0 0 0 0  
##   
## nb\_predict Inland marine (comm) Inland Marine (pers)  
## Cancel Conf 0 1  
## Cancel Req 0 0  
## Cancel/DNR 0 0  
## DB Synch 0 0  
## New Business 0 0  
## Non-Renewal 0 0  
## Policy Change 0 0  
## Re-Issue 0 0  
## Reinstate 0 0  
## Renew Quote 0 0  
## Renewal 0 0  
## Renewal Re-Quote 0 0  
## Rewrite 0 0  
##   
## nb\_predict Personal Liability Professional Liab Renters Signs  
## Cancel Conf 0 0 0 1  
## Cancel Req 0 1 0 0  
## Cancel/DNR 0 0 0 0  
## DB Synch 0 0 1 0  
## New Business 0 1 1 0  
## Non-Renewal 0 0 0 0  
## Policy Change 0 0 0 0  
## Re-Issue 0 0 0 0  
## Reinstate 0 0 0 0  
## Renew Quote 0 0 0 0  
## Renewal 0 0 0 0  
## Renewal Re-Quote 0 0 0 0  
## Rewrite 0 0 0 0  
##   
## nb\_predict Umbrella - Comm Umbrella - Personal  
## Cancel Conf 2 4  
## Cancel Req 0 0  
## Cancel/DNR 0 0  
## DB Synch 0 0  
## New Business 0 0  
## Non-Renewal 0 0  
## Policy Change 0 0  
## Re-Issue 0 0  
## Reinstate 0 0  
## Renew Quote 0 0  
## Renewal 0 0  
## Renewal Re-Quote 0 0  
## Rewrite 0 0  
##   
## nb\_predict Watercraft (small boat) Workers comp  
## Cancel Conf 0 0  
## Cancel Req 0 0  
## Cancel/DNR 0 0  
## DB Synch 0 0  
## New Business 1 0  
## Non-Renewal 0 0  
## Policy Change 0 0  
## Re-Issue 0 0  
## Reinstate 0 0  
## Renew Quote 0 0  
## Renewal 0 0  
## Renewal Re-Quote 0 0  
## Rewrite 0 0

table(nb\_predict, test\_ad$master\_company)

##   
## nb\_predict Aimonetti Insurance Beaulah General Agency  
## Cancel Conf 220 0  
## Cancel Req 2 0  
## Cancel/DNR 3 0  
## DB Synch 2 0  
## New Business 1 2  
## Non-Renewal 0 0  
## Policy Change 0 0  
## Re-Issue 0 0  
## Reinstate 3 0  
## Renew Quote 0 0  
## Renewal 0 0  
## Renewal Re-Quote 0 0  
## Rewrite 0 0  
##   
## nb\_predict Beaulah Insurance Beyer Strategic Insurance  
## Cancel Conf 56 32  
## Cancel Req 0 0  
## Cancel/DNR 0 0  
## DB Synch 0 0  
## New Business 1 3  
## Non-Renewal 0 0  
## Policy Change 0 0  
## Re-Issue 0 0  
## Reinstate 0 1  
## Renew Quote 0 0  
## Renewal 0 0  
## Renewal Re-Quote 0 0  
## Rewrite 0 0  
##   
## nb\_predict Borer Group, LLC Brakus Fire & Casualty  
## Cancel Conf 0 2  
## Cancel Req 0 0  
## Cancel/DNR 0 0  
## DB Synch 0 0  
## New Business 0 0  
## Non-Renewal 0 0  
## Policy Change 0 0  
## Re-Issue 0 0  
## Reinstate 0 0  
## Renew Quote 0 0  
## Renewal 0 0  
## Renewal Re-Quote 0 0  
## Rewrite 0 0  
##   
## nb\_predict Breitenberg Insurance DuBuque Insurance  
## Cancel Conf 129 56  
## Cancel Req 0 0  
## Cancel/DNR 16 0  
## DB Synch 2 0  
## New Business 0 1  
## Non-Renewal 0 0  
## Policy Change 0 1  
## Re-Issue 0 0  
## Reinstate 0 4  
## Renew Quote 0 0  
## Renewal 1 0  
## Renewal Re-Quote 0 0  
## Rewrite 0 0  
##   
## nb\_predict Friesen Insurance Helen Herman Group Hui Insurance  
## Cancel Conf 24 2 0  
## Cancel Req 0 1 0  
## Cancel/DNR 0 0 0  
## DB Synch 0 0 0  
## New Business 0 0 2  
## Non-Renewal 0 0 0  
## Policy Change 0 0 0  
## Re-Issue 0 0 0  
## Reinstate 0 0 0  
## Renew Quote 0 0 0  
## Renewal 0 0 0  
## Renewal Re-Quote 0 0 0  
## Rewrite 1 0 0  
##   
## nb\_predict Kilback Excess & Surplus Roderick Insurance  
## Cancel Conf 0 4  
## Cancel Req 1 0  
## Cancel/DNR 0 0  
## DB Synch 0 0  
## New Business 2 0  
## Non-Renewal 0 0  
## Policy Change 0 1  
## Re-Issue 0 0  
## Reinstate 0 0  
## Renew Quote 0 0  
## Renewal 0 0  
## Renewal Re-Quote 0 0  
## Rewrite 0 0  
##   
## nb\_predict Ryan Hyatt Insurance Schimel Mutual Insurance  
## Cancel Conf 10 4  
## Cancel Req 0 0  
## Cancel/DNR 0 0  
## DB Synch 0 0  
## New Business 0 12  
## Non-Renewal 0 0  
## Policy Change 0 0  
## Re-Issue 0 0  
## Reinstate 2 0  
## Renew Quote 0 0  
## Renewal 0 0  
## Renewal Re-Quote 0 0  
## Rewrite 0 0  
##   
## nb\_predict Schuppe Group Simonis Insurance Spinka West Insurance  
## Cancel Conf 47 42 10  
## Cancel Req 0 0 0  
## Cancel/DNR 1 0 0  
## DB Synch 1 0 0  
## New Business 1 0 0  
## Non-Renewal 0 0 0  
## Policy Change 0 0 0  
## Re-Issue 0 0 0  
## Reinstate 0 0 1  
## Renew Quote 0 0 0  
## Renewal 0 0 0  
## Renewal Re-Quote 0 0 0  
## Rewrite 0 0 0  
##   
## nb\_predict Streich Group Insurance Sultan Insurance  
## Cancel Conf 4 0  
## Cancel Req 0 0  
## Cancel/DNR 0 0  
## DB Synch 0 1  
## New Business 0 0  
## Non-Renewal 0 0  
## Policy Change 0 0  
## Re-Issue 0 0  
## Reinstate 1 0  
## Renew Quote 0 0  
## Renewal 0 0  
## Renewal Re-Quote 0 0  
## Rewrite 0 0

