Planned Resource Optimization Model with Experimental Design (PROM-WED)

USER MANUAL







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NOTICE:

The user is cautioned that PROM-WED has not undergone formal verification and validation testing, and comes without any warranty. Informal testing confirms the outputs from PROM-WED match the output from the legacy PRO model.

I. WHAT IS PROMWED

PROM-WED embeds the legacy PRO model within a data farming environment. The foundation of PROM-WED's data farming wrapper is the nearly orthogonal Latin hypercube (NOLH). The NOLH design of experiment (DOE) builds experimental designs that efficiently and effectively explore the solution space. This good space-filling capability means that uncertainties and fluctuations in input variables along with multivariable interactions are adequately investigated.

The 33 and 129 point NOLH designs makeup PROM-WED's data farming wrapper. The 33-point NOLH DOE tests each variable at 33 levels and grows data for 33 legacy PRO model runs, whereas the 129-point NOLH DOE tests each variable at 129 levels and grows data for 129 legacy PRO model runs. PROM-WED's graphical user interface (GUI) allows users to easily enter a range of values for each input variable into the NOLH DOE worksheet, regardless of their level of knowledge or familiarity with data farming or DOE techniques.

A completed PROM-WED excursion grows a data set of either 33 or 129 data points. Automatically generated sensitivity analysis provides users with a basic risk assessment picture focused on the decision variables. Further insights into variable interactions and effects of input variables can be easily explored using commercial statistics software package. PROM-WED transforms the legacy PRO model into a resource that N1 can use to gain robust insights into the optimal allocation of recruiting resources.

II. OUTPUT OPTIONS

PROM-WED provides users with decision support capabilities to analyze the data grown by each excursion. PROM-WED offers two decision support capabilities: (A) automatically generated analysis, and (B) data generated for further analysis requiring a statistical software package.

A. Automatically Generated Analysis

PROM-WED's "Decision Support Analysis" for the traditional run option provides users with a broad understanding of how variability in decision variables, controllable policy changes, and uncontrollable market factors affect the total cost of recruiting. This type of analysis would be appropriate for testing excursions during a time constrained meeting, working group, or whenever basic analysis needs to be generated quickly.

An example of PROM-WED's automatically generated analysis follows.





B. JMP Analysis

Analysts will need to use a statistical software package to take full advantage of the data grown by PROM-WED. Therefore, data produced by PROM-WED is designed to be easily uploaded into a software package, such as JMP.

The following are examples of insights gained through analysis of PROM-WED data in JMP.

1. Partition Tree



Over 80 percent of variance in the total cost of recruiting is explained by the amount of funds allocated to advertising.

2. Stepwise Regression

The total cost of recruiting can be formulated into a stepwise regression model:

Prediction Expression

150.980052850998

- + 0.02553596931337 * NCO
- + -24.593679044673* Unemployment
- + -550.34801858165 * Relative Pay
- + (NCO 35000.0620155039)* ((Relative Pay 1)* -0.1270005027034)
- + [NCO 35000.0620155039] * [[NCO 35000.0620155039] * 0.00000304992539]
- + (Relative Pay 1)* ((Relative Pay 1)* 1882.37625427676)

3. Contour Plots



The contour plot indicates that nearly half of the solution space supports a low advertising budget, represented by the dark blue region. The cost of advertising substantially increases when relative pay favors the civilian sector and the accession mission is high, represented by the red region. Once relative pay exceeds approximately 1.00, changes in the new accession mission have little to no effect on the amount of resources allocated to advertising.

III. STEP-BY-STEP INSTRUCTIONS TO RUN PROM-WED

Step 1: Unzip the "PROM-WED.zip" file, and save the "PROM-WED.xlsm" file and "NOLH.xls" file in the same folder. This folder is where the output file generated by PROM-WED will be saved following the PROM-WED excursion.

	ED > PROM-WED			
Organize 🔻 🛛 Burn	New folder			
☆ Favorites	Name	Date modified	Туре	Size
Recently Changed	NOLH	5/20/2016 2:16 PM	Microsoft Excel 97	1,136 KB
퉬 Public	PROM-WED_v2	1/20/2017 11:55 AM	Microsoft Excel M	2,157 KB
🧮 Desktop				
🚺 Downloads				
📃 Recent Places				
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Step 2: Open the PROM-WED file, and ensure the "Enable Content" button is selected.

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	Security W	larning S	ome active o	ontent has t	been disable	d. Click for r	tore details.	Enabl	e Content							
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17								PRON	-WED							
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The first time you open PROM-WED, the NOLH.xls file link needs to be updated. To do this, select the "Edit Links..." button.

A	We can't update some of the links in	n your workbook right	t now.
	You can continue without updating	their values, or edit th	he links you think are wrong.
	Continue	EditLinks	

To update the NOLH.xls file, click on the "Change Source..." button.

Source	Туре	Update	Status		Update Values
NOLH.xls	Worksheet	A	Error: Source not found		Change Source
					Open Source
					<u>B</u> reak Link
٠				•	Check Status
ocation: C	:\Desktop\Hog	arth_Thesis			
pdate: @	Automatic	🔿 Manual			
Startup Pro	ompt				Close

A file search window will pop-up. Navigate to the folder where you saved the files after unzipping them. Select the "NOLH.xls" file, and click on the "OK" button.

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Microsoft Excel	^ N	ame		Date modified	Туре
A	8) NOLH		2/2/2017 11:24 AM	Microsoft Excel 97
E Desktop		PROM-WED		2/2/2017 11:24 AM	Microsoft Excel M
Downloads 📃 Recent Places	н				
☐ Libraries ☐ Documents ♪ Music					
Videos					
👯 Computer	v €				+
	File name:	NOLH	Tools	Excel Files OK	Cancel

The "Edit Links" window will pop-up. Once the "NOLH.xls" worksheet's status updates to "OK," click on the "Close" button.

Edit Links					S X
Source	Туре	Update	Status		Update Values
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•				•	Check Status
Location: C Item: Update: @	:\Users\sam_gr	ay∖Desktop∖ ⊙ Manual	PROM-WED		
Startup Pro	ompt				Close

Step 3: Open the PROM-WED file, and select the "PROM-WED" button to open the GUI.



Step 4: Select the appropriate starting fiscal year (FY) from the drop-down list. The current version of the legacy PRO model is set at a FY 2015 start.

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ISDG Jinemp	koyment Rate De Base	sign of Exper	iments Tab High	le Decimal	Remove		Analysi	s Options	
· ·						Select Ru Traditional Run Capacity Run	un Type	Design of 33 Design Por 129 Design Po	f Experiments nts ints
						F Include output F Save Scenario Rue	for analysis in 34 Name S	¢ cenario	
		-	_			NOLH Run	Select to run spec DOE excursions	whiling	Cancel

Step 5: To constrain a decision variable, select it from the list, and click "Fix DV" button.

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QMA TSC I-IIIA			Range of Values	Set Hange	Farsed market ractors	Tixed Planket Pactors
HSDG Unemployment	Rate	•		Renove		
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		1				1.550.000.000
FY17			14			
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957	-	i – r			Run	in second in 1
	_				Select to not	apage filing
PY21		1 1			DOE econ	un Cauca

The default data from the legacy PRO Model will automatically populate the "Design of Experiments Table."

TRAF	NP	si -	Plar	nned wit	Resou th Exp	irce Op ierimen (PROM-WE	timizatio tal Desig ^(D)	n Mode In	^{el} (C	
itart in f	Y	FY 2015 +]	Saved Sci	enarios:	-				
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Unercol	oyment Rati				-	Remove				
FY	Base Value	Low Level	riments Ta High Level	ble Decimal Places			1.	Analysis	Options	
FY15	3913	3913	3913	0			Traditional Run	un Type	33 Design Po	nts
FY16	3685	3685	3685	0			Capacity Run		129 Design P	oints
FY17	3685	3685	3685	0						
FY18	3685	3685	3685	0			T Include output	for analysis in .14	P	
FY19	3685	3685	3685	0			F Save Scenario	Name Sc	enario	
FY20	3685	3685	3685	0			Run			
F121	3685	3685	3685	0			NOLH Run	Select to Ain space DOE excursions	-dilag.	Cancel

Step 6: Input the range of values for the decision variable in the "Design of Experiments Table." Input the low value of the range in the "Low Level" text box for each FY, and the high value of the range in the "High Level" text box for each FY. In this example, the number of recruiters is tested from 2,500 to 3,500 for each FY.

Each year can be tested using different ranges. For example, to represent a smaller recruiter force in FY 2021, the range could be inputted as 2,000 to 2,700.

If you want to constrain the decision variable at the default value populated by the legacy PRO model, select the "Fix Value" button. By selecting "Fix Value," the default values for the decision variable in the "Design of Experiments Table" are deposited into the NOLH worksheet for each FY. This decision variable is now moved to the "Fixed Decision Variables" list, and the "Design of Experiments Table" is cleared. (If this is your course of action, continue to Step 8.)

If you want to constrain the decision variable at one number that is different than the default value populated by the legacy PRO model, the same number has to be inputted into the "Low Level" and "High Level" text boxes. For example, if you want to constrain the number of recruiters in FY 2021 to 2700, then you would enter 2700 in both the "Low Level," and "High Level" text boxes.

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tart in F	ny l	PY 2015 +		Saved	Scenarios:	•		
ecision	Set Varial Variables	iles			Input	Values	Var Formed Operations Manifelder	nable Set
	College First		Pix D	W	Recruitera			
Adverta EB	sing (AC Eni	Only)			Select to Test Single Value	Pix Value		
Relative QMA TSC 1-0	Pay	-	Add1	er	Select to Test Range of Values	Set Range	Varied Harket Factors	Fixed Market Factors
HSDG Unempk	ovment Rate		í.			Renove		
	De	sign of Expe	riments Ta	able				
FY	Base Value	Low Level	High Level	Place			Ana	lysis Options
PY15	3913	2500	3500	0			Traditional Run	33 Design Points
1116	3685	2500	3500	0			Capacity Run	129 Design Points
717	3685	2500	3500	0				
1118	2685	2500	3500	0			T Include output for analysis	n 34P
PY19	3685	2500	3500	0			T Save Scenario Nam	e Scenario
W20	3685	2500	3500	0			Run	
10721	3645	2500	7500	0	-		NOLH Run Select to sur	anor-filing Cancel

Step 7: Once the "Design of Experiments Table" is fully populated with the low and high levels for each FY, select the decision variable from the "Input Values" box, and click on the "Set Range" button.

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start in I	Y	FY 2015 -	1	Saved S	Scenarios:	-		
Decision	Set Variat Variables	oles		ſ	Input	/aiues	Va Evad Decision Variables	riable Set
NCF + 0	College First		Fix D	w I	Recruiters	_	Fixed Decision variables	
Adverti EB	sing (AC Enl.	. Only)	-		Select to Test	Fix Value		
Relative QMA TSC I-II	Pay IA	-	Add N	Æ	Select to Test Range of Values	Set Range	Varied Market Factors	Fixed Market Factors
HSDG Unempli	oyment Rate		1			Remove		
	De	sign of Expe	riments Ta	able				
FY	Base Value	Low Level	High Level	Places	al s		Ana Salast Run Turas	alysis Options
FY15	3913	2500	3500	0			Traditional Run	33 Design Points
FY16	3685	2500	3500	0			Capacity Run	129 Design Points
FY17	3685	2500	3500	0	-			
FY18	3685	2500	3500	0			T Include output for analysis	in JMP
FY19	3685	2500	3500	0	-		T Save Scenario Nar	me Scenario
FY20	3685	2500	3500	0	-		Run	
FY21	3685	2500	3500	0	-		NOLH Run Select to run DOE excurs	r space-filing. Cancel

By selecting "Set Range," the low and high values entered for this decision variable in the "Design of Experiments Table" are deposited into the NOLH worksheet for each FY. This decision variable is now moved to the "Fixed Decision Variables" list, and the "Design of Experiments Table" is cleared.

