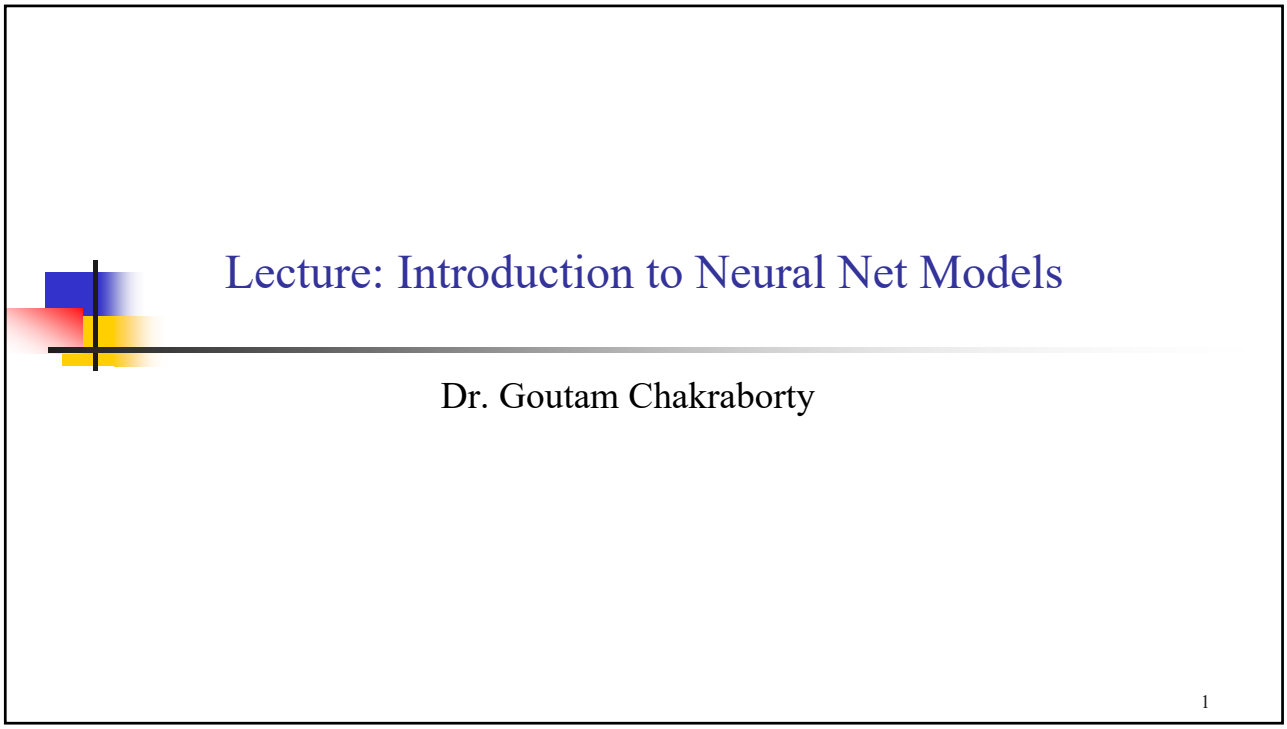
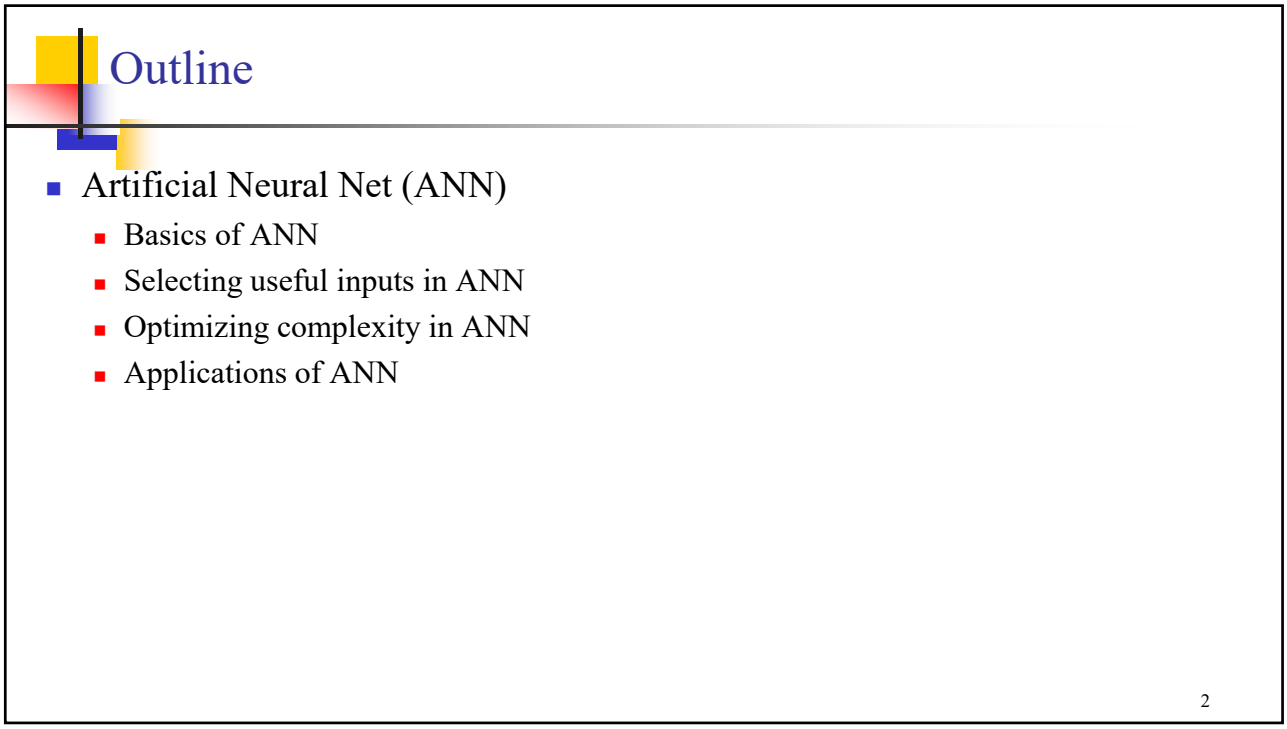