#table(nb\_predict, test\_ad$effective\_date) # bin this  
table(nb\_predict, test\_ad$policy\_term)

##   
## nb\_predict 12 Months 6 Months 7 Months  
## Cancel Conf 355 287 0  
## Cancel Req 3 1 0  
## Cancel/DNR 2 18 0  
## DB Synch 3 2 1  
## New Business 25 0 0  
## Non-Renewal 0 0 0  
## Policy Change 2 0 0  
## Re-Issue 0 0 0  
## Reinstate 9 3 0  
## Renew Quote 0 0 0  
## Renewal 1 0 0  
## Renewal Re-Quote 0 0 0  
## Rewrite 1 0 0

table(nb\_predict, test\_ad$policy\_type)

##   
## nb\_predict Commercial Personal  
## Cancel Conf 12 630  
## Cancel Req 3 1  
## Cancel/DNR 0 20  
## DB Synch 0 6  
## New Business 18 7  
## Non-Renewal 0 0  
## Policy Change 0 2  
## Re-Issue 0 0  
## Reinstate 1 11  
## Renew Quote 0 0  
## Renewal 0 1  
## Renewal Re-Quote 0 0  
## Rewrite 0 1

table(nb\_predict, test\_ad$rating\_state)

##   
## nb\_predict FL ND NV OK OR UT WA WY  
## Cancel Conf 639 1 0 0 1 1 0 0  
## Cancel Req 4 0 0 0 0 0 0 0  
## Cancel/DNR 20 0 0 0 0 0 0 0  
## DB Synch 6 0 0 0 0 0 0 0  
## New Business 25 0 0 0 0 0 0 0  
## Non-Renewal 0 0 0 0 0 0 0 0  
## Policy Change 1 0 0 1 0 0 0 0  
## Re-Issue 0 0 0 0 0 0 0 0  
## Reinstate 12 0 0 0 0 0 0 0  
## Renew Quote 0 0 0 0 0 0 0 0  
## Renewal 1 0 0 0 0 0 0 0  
## Renewal Re-Quote 0 0 0 0 0 0 0 0  
## Rewrite 1 0 0 0 0 0 0 0

table(nb\_predict, test\_ad$status)

##   
## nb\_predict Active Inactive  
## Cancel Conf 0 642  
## Cancel Req 0 4  
## Cancel/DNR 0 20  
## DB Synch 0 6  
## New Business 1 24  
## Non-Renewal 0 0  
## Policy Change 1 1  
## Re-Issue 0 0  
## Reinstate 1 11  
## Renew Quote 0 0  
## Renewal 1 0  
## Renewal Re-Quote 0 0  
## Rewrite 1 0

## Confusion Matrix

Build a simple confusion matrix and then plot it.

confusion\_matrix <- table(nb\_predict, test\_ad$transaction\_type)