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tart in FY	FY 2015 -	Save	ed Scenarios:	•				
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NCF + College F	irst	Fix DV	-		Recruiters	ranaures		
Advertising (AC EB Relative Pay QMA TSC I-IIIA HSDG	Eni. Oniy)	Add MF	Select to Test Single Value Select to Test Range of Values	Fix Value	Varied Market	Factors F	ixed Harket I	Factors
Base FY Value	Design of Exper	riments Table High Dec Level Pla	imal ices		Select R	Analysis (un Type	Options Design of	Experiments
FY15 FY16 FY17					Traditional Run Capacity Run		33 Design Poin 129 Design Poi	ts nts
FY18			-		☐ ☐ Indude outpu	t for analysis in JMP		
FY19					Save Scenario	Name Sce	nario	
FY20			_		Run NOLH Run	Select to run space-f DOE excursions	iling.	Cancel

Step 8: Follow Steps 5-7 to fix any other decision variables.

Reminders:

- If you constrain a decision variable to a number other than the default values populated from the legacy PRO model, as mentioned earlier enter the same number into the low and high level text boxes, and select the "Set Range" button when complete.
- Since the PRO model solves an optimization problem, ensure that at least one of the following decision variables: Recruiters, Advertising or Enlistment Bonus (EB) remain in a "float" status. In this example, only the number of recruiters are fixed.

Step 9: Once all decision variables that need to be fixed are fixed, gears shift to the market factors. The "Market Factors" list includes all market factors (relative pay, QMA and unemployment rate) and policy factors (percentage of high quality recruits (TSC I-IIIA), percentage of recruits with a high school diploma (HSDG), and NCO). Each market factor, from relative pay to NCO, must either be fixed at one value, or a range of values needs to be entered.

Similar to how decision variables are fixed, select "Relative Pay" from the list of market factors, and select the "Add MF" button.

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tart in FY	FY 2015 👻	s	aved Scenarios:	•		
Set Vari Decision Variable	iables es		Input	Values	Va Fixed Decision Variables	riable Set
NCF + College Fi Recruiters Advertising (AC E EB	rst Enl. Only)	Fix DV	Select to Test	Fix Value	Recruiters	
arket Factors Relative Pay QMA TSC I-IIIA		Add MF	Select to Test Range of Values	Set Range	Varied Market Factors	Fixed Market Factors
Unemployment R	ate 💌	l		Remove		
Base FY Value	Low Level	High I Level	Decimal Places		An: Select Run Type	alysis Options Design of Experiments
Y15			_		Traditional Run Capacity Run	33 Design Points 129 Design Points
Y18					F Indude output for analysis	in JMP
Y19					Save Scenario Nar	ne Scenario
Y20					Run	
FY21					NOLH Run Select to run DOE excurs	n space-filling. Cancel

The default data from the legacy PRO Model automatically populates in the "Design of Experiments Table."

PRNE			Plar	ned wi	Resou th Exp	i rce Op t erimen (PROM-WE	ti mizatio t al Desig D)	n Mod In	el 🜔	
start in I	FY	FY 2015 -]	Saved Se	enarios:	-				
Decision	Set Varial Variables	bles			Input	/alues	Fixed Decision 1	Varial	ble Set	
Adverti EB	College First sing (AC Enl	. Only)	Fix D	v [Relative Pay	Fix Value	Recruiters			
QMA TSC I-II HSDG	Factors IPay IIA	-	Add M	¢ ,	Select to Test Range of Values	Set Range	Varied Market I	factors	Fixed Market	Factors
Unempl	oyment Rati	• •]		-	Remove				
FY	Base Value	Low Level	High Level	ble Decimal Places				Analys	is Options	(C)
FY15	0.4	0.4	0.4	6			Traditional Run	in Type	33 Design Po	ints
FY16	0.4	0.4	0.4	6			Capacity Run		129 Design P	oints
FY17	0.4	0.4	0.4	6						
FY18	0.4	0.4	0.4	6			☐ Include output	for analysis in J	MP	
FY19	0.4	0.4	0.4	6			Save Scenario	Name	Scenario	
FY20	0.4	0.4	0.4	6			Run			
FY21	0.4	0.4	04	6	-		NOLH Run	Select to run spe	or-filing.	Cancel

Step 10: Input the range values for the market factor in the "Design of Experiments Table." Input the low value of the range in the "Low Level" text box for each FY, and the high value of the range in the "High Level" text box for each FY.

In this example, the relative pay is tested from 0.8 to 1.2 for each FY. Clicking the "Set Range" button deposits the low and high values entered for this market factor into the NOLH worksheet for each FY.

FRAL	NPS STANTIA PER SC		Plar	nned wi	Resou ith Exp	u rce Op t D erimen (PROM-WE	timizatio tal Desig D)	n Mode In	el 🌔	
Start in	FY	FY 2015 🔻]	Saved S	cenarios:	•				
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NCF +	College First		Fix D	w I	Relative Pay		Recruiters	ranabics		
Advert EB	sing (AC Enl.	Only)			Select to Test	Fix Value				
Market	Factors				Single Value					
QMA TSC 1-1	e Pay	^	Add N	4F	Select to Test Range of Values	Set Range	Varied Market I	Factors	Fixed Mari	ket Factors
HSDG	oyment Rate	•			_	Remove				
	De	sign of Expe	riments Ta	able						
FY	Base Value	Low Level	High Level	Decima Places	4			Analysis	s Options	
FY15	0.4	0.8	1.2	6			Traditional Run	un Type	33 Design	Points
FY16	0.4	0.8	1.2	6			Capacity Run		129 Desig	n Points
FY17	0.4	0.8	1.2	6						
FY18	0.4	0.8	1.2	6			T Include output	for analysis in JM	P	
FY19	0.4	0.8	1.2	6			T Save Scenario	Name So	cenario	
FY20	0.4	0.8	1.2	6			Run			
FY21	0.4	0.8	1.2	6	-		NOLH Run	Select to run space DOE excursions	s-filling,	Cancel

This market factor is now moved to the "Varied Market Factors" list, and the "Design of Experiments Table" is cleared.

TRAESTANTIA PE		Plar	ned l wit	Resou h Exp	u rce Op D erimen (PROM-WE	timization Mo tal Design ^{D)}	odel 🛞
itart in FY	FY 2015 -]	Saved Sce	narios:	•		
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NCF + College Fir Recruiters Advertising (AC E EB	rst Enl. Only)	Fix D	v	elect to Test Single Value	Fix Value	Recruiters	
Rélative Pay QMA TSC I-IIIA HSDG Unemployment R	ate 💌	Add M	IF S Ra	elect to Test nge of Values	Set Range Remove	Varied Harket Factors Relative Pay	Fixed Market Factors
Base Value	Low	High	Decimal			An	alysis Options
FY15 FY16 FY17 FY17						Select Run Type Traditional Run Capacity Run	Design of Experiments 33 Design Points 129 Design Points
FY18 FY19						I Include output for analysis I Save Scenario Nai	s in JMP me Scenario
FY20 FY21						Run NOLH Run DOE excent	n space-filing. Cancel

Step 11: Work through each "Market Factor" in the list, from "Relative Pay" to "NCO" following Steps 9-10.

Note that each year can be tested using a different range of values for the market factors. For example, an annual decrease of 10,000 QMA can be entered as shown in the figure below.

	Des	ign of Expe	riments Tal	ble
FY	Base Value	Low Level	High Level	Decimal Places
FY15	1883304	1873304	1883304	0
FY16	1883304	1863304	1873304	0
FY17	1883304	1853304	1863304	0
FY18	1883304	1843304	1853304	0
FY19	1883304	1833304	1843304	0
FY20	1883304	1823304	1833304	0
FY21	1883304	1813304	1823304	0

If you want to constrain the market factor at one number different than what is populated by the legacy PRO model, the same number has to be inputted into the "Low Level" and "High Level" text boxes. Then select the "Set Range" button. To constrain the market factor at the value automatically populated in the "Design of Experiments Table," select the market factor from the "Input Values" box, and click on the "Fix Value" button.

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tart in I	PY	FY 2015 -		Saved 9	Scenarios:	•				
ecision	Set Variat <i>Variables</i>	les		ſ	Input	Values	Fixed Decision	Varia Variables	ble Set	
NCF + 0	College First		Fix D	W	HSDG		Recruiters	- unuurus		
Adverti EB	sing (AC Enl.	Only)			Select to Test Single Value	Fix Value				
Relative QMA	Pay	<u> </u>	Add M	MF	Select to Test Range of Values	Set Range	Varied Market	Factors	Fixed Market	Factors
HSDG Unemple	oyment Rate	•			_	Remove	QMA TSC I-IIIA			
FY	De Base Value	sign of Expe Low Level	riments Ta High Level	able Decim Place	al s			Analy	sis Options	
FY15	0.95	0.95	0.95	2	-		Select R	un Type	Design o	f Experiments
FY16	0.95	0.95	0.95	2			Capacity Run		129 Design Po	oints
FY17	0.95	0.95	0.95	2						
FY18	0.95	0.95	0.95	2			Indude outpu	t for analysis in I	IMP	
FY19	0.95	0.95	0.95	2			C Save Scenario	Name	Scenario	
FY20	0.95	0.95	0.95	2			Run			
FY21	0.95	0.95	0.95	2	-		NOLH Run	Select to run spi DOE excursions	ice-filing.	Cancel

Step 12: Work through all seven market factors until they are all accounted for. A market factor is accounted for once it appears in either the "Varied Market Factors," or "Fixed Market Factors" lists.

tart in F	× [FY 2015 +		Saved Scenarios:				
Decision	Set Variab Variables	les		Input	Values	Variable Set		
NCF + 0 Requite	ollege First		Fix D	v	10	Recruiters		
Advertis EB	ing (AC Enl.	Only)		Select to Test Single Value	Fix Value			
TSC I-II HSDG	IA	-	Add M	F Select to Test	Set Range	Varied Market Factors	Fixed Market Factors	
Unemplo	oyment Rate	•		Ange of Values	Remove	Relative Pay QMA TSC I-IIIA	HSDG LRP	
	Des	sign of Expe	riments Ta	ble		NCO (50% BoY DEP)		
FY	Value	Level	Level	Places		Ana Colort Run Turco	lysis Options	
FY15						Traditional Run	33 Design Points	
FY16						Capacity Run	129 Design Points	
FY17								
FY18						Include output for analysis i	n JMP	
FY19						Save Scenario Nam	e Scenario	
FY20						Run		
		1		1.		Colort to our	energe Alling	

Step 13: Select "Traditional Run" under "Select Run Type." (Currently, only the Traditional Run option is operational).

Automatically Generated Decision Support:

The "33 Design Points" option is well suited for the automatically generated decision support analysis. The "129 Design Points" option can also be used, but it will take additional time to run (approximately 10 minutes versus 2-3 minutes). The "129 Design Points" option grows more data, resulting in a narrower 95% confidence interval.

Analysis in JMP:

The "129 Design Points" option is intended to be used for further analysis in a commercial statistical software package, such as JMP.

