JMP has many ways to join data tables. Using traditional Join, you can easily join two tables together. JMP Query Builder enhances the ability to join, providing a rich interface that allows additional options, including inner and outer joins, combining more than two tables, and adding new columns, customizations and filtering. In JMP 13, virtual joins for data tables were developed which enables you to use common keys to link multiple tables, without using the time/memory necessary to create a joined (denormalized) copy of your data.

Virtually joining tables gives a table access to columns from the linked tables for easy data exploration. In JMP 14 and JMP 15, new capabilities were added to allow linked tables to communicate with row state synchronization. Column options allow you to set up a linked reference table to listen and/or dispatch row state changes among virtually joined tables. This feature provides an incredibly powerful data exploration interface that avoids unnecessary table manipulations or data duplications. (Part 2 of this presentation will demonstrate these JMP 14 features, using a practical application implemented in JMP Clinical)

Additionally, JMP 15 offers selections to use shorter column names, auto-open your tables, and a way to go a step further, using a Link ID and Link Reference on the same column to virtually "pass through" tables.

Part 1: Introduction to Joins, Query Builder and All Things about "Virtual Joins"

Joining Data Tables

JMP can combine two data tables into one new table by selecting Tables > Join. There are multiple matching specifications to choose from listed here:

- By row number This joins tables side by side with an unequal number of rows
- Cartesian Join This joins two tables, forming a new table consisting of all possible combinations of the rows from the original tables.

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💼 species		5	COYOTE	spring					
🖺 season		6	COYOTE	summer					
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• By matching columns – JMP finds specified column values that exist in both tables, combining of all the values associated with that specified column, into a new table. To join with matching columns, the columns must have the same data type.

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Columns (6/0)	4	1	4	1	2	1	BWC	
Survey	5	1	5	1	2	1	BWC	
L Choice Set	6	1	6	1	2	1	BWC	
L Choice1	7	2	7	1	2	2	AAL	
L Choice2	8	2	8	1	2	1	AAL	
Response	9	2	9	1	2	1	AAL	
Person	10	2	10	1	2	1	AAL	
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Rows	12	2	12	1	2	2	AAL	
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Output Table Output Table

To join tables with different numbers of rows and different column names, use the following match selections.

📕 Join - JMP Pro		– 🗆 X
Join rows from several sources	s by matching value.	
Join 'Laptop Runs' with Laptop Runs Laptop Subjects Source Columns Laptop Runs Laptop Runs Choice1 Choice2 Response Person Laptop Subjects Sender Gender Sender Job	Options ✓ Preserve main table order ∪ Update main table with data from second table Merge same name columns Match Flag Main Table ✓ Copy formula ✓ Matching Specification Match Person=Person Main Table Main Table Drop multiples Inner Join <td>Action OK Cancel Remove Recall Help Output table name: LaptopJoin</td>	Action OK Cancel Remove Recall Help Output table name: LaptopJoin
	Output Columns	
 ☐ Keep dialog open ✓ Save Script to Source Table 		

```
Data Table( "Laptop Runs.jmp" ) << Join(
    With( Data Table( "Laptop Subjects.jmp" ) ),
    By Matching Columns( :Person = :Person ),
    Drop multiples( 0, 0 ),
    Include Nonmatches( 0, 0 ),
    Preserve main table order( 1 ),
    Output Table( "LaptopJoin" )
);
```

📑 LaptopJoin - JMP Pro										- 0	×	
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Source	F	Survey	Choice Set	Choice1	Choice2	Response	of	of	Gender	Job		
Open Profile bjects Tables	1	1	1	1	2	1	BWC	BWC	M	Development		\wedge
Choice with Gender Choice Reduced Model	2	1	2	1	2	2	BWC	BWC	M	Development	_	
Choice witharchical Bayes	3	1	3	1	2	1	BWC	BWC	М	Development		
,	4	1	4	1	2	1	BWC	BWC	M	Development		
	5	1	5	1	2	1	BWC	BWC	M	Development		
	6	1	6	1	2	1	BWC	BWC	M	Development		
Columns (9/0)	7	2	7	1	2	2	AAL	AAL	F	Development		
L Survey	8	2	8	1	2	1	AAL	AAL	F	Development		
Choice Set	9	2	9	1	2	1	AAL	AAL	F	Development		
Choice2	10	2	10	1	2	1	AAL	AAL	F	Development		
Response	11	2	11	1	2	2	AAL	AAL	F	Development		
📕 Person of Laptop Runs	12	2	12	1	2	2	AAL	AAL	F	Development		
Lerson of Laptop Subjects	13	1	1	1	2	1	BAG	BAG	M	Development		
Gender	14	1	2	1	2	2	BAG	BAG	M	Development		
dor "	15	1	3	1	2	2	BAG	BAG	M	Development		
	16	1	4	1	2	2	BAG	BAG	M	Development		
	17	1	5	1	2	1	BAG	BAG	M	Development		
	18	1	6	1	2	2	BAG	BAG	M	Development		
Rows	19	2	7	1	2	1	CMG	CMG	M	Development		
All rows 96	20	2	8	1	2	1	CMG	CMG	M	Development		
Selected 0	21	2	9	1	2	2	CMG	CMG	M	Development		
Hidden 0	22	2	10	1	2	1	CMG	CMG	M	Development		
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A simple joining of data tables works well when you are working with smaller data, or data that will be easier to manipulate and present if it is all located in the same data table.