Lecture: Introduction to Neural Net Models
Dr. Goutam Chakraborty
1

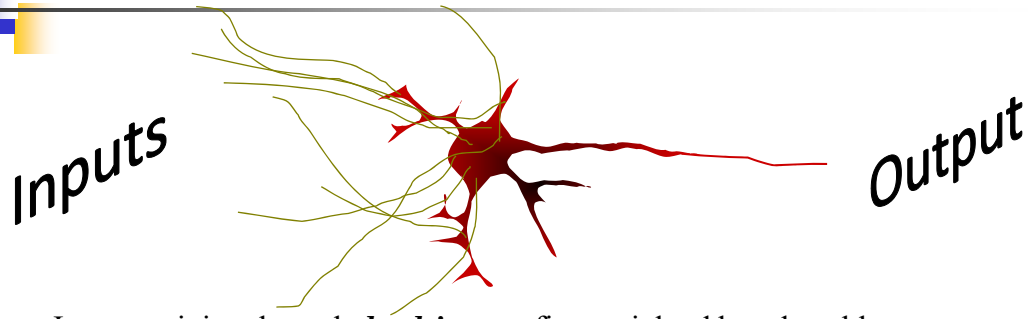

Outline
Artificial Neural Net (ANN)
Basics of ANN
Selecting useful inputs in ANN
Optimizing complexity in ANN
Applications of ANN
2

Artificial Neural Net (ANN)

- Developed with the intention to resemble how the human brain works (in particular its ability to learn from experience)!

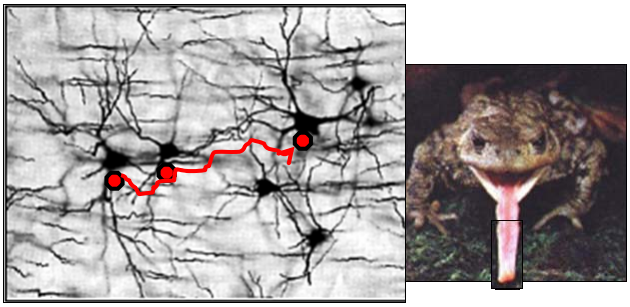
3

The Biological Neuron



- Inputs arriving through ***dendrites*** are first weighted by adaptable synapses before being summed.
- If the sum is greater than an adaptable ***bias***, the neuron sends a signal down its axon to other neurons.

A Frog, a Fly and a Neural Net?



How does a frog catch a fly?

- A neuron fires in visual system in response to fly-like movement
- Another neuron fires in response to size of the fly
- The signals pass on to another neuron downstream
- When this neuron fires, it results in tongue-flicking behavior

Source: Data Mining techniques by Berry and Linoff

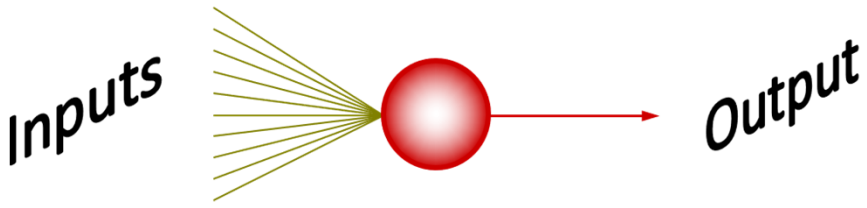
5

The Mathematical (Artificial) Neuron

- The mathematical neuron has two parts:
  - combination function (pre-activation)
  - activation function