PRAESTINT	PS PRESCIENTIAN	Plan	ned Resou with Exp	i rce Op erimen (PROM-WI	timization Mo ital Design ^{ED)}	odel 🛞
tart in FY	FY 2015]	Saved Scenarios:	•		
Set Decision Vari	Variables Jables	_	Input	/alues	Va Fixed Decision Variables	nriable Set
NCF + Colleg Recruiters	je First	Fix DV			Recruiters	
Advertising (EB	AC Enl. Only)		Select to Test Single Value	Fix Value		
TSC I-IIIA	ars 	Add M	= Select to Test	Set Range	Varied Market Factors	Fixed Market Factors
Unemployme LRP NCO (50% B	nt Rate		Kange of Values	Remove	Relative Pay QMA TSC I-IIIA	HSDG LRP
	Design of Exp	eriments Tal	ble		NCO (50% BoY DEP)	
Ba Va	use Low	High	Decimal Places		An	alysis Options
FY15					Select Run Type	Design of Experiments
FY16					Capacity Run	129 Design Points
FY17						
FY18					Tindude output for analysis	in JMP
FY19					Save Scenario Na	me Scenario
FY20					Run	
FY21					NOLH Run Select to ru DOE excuto	n space-filing. sions Cancel

Step 14: To save PROM-WED output to a separate .xls file for analysis in JMP, select the "Include output for analysis in JMP" box. This will save the PROM-WED output as a .xls file in the same folder that the PROM-WED model was saved in.

tart in FY	FY 2015 -]	Saved Scenarios:	•			
Set Va ecision Varial	iriables bles		Input V		Variable Set		
NCF + College Recruiters	First	Fix D/	v [Recruiters		
Advertising (Al EB Iarket Factor	: Eni. Oniy)		Select to Test Single Value	Fix Value			
TSC I-IIIA		Add M	F Select to Test	Set Range	Varied Market Factors	Fixed Market Factors	
Inemployment RP VCO (50% Bo)	Rate	-	Kange of Values	Remove	Relative Pay QMA TSC I-IIIA Unemployment Rate	HSDG LRP	
Rac	Design of Expe	eriments Ta	ble		NCO (50% Boy DEP)	1	
FY Valu	e Level	Level	Places		Ana Select Run Type	lysis Options Design of Experiment	
FY15					Traditional Run Capacity Run	33 Design Points 129 Design Points	
Y17							
Y18					Include output for analysis i	n JMP	
Y19					E Save Scenario Marr	e Scenario	
Y20		-			Run		
		1			Select to run	space-filing.	

Step 15: Once the run options are set, select the "NOLH Run" button. A message will pop-up providing an estimated wait time for the PROM-WED excursion. Click "OK."

TRANSTRANT		Planned v	d Resource C vith Experime (PROM-)ptimization ental Desig ^{WED)}	n Model n	
tart in FY	FY 2015 -	Saved	Scenarios:	•		
Set \ ecision Varia	Variables J <i>ables</i>		Input Values		Variable	Set
NCF + Colleg	e First	Fix DV		Recruiters	ariables	
Advertising (AC Enil. Only)		1. 			
	Microsoft Excel		man in the state	×		
	complexe. mank y	ou for your patient	ice and nave a tine navy day.	ОК	ate (EP) Analysis (TSC I-IIIA HSDG LRP Options
FY15	_	_	_	tu	п Туре	Design of Experiments
FY16			-	Capacity Run		129 Design Points
FY18		[I Indude output	for analysis in JMP	
PY19				Save Scenario	Name Sce	nario
FY20			-	Run		
FY21			-	NOLH Run	Select to run space-fi DOE excursions	iling Cancel

Step 16: When the PROM-WED excursion is complete, the automatically generated decision support analysis will appear (this is true for both the 33 and 129 point designs). If you selected the option to output PROM-WED data for analysis in JMP, the .xls file named "PROMWED_Output129.xls" will appear in the folder that your PROM-WED model is saved in.

🔊 🕞 - 🗾 🕨 PROM-	WED			✓ 4y Search PROF	1-WED	\$
Organize 👻 Include	in library 🕶 Share with 💌 Burn	New folder			H • 🗐	0
🔆 Favorites	Name	Date modified	Туре	Size		
🛄 Desktop	NOLH	2/2/2017 11:24 AM	Microsoft Excel 97	1,136 KB		
🚺 Downloads	PROM-WED	2/2/2017 11:24 AM	Microsoft Excel M	2,186 KB		
💹 Recent Places	PROMWED_Output129	2/2/2017 11:45 AM	Microsoft Excel W	182 KB		

Please be aware that each 129 design point output file will be named "PROMWED_Output129.xls." It is recommended that you rename the file before running another PROM-WED excursion.

IV. GUIDELINES FOR ANALYSIS OF PROM-WED DATA IN JMP

Using JMP Pro 12, the following section provides a tutorial on analysis techniques for PROM-WED output. Steps 1-5 explain how to upload and prepare the data for analysis in JMP, followed by guidance on how to conduct various analysis techniques.

Analysis Techniques:

- A. Oneway Analysis of Total Cost of Recruiting by FY
- B. Explore Outliers from the Oneway Analysis Graph
- C. Select one FY to Analyze
- D. Distribution
- E. Partition Trees
- F. Stepwise Regression Model
- G. Scatterplot Matrix
- H. Contour Plot

Step 1: To load the PROM-WED data into JMP, select the folder icon.



Step 2: Select the output data of interest, select the "Best Guess" option, and click "Open."

Organize 🔻 New fo	lder			1	
JMP Application	N N	ame	Da 2/2 2/2	te modified 2/2017 11:24 AM	Type Microsoft Excel 97
Favorites	9	PROMWED_Output129	2/2	2/2017 11:45 AM	Microsoft Excel W
E Desktop	E.				
Downloads					
词 Libraries					
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Always Excel Row 1	enford as labd	 Best Guess Always Never 			,
File	name:	PROMWED_Output129	-	All JMP Files	-
		Sel tim	ect this filter the next this window is	Open 🚽	Cancel

Step 3: Select the "Import" button.

	Run #	FY	Total Cost of Recruiting	Advertising	EB	E 1	Select Custom sheets to open setting
1	1	2015	327.1265	35.7344	47.1694		JMP_129DesPts
2	2	2015	377.1404	7.1404 55.9153 73.8082			Select all
3	3	2015	410.8494	85.6254	113.0255		(
4	4	2015	283.2184	20.127	26.5676		
5	5	2015	359.4841	43.8919	57.9373		
6	6	2015	467.9692	85.7103	113.1376		
7	7	2015	316.5387	18.2144	24.043	*	
8	4					•	
ws Shown: 100 / Idividual Worksl Worksheet co	903 neet Settin ntains colu	gs umn hea	ders	iew Pane Refre Jpdate settings	sh on any char	nge	
vs Shown: 100 / Idividual Worksl Worksheet co 1 Colur 1 Numl	903 heet Settin ntains colu nn header: ber of row:	gs umn hea s start on s with co	ders row () lumn headers () S	iew Pane Refre Jpdate settings Jate now how all rows	sh on any char	nge	
ws Shown: 100 / ndividual Worksl Worksheet co 1 Colur 1 Numl 2 Data	903 heet Settin ntains colu on headers ber of rows starts on ro	gs umn hea s start on s with co ow 🚇	ders row lumn headers 1	iew Pane Refre Jpdate settings Jate now] ihow all rows	sh on any char	nge	
ws Shown: 100 / ndividual Worksl Worksheet co 1 Colur 1 Colur 2 Data 1 Data	903 neet Settin ntains colu nn headers ber of rows starts on ro starts on co	gs umn hea s start on s with co ow ow	ders row lumn headers	iew Pane Refre Jpdate settings Jate now] how all rows	sh on any char	nge	
ws Shown: 100 / dividual Worksl Worksheet co 1 + Colur 1 + Numl 2 + Data : 1 + Data : Concatenate w	903 heet Settin ntains colu nn header ber of row starts on ro starts on c orksheets a	gs umn hea s start on s with co ow ow our for olumn and try to	ders row lumn headers match columns t name when concatenatin	iew Pane Refre Jpdate settings Jate now Show all rows	sh on any char	nge	

The PROM-WED output data should appear in a table, as shown below:

JMP_129DesPts - JMP Pro								Х
File Edit Tables Rows 🛛	Cols DOE Analy	ze Grapi <mark>y_x >=</mark>	h Tool:	s View Window He	⊧lp			
▼JMP_129DesPts		Pup #	EV	Total Cost of Recruiting	Advertising	ED	Education	Tet
Source	1	1	2015	227 1265	25 7244	47 1604	ncentive	101
	1	1	2015	327.1203	55,7344	72,0002	0	
	2	2	2015	577.1404	33.9135	/ 5.0002	0	
Columns (15/0)	3	3	2015	410.8494	85.6254	113.0255	0	
A Run #	4	4	2015	283.2184	20.127	26.5676	0	
FY FY	5	5	2015	359.4841	43.8919	57.9373	0	
Iotal Cost of Recruiting	6	6	2015	467.9692	85.7103	113.1376	0	
Advertising	7	7	2015	316.5387	18.2144	24.043	0	
ED Education Incentive	8	8	2015	464.2046	77.1682	101.862	0	
A Total Recruiters	9	9	2015	404.0421	73.583	97.1295	0	
A Recruiter Cost	10	10	2015	471.4698	104.0235	137.311	0	
NCO	11	11	2015	320.903	30.0158	39.6208	0	
🚄 LRP	12	12	2015	401 3847	72.72	95 9904	0	
A HSDG	12	12	2015	216 /0/0	11 2114	1/ 0211	0	
TSC I-IIIA	14	14	2015	510.4545	120.0219	150 4410	0	
Unemployment	14	14	2015	300.10/1	120.0516	130.4419	0	
A Relative Pay	15	15	2015	310.9625	8.0795	10.6649	0	
	16	16	2015	489.4982	84./8/4	111.9194	0	
Rows	17	17	2015	450.3778	95.4969	126.056	0	
All rows 90	3 18	18	2015	422.3013	81.1709	107.1456	0	
Selected	19	19	2015	313.7766	33.8635	44.6998	0	
Excluded	20	20	2015	332.7022	38.4201	50.7146	0	
Hidden	21	21	2015	382.5251	44.468	58.6978	0	Ξ.
Labelled								

Step 4: Change the FY column from "continuous" to "nominal" data, by right-clicking on the blue triangle next to "FY," and select "nominal" from the drop-down menu.

JMP_129DesPts	Þ	۹		
Source	-	•	Run #	FY
		1	1	2015
		2	2	2015
Columns (15/1)		3	3	2015
A Run #		4	4	2015
🔺 🛐		5	5	2015
 Continuous 		6	6	2015
Ordinal		7	7	2015
		8	8	2015
Nominal		9	9	2015
Recruiter Cost	'	10	10	2015
NCO		11	11	2015
A LICPC		12	12	2015
		13	13	2015
Unemployment		14	14	2015
Relative Pay		15	15	2015
A QMA		16	16	2015
Rows		17	17	2015
All rows 9	03	18	18	2015
Selected	0	19	19	2015
Excluded	0	20	20	2015
Hidden	0	21	21	2015
Labelleu	"		4	

The blue triangle next to FY will change to a red bar chart icon when JMP changes its classification to nominal data.



The data is now ready to be analyzed.



A. Oneway Analysis of Total Cost of Recruiting by FY

Step 1: To create an oneway analysis of total cost of recruiting by FY graph, select "Analyze" from the ribbon, and select "Fit Y by X."

⊨	Distribution						
<u>у</u> х	Fit Y by X		Examine variables	relationships . Creates a O	lucation	Tot	
¥	Matched Pairs		Conting	ency, or Logi	stic analysis	0	
	Tabulate		based or	0			
			10.8494	80.0204	113.0200	0	
)	Fit Model		83.2184	20.127	26.5676	0	
	Modeling		59.4841	43.8919	57.9373	0	
			67.9692	85.7103	113.1376	0	
	Multivariate Methods	•	16.5387	18.2144	24.043	0	
	Ouality and Process		64.2046	77.1682	101.862	0	
	Deliability and Combined		04.0421	73.583	97.1295	0	
	Reliability and Survival	•	71.4698	104.0235	137.311	0	
	Consumer Research		320.903	30.0158	39.6208	0	
-14	2 12 2013		401.3847	72.72	95.9904	0	

Step 2: Select "Total Cost of Recruiting" from the list of columns, and select the "Y, Response" button.