JMP Query Builder

The JMP Query Builder option in the Tables menu enables you to query data tables and save selected data into a new table. This feature allows you to perform queries before saving the data.

• Using Laptop Runs.jmp and Laptop Subjects.jmp, select Tables > JMP Query Builder

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				1	5	1	2	1	BWC				
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Survey		Update		2	7	1	2	2	AAL				
L Choice S		Concatonato		2	8	1	2	1	AAL				
📕 Choice1	ada -	concatenate		2	٥	1	2	1	AAL				
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Response	1993	Missing Data Da	ttorn	JMP da	ta tables.		2	2	AAL				
II. Person	5	wissing Data Pa	luem	2	12	1	2	2	AAL				
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		Anonymize	-	1	2	1	2	2	BAG				
		-	15	1	3	1	2	2	BAG				
			16	1	4	1	2	2	BAG				
			17	1	5	1	2	- 1	BAG				
Rows			19	1	6	1	2	2	BAG				
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🖏 Select Tables for Query - JMP Pro					-		×
Data Source: JMP Open							
⊿ Available Tables	Select Tabl	es for Query					
Search	Primary	Laptop Runs (t	1)				X
Laptop Runs							
Laptop Subjects	Secondary	Laptop Subject	s (t2)			•	0
		optional					\times
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	Preview Join						-
	Laptop Subjects	5			(16 Rows	, 3 Colur	nns)
	Columns Table	Snapshot					
	Column Name	Data Type	Key	Join			
	Person	\land varchar		Laptop Runs.Person			
	Gender	A varchar	-				
	Job	\land varchar					
				Build Query Ru	Now Cance	I H	elp

Click "Build Query" button

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Query Name: LaptopNe		Data Sour	rce: JMP											Start	Over
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Laptop Runs (t1)									37						
Laptop Subjects (t2) 🔍	Variable Name	IMP	Name	Format	Aa	regation		Group By	$^{\sim}$						
	1.Survey	Surve	y L	Best	✓ No	ne	~		××						
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	4	1	4	1	2	1	BWC	BWC	M						
	5	1	5	1	2	1	BWC	BWC	M						
	6	1	6	1	2	1	BWC	BWC	M						
	7	2	7	1	2	2	AAL	AAL	F						
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Select columns to add, and check "Distinct rows only" to avoid having duplicate rows. I selected "Add All", and named the query **LaptopNew**, then clicked "Run Query".

Now observe the tables are joined and all columns are updated.

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■ LaptopNew	۹ 🔍 💌												
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Open Profile bjects Tables Choice with Gender	2	1	2	1	2	2	BWC	BWC	M	Development			
Choice Reduced Model	3	1	3	1	2	1	BWC	BWC	М	Development			
Choice witharchical Bayes	4	1	4	1	2	1	BWC	BWC	М	Development			
Modify Query	5	1	5	1	2	1	BWC	BWC	М	Development			
Update From Database	6	1	6	1	2	1	BWC	BWC	М	Development			
	7	2	7	1	2	2	AAL	AAL	F	Development			
	8	2	8	1	2	1	AAL	AAL	F	Development			
	9	2	9	1	2	1	AAL	AAL	F	Development			
	10	2	10	1	2	1	AAL	AAL	F	Development			
Columns (9/0) Survey	11	2	11	1	2	2	AAL	AAL	F	Development			
	12	2	12	1	2	2	AAL	AAL	F	Development			
Choice Set	13	1	1	1	2	1	BAG	BAG	М	Development			
Choice2	14	1	2	1	2	2	BAG	BAG	М	Development			
Response	15	1	3	1	2	2	BAG	BAG	м	Development			
erson	16	1	4	1	2	2	BAG	BAG	M	Development			
Person 2	17	1	5	1	2	1	BAG	BAG	M	Development			
Gender	18	1	6	1	2	2	BAG	BAG	М	Development			
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	23	2	11	1	2	2	CMG	CMG	M	Development			
Rows	24	2	12	1	2	2	CMG	CMG	M	Development			
All rows 96	25	1	1	. 1	2	2	WCH	WCH	M	Development			
Selected 0	26	1	2	1	2	2	WCH	WCH	M	Development			
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	20	1	5	1	2	1	WCH	WCL	M	Development			~
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Open Laptop Profile.jmp data table and perform Tables > JMP Query Builder again. This time select to use all 3 tables to build this query and click "Build Query".