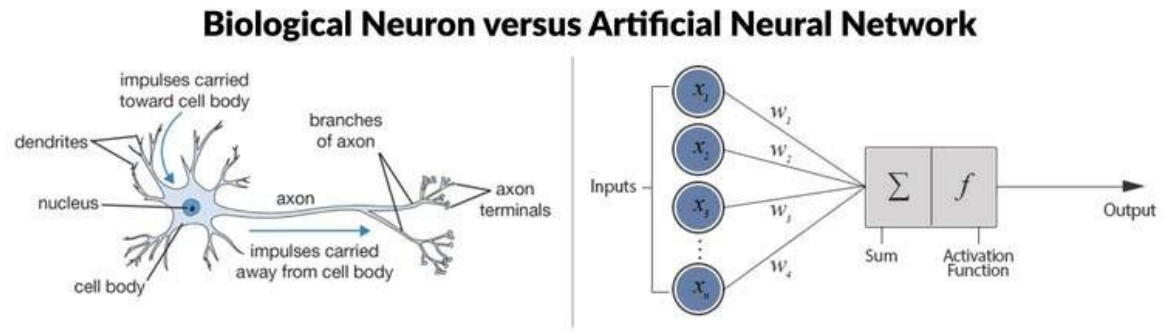
$$H = f\left(w_0 + \sum_{i=1}^{d} w_i x_i\right)$$

Bias Value



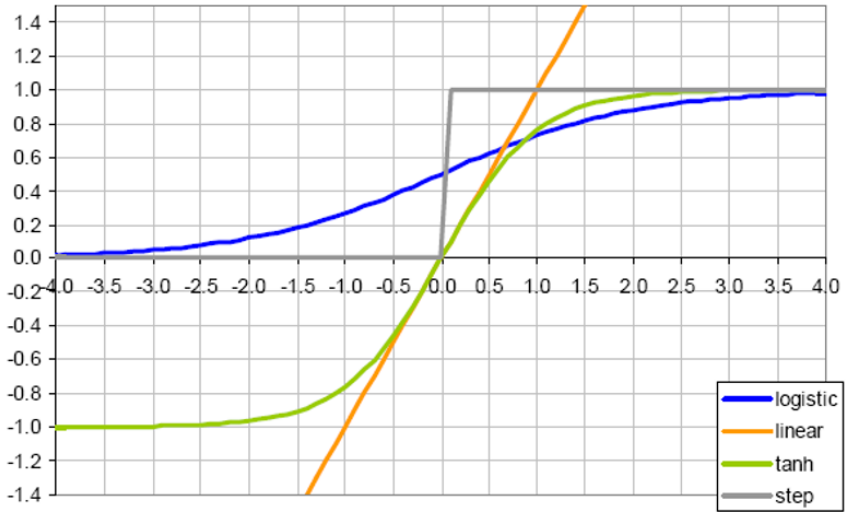
...

Biological Versus Artificial Neural Network



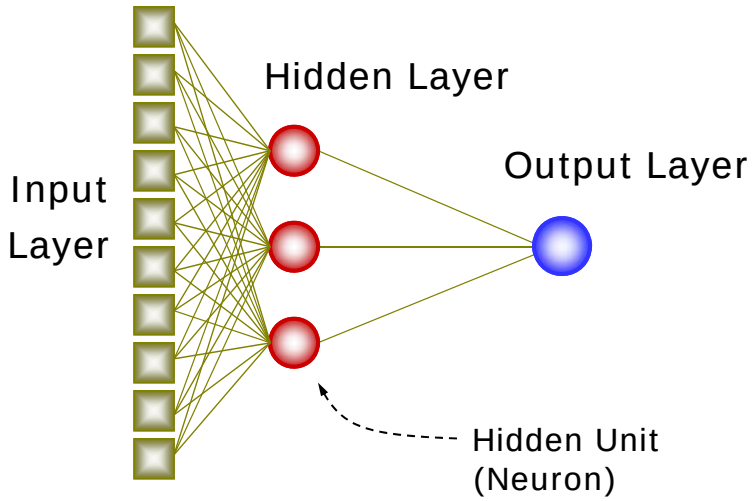
7

Different Activation (or, Transfer) Functions



8

Multilayer Perceptron (MLP)