^y x Fit Y by X - Contextual - JMP Pro						
Distribution of Y for each X. Modeling types determin	e analysis.					
Select Columns	Cast Selected Columns into Roles					
Columns	Y, Response	required	ОК			
Run #		optional	Cancel			
Total Cost of Persuition			(
Adventising	(ve v)					
▲ EB	X, Factor	ontional	Remove			
Education Incentive		- upresent two	Recall			
Total Recruiters			Help			
ANCO	Block	optional				
LRP	Weight	optional numeric				
TSC I-ⅢA	Freq	optional numeric				
4Unemployment	By					
A Relative Pay						
Bivariate Oneway						

"Total Cost of Recruiting" should now appear in the "Y, Response" box.

stribution of Y for each X. Modeling typ	es determine analysis.					
elect Columns	Cast Selected	Columns into Roles	Action -			
15 Columns	Y, Response	Total Cost Recruiting	OK			
ARun #		optional	Cancel			
Total Cost of Recruiting			Contraction			
Advertising	(V. Easter	required	Remains			
AEB	- racior	optional	Kemove			
AEducation Incentive			Recall			
Iotal Recruiters Recruiter Cost			Help			
	Block	optional				
L RP	Weight					
AHSDG	Free	Free Ontional numeric				
All nemployment	(op monutine mente				
ARelative Pay	Ву	optional				
4QMA						
000						
Bivariate Oneway						
4 🗾 🖬 🛛						
Logistic Contingency						

Step 3: Select "FY" from the list of columns, and select the "X, Factor" button.

Select Columns	Cast Selected	Action		
15 Columns	Y, Response	Total Cost Recruiting optional	OK Cancel	
Advertising EB	X, Factor	required optional	Remov	
Total Recruiters	Block	optional	Help	
LRP	Weight	optional numeric		
TSC I-IIIA	Freq	optional numeric		
Unemployment Relative Pay	Ву	optional		
Bivariate Oneway				

"FY" should now appear in the "X, Factor" box.

istribution of Y for each X. Modeling types de	etermine analysis.		
Select Columns	Cast Selected	Columns into Roles	Action
■15 Columns	Y, Response	Total Cost Recruiting	OK
ARun #		optional	Cance
Tatal Cast of Resputting			(more concerned)
Advartiging			
Advertising AFR	X, Factor	FY	Remove
Action Incentive		optional	Recall
Total Recruiters			Help
ARecruiter Cost	Block	optional	Trep
ALRP	Weight	pational numeric	
A HSDG	weight		
ATSC I-IIIA	Freq	optional numeric	
-Unemployment	By	optional	
Aciative Pay			
Oneway Bivariate Oneway			

Step 4: Click-on the "OK" button to generate the graph of FY by total cost of recruiting.

Distribution of Y for each X. Modeling types	determine analysis.					
Select Columns	Cast Selected	Columns into Roles	Action			
15 Columns	Y, Response	Total Cost Recruiting	OK			
ARun #		optional	Cancel			
Total Cost of Bossilling			curree			
Advertising						
AEB	X, Factor	FY	Remove			
Education Incentive		optional	Recall			
Total Recruiters			Help			
ARecruiter Cost	Block	optional				
	Weight					
TSC I-IIIA	Freq	Freq optional numeric				
Unemployment	By	optional				
Oneway						
Bivariate Oneway						
Logistic Contingency						

Step 5: To add boxplots on the data for each FY, select the red triangle in the upper left hand corner of the graph. From the drop-down menu, select "Quantiles."

x JMP_129DesPts - Fit Y by X of Total Cost of Recruiting by FY - JMP Pro

Quantiles	uantiles						
Means/Anova		• •	•				
Means and Std Dev			:				
Analysis of Means Methods	•	: :	:				
Compare Means							



B. Explore Outliers from the Oneway Analysis Graph

Step 1: Hover your mouse over a data point of interest to retrieve information regarding that point.



Clicking on the data point on the graph will highlight it within the greater data set. Understanding the input variables can help explain why the total cost of recruiting was unusually high for this data point.

IMP 129DesPts		Run		Total Cost			Education	Total	Recruiter				TSC		Relative				_
Source		#	FY	of Recruiting	Advertising	EB	Incentive	Recruiters	Cost	NCO	LRP	HSDG	I-IIIA U	nemployment	Pay	QMA			
	78	78	2015	865.4414	279.911	369.4825	0	2547	208.6079	39531	7.44	0.95	0.7	7	0.84375	1883304			
	79	79	2015	257.214	16.6496	21.9775	0	2578	211.1469	30859	7.44	0.95	0.7	7.1	1.04375	1883304			
	80	80	2015	959.1079	321.1317	423.8939	0	2523	206.6423	39688	7.44	0.95	0.7	5.9	0.878125	1883304			
Columns (15/0)	81	81	2015	271.5776	25.0296	33.0391	0	2516	206.0689	30234	7.44	0.95	0.7	5	1.03125	1883304			
Run #	82	82	2015	324.3377	20.1992	26.663	0	3297	270.0355	33125	711	0.95	0.7	73	0.9625	1883304			
r Y Total Cost of Recruiting	83	83	2015	332.0137	25.7319	33.9662	0	3234	264.8756	38516	y _x	JMP_12	9DesPts -	Fit Y by X of To	tal Cost of	Recruiting by	FY - JMP Pro		×
Advertising	84	84	2015	420.0764	64.2196	84.7698	0	3219	263.647	33203	1E							_	
EB	85	85	2015	375.048	48.4117	63.9034	0	3117	255.2929	36563	⊿	 One 	way An	alysis of Tot	al Cost o	f Recruiting	g By FY		
Education Incentive	86	86	2015	406.6708	77.4697	102.26	0	2680	219.5011	36953			T						
Total Recruiters	87	87	2015	287.67	20.1041	26.5374	0	2852	233.5885	31406		100	0-						0
Recruiter Cost	88	88	2015	889.4207	283.8923	374.7378	0	2727	223.3506	39453		90		Row: 78			:	:	
IRP	89	89	2015	284.4178	30.0346	39.6457	0	2531	207.2975	31875		0	i	FY: 2015		CE 4414	ă.	•	
HSDG	90	90	2015	385.3536	55.325	73.029	0	3047	249.5596	35313		·달 80	0-0	Total Cost of P	kecruiting: a	505.4414			
TSC I-IIIA	91	91	2015	309.2005	22.7828	30.0733	0	3039	248.9044	36172		มี 70							0
Unemployment	92	92	2015	405.8733	57.8151	76.3159	0	3227	264.3023	33984		of R.		ě	0	•	•	•	2
Relative Pay	93	93	2015	352.9529	38.3231	50.5865	0	3133	256.6033	37188		tg 60	D- 8	8	8				
QMA	94	94	2015	509.7736	120.0042	158.4055	0	2734	223.9239	40000		Ŭ 500			- 1 -			i	- i -
	95	95	2015	279.5667	28.7556	37.9574	0	2508	205.4137	32578		ota						i i	
D	96	96	2015	847.7716	263.7513	348.1517	0	2789	228.4286	39609		- 40				_	-	+	-
rows 00	97	97	2015	270.0264	22.7017	29.9663	0	2563	209.9184	33359		30	-		_	_			
oted 1	98	98	2015	301.1586	14.3387	18.9271	0	3180	260.4528	30938									
cluded (99	99	2015	368.3449	37.2262	49.1385	0	3352	274.5402	36250		20	201	5 2016	2017	2018	2019 2	020 2	2021
lden (100	100	2015	328.4267	16.7369	22.0926	0	3445	282.1572	30625						FY			
elled (101	101	2015	601.0501	138.095	182.2854	-0	3336	273.2297	38906									
							٥	2850	22/ 1618	35224	1	row selec	ted					<u> </u>	•

Step 2: To explore a group of outliers, lasso the data points of interest by creating a box around the data points with your mouse. Lassoing the data points will automatically select these data points within the greater data set.

JMP_129DesPts - JMP Pro								🕅 JMP_129DesPts - Fit Y by X of Total Cost of Recruiting by FY - JMP Pro
File Edit Tables Rows C	ols DOE Analy	ze Grap	h Tools	View Window H	lelp			
🔠 🔁 🧉 🖬 👗 🛍 🖄	🖶 🛗 🖽 🖛	• 🖄 🏓	2					Oneway Analysis of Total Cost of Recruiting By FY
▼JMP_129DesPts D	۲ 🔍			Total Cost of			Education	1000-
 Source 		Run #	FY	Recruiting	Advertising	EB	Incentive To	otalRecru 900
	75	75	2015	326.4324	21.667	28.6004	0	
	76	76	2015	402.9634	63.7627	84.1667	0	jē 800-
Columns (15/1)	77	77	2015	358.7623	36.6967	48.4396	0	8 700
A Run #	78	78	2015	865.4414	279.911	369.4825	0	a 700
	79	79	2015	257.214	16.6496	21.9775	0	600-
Total Cost of Recruiting	80	80	2015	959.1079	321.1317	423.8939	0	S root
Advertising	81	81	2015	271.5776	25.0296	33.0391	0	
EB EB	82	82	2015	324.3377	20.1992	26.663	0	⁴⁰⁰
Education Incentive	83	83	2015	332.0137	25.7319	33.9662	0	
Iotal Recruiters	84	84	2015	420.0764	64.2196	84.7698	0	300 -
A NCO	85	85	2015	375.048	48.4117	63.9034	0	200
LRP	86	86	2015	406.6708	77.4697	102.26	0	2015 2016 2017 2018 2019 2020 2021
HSDG	87	87	2015	287.67	20.1041	26.5374	0	FY
TSC I-IIIA	88	88	2015	889.4207	283.8923	374.7378	0	28 rows selected
Unemployment	89	89	2015	284.4178	30.0346	39.6457	0	
A Relative Pay	90	90	2015	385.3536	55.325	73.029	0	3047 249.5596 35313
- QMA	91	91	2015	309.2005	22.7828	30.0733	0	3039 248.9044 36172
	92	92	2015	405.8733	57.8151	76.3159	0	3227 264.3023 33984
- Power	93	93	2015	352.9529	38.3231	50.5865	0	3133 256.6033 37188
All rows 903	94	94	2015	509.7736	120.0042	158.4055	0	2734 223.9239 40000
Selected 28	95	95	2015	279,5667	28,7556	37.9574	0	2508 205,4137 32578
Excluded 0	96	96	2015	847 7716	263 7513	348 1517	0	2789 228.4285 39609
Hidden 0	97	97	2015	270.0264	22,7017	29,9663	0	2563 209 9184 33359
Labelled 0	00	0.0	2015	2/0.0204	1/ 2207	19 0 271	0	2100 260 4529 20029
		4			11			

Step 3: The selected data points can be further analyzed on their own. Right-click on "Selected."

 Columns (15/1) 🚄 Run # ul. FY Total Cost of Recruiting Advertising
EB Education Incentive Total Recruiters ⊿ Recruiter Cost A NCO 🔺 LRP HSDG 🚄 TSC I-IIIA Unemployment A Relative Pay 📕 QMA Rows All rows 903 28 Selected Excluded 0 Hidden 0 Labelled 0

Then choose "Data View" from the drop down menu.

