



# WEST COAST UNIVERSITY

## Ensemble Predictions of Graduates' Success at High-Stakes Licensure Examinations

Dr. Jeb Egbert, University Provost

Dr. Mahmoud AlBawaneh, University Director of Institutional Research

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# Agenda

- Who We are
- Introduction
- Motivation
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- Predictors Used in Modeling
- Predictive Model Building
- Classification-Type Models
- Ensemble Creation
- Results
- From Predictive Analytics to Operationalized Analytics

Dr. Jeb Egbert, University Provost

# Who We are

West Coast University is a multi-state and multi-campus offering and delivering health care education

**Orange County Campus**



**Los Angeles Campus**



**Miami Campus**



**Ontario Campus**



**Los Angeles Campus  
North Hollywood**



**Dallas Campus**



# Who We are

## Undergraduate and Graduate Programs:

### Undergraduate Degrees

- BS in Nursing
- LVN to BSN
- RN to BSN
- BS in Dental Hygiene

### Graduate Degrees

- MS in Nursing
- MS in Occupational Therapy
- Mater of Health Administration

### Doctoral Programs

- Doctor of Physical Therapy
- Doctor of Pharmacy

## Active Enrollment {11/5/2014}

Program	Headcount
<b>BSN</b>	<b>4,233</b>
RN-BSN	56
DHYG	181
MSN	60
MSOT	71
MSHCM	45
DPT	40
PARMD	42
Grand Total	4,729

# Introduction

## NCLEX-RN

National Council Licensure Examination {NCLEX} developed by National Council of State Boards of Nursing (NCSBN) for the licensing of nurses in the US

- ✓ Successful graduation from an accredited nursing program is the first step in becoming an RN
- ✓ Additionally, graduates must pass NCLEX-RN in order to be practicing RN

# Motivation

- ✓ West Coast University wishes to have better than State average NCLEX outcomes. And we *strive* to consistently exceed 90% pass rates
- ✓ **Programmatic Accreditation** : The Commission on Collegiate Nursing Education (CCNE)

*“The NCLEX-RN pass rate for each campus/site and track is 80% or higher for the first-time takers for the most recent calendar year”*

- ✓ **California Board of Registered of Nursing**

***“1431. Licensing Examination Pass Rate Standard***

*The nursing program shall maintain a minimum pass rate of seventy-five percent (75%) for first time licensing examination candidates.”*

- ✓ Job Placement Rates, Loan Default Rates and Gainful Employment

Dr. Mahmoud AlBawaneh,  
University Director of Institutional Research



# Objective

- ✓ **Predict if a student will PASS or FAIL NCLEX-RN exam one term before graduation**
  - 1) Response is *categorical*: Either **Pass** or **Fail**
  - 2) Predictors (or features) can be *categorical* or *numerical*

	Predictor 1 {Gender}	Predictor 2 {CGPA}	Predictor 3 {Race}	....	Predictor m {# Failed Courses}	Response {NCLEX-RN Outcome}
Obs 1	Male	3.00	African American		0.00	Pass
Obs 2	Female	2.00	White		2.00	Fail
Obs 3	Female	2.50	Hispanic		3.00	Fail
.....						
Obs n	Female	3.75	Asian		0.00	Pass

- ✓ **Classification-type models**
- ✓ **Classifier** (Either Pass or Fail)

# Predictors {or Features} Used in Modeling

Student Demographic Data	
Gender	Nominal
Age	Continuous
Race/Ethnicity	Nominal
Campus	Nominal
Student Admission Data	
HESI	Continuous
TEAS V	Continuous
SAT	Continuous
ACT	Continuous
Third-Party Proctored Assessment Data	
Maternal Newborn	Continuous
Fundamentals	Continuous
Adult Medical Surgical	Continuous
Mental Health	Continuous
Pharmacology	Continuous
Nursing Care of Children	Continuous
Community Health	Continuous
Nutrition	Continuous
Leadership	Continuous