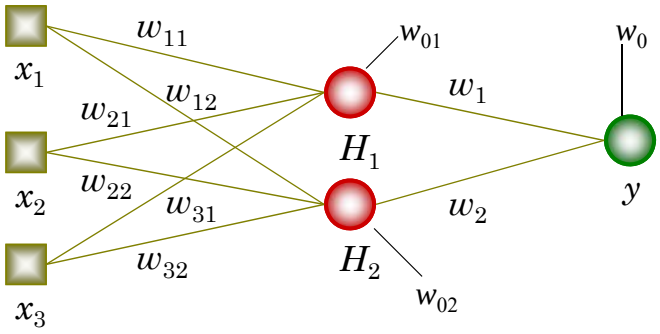
9

Feed-Forward Neural Network

$$y = w_0 + w_1 H_1 + w_2 H_2$$

$$H_1 = g_1(w_{01} + w_{11}x_1 + w_{21}x_2 + w_{31}x_3)$$

$$H_2 = g_2(w_{02} + w_{12}x_1 + w_{22}x_2 + w_{32}x_3)$$



10

Feed Forward Neural Network

- Input data vales are passed through from input layer to hidden layer to the output layer
  - Usually all input values are massaged/transformed so that their ranges are restricted to either (0,1) or (-1,1)
  - The output value is also restricted to (0,1) but we can always convert it back to its original range
- Values for all weights start randomly and updated as each observation is fed through the ANN and the error sent back

11

Model Essentials – Neural Networks

Predict new cases.	Prediction formula
Select useful inputs.	None
Optimize complexity.	Stopped training

...

Model Essentials – Neural Networks

- Predict new cases. — Prediction formula
- Select useful inputs. — None
- Optimize complexity. — Stopped training

...

Neural Nets: Beyond the Prediction Formula

- Manage missing values.
- Handle extreme or unusual values.
- Use non-numeric inputs.
- Account for nonlinearities.
- Interpret the model.

...

Demo 1: Neural Net using JMP Pro

Dr. Goutam Chakraborty

15

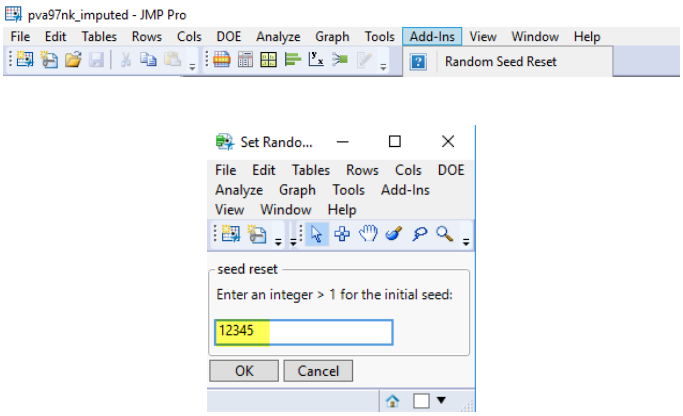
Outline

- Add Random Seed Add-In and set seed to 12345
- Run ANN without any variable selection
- Explore results

16

Random Seed Reset Add-In

- First, get "Random Seed Reset Add In".
- Double-click on the file and it should prompt you for installing the Add-In. Accept
- If things go right, in your JMP top-menu, you will see Random Seed Reset under Add-ins
- Open the Add-In and set seed to 12345 – Must do this **every time** you run Neural



17

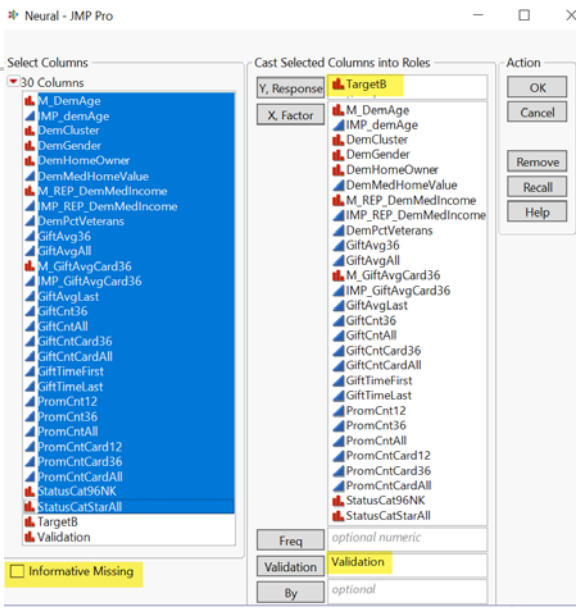
Continue with Data Set Pva97nk_imputed

- Delete all predicted probabilities from running of earlier models
- Makes sure following variables are set to rejected (right-click on variable name under columns and select exclude) :
  - DemAge, DemMedIncome, REP_DemMedIncome and GiftAvgCard36 (because we have imputed their missing values and will use the new variables such as M_DemAge and Imp_DemAge and so on)
  - TargetD