		28
•	Select Rows Clear Select	
	Data View	

File Edit Tables Rows Co	ols DOE Anal	yze Gra	ph Too	ls View Window Hel	p				
1 📴 🤮 🧉 🔒 🐰 🗈 🛝		- <u>⊻</u> x ≽							
■ Untitled 15 D Linked Subset This subset is linke		Run #	FY	Total Cost of Recruiting	Advertising	EB	Education Incentive	T	Fc
		78	2015	865.4414	279.911	369.4825	(0	*
		80	2015	959.1079	321.1317	423.8939	(0	
Columns (15/0)		88	2015	889.4207	283.8923	374.7378	(D	
⊿ Run #	4	96	2015	847.7716	263.7513	348.1517	(D	
d, FY	5	207	2016	874.0407	281.0028	370.9237	(D	
Total Cost of Recruiting	6	209	2016	968.0586	322.3843	425.5473	(D	
Advertising	7	217	2016	898.2175	284.9996	376.1995	(D	_
ED Education Incentive	8	225	2016	856.4419	264.7801	349.5097	(0	=
Total Recruiters	9	336	2017	879.807	282.0989	372.3705	(D	
Recruiter Cost	10	338	2017	974.1696	323.6418	427.2072	(0	
A NCO	11	346	2017	904.2436	286.1113	377.6669	(0	-
LRP .	12	354	2017	862.362	265.8129	350.873	(0	-
A TOOL WA	13	465	2018	885.6706	283.1992	373.8229	(0	
ISCI-IIIA	14	467	2018	980.3789	324.9042	428.8735	(0	
A Relative Pav	15	475	2018	910.3705	287.2273	379.14	(0	
QMA	16	483	2018	868.3833	266.8497	352.2416	(0	
Rows	17	594	2019	891.5424	284.3038	375.2811	(0	
All rows 28	18	596	2019	986.5974	326.1715	430.5464	(0	
Selected 28	19	604	2019	916.509	288.3476	380.6189	(0	
Excluded 0	20	612	2019	874.4168	267.8906	353.6155	(0	
Hidden 0	21	723	2020	897.9872	285,4128	376,7449		0	
Labelled 0									Ŧ
		4						•	

This will create a separate data table with just the outliers.

C. Select one FY to Analyze

To focus analysis on one specific FY, the other six FYs must be hidden and excluded. In this example, FY 2017 is the FY of interest. FYs 2015, 2016, 2018, 2019, 2020, and 2021 will be hidden and excluded.

Step 1: To exclude FY 2015 and 2016, select on the first row of FY 2015 data in the furthest column to the left. Hold the "shift" keyboard button.

File Edit Tables Rows	i Co	ls DOE Analy	ze Grap	h Tools	View Window H	elp
📴 🍋 🎽 🗔 🕺 🌆		i 🖶 🛅 🎫 🖿	- Ľ <u>x</u> ≽	2		
 JMP_129DesPts 	Þ				Total Cost of	
 Source 			Run #	FY	Recruiting	Advertising
		1	1	2015	302.7718	25.236
		2	2	2015	364.2534	50.360
		3	3	2015	407.1973	84.051
Columns (15/1)		4	4	2015	272.668	15.579
Run ≠		5	5	2015	314.7028	24.589
		6	6	2015	455.8674	80.49
Total Cost of Recruiting	- [7	7	2015	296.7907	9.702
Advertising	- [8	8	2015	461.4439	75.978
🚄 EB	- 1	9	9	2015	386.4563	66.002
Education Incentive Total Recruiters Page iter Cost		10	10	2015	410.5732	77.77
	1	11	11	2015	314.3641	27.197
A NCO		12	12	2015	343.2203	47.649
/ LRP		13	13	2015	309.9515	8.49
A HSDG		14	14	2015	488.9989	86.76
🖌 TSC I-IIIA		15	15	2015	309.0097	7.237
Unemployment		16	16	2015	423,4232	56.306
Relative Pay		17	17	2015	424,451	84.321
		18	18	2015	377.506	61.862
		19	19	2015	299.8877	27.876
		20	20	2015	324,3671	34,827
		21	21	2015	331,2071	22 348
		22	22	2015	427.0495	69.731
Rows		22	23	2015	290.6615	6,530
All rows	903	2.5	24	2015	407 0701	49 787
Selected	1	24	25	2015	216 270	28.9
Excluded	0	25	25	2015	A22 2102	74 20/0
Hidden	0	20	20	2015	422.5105	20.031
abelled	이	21	21	2015	301.4409	28.831

Step 2: Scroll down to the last row of FY 2016 data (which appears in row "258"). Click on the "258" cell in the furthest column to the left.

File Edit Tables Rows Co	ols DOE Analy:	te Grapi	h Tools	View Window H	elp
🔁 🔂 💕 🔛 🐰 🕰 🖏) 🚔 🛅 🖽 🛤	Ľ <u>x</u> ≽	2		
JMP_129DesPts		Run #	FY	Total Cost of Recruiting	Advertising
Jobarce	243	243	2016	307.3522	9.687
	244	244	2016	445.0398	66.251
	245	245	2016	303.2966	12.11
	246	246	2016	417.8577	55.391
Columns (15/1)	247	247	2016	341.4981	38.645
E FY	248	248	2016	447.4629	95.7411
Total Cost of Recruiting	249	249	2016	348.5629	39.442
	250	250	2016	597.7795	157.463
EB EB	251	251	2016	299.0017	11.1203
Education Incentive	252	252	2016	393.1824	43.078
A Recruiter Cost	253	253	2016	345.3272	33.872
A NCO	254	254	2016	530.3328	114.436
LRP	255	255	2016	337.6762	47.8482
A HSDG	256	256	2016	289.7138	16.6105
TSC I-IIIA	217	257	2016	332.0182	43.4822
Onemployment Relative Day	258	258	2016	335.8113	38.4074
	259	259	2017	313.2553	25.43
-	260	260	2017	375.2758	50.7542
	261	261	2017	417.9106	84.7082
	262	262	2017	282.7752	15.7012
	263	263	2017	325.5253	24.7818
	264	264	2017	468.0033	81.1232

Step 3: Right-click on the selected rows, and choose "Hide and Exclude" from the drop down menu.

File Edit Tables Rows Cols	DOE Analy	ze Grap	h Tools	View Window H	elp
🔠 🔁 🐸 🖬 🛛 X 🖏 🖏 📗		- Ľx >=	1		
JMP_129DesPts				Total Cost of	
Source	•	Run#	FY	Recruiting	Advertising
	248	248	2016	447,4629	95.741
	249	249	2016	348.5629	39.442
	250	250	2016	597.7795	157.463
Columns (15/1)		251	2016	299.0017	11.1203
Run #		252	2016	393.1824	43.078
L FY	253	253	2016	345.3272	33.872
A Total Cost of Recruiting		254	2016	530.3328	114.436
Advertising		255	2016	337.6762	47.848
Education Incentive		256	2016	289.7138	16.610
Total Recruiters	257	257	2016	332.0182	43.4822
Recruiter Cost	Hi	de and Ex	5.8113	38.4074	
A NCO	Ex	dode/Une	velude	3.2553	25.43
LRP		5.2758	50.754		
A HSDG	H	de/Unhide	7.9106	84.7082	
ISCI-IIIA	La	bel/Unlab	\$2.7752	15.701	
A Relative Pay	Co	lors		\$ 5.5253	24.7818
A QMA				8.0033	81.123
	IN I	arkers		7.7777	9.778
	Co	lor Rows	by Row Sta	ate 3.9173	76.572
	Se	lect Match	ning Cells	7.3943	66.518
	In	1.6413	78.382		
				25.067	27.4098
Rows	C	ear Now St	tates	3.8085	48.0216
All rows 903	Ad	1.3336	8.557		
Selected 258		01.734	87.439		
Hidden	De	iete Kows	6	0.4205	7.294

You should now see



next to each row of data from FY 2015 and 2016.

rite tait lables Kows Cols DUE Analyze Graph Tools View Window Help										
JMP_129DesPts Source		Run #	FY	Total Cost of Recruiting	Advertising					
	9 55 248	248	2016	447.4629	95.7411					
	S 60 249	249	2016	348.5629	39.4425					
	🔕 ණ 250	250	2016	597.7795	157,4634					
Columns (15/1)	⊘ ≈ 251	251	2016	299.0017	11.1203					
A Bun B	🚳 🕷 252	252	2016	393.1824	43.0785					
FY	🔕 ଜ 253	253	2016	345.3272	33.8721					
Total Cost of Recruiting	⊘ ∞ 254	254	2016	530.3328	114.4367					
Advertising	S 66 255	255	2016	337.6762	47.8482					
EB	ම 🗟 256	256	2016	289.7138	16.6105					
Total Recruiters	ම 6 257	257	2016	332.0182	43.4822					
A Recruiter Cost	⊗ ක 258	258	2016	335.8113	38.4074					
A NCO	259	259	2017	313.2553	25.434					
🔺 LRP	260	260	2017	375.2758	50.7542					
A HSDG	261	261	2017	417.9106	84.7082					
ISC I-IIIA	262	262	2017	282.7752	15.7012					
A Relative Pay	263	263	2017	325.5253	24.7818					
OMA	264	264	2017	468.0033	81.1232					

Step 4: Follow steps 1-3 to hide and exclude data from FY 2018, 2019, 2020 and 2021. Row 388 is the first row of data for FY 2018.

File Edit Tables Rows C	ols DOE Analy	ze Grap	h Tools	View Window H	elp
🚑 🔁 💕 🖬 👗 🖦 🛝	: 🖶 🖬 🖽 🖿	- 🖄 🏓	2		
JMP_129DesPts Source		Rup #	FY	Total Cost of Recruiting	Advertising
	377	377	2017	451.601	96.114
	378	378	2017	352,6672	39,596
	379	379	2017	602.583	158.077
	380	380	2017	303.092	11.163
Columns (15/1)	381	381	2017	307.8625	43 246
🖉 Run #	292	292	2017	240 5265	24.004
Total Cost of Recruiting	302	302	2017	535 2227	114 883
Advertising	204	204	2017	241 4000	49.024
EB	206	200	2017	341.4009	16.675
Education Incentive	303	202	2017	295.5255	10.075
Total Recruiters	380	380	2017	335.7705	43.001
Recruiter Cost	38/	38/	2017	339./511	38.55/
A NCO	388	388	2018	317.23	25.533
A HSDG	389	389	2018	379.5288	50.952
TSC I-IIIA	390	390	2018	421.9288	85.038
Unemployment	391	391	2018	286.5432	15.762
Relative Pay	392	392	2018	329.7009	24.878
🚽 QMA	393	393	2018	472.8652	81.439
	394	394	2018	312.0732	9.816
	395	395	2018	478.985	76.870
	396	396	2018	401.5732	66.778
	397	397	2018	425.8783	78.688
	398	398	2018	329.168	27.516
Rows	399	399	2018	357.8098	48.208
All rows 903	400	400	2018	325.8641	8.590
selected 1	401	401	2018	506.9392	87.780
Hidden 258	402	402	2018	324.9698	7.322
Labelled 0	403	403	2018	440.7446	56.968
		4			

D. Distribution

The distribution of the total cost of recruiting for FY 2017 is explored. This technique can be applied to any of the output variables to better understand its distribution and possible spread values.



Step 1: Select "Analyze" from the ribbon, and select "Distribution" from the drop down menu.