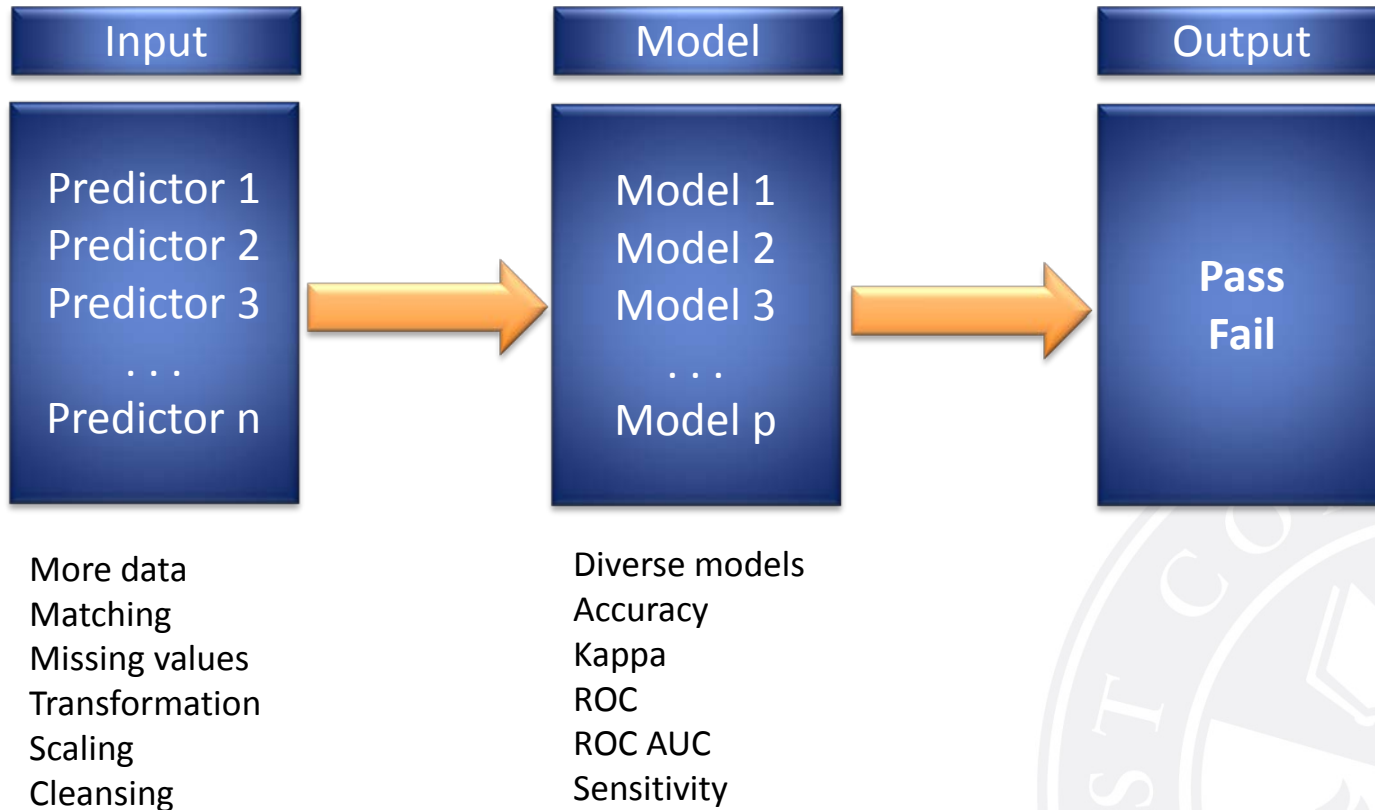
Student Academic Data (course by course)	
Science Courses	Continuous
General Education Courses	Continuous
Non-Clinical Nursing Courses	Continuous
Clinical Nursing Courses	Continuous
Derived Aggregate Variables	
Number of Transfer Courses	Continuous
Number of Failed Science Courses	Continuous
Number of Failed GE Courses	Continuous
Number of Failed Non-Clinical Nursing Courses	Continuous
Number of Failed Clinical Nursing Courses	Continuous
Science GPA	Continuous
General Education GPA	Continuous
Non-Clinical Nursing GPA	Continuous
Clinical Nursing GPA	Continuous

**96 Predictors {Features or Columns}**

**2362 Observations {Rows}**

# Predictive Model Building

- ✓ Input → Modeling → Output {IMO}
- ✓ Predictors → Classifier → Predicted Response