18

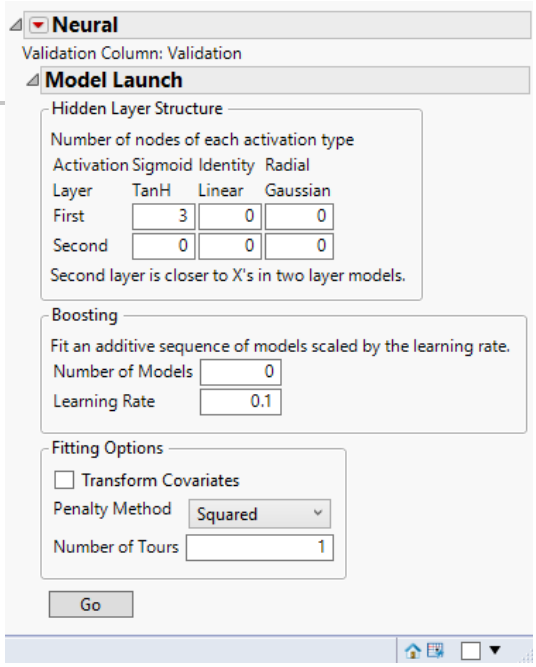
JMP Steps

- Data set: pva97nk_imputed
- Analyze > Predictive Modeling > Neural
- TargetB as Y
- All available variables as X
- Validation as Validation
- Do not check the box of Informative Missing
- Click OK



JMP Steps (Contd.)

- Use default options in Model launch platform for now
- Click **Go**



ANN Results

Neural

Validation Column: Validation

Model Launch

Model NTanH(3)

Training

TargetB

Measures	Value
Generalized RSquare	0.050471
Entropy RSquare	0.0278356
RMSE	0.4903782
Mean Abs Dev	0.4821276
Misclassification Rate	0.4183357
-LogLikelihood	3263.4702
Sum Freq	4843

Confusion Matrix

Actual	Predicted Count	
TargetB	0	1
0	1275	1147
1	879	1542

Confusion Rates

Actual	Predicted Rate	
TargetB	0	1
0	0.526	0.474
1	0.363	0.637

Validation

TargetB

Measures	Value
Generalized RSquare	0.039561
Entropy RSquare	0.0217269
RMSE	0.4924916
Mean Abs Dev	0.484115
Misclassification Rate	0.4270081
-LogLikelihood	3283.9765
Sum Freq	4843

Confusion Matrix

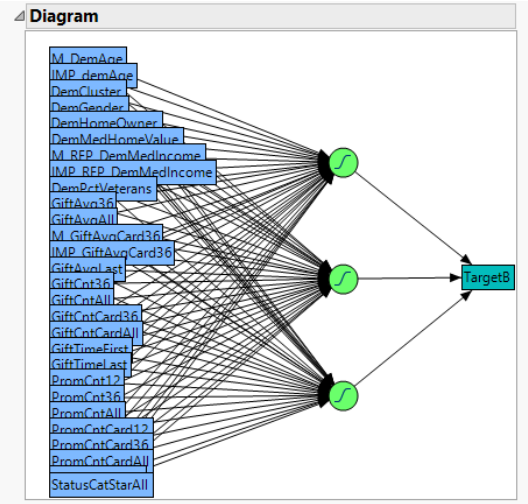
Actual	Predicted Count	
TargetB	0	1
0	1272	1149
1	919	1503

Confusion Rates

Actual	Predicted Rate	
TargetB	0	1
0	0.525	0.475
1	0.379	0.621

21

Diagnostics (Red Triangle Options for Model > Diagram)



22

Diagnostics (Red Triangle Options for Model > Show Estimates)

Neural

Model NTanH(3)

Training | Validation

Estimates

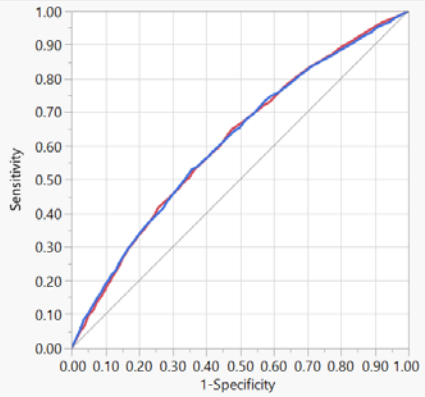
Parameter	Estimate
H1_1:M_DemAge:0	-0.05401
H1_1:IMP_demAge	-0.10284
H1_1:DemCluster:00	-1.83537
H1_1:DemCluster:01	-0.0074
H1_1:DemCluster:02	-2.25881
H1_1:DemCluster:03	-4.05407
H1_1:DemCluster:04	-4.76268
H1_1:DemCluster:05	0.178039
H1_1:DemCluster:06	-1.15895
H1_1:DemCluster:07	-4.26351
H1_1:DemCluster:08	0.522644
H1_1:DemCluster:09	-1.49378
H1_1:DemCluster:10	2.105938
H1_1:DemCluster:11	-5.1316
H1_1:DemCluster:12	2.275568
H1_1:DemCluster:13	-2.02893
H1_1:DemCluster:14	-0.28969
H1_1:DemCluster:15	-2.55927
H1_1:DemCluster:16	1.303225
H1_1:DemCluster:17	-0.39582
H1_1:DemCluster:18	-0.69183
H1_1:DemCluster:19	-2.68023
H1_1:DemCluster:20	-2.45755
H1_1:DemCluster:21	1.41054
H1_1:DemCluster:22	0.587687
H1_1:DemCluster:23	-0.48423
H1_1:DemCluster:24	-5.74396
H1_1:DemCluster:25	0.026394