-	IMD	120DecDtc	- IMD	Dre
	JIVIP	129Desets	- JIVIP	PIC

JWF_125DESFIS - JWF FIO	Statistic states		and the second s					
File Edit Tables Rows	Cols DOE	Ana	lyze Graph Tools View	v Wir	ndow Hel	lp.		
i 🔛 🎽 🛃 X 🗈 🛝		F	Distribution		Distribu	tion of a bate	h of values.	
▼ JMP_129DesPts ▼ Source		yx IN	Fit Y by X Matched Pairs	quantiles if continuous. Histograr g Box Plots, Quantile Plots. Tests on means, Fitting distributions.				
	06		Tabulate		4 Capabil	ity.		
	06	~	Eit Madal		61.2343	16.9685	22.3984	
Columns (15/1)	<u> </u>	2			51.0429	113.5786	149.9238	
Run #	06		Modeling		38.6302	13.87	18.3085	
FY	06		Multivariate Methods		02.3941	81.1356	107.099	
Total Cost of Recruiting	06				52.9205	31.5034	41.5845	
Advertising	06		Quality and Process		38.0567	72.72	95.9904	
EB	06		Reliability and Suprival		88.5754	53.2076	70.234	
Total Recruiters	06		Reliability and Survival		24.4584	74.0829	97.7894	
A Recruiter Cost	06		Consumer Research		30.8024	9.8779	13.0388	
A NCO	06	889	889 2021	- 2	171.6017	67,5539	89,1712	

Step 2: Select "Total Cost of Recruiting" from the list of columns, and click on the "Y, Columns" button.

elect Columns	Cast Selected	Columns into Roles	Action
15 Columns	Y, Columns	required	ОК
Total Cost of Recruiting		optional	Cancel
Advertising	Weight	optional numeric	Remove
Education Incentive	Freq	optional numeric	Recall
Total Recruiters Recruiter Cost NCO LRP USDG	Ву	optional	Help
TSC I-IIIA Unemployment Relative Pay			
2QMA			

The distribution for Total Cost of Recruiting will appear.

Step 3: To rotate the distribution to appear horizontal, click on the red triangle in the upper left hand corner of the graph, and select "Stack" from the drop down menu.

	1			Grap	n tools	view Window
Istribut	ions				2	
Uniform	Scaling					Total Cost of
Stack				1	Rotates the	histogram and stac
Arrange	in Rows			-	individual o	listribution output
Counter	Adaba Elash i	alatterna (SINE)		5	ever	
Save for	Adobe riash p	plationn (.Swr)		0	2021	361.23
Script				• 11	2021	551.04
-				882	2021	338.63
700	1	•		883	2021	502.39
				884	2021	352.92
600		4		885	2021	438.05
				886	2021	388.57
500-				887	2021	424.45
400		占		888	2021	330.80
400-		r		889	2021	471.60
300			Ε	890	2021	326.05
500		1		891	2021	443.76
				892	2021	363.54
Quanti	les			893	2021	469.92
100.0% r	naximum	974.1696		894	2021	371.07
99.5%		974.1090		895	2021	623.64
90.0%		533.85		896	2021	321.55
75.0%	quartile	433.12145		897	2021	418.84
50.0%	median	361.2135		898	2021	368.38
25.0%	quartile	320.18825		899	2021	556.90
10.0%		293.5959		900	2021	358.0
2.5%		276.82095		0.01	20.21	210 70
0.5%		201.0095				

E. Partition Trees

The partition tree on total cost of recruiting will be explored. The partition tree is a useful method that can help provide insights into variable interactions.



Step 1: To create a partition tree, select "Analyze" from the ribbon. Then choose "Modeling," and "Partition" from the drop down menus.

File Edit Tables Rows	Cols DOE	Anal	yze Grap	h Too	ls View	Wine	dow H	elp				
i 🔛 🤮 🔛 X 🕒 🛎		-	Distributio	n								
■ JMP_129DesPts Source		^y x	Fit Y by X Matched	Pairs			of g	Advertising	EB	Education Incentive	TotalRecruiters	Re
	06	-					52.0454	90.5324	119.5028	0	2570	1
	06		Tabulate				49.4008	43.8552	57.8889	0	2633	1
	06	-	CALL AND				61.2343	16.9685	22.3984	0	3461	
Columns (15/1)	06	3	Fit Model			_	51.0429	113.5786	149.9238	0	3078)
Kun # FY Total Cost of Recruiting Adverticing	06		Modeling Multivaria	te Meth	ods	•	群 Par 添 Ne	tition ural		Recursively pa predict a respo regression tree	rtition the data to onse. Classification es.	and
EB	06		Quality an	d Proce	ss		🕂 Model Comparison		on	0	2875	
Education Incentive	06		Reliability	and Suninal			V No	nlinear		0	2828	1
Total Recruiters	06		rendbinty	und Sul	11401	-				0	2688	1
A NCO	06		Consume	Researc	:h		🍌 Ga	ussian Process		0	3305	l.
LRP	06	889	889	2021		-	what Tin	ne Series		0	3383	1
HSDG	08	890	890	2021			-			0	3188	
TSC I-IIIA	0.4	891	891	2021			Sci	eening		0	3359	1
Unemployment Relative Day	08	892	892	2021			27 P-	manea Cerrani		0	2906	i.
A OMA	08	893 893		2021	2021		S Re	Response Screening		0	2586	i

Step 2: Select "Total Cost of Recruiting" from the list of columns, and click on the "Y, Response" button.

Select Columns		Cast Selected	Columns into Roles	Action
 15 Columns 		Y, Response	required	ОК
ARun #		444	optional	Cancel
Total Cost of F	Recruiting			
Advertising		X, Factor	required	Remove
Education Inc	entive		optional	Recall
Total Recruite	rs			Help
ARecruiter Cost		Weight	optional numeric	
LRP		Freq	optional numeric	
AHSDG		Validation	optional numeric	
Unemploymen	nt	Ву	optional	
4QMA				
Informative Mis	sing			
Ordinal Restricts	s Order			
Validation Portion	0			
Method	Decision Tree 🔹			

Step 3: Select each decision variable (Advertising, EB, Education Incentive, Total Recruiters) from the list of columns, then click on the "X, Factor" button.

elect Columns	Cast Selected	Columns into Roles ——	Action -
15 Columns	Y, Response	Total Cost Recruiting	OK
ARun # FY Total Cost of Recruiting		optional	Cancel
Advertising EB Education Incentive	X, Factor	required optional	Remove
Recruiter Cost	Weight	optional numeric	Help
LRP	Freq	optional numeric	
	Validation	optional numeric	
Unemployment Relative Pay	Ву	optional	
 ✓ Informative Missing ✓ Ordinal Restricts Order ✓ Information Destricts 	1		
Aethod Decision Tree -]		

Step 4: Click on the "OK" button.

Recursive partitionin	9				
- Select Columns			Cast Selected	Columns into Roles	Action
15 Columns			Y. Response	Total Cost Recruiting	ОК
▲Run # ▲FY ▲Total Cost of F	Recruiting			optional	Cancel
Advertising EB Education Inc Total Recruite	entive rs		X, Factor	Advertising EB Education Incentive Total Recruiters	Remove Recall Help
ANCO			Weight	optional numeric	
			Freq	optional numeric	
TSC I-IIIA			Validation	optional numeric	
Unemploymer Relative Pay QMA	nt		Ву	optional	
 Informative Mis Ordinal Restricts Validation Portion Method 	sing s Order Decision Tree	0			
					☆ ■ ▼

The partition tree window will pop-up with just the parent node.





Step 5: To make the first split on "Total Cost of Recruiting," click on the "Split" button.

Continue to split, by clicking the "Split" button. If you want to undo a split, click on the "Prune" button. A "Training" R^2 value of 0.80 is an adequate threshold to achieve. In this case, disregard the "Validation" R^2 value.

F. Stepwise Regression Model

To develop a model for the total cost of recruiting, stepwise regression is used to determine the beta estimates to fit a model.

Step 1: Select "Analyze" from the ribbon, then "Fit Model" from the drop down menu.



Step 2: Select "Total Cost of Recruiting" from the list of columns, and click on the "Y" button.

 Model Specification 		
Select Columns	Pick Role Variables	Personality:
■15 Columns	Y required	
ARun #	optional	
FY		Help Run
Iotal Cost of Recruiting	Weight optional numeric	
Advertising FB	Freq ontional numeric	Recall Keep dialog open
Education Incentive	optionaritamente	Remove
Total Recruiters	By optional	
Recruiter Cost		
ANCO	Construct Model Effects	
	Add	
	Cross	
ARelative Pay	Nest	
4QMA	Macros 🕶	
	Degree 2	
	Attributes 💌	
	Transform 💌	
	No Intercept	

Step 3: While holding the Ctrl key, select each market factor that was varied in the PROM-WED excursion.

Select Columns	Pick Role Variables	Personality:	Standard Least Squares
▼15 Columns ▲Run #	Y Total Cost of Recruiting optional	Emphasis:	Effect Leverage
FY Total Cost of Recruiting	Weight optional numeric		Dura
Advertising EB Education Inconting	Freq optional numeric	Recall	Keen dialog open
	Validation optional	Remove	
NCO	By optional		
LRP HSDG TSCI-IIIA Unemployment	Construct Model Effects		
	Nest Macros 🔻		
	Degree 2 Attributes 💌		
	Transform 💌		

Select the right corner of the "Macros" button (i.e. the arrow), and select "Factorial to degree" from the drop-down menu.

ect Columns	Pick Role Variables	Personality: Standard Least Square
15 Columns Run #	Y Total Cost of Recruiting optional	Emphasis: Effect Leverage
Total Cost of Recruiting	Weight optional numeric	Help
⊿ EB	Freq optional numeric	
Education Incentive Total Recruiters	Validation optional	Recall Keep dialog open
Recruiter Cost	By optional	
A LRP	Construct Model Effects	
▲HSDG ▲TSC I-ⅢA	Add	
	Cross	
Relative Pay QMA	Nest	
	Macros 👻	
	Full Factorial	-
	Factorial to degree	Add selected columns and
	Factorial sorted	degree, E.g., degree 2 enters main
	Response Surface	effects and two-way interactions.

This will add all main effect and two-way interactions.

Select Columns	Pick Role Variables	Personality: Standard Least Squares
■15 Columns ■Run # ■FY	Y Total Cost of Recruiting	Emphasis: Effect Leverage
 Total Cost of Recruiting Advertising 	Weight optional numeric	Help Run
▲EB	Freq optional numeric	
Education Incentive Total Recruiters	Validation optional	Keep dialog open
ARecruiter Cost	By optional	Remove
_ LRP	Construct Model Effects	
	Add	
/Unemployment	Cross Deleting Para	
Relative Pay	Nort NCO*Unemployment	
-QMA	NCO*Relative Pay	
	Macros Unemployment*Relat	tive Pay
	Degree 2	
	Attributes 💌	
	Transform	

Again, while holding the Ctrl key, select each market factor that was varied in the PROM-WED excursion. Select the right corner of the "Macros" button (i.e. the arrow), and select "Polynomial to degree" from the drop-down menu. This will add all second degree polynomial interactions.

 Model Specification 						
Select Columns	Pick Role Va	riables	Personality:	Standard Least Squares		
■15 Columns	Y	Total Cost of Recruiting	Emphasis:	Effect Leverage		
FY FY		optional		Litect Levelage		
Total Cost of Recruiting Advertising EB Education Incentive	Weight	optional numeric		Prop		
A EB	Freq	optional numeric	-reip	Kun		
Education Incentive	Validation optional		Kecall	Keep dialog open		
ARecruiter Cost	By	ontional	Remove			
NCO		op stor on				
	- Construct M	odel Effects				
▲TSC I-ⅢA	Add	NCO				
Unemployment	Cross	Relative Pay				
TSC I-IIIA Unemployment Relative Pay QMA	Nest	NCO*Unemployment				
- Landara	Macro	Unemployment*Relative	tive Pav			
	Full F	actorial				
	Facto	rial to degree				
	Facto	rial sorted				
	Respo	onse Surface				
	Matu	re Response Surface		Cross	ie Pa	
	Polyn	omial to Degree	Add the sel	lected columns (say, X)	Per	
	Schef	fe Cubic	to the spec	owers (X*X, X*X*X, etc.) up ified degree.	byn	
					_	

Step 4: From the "Personality" drop-down menu, select "Stepwise."