# Classification-Type Models

## Rule Induction Models:

- **CART**
  - ✓ Classification and Regression Tree
  - ✓ Grows a tree using Information gain
- **C5**
  - ✓ Proprietary algorithm like C&R Tree
  - ✓ Grows a tree using Information gain
- **CHAID**
  - ✓ Chi Square Automatic Interaction Detection
  - ✓ Grows a tree using Significance test
- **Quest**
  - ✓ Quick Unbiased Efficient Statistical Tree
  - ✓ Grows a tree using Significance test
- **Decision List**
  - ✓ Produces a list of rules not a tree

# Classification-Type Models

## Traditional Statistical Models:

- Make certain assumptions
- Produce equations
- Statistical tests may guide feature selection

- **Logistic Regression**

- **Discriminant**

- ✓ Generates a linear combination of features in order to separate between groups
- ✓ Similar to ANOVA

- **GLM**

- ✓ Generalized Linear Model

# Classification-Type Models

## Machine Learning Models:

- Do not make certain assumptions
- Do not generate set of rules
- Black box models

- **Neural Networks**

- **SVM**

- ✓ Support Vector Machines
- ✓ Similar to **Discriminant**
- ✓ Use complex functions

- **Bayesian Network**

- ✓ Bayes nets
- ✓ Graphical Models for reasoning under uncertainty
- ✓ Diagnostic and predictive reasoning

- **KNN**

- ✓ k-nearest neighbors

## What is Ensemble?

Ensemble is a *collection of models* whose predictions are combined by weighted averaging or voting

# Ensemble Creation

**STEP 1**: Split the dataset into:

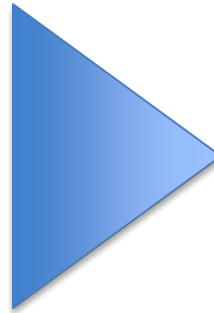
- ✓ Stratified sampling
- **Training** {70%}
- **Testing** {30%}



# Ensemble Creation

**STEP 2**: Build several models using **ONLY** the **Training set**

Model Type
CART
C5
CHAID
QUEST
Discriminant
Logistic
NN
SVM
Bayes Net
KNN
...



- Diverse Models
- 40 different models were built

# Ensemble Creation

## **STEP 3**: Assess each model based on the **Testing** set

Model Type	Accuracy
CART	82%
C5	87%
CHAID	75%
QUEST	70%
Discriminant	77%
Logistic	76%
NN	85%
SVM	84%
Bayes Net	60%
KNN	77%
...	....

# Ensemble Creation

**STEP 4:** Select models with above acceptable business “cut off” value

✓ Cut off  $\geq 80\%$

Model Type	Accuracy on Testing data
CART	82%
C5	87%
CHAID	75%
QUEST	70%
Discriminant	77%
Logistic	76%
NN	85%
SVM	84%
Bayes Net	60%
KNN	81%
...	....