23

Diagnostics (Red Triangle Options for Model > ROC Curve)

Training

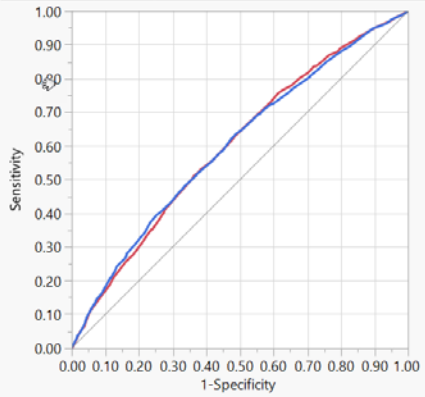
Receiver Operating Characteristic



TargetB	Area
0	0.6130
1	0.6130

Validation

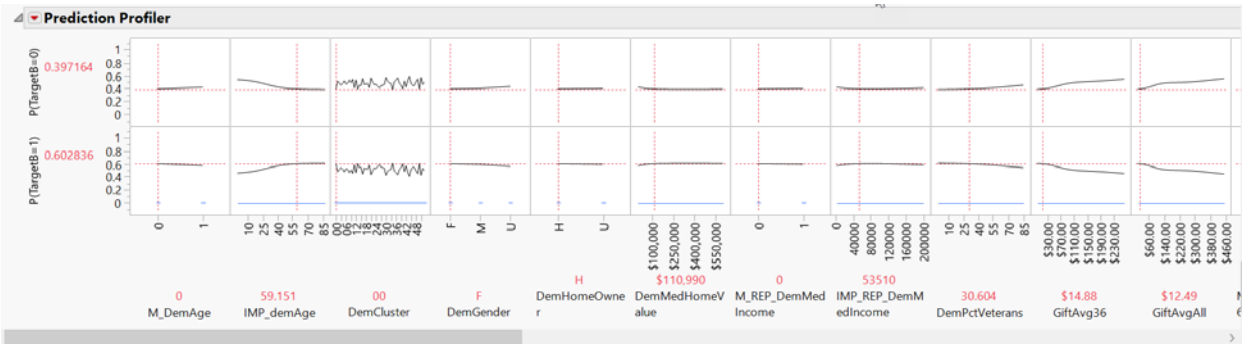
Receiver Operating Characteristic on Validation Data



TargetB	Area
0	0.6005
1	0.6005

24

Diagnostics (Red Triangle Options for Model > Profiler)



A Summary of Models Built so Far

Model	# of Vars	Valid Misc	Valid Sens	Valid Spec	
Auto Tree	4	43.01%	61.80%	52.17%	
ANN	262	42.70%	62.10%	47.50%	

Optional: Saving some details from this model (from red triangle)

- Save prediction formula
- Publish prediction formula

27

Demo 2: LR and Neural Net using JMP Pro

Dr. Goutam Chakraborty

28

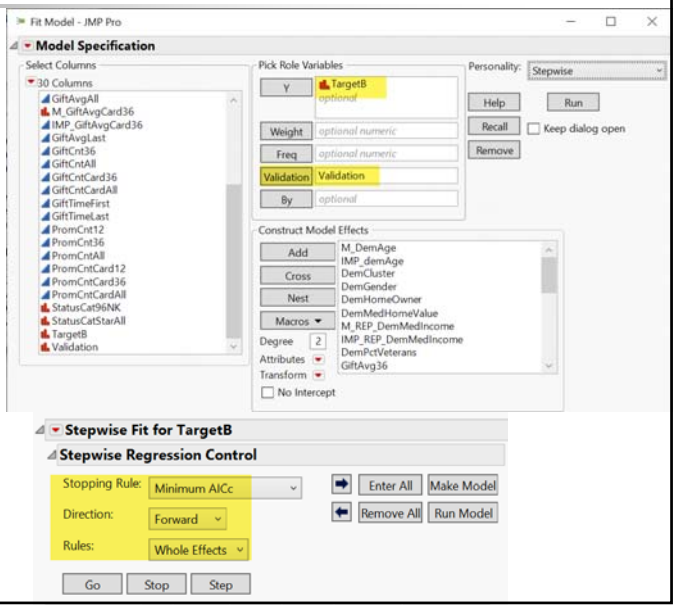
Outline

- Use LR as a *predictive model* with **Minimum AICC** as variable selection criteria
  - Use validation to select least complex best performing model
  - To establish a baseline model for comparison with DT and ANN
  - To select variables for ANN
- Run ANN with the variables selected by the LR model
  - Compare results