Select Columns	Pick Role Va	riables	Personality:	Standard Least Squares
15 Columns Arun #	Y	Total Cost of Recruiting	Emphasis:	Standard Least Squares
AFY		optional		Generalized Regression
Total Cost of Recruiting	Weight	optional numeric		Mixed Model Manova
	Freq	optional numeric	Неір	Loglinear Variance
Education Incentive	Validation	ontional	Recall	Nominal Logistic
Total Recruiters		optional	Remove	Ordinal Logistic
NCO	By	optional		Parametric Survival
A LRP	- Construct M	odel Effects		Generalized Linear Mode
HSDG	Add	NCO		Partial Least Squares
TSCI-IIIA	- Add	Unemployment		Response Screening
ARelative Pay	Cross	Relative Pay		
A QMA	Nest	NCO*Belative Pay		
	Macros •	Unemployment*Relative	Pay	
	Degree	2 NCO*NCO		
	Attributes (Relative Pay*Relative Pay	byment	
	Transform			

Step 5: Ensure that the "Keep dialog open" box is checked, and click the "Run" button.

elect Columns	Pick Role Va	riables	Personality:	Stepwise
15 Columns	Y	Total Cost of Recruiting		(
FY Total Cost of Recruiting			Help	Run
Advertising	Weight	optional numeric	Recall	Keen dialog open
A EB	Freq	optional numeric		M Keep dialog open
Education Incentive Total Recruiters	Validation	optional	Remove	
Recruiter Cost	Ву	optional		
	Construct M	odel Effects		
TSC I-IIIA	Add	NCO Unemployment		
4Unemployment	Cross	Relative Pay		
ARelative Pay	Nest	NCO*Unemployment		
	Macros	Unemployment*Relative	Pay	
	Degree Attributes Transform	2 NCO*NCO Unemployment*Unemplo Relative Pay*Relative Pay	oyment	
	No Inter	cept		

Stepwise	e Fit for T	otal (ost of R	ecruiting						
Stepwise	Regressi	on Co	ntrol							
Stopping R	ule: Minim	num BIC	2	• •	Enter All	Make Mo	del			
Direction:	Forwa	rd 🔻)	-	Remove All	Run Mod	el			
Rules:	Comb	ine	•							
60	Ston	Ste								
774 rows no	ot used due f	to exclu	ided rows (or missing valu	es.					
SSE	DFE	RMSE	RSquare	RSquare Adj	Ср	р	AICc	BIC		
988450.3	128 124.	63855	0.0000	0.0000	717.81945	1 1614	1.135	1619.76		
Current E	stimates									
Lock Enter	red Parame	eter				Estimate	nDF	SS	"F Ratio"	"Prob>F
1 1	Interce	pt				398.246889	1	0	0.000	
	NCO					0	1	720111.2	72.105	4.6e-1
	Unemp	loymen	it i			0	1	108286.7	7.314	0.007
	Relative	e Pay				0	1	533851.6	46.610	3.2e-
	(NCO-3	35000.1	l)*(Unempl	loyment-6.0031	.)	0	3	841588.2	30.576	6.8e-3
	(NCO-3	35000.1	l)*(Relative	Pay-1)		0	3	1459125	114.857	9.2e-
	(Unemp	ployme	nt-6.0031)	*(Relative Pay-	1)	0	3	657070.1	20.564	6.8e-
	(NCO-3	35000.1	l)*(NCO-3	5000.1)		0	2	837680.8	45.860	1.1e-
							2	1100064	2 722	0.006
	(Unemp	ployme	nt-6.0031)	*(Unemployme	nt-6.0031)	0	2	1109204	3.722	0.0260

Step 6: The "Stepwise Regression Control" window will appear. Press the "Go" button.

Step	owise R	egressi	on Cor	ntrol														
Stop	ping Rule	Minim	um BIC		•		Enter All	Make	Mod	el								н.
Dire	ction:	Forwa	rd 🔹				Remove Al	Run	Mode									н.
Rule	5:	Comb	ine	•					1	Tak	e curre	ent mo	del and f	t it in a	sepa	rate fu	ll-featured fit	ting pla
_		Como								-								
	Go	Stop	Step	p														
774	rows not i	used due t	to exclus	ded rows	or mis	ising value	es.											н.
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8697	4.74 1	20 48.9	02517	0.8557		0.8461	10.92502	9	1382.	197	1408.9	931				2		
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/	1	Interce	pt					150.49	2117	1		0	0.000		1			181
	V	NCO						0.0255	2672	4	1034	475	108.143	7.7	e-39			
	1	Unemp	loyment	2				-24.59	8171	3	1323	74.1	18.451	6.6	e-10			
	1	Relative	Pay					-550.24	4982	4	7341	28.1	76.745	3.7	e-32			
	1	(NCO-3	5000.1)*(Unemp	oloyme	nt-6.0031)	-0.003	5413	1	1606	2.16	6.716	0.0	1074			
		(NCO-3	5000.1	(Relativ	e Pav-	1)		-0.123	1431	1	1638	47.2	68.514	2	e-13			
ī .		(Unem	lovmen	t-6.0031)*(Rela	ative Pav-	1)	84.066	2002	1	1566	0.78	6.549	0.0	1174			
Ē.		(NCO-3	5000.1	*(NCO-3	50001	1	~	3.0928	30-6	1	6278	413	26.254	1.1	66-6			
÷	in the second se	(Unem)	lowmen	+-6.0031	1*/11ne	v emploume	nt-6 0031)	010020	0	1	6884	615	2 925	0.0	8982			
	1	(Relativ	e Pay-1)*(Relativ	e Pay-	1)	110 0.0002.0	1907.3	7931	1	6309	6.42	26.384	1.	1e-6			
Step	Histor	у																1
Step	Paran	neter					Action	"Sig F	Prob"	Se	eq SS	RSqua	re	р	р	AICc	BIC	
1	(NCO	-35000.1)*(Relati	ive Pay-1)	1		Entered	0	.0000	145	9125	0.73	38 103.	89	4 1	449.8	1463.61 🔘	
2	Unen	ployment	t				Entered	0	.0000	105	529.6	0.78	69 61.0	55	5 14	123.31	1439.78 🔘	
3	(NCO	-35000.1)*(NCO-	35000.1)			Entered	0	.0001	485	41.67	0.81	13 42.4	32	6 14	109.86	1428.95 0	
4	(Relat	tive Pay-1)*(Relati	ive Pay-1)		Entered	0	.0000	615	80.54	0.84	23 18.2	68	7 13	389.01	1410.69 🔘	
	INCO	-35000.1)*(Unem	ploymer	t-6.00	31)	Entered	0	.0377	110	38.26	0.84	78 15.5	79	8 1	1386.7	1410.93	-
6	(Une	mploymen	t-6.003	1)*(Relat	ivePau	(-1)	Entered	0	.0117	156	60.78	0.85	57 10.9	25	9	382.2	1408.93	- 0
	i i i i i i i i i i i i i i i i i i i	- Projunci		-, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		1.76											1110.00	
-	(Uner	moloymer	t-6.003	1)*(Uner	nnlown	nent-6.00	 Entered 	0	0898	688	4.615	0.85	91	10 1	0 1	(81 Ah	1410.66.000	

Step 7: Once settled, select the "Run Model" button.

The "Report: Fit Model" window will appear.

it Grou	р								
Respo	nse Tot	al Cost o	of Recruit	ing					
Effect S	umma	Ŋ							
Source			LogWort	th				1	PValue
NCO			33.55	53				0	.00000
Relative	Pay		28.27	73				0	.00000
NCO*Re	elative Pa	у	12.69	94				0	.00000
Unempl	oyment		9.03					0	.00000
NCO*N	Pay" Kela	itive Pay	5.90	26					00000
NCO*U	co remployr	nent	1.95	59				0	01074
Unempl	ovment*	Relative Pa	v 1.93	30				ő	.01174
Remov	e Add E	dit 🔲 ED	R						
Summa	ry of F	it							
RSquare			0.855679						
RSquare A	ldj	-	0.846058						
Moot Mea	n Square	Error	48.90252						
Observati	ons (or Si	um Wats)	129						
Analysi	s of Va	riance							
		Sum of	F						
Source	DF	Square	s Mean Squ	uare FRa	tio				
Model	8	1701475.6	5 212	2684 88.9	351				
Error	120	286974.	7 2	2391 Prob	> F				
C. Total	128	1988450.3	3	<.00)1*				_
Parame	eter Est	imates							
Term				Estimate	Std	Error	t Ratio	Prob> t	
Intercept				150.49212	68.	20602	2.21	0.0293*	
Unemploy	ment			-24 50817	3.6	00148	-6.65	<.0001*	
Relative P	av			-550 2498	370	00036	-14.87	< 0001*	
(NCO-350	000.1)*(U	nemploym	ent-6.0031)	-0.003541	0.0	01366	-2.59	0.0107*	
(NCO-350	000.1)*(R	elative Pav	-1)	-0.123143	0.0	14877	-8.28	<.0001*	
(Unemplo	vment-6	0031)*/8-	lative Pav-1)	84 0662	32	8508	2.56	0.0117*	
(Unemplu	ymene o	(ive	adver by 1)	04.0002			2.20	010441	
(NCO-350)00.1)*(N	ICO-35000	1)	3.0928e-6	6.0	36e-7	5.12	<.0001*	

At this point, you can decide if you would like to make manual adjustments to the stepwise regression. For example, the interactions between unemployment rate and relative pay, and the new accession mission and unemployment in this example both exhibit low "t Ratio" values.

To remove these terms from the model, return to the "Stepwise Fit" window, and uncheck the terms in the "Entered" column that you would like to remove. Select "Run Model" to fit the new model.

Stepwi														
	ise Regr	ession Cont	rol											
Stoppin	g Rule:	Ainimum BIC	0		Enter All	Make Mo	del							
Directio	n: F	orward 💌		-	Remove All	Run Mo	del							
Rules:	(Combine 🔹				-								
Go	Ste	op Step												
774 rows	s not used	due to exclude	d rows o	r missing valu	ies.									
SSE 3030365	E DFE 9 121	RMSE RS 50.044352	quare 0.8476	RSquare Adj 0.8388	Cp 15.749241	P 8 138	AIC	c 1 1	BIC 1411.096					
Curren	nt Estim	ates												
Lock Er	ntered Pa	arameter				Estimate	nD)F	S	S "F Rat	io" "I	Prob>F	•	
	In N	tercept CO				0.0255297	9	1	101841	0 0. 3 135.	000 548	1.6e-3	1 B	
	U	nemployment				-24.567887	7	2	116311	9 23.	221	2.92e	9	
	(1)	ICO-35000.1)*(Unemplo	oyment-6.003	1)	-550.45555)	1	16062.1	5 74. 6 6.	716	0.0107	4	
	()	ICO-35000.1)*(Relative	Pay-1)		-0.1277552	2	1	178910	4 71.	437	7.6e-1	4	
	(L	Inemployment-	5.0031)*	(Relative Pay-	-1)	68.044342	1	1	10636.8	8 4.	247	0.0414	6	
	(1	Inemployment-	5.00311*	(Unemploym	ent-6.0031)	2.9398084	5	1	9014.02	2 22. 4 3	679	0.0574	B	
	(F	lelative Pay-1)*(Relative	Pay-1)	circ oroosiy	1917.1170	9	1	63748.8	5 25.	454	1.61e-	5	
Step H	istory													
Step	Paramete	er			Action	"Sig Pro	ob"	5	ieq SS	RSquare	C	p p	AICc	BIC
1	(NCO-35	000.1)*(Relative	Pay-1)		Entered	0.0	000	14	59125	0.7338	103.8	9 4	1449.8	1463.61 🤇
2	Unemplo	yment			Entered	0.0	000	10	5529.6	0.7869	61.05	5 5	1423.31	1439.78
3	(NCO-35	000.1)*(NCO-35	5000.1)		Entered	0.0	001	48	541.67	0.8113	42.43	2 6	1409.86	1428.95
4	(Relative	Pay-1)*(Relative	Pay-1)		Entered	0.0	000	61	580.54	0.8423	18.26	8 7	1389.01	1410.69
5	(NCO-35	000.1)*(Unempl	oyment-	-6.0031)	Entered	0.0	377	11	038.26	0.8478	15.57	9 8	1386.7	1410.93
0	Unemplo	yment-6.0031)	(Relativ	e Pay-1)	Entered	0.0	117	15	000.78	0.8557	10.92	9	1382.2	1408.93
0	Dent	yment-0.0031)	Unemp	pioyment-6.00	(JS1) Entered	0.0	698	08	64.010	0.8591	10.02	0 10	1381.40	1410.00
0	INCO 25	000 11*/11-		6 00211	Permit		107	16	06216	0.833/	15.74	0 0	1296.97	141114

Step 8: To graph the "Actual by Predicted" plot, select the red triangle next to "Response Total Cost of Recruiting." From the drop-down menu, select "Row Diagnostics" and "Plot Actual by Predicted."