## Finally, Show Stats on the Confusion Matrix

## Confusion Matrix and Statistics  
##   
##   
## nb\_predict Cancel Conf Cancel Req Cancel/DNR DB Synch New Business  
## Cancel Conf 609 5 0 0 6  
## Cancel Req 1 2 0 0 1  
## Cancel/DNR 15 0 5 0 0  
## DB Synch 1 0 0 3 2  
## New Business 14 0 0 0 7  
## Non-Renewal 0 0 0 0 0  
## Policy Change 0 0 0 0 0  
## Re-Issue 0 0 0 0 0  
## Reinstate 7 0 0 0 2  
## Renew Quote 0 0 0 0 0  
## Renewal 0 0 0 0 0  
## Renewal Re-Quote 0 0 0 0 0  
## Rewrite 0 0 0 0 0  
##   
## nb\_predict Non-Renewal Policy Change Re-Issue Reinstate  
## Cancel Conf 0 15 0 5  
## Cancel Req 0 0 0 0  
## Cancel/DNR 0 0 0 0  
## DB Synch 0 0 0 0  
## New Business 0 2 0 1  
## Non-Renewal 0 0 0 0  
## Policy Change 0 2 0 0  
## Re-Issue 0 0 0 0  
## Reinstate 0 1 0 2  
## Renew Quote 0 0 0 0  
## Renewal 0 0 0 0  
## Renewal Re-Quote 0 0 0 0  
## Rewrite 0 0 0 0  
##   
## nb\_predict Renew Quote Renewal Renewal Re-Quote Rewrite  
## Cancel Conf 1 0 1 0  
## Cancel Req 0 0 0 0  
## Cancel/DNR 0 0 0 0  
## DB Synch 0 0 0 0  
## New Business 0 1 0 0  
## Non-Renewal 0 0 0 0  
## Policy Change 0 0 0 0  
## Re-Issue 0 0 0 0  
## Reinstate 0 0 0 0  
## Renew Quote 0 0 0 0  
## Renewal 0 1 0 0  
## Renewal Re-Quote 0 0 0 0  
## Rewrite 0 0 0 1  
##   
## Overall Statistics  
##   
## Accuracy : 0.8864   
## 95% CI : (0.8608, 0.9088)  
## No Information Rate : 0.9074   
## P-Value [Acc > NIR] : 0.9747   
##   
## Kappa : 0.374   
##   
## Mcnemar's Test P-Value : NA   
##   
## Statistics by Class:  
##   
## Class: Cancel Conf Class: Cancel Req  
## Sensitivity 0.9413 0.285714  
## Specificity 0.5000 0.997167  
## Pos Pred Value 0.9486 0.500000  
## Neg Pred Value 0.4648 0.992948  
## Prevalence 0.9074 0.009818  
## Detection Rate 0.8541 0.002805  
## Detection Prevalence 0.9004 0.005610  
## Balanced Accuracy 0.7206 0.641441  
## Class: Cancel/DNR Class: DB Synch Class: New Business  
## Sensitivity 1.000000 1.000000 0.388889  
## Specificity 0.978814 0.995775 0.974101  
## Pos Pred Value 0.250000 0.500000 0.280000  
## Neg Pred Value 1.000000 1.000000 0.984012  
## Prevalence 0.007013 0.004208 0.025245  
## Detection Rate 0.007013 0.004208 0.009818  
## Detection Prevalence 0.028050 0.008415 0.035063  
## Balanced Accuracy 0.989407 0.997887 0.681495  
## Class: Non-Renewal Class: Policy Change  
## Sensitivity NA 0.100000  
## Specificity 1 1.000000  
## Pos Pred Value NA 1.000000  
## Neg Pred Value NA 0.974684  
## Prevalence 0 0.028050  
## Detection Rate 0 0.002805  
## Detection Prevalence 0 0.002805  
## Balanced Accuracy NA 0.550000  
## Class: Re-Issue Class: Reinstate Class: Renew Quote  
## Sensitivity NA 0.250000 0.000000  
## Specificity 1 0.985816 1.000000  
## Pos Pred Value NA 0.166667 NaN  
## Neg Pred Value NA 0.991441 0.998597  
## Prevalence 0 0.011220 0.001403  
## Detection Rate 0 0.002805 0.000000  
## Detection Prevalence 0 0.016830 0.000000  
## Balanced Accuracy NA 0.617908 0.500000  
## Class: Renewal Class: Renewal Re-Quote Class: Rewrite  
## Sensitivity 0.500000 0.000000 1.000000  
## Specificity 1.000000 1.000000 1.000000  
## Pos Pred Value 1.000000 NaN 1.000000  
## Neg Pred Value 0.998596 0.998597 1.000000  
## Prevalence 0.002805 0.001403 0.001403  
## Detection Rate 0.001403 0.000000 0.001403  
## Detection Prevalence 0.001403 0.000000 0.001403  
## Balanced Accuracy 0.750000 0.500000 1.000000

The predictive quality for agency data shows promise. Some very specific points about the results: 1. A 0.8863955 accuracy for transaction\_type is very good.

1. There’s a 95% chance that the accuracy is between 88% and 93% - also very good.
2. The accuracy is greater than the No Information Rate, which indicates significance.