	Selected
	Not Selected

# Ensemble Creation

**STEP 5**: Combine {Assemble} ODD # of selected models using voting

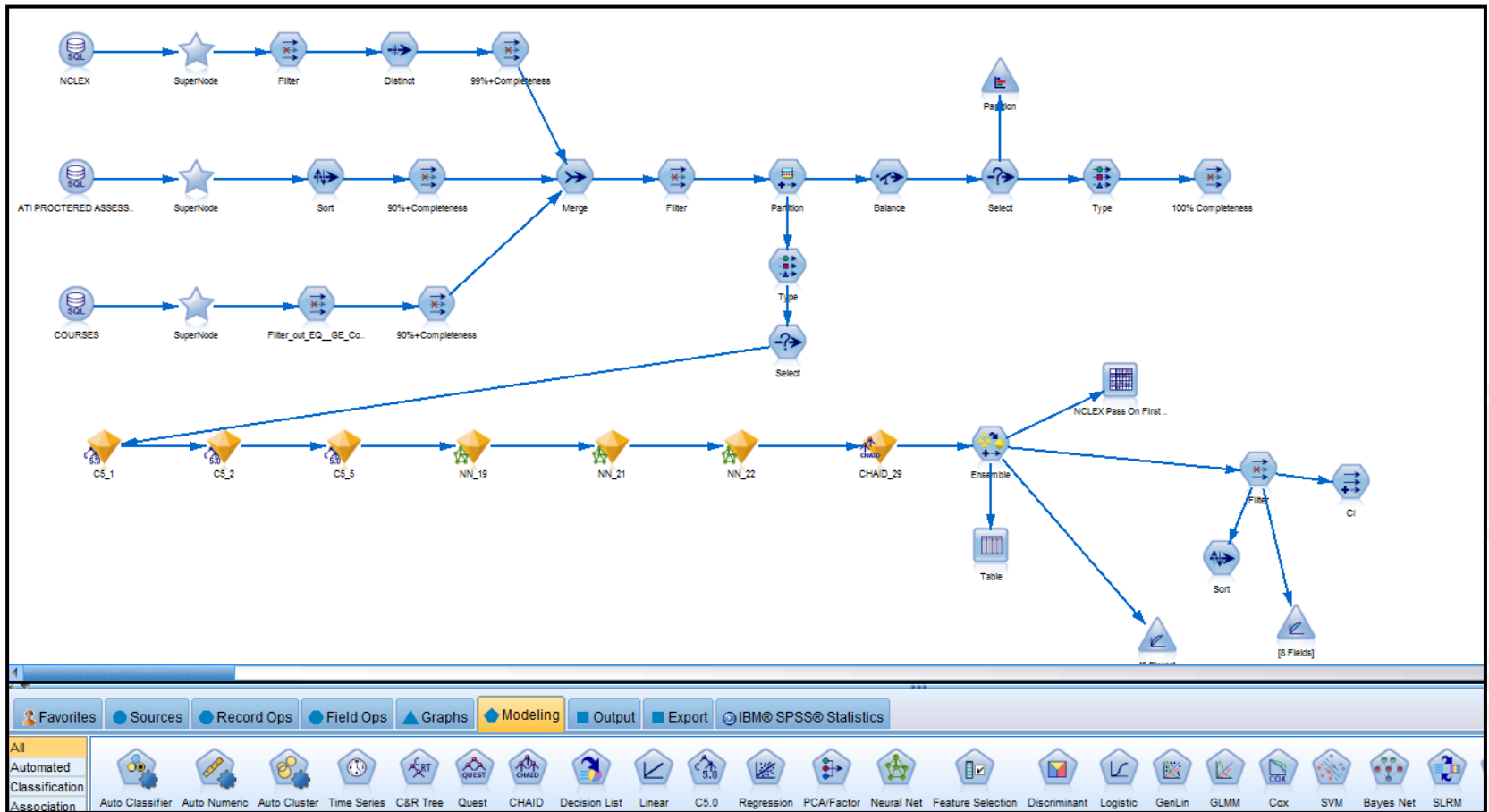
Obs	CART	C5	NN	SVM	KNN	Predicted Class
Obs 1	Pass	Pass	Fail	Fail	Pass	Pass
Obs 2	Pass	Pass	Pass	Pass	Fail	Pass
Obs 3	Fail	Fail	Pass	Fail	Fail	Fail
...	...	...	...	...	...	...
Obs n	Fail	Fail	Fail	Fail	Fail	Fail

## Results

- Best **single** model performance on testing is C5
  - ✓ Overall Accuracy  $\approx 83\%$
  
- **Ensemble** model performance on testing is:
  - ✓ Overall Accuracy  $\approx 91\%$

# Software Used

- IBM SPSS Modeler



Galina Belokurova,  
Institutional Research Specialist

# From Predictive Analytics to Operationalized Analytics

## NOTA DASHBOARD

NCLEX OPERATIONAL, TRACKING AND ANALYSIS DASHBOARD

Please Contact Director of Institutional Research (Mahmoud AlBawaneh) at [Malbawaneh@westcoastuniversity.edu](mailto:Malbawaneh@westcoastuniversity.edu) or (949) 783 4801 if you have any question