29

Running LR Stepwise

- JMP, Analyze> Fit Model > Select TargetB as Y > Change Personality to Stepwise> All other variables as Add Construct Model Effects > Validation as Validation > Run
- Change Stepwise Regression Control as shown > GO
- *After Forward selection with Minimum AICC runs*, **click**
- **Make Model > Change Target level to 1 > Run Model**
- Explore results



LR (Min. AICC) Output from JMP

Nominal Logistic Fit for TargetB

Effect Summary

Source	LogWorth	PValue
GiftTimeLast	11.544	0.00000
DemMedHomeValue	4.418	0.00004
PromCnt12	2.840	0.00145
GiftCntCard36	2.393	0.00405
IMP_demAge	2.317	0.00481
GiftAvgLast	2.236	0.00580
PromCnt36	1.091	0.08102
StatusCatStarAll	0.849	0.14170
GiftCntCardAll	0.448	0.35623
GiftCnt36	0.054	0.88301

Converged in Gradient, 3 iterations

Iterations

Whole Model Test

Model	-LogLikelihood	DF	ChiSquare	Prob>ChiSq
Difference	96.1787	10	192.3574	<.0001*
Full	3260.7330			
Reduced	3356.9117			

RSquare (U)	0.028
AICc	6543.52
BIC	6614.8
Observations (or Sum Wgts)	4843

31

LR Output: Red Triangle > Confusion Matrix

Confusion Matrix

Training

Actual TargetB	Predicted Count 1	0
1	1340	1081
0	959	1463

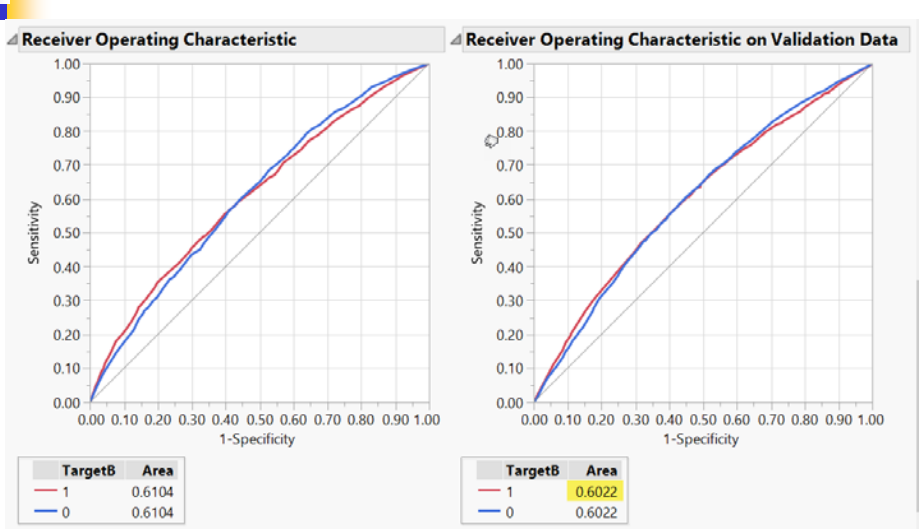
Validation

Actual TargetB	Predicted Count 1	0
1	1357	1065
0	984	1437

% Overall correct in Validation = (1357+1437)/(1357+1065+984+1437) = 2794/4843 = 57.67%
% Misclassification in Validation = 100-57.67 = 42.33%
% Sensitivity in Validation = 1357/(1357+1065) = 1357/2422 = 56.0%
% Specificity in Validation = 1437/ (1437+984) = 1437/2421 = 59.36%

32

LR Output: Red Triangle > ROC Curve



33

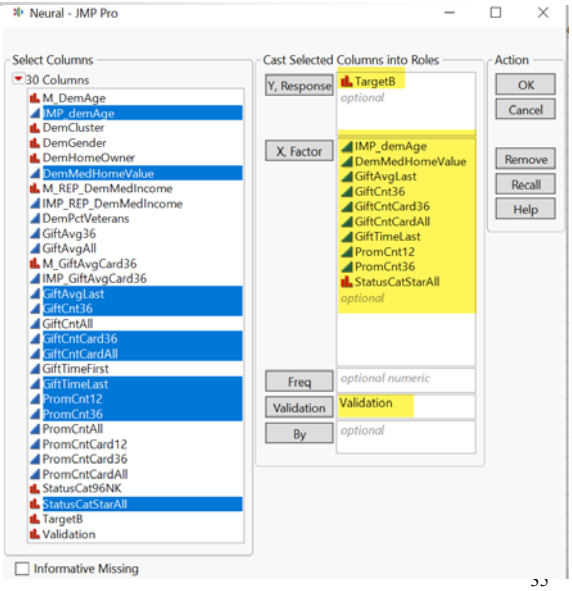
A Summary of Models Built So Far

Model	# of Vars	Valid Misc	Valid Sens	Valid Spec	AUC
Auto Tree	4	43.01%	61.80%	52.17%	0.58
ANN	262	42.70%	62.10%	47.50%	0.6
LR (AICC)	10	42.33%	56.00%	59.36%	0.6