Fit Group)				
Respon	se Total Cost	of Red	cruiting		AaBbCcDi Aa
Regres	sion Reports	•			Subtle Em Em
Effect	tes Screening	; 9	Worth 33.553	PValue 0.00000	
Factor	Profiling		28.273	0.00000	
Row D	iagnostics		Plot Actual by Predicted	Actual response Predicted value of	value on Y axis, by
Save C	olumns		Plot Effect Leverage	fits, points are ne	ear the diagonal. You
Model	Dialog Summary		Plot Residual by Predicted Plot Residual by Row	can see which po for patterns, visu	pints do not fit, look alize the test.

Step 9: To fit the prediction model, select the red triangle next to "Response Total Cost of Recruiting." From the drop-down menu, select "Estimates" then "Show Prediction Expression."

Fit Gro	up			
Resp	onse Total Cos	t of Rec	ruiting	
Reg	ression Reports	-		
Estin	mates	•	Show Prediction Expression	Displays or hides the prediction formula in the report.
Effe	ct Screening		Sorted Estimates	0.00000
Fact Row Save	tor Profiling v Diagnostics e Columns	• •	Expanded Estimates Sequential Tests Custom Test	0.00000 0.00000 0.00000 0.00000 0.00000
✓ Mor Effe Scri	del Dialog ct Summary pt		Multiple Comparisons Joint Factor Tests Inverse Prediction	0.01074 0.01174

G. Scatterplot Matrix

Scatterplot matrices can be used to visualize trends when multiple variables are changing.



Step 1: Select "Graph" from the ribbon, then "Scatterplot Matrix" from the drop down menu.

JMP_129DesPts - JMP Pro								
File Edit Tables Rows	Cols DOE Ana	lyze	Grap	h Tools View Window	ł	Help		
1 🔛 🤮 💕 🖬 3, 🖏 🖄		₽ Ľ		Graph Builder				
JMP_129DesPts			0.	Bubble Plot				Educati
Source		R	4	Scatternlot Matrix	1	Advanticing Displays multip	ariate data i	n a grid of
	S 😽 87	◎ <i>≈</i> 878		H. Scatterpiot Matrix		2-dimensional scatterplots.		
	S 87	9	1	Parallel Plot	Da	+3.0332	37.0005	
	68 88	0	10	Cell Plot	43	16.9685	22.3984	
Columns (15/1)	S	1	F.als		29	113.5786	149.9238	
Run #	S 88	2	浃	Scatterplot 3D	02	13.87	18.3085	
FY	6 😽 88	3	20	Contour Plot	41	81.1356	107.099	
Total Cost of Recruiting	S 88	4	A	Ternany Plot	05	31.5034	41.5845	
Advertising	A 2 00	c .	11	rendry Flot	-	70.70	05 0004	

Step 2: To set the Y-axis variables, select "Total Cost of Recruiting" and "Advertising" from the list of columns, and click on the "Y, Columns" button.

Scatterplots of all pairs of Y variables, or all X-Y pairs if	X's specified		
Select Columns	Cast Selected	Columns into Roles	Action
Run #	r, columns	optional	Cancel
Advertising	X	optional	Remove
Control Control Con			Recall Help
	Group	optional	
HSDG ITSC I-ⅢA	Ву	optional	
Unemployment Relative Pay			
Matrix Format Lower Triangular			
			☆ 🗆 🔻 🖽

Step 3: To set the X-axis variables, select the variables of interest (NCO, Unemployment Rate and Relative Pay in this case), and click on the "X" button.

Select Columns	- Cast Selected	Columns into Roles	Action
■15 Columns ■Run # ■FY	Y, Columns	Total Cost Recruiting Advertising optional	OK
Total Cost of Recruiting Advertising EB Fducation Incentive	X	optional	Remove
Total Recruiters Recruiter Cost NCO	Group	optional	Help
HSDG TSC I-IIIA Unemployment Relative Pay	Ву	optional	
AQMA Matrix Format Lower Triangular			

Step 4: Repeat Step 3 for Unemployment Rate and Relative Pay.

Step 5: To generate the scatterplot matrix, click the "OK" button.

Scatterplot Matrix - JMP Pro		_	
Scatterplot Matrix - JMP Pro Scatterplots of all pairs of Y variables, or all X-Y pairs if Select Columns IS Columns IS Columns Run # FY Total Cost of Recruiting Advertising EB Education Incentive Total Recruiters Recruiter Cost NCO LRP HSDG TSC I-IIIA Unemployment Relative Pay QMA	X's specified Cast Selected Y, Columns X Group By	Columns into Roles Total Cost Recruiting Advertising optional NCO Unemployment Relative Pay optional optional optional	Action OK Cancel Remove Recall Help
Lower Iriangular V			☆ 🗖 ▼

Step 5: To fit a trend line on the plots, click the red triangle, and select "Fit Line" from the drop down menu.



H. Contour Plots



Step 1: Select "Graph" from the ribbon, then "Contour Plot" from the drop down menu.

JMP_129DesPts - JMP Pro							
File Edit Tables Rows	Cols DOE Analyze	Grap	h Tools View Window	v H	lelp		
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▼JMP_129DesPts ▼Source			Bubble Plot		Advertising	EB	Educ
	S 🗟 🖓 878		Scatterplot Matrix	54	90.5324	119.5028	
	S 😽 879		Parallel Plot	08	43.8552	57.8889	
	Sec. 880	117	Cell Plot	43	16.9685	22.3984	
Columns (15/1)	S 881	1		29	113.5786	149.9238	
Run#	\$ 682	×	Scatterplot 3D	02	13.87	18.3085	
FY	⊗ <i>€</i> 883	2	Contour Plot	4	Displays three	variables in	a 2-
Total Cost of Recruiting	⊗ € 884	A	Ternany Plot	-	dimensional view where the third		
Advertising	⊗ <i>€</i> 885	1-1	Tennary Flot	5	variable is repr	esented by o	contour
EB	⊗ <i>€</i> 886	1	Surface Plot	54	23.2010	10.234	

Step 2: To set "Total Cost of Recruiting" as the variable represented by the color scale, select "Total Cost of Recruiting" from the list of columns, and click the "Y" button.

Please specify two X columns and one or more Y colum	nns.	
Select Columns	Cast Selected Columns into Roles	Action
Run #	optional numeric	Cancel
EB Education Incentive Total Recruiters Recruiter Cost NCO LRP HSDG TSC I-IIIA Unemployment Relative Pay	X required numeric required numeric By optional	Remove Recall Help
Options Contour Values: Specify Retrieve Display: Fill Areas Data: Vise Table Data Specify Grid		
		🖬 🛄 🔻 🖽

Step 3: To set "Relative Pay" as the x-axis, select "Relative Pay" from the list of columns, and click the "X" button.

elect Columns	Cast Selected Columns into Roles
15 Columns Run # FY	Y 4 Total Cost Recruiting OK optional numeric Cano
Advertising EB Education Incentive Total Recruiters Recruiter Cost NCO LRP HSDG TSC I-IIIA Unemployment Relative Pay	X required numeric required numeric By optional Hel
ptions ontour Values: Specify Retrieve	
isplay: Fill Areas	
ata: 🕼 Use Table Data Specify Grid.	

Step 3: To set the new accession mission (NCO) as the y-axis, select "NCO" from the list of columns, and click the "X" button.

Please specify two X columns and one or more Y colur	nns.	
Select Columns	Cast Selected Columns into Roles	Action —
15 Columns	γ Total Cost Recruiting	ОК
ARun #	optional numeric	Cancel
ULFY		Cancer
Total Cost of Recruiting		
	X ARelative Pay	Remove
Action Incentive	required numeric	Recall
Total Recruiters	By optional	
Recruiter Cost		Help
NCO		
LRP		
ISCI-IIIA		
Relative Pav		
/QMA		
Options		
Contour Values: Specify Retrieve)	
Display: 🔲 Fill Areas		
Data: Vise Table Data Specify Grid		
		🟠 🔲 🔻 🖽

Step 4: Select the "Fill Areas" box, then click the "OK" button to generate the contour plot.

Please specify two X columns and one or more Y colu	mns.	
Select Columns	Cast Selected Columns into Roles	Action —
■15 Columns	Y A Total Cost Recruiting	ОК
Run # FY Total Cost of Recruiting Advertising EB Education Incentive Total Recruiters Recruiter Cost NCO LRP HSDG TSC I-IIIA Unemployment Relative Pay QMA	X Relative Pay NCO By optional	Cancel Remove Recall Help
Options		
Contour Values: Specify Retrieve		
Display: 📝 Fill Areas		
Data: Use Table Data Specify Grid		
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V. EXAMPLE TEST CASES

Two test case examples are provided to demonstrate PROM-WED's capabilities.

A. Effect of Economic Uncertainties

What is the optimal allocation of recruiting resources that is robust to a broad range of economic uncertainties?

Variable Type	Variable Name	Value Low	Value High
Decision Variable	Recruiters	2,500 recruiters	3,500 recruiters
Market Factor	Unemployment Rate	4.0%	8.0%
Market Factor	Relative Pay	0.80	1.20
Policy Factor	Recruiting Mission (NCO)	30,000 recruits	40,000 recruits

B. Effect of Legalization of Marijuana Test Case:

What is the optimal allocation of recruiting resources if the Navy desires to increase the percentage of high quality recruits from 70 percent to 85 percent? Due to uncertainties in the current fiscal environment, the unemployment rate may fluctuate between 4 to 8 percent and the ratio of relative pay may vary between 0.8 and 1.2. In addition, since marijuana has been legalized for recreational use in many states nationwide, drug-use amongst 18-24 year-olds is expected to increase. An increase in drug-use means less young adults qualify for military service. This test case models the effect of an annual decrease of 10,000 qualified military available due to pre-service drug-use.

Variable Type	Variable Name	Value Low	Value High
Decision Variable	Production Recruiters	2,500 recruiters	3,500 recruiters
Market Factor	Unemployment Rate (UE)	4.0%	8.0%
Market Factor	Percentage of High Quality Recruits (TSC I-III)	70%	85%
Market Factor	Relative Pay	0.8	1.2
Market Factor	Qualified Military Available (QMA)	*See Table 13	
Policy Factor	Recruiting Mission (NCO)	30,000 recruits	40,000 recruits

FY	QMA Value Low	QMA Value High
2015	1,873,304	1,883,304
2016	1,863,304	1,873,304
2017	1,853,304	1,863,304
2018	1,843,304	1,853,304
2019	1,833,304	1,843,304
2020	1,823,304	1,833,304
2021	1,813,304	1,823,304

Cumulative Effect of Decrease in QMA