Remove the duplicate column names and add a filter using **Survey**, to select either 1 or 2, producing a single table based on that selection.

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Query Name: LaptopPro	ofile Dat	a Source: JM	Ρ										Star	t Over
⊿ ▼Tables	Included Columns	Sample								4	Filters			
Laptop Runs (t1) Laptop Profile (t3)	Variable Name	JMP Name		Format		Aggregation		Group By	×		Inverse			
Laptop Subjects (t2) 🔍	🕲 t1.Survey	Survey	- th	Best	•	None	~		×.		ti.survey			
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	t1.Choice1	Choice1	d.	Best	*	None	*			11	-			
Change	t1.Choice2	Choice2	ւսե	Best	*	None	*		+		Not in list			
Available Columns	t1.Response	Response	d.	Best	*	None	*				0.0			
	\land t1.Person	Person	d.			None	*		V	4	OR			
Search	t3.Choice ID	Choice ID	d.	Best	¥	None	*		1 1 1					
1.Survey	A t3.Hard Disk	Hard Disk	ıl.			None	*							

Click "Run Query" and you see this table for Survey 1.

📑 LaptopProfile - JMP Pro													-		×
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Design Discrete Choice	^	-	Survey	Choice Set	Choice1	Choice2	Response	Person	Choice ID	Hard Disk	Speed	Battery Life	Price	Gender	L
SQL_SELECT DISTINCT t1.Sur		1	2	7	1	2	. 2	AAL	1	40 GB	2.0 GHz	4 hours	\$1,200	F	Devel
Source Open Profil jests Tables		2	2	7	1	2	2	AAL	2	80 GB	1.5 GHz	6 hours	\$1,500	F	Devel
Choice with Gender		3	2	8	1	2	1	AAL	1	40 GB	2.0 GHz	6 hours	\$1,200	F	Devel
Choice Reduced Model		4	2	8	1	2	1	AAL	2	80 GB	1.5 GHz	4 hours	\$1,000	F	Devel
Choice witrchical Bayes	\sim	5	2	9	1	2	1	AAL	1	80 GB	1.5 GHz	6 hours	\$1,200	F	Devel
Columns (13/0)		6	2	9	1	2	1	AAL	2	40 GB	2.0 GHz	6 hours	\$1,500	F	Devel
Survey	~	7	2	10	1	2	1	AAL	1	40 GB	2.0 GHz	6 hours	\$1,000	F	Devel
Choice Set		8	2	10	1	2	1	AAL	2	80 GB	1.5 GHz	6 hours	\$1,200	F	Devel
L Choice1		9	2	11	1	2	2	AAI	1	40 GB	1.5 GHz	6 hours	\$1,000	F	Devel
L Choice2		10	2	11	1	2	2	ΔΔΙ	2	80 GB	2.0 GHz	4 hours	\$1,200	F	Devel
Response		11	2	12	1	2	2		1	40 GB	1.5 GHz	6 hours	\$1,500	F	Devel
Choice ID		12	2	12	1	2	2		2	80 GB	1.5 GHz	4 hours	\$1,000	F	Devel
Hard Disk		13	2	7	1	2	1	CMG	1	40 GB	2.0 GHz	4 hours	\$1,000	M	Devel
• c	~	14	2	7	1	2	1	CMG	2	80 GB	1.5 GHz	6 hours	\$1,200	M	Devel
 Rows 		15	2		1	2	1	CMG	- 1	40 GB	2.0 GHz	6 hours	\$1,000	M	Devel
All rows	96	15	2	9	1	2	1	CMG	2	40 GB	1.5 GHz	4 hours	\$1,200	M	Devel
Selected	0	10	2	0	1	2	2	CMG	1	00 GB	1.5 GHz	6 hours	\$1,000	M	Daval
Hidden	0	10	2	9	1	2	2	CMG	1	40 GP	2.0 GHZ	6 hours	\$1,200	M	Devel
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The size of your tables may be a reason to select which method of joining tables is most desirable. In this example, Laptop Runs.jmp is 9 KB, Laptop Subjects.jmp is 2 KB and Laptop Profile.jmp is 6KB. The completed query creates one table which is 21 KB in size. Doing this several times may take up disk space and possibly slow performance.

Virtual Join

JMP Version 13 introduced virtual joins for JMP tables. This "joining without joining" capability allows linking multiple tables, without doing a physical join. JMP 14 and 15 added even more features that will be demonstrated in the following examples. (NOTE: New data tables have been added to JMP 15 to demonstrate some new