NOTA  
RELEASE 1.0

<p style="text-align: center; margin: 0;"><b>EXECUTIVE CORNER</b> President, CEO Provost COO Campus Executive Directors Executive Director, Campus Operations</p>	<p style="text-align: center; margin: 0;"><b>ACADEMIC CORNER</b> College Dean Associate College Dean Campus Deans ADONs</p>	<p style="text-align: center; margin: 0;"><b>FACULTY CORNER</b> NCLEX Specialists NCLEX Faculty Coordinators FT NURSING Faculty</p>	<p style="text-align: center; margin: 0;"><b>DATA ENTRY CORNER</b> Testing Coordinators (TCs)</p>
<u>PAST PERFORMANCE</u>	<u>GUIDED ANALYTICS FOR INSIGHTS</u>	<u>REVIEW AT RISK ACTIVE STUDENTS &amp; CREATE ACADEMIC ACTION PLANS</u>	<u>TCs MUST UPDATE CLA ON DAILY BASIS</u>
HISTORICAL PASS RATES	QUARTERLY ANALYTICS	ACTIVE STUDENTS STARS	NCLEX AND VATI DATA ENTRY VERIFICATION
<u>CURRENT PERFORMANCE</u>	UP-TO-DATE ANALYTICS	<u>REVIEW AT RISK GRADS NOT TESTED YET &amp; ENGAGE IN ATI VATI</u>	<u>CONTACT GRADUATES NOT TESTED YET NOT ACTIVE IN VATI TO INCREASE PARTICIPATION</u>
CURRENT QUARTER PASS RATES	MULTI VARIABLES ANALYTICS	GRADUATES NOT TESTED STARS	GRADUATES NOT TESTED YET BY VATI STATUS
ATI VATI STATS	COURSES ANALYTICS		
NCLEX PASS RATES WEEKLY GOALS	GRADS COHORT ANALYTICS		
<u>FUTURE PERFORMANCE INDICATORS</u>	<u>TIME TREND FOR ENTERING CORE NURSING COHORT</u>		
WCU-ATI STARS STATS	CORE NURSING STARS		
WCU-IR STARS STATS			



# From Predictive Analytics to Operationalized Analytics

HOVER FOR HELP

## NCLEX ACTIVE STARS OPERATIONAL DASHBOARD

DOUBLE CLICK TO GO BACK

Please Contact Director of Institutional Research (Mahmoud AlBawaneh) at [Malbawaneh@westcoastuniversity.edu](mailto:Malbawaneh@westcoastuniversity.edu) or (949) 783 4801 if you have any question

LastName, FirstName	StuNum	Risk Level	DidGPA	NURSGPA	#FDid	# ATI Assessments Taken	% Of ATI Assessments Failed
	W220279	None	3.90	3.91	0	7	14%
	W229810	None	3.86	3.87	0	8	0%
	W215866	None	3.79	3.82	0	9	22%
	W262788	None	3.71	3.71	0	10	30%
	W249157	None	3.69	3.70	0	10	30%
	W163266	None	3.66	3.71	0	10	0%
	W200569	None	3.66	3.70	0	10	0%
	W215055	None	3.65	3.66	0	10	30%
	W249809	None	3.64	3.66	0	8	63%
	W256075	None	3.63	3.64	0	9	33%
	W183224	None	3.62	3.67	0	12	17%
	W173849	None	3.60	3.65	0	10	10%

FERPA

LastName, FirstName:   
 Risk Level:  None  Moderate  Low  High  
 Expected Graduation Date:   
 Campus:   
 Proficiency Level:   
 Grade:

StuNum	CourseCode	Course Taken	College	Grade
W87515	ANAT 260	May,2009	CHAFFEY COLL.	TC
	CHEM 260	June,2012	West Coast Uni	C+
	ENGL 140	May,2007	CHAFFEY COLL.	TC
	ENGL 340	April,2012	West Coast Uni	A
	HCA 206	June,2012	West Coast Uni	B-
	HCA 434	August,2012	West Coast Uni	B-
	HUM 470	April,2012	West Coast Uni	B+
	MATH 108	May,2010	CHAFFEY COLL.	TC
	MATH 210	January,2013	West Coast Uni	A-
	MICR 140	May,2011	CHAFFEY COLL.	TC
	NURS 100	April,2013	West Coast Uni	B-
	NURS 101L	April,2013	West Coast Uni	A
	NURS 110	April,2013	West Coast Uni	A