34

Using only Selected Variables from LR in ANN

- **First**, reset random seed to 12345 (have to do this every time before you run a model)
- Use only 10 input as shown on screen shots for X, Factor> OK
- Run ANN model with default options



33

Neural Results (10 Variables from Stepwise LR)

Model NTanH(3)

Training

TargetB

Measures	Value
Generalized RSquare	0.0382156
Entropy RSquare	0.0209771
RMSE	0.4927315
Mean Abs Dev	0.4842627
Misclassification Rate	0.4220524
-LogLikelihood	3286.4934
Sum Freq	4843

Confusion Matrix

Actual TargetB	Predicted Count 0	1
0	1605	817
1	1227	1194

Confusion Rates

Actual TargetB	Predicted Rate 0	1
0	0.663	0.337
1	0.507	0.493

Validation

TargetB

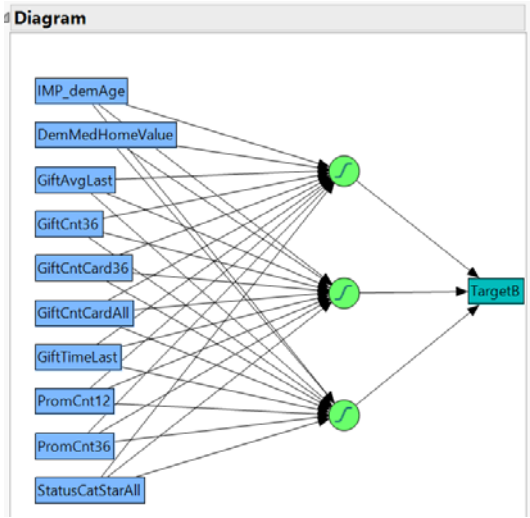
Measures	Value
Generalized RSquare	0.0428402
Entropy RSquare	0.0235575
RMSE	0.4918254
Mean Abs Dev	0.4833403
Misclassification Rate	0.4123477
-LogLikelihood	3277.8312
Sum Freq	4843

Confusion Matrix

Actual TargetB	Predicted Count 0	1
0	1611	810
1	1187	1235

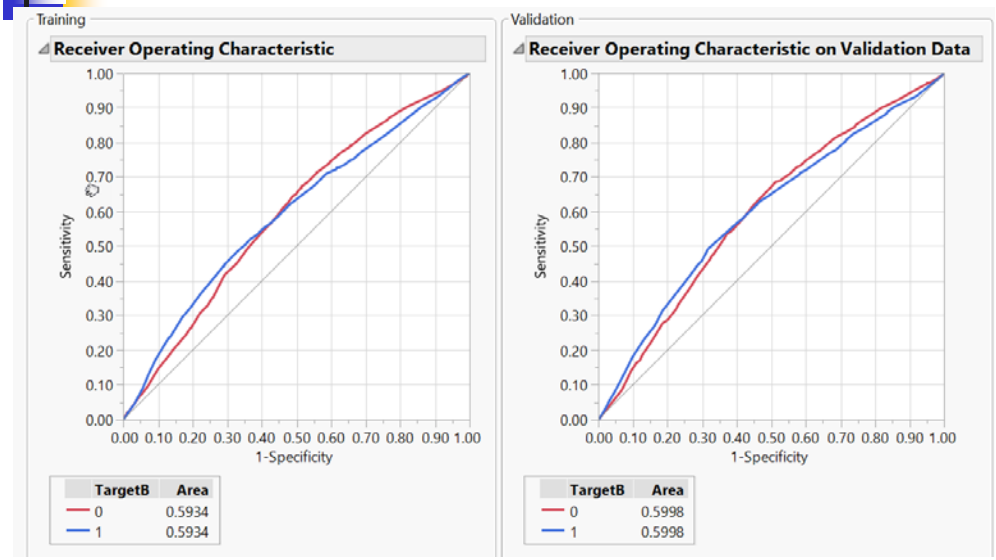
Confusion Rates

Actual TargetB	Predicted Rate 0	1
0	0.665	0.335
1	0.490	0.510



36

Red Triangle > ROC Curve



37

A Summary of Models Built so Far

Auto Tree	4	43.01%	61.80%	52.17%	0.58
ANN	262	42.70%	62.10%	47.50%	0.6
LR (AICC)	10	42.33%	56.00%	59.36%	0.6
LR+ANN	37	41.20%	51.00%	66.50%	0.6

38