StuNum	Assessment	Proficiency	Assesment Taken
W87515	Critical Thinking Assessment: Entrance		May,2013
	Dosage Calculation RN Maternal Newborn Proctored ..		April,2014
	Dosage Calculation RN Nursing Care of Children Pro..		April,2014
	RN Fundamentals 2010 Form A Web	Level 1	August,2013
	RN Fundamentals 2010 Form B	Level 1	August,2013
	RN Mental Health 2010 Form A Web	Below Level 1	October,2013
		Level 2	January,2014
	RN Nutrition 2010 Form A Web	Level 1	March,2014
	West Coast RN Adult Medical Surgical	Level 2	October,2014
	West Coast RN Community Health	Level 2	August,2014
	West Coast RN Leadership	Level 1	October,2014
	West Coast RN Maternal Newborn	Level 1	May,2014
	West Coast RN Nursing Care of Children	Level 1	May,2014

Dr. Mahmoud AlBawaneh,  
University Director of Institutional Research

# Future Project

- Enhance Ensembles by using R CARET Package:
  - ❑ 169 available models
  - ❑ Automatic tuning model parameters

```

> names(getModelInfo())
[1] "ada"                "ANFIS"                "avNNet"
[4] "bag"                "bagEarth"            "bagFDA"
[7] "bayesglm"          "bdk"                  "blackboost"
[10] "Boruta"            "brnn"                 "bstLs"
[13] "bstSm"             "bstTree"             "C5.0"
[16] "C5.0Cost"          "C5.0Rules"           "C5.0Tree"
[19] "cforest"           "CSimca"               "ctree"
[22] "ctree2"            "cubist"               "DENFIS"
[25] "dnn"               "earth"                "..."
[28] "enet"              "evtree"               [109] "pda"                "pda2"
[31] "fda"               "FH.GBML"              [112] "PenalizedLDA"      "plr"
[34] "foba"              "FRBCS.CHI"           [115] "plsRglm"            "ppr"
[37] "FS.HGD"            "gam"                  [118] "qda"                "QdaCov"
[40] "gamLoess"          "gamSpline"           [121] "qrnn"               "rbf"
[43] "gaussprPoly"       "gaussprRadial"       [124] "rda"                "relaxo"
[46] "gcvEarth"          "GFS.FR.MOGAL"        [127] "rFerns"             "RFlda"
[49] "GFS.LT.RS"         "GFS.Thrift"          [130] "rknn"               "rknnBel"
[52] "glmboost"          "glmnet"               [133] "rocc"               "rpart"
[55] "gpls"              "hda"                  [136] "rpartCost"         "RRF"
[58] "HYFIS"             "icr"                  [139] "rrlda"              "RSimca"
[61] "JRip"              "kernelpls"           [142] "rvmPoly"            "rvmRadial"
[64] "knn"               "krlsPoly"            [145] "sda"                "sddaLDA"
[67] "lars"              "lars2"                [148] "simpls"             "SLAVE"
[70] "lda"               "lda2"                 [151] "smda"               "sparseLDA"
[73] "leapForward"       "leapSeq"              [154] "stepLDA"            "stepQDA"
[76] "lm"                "lmStepAIC"           [157] "svmBoundrangestring" "svmExpostring"
[79] "logicBag"          "LogitBoost"          [160] "svmPoly"            "svmRadial"
[82] "lssvmLinear"       "lssvmPoly"           [163] "svmRadialweights"  "svmspectrumstring"
[85] "lvq"               "M5"                  [166] "vbmpRadial"        "widekernelpls"
[88] "mda"               "Mlda"                [169] "xyf"                "WM"
[91] "mlpweightDecay"    "multinom"
[94] "neuralnet"         "nnet"
[97] "oblique.tree"      "oner"

```

# Q&A

- Please feel free to contact Mahmoud AlBawaneh:
  - ✓ [malbawaneh@westcoastuniversity.edu](mailto:malbawaneh@westcoastuniversity.edu)
  - ✓ Direct (949) 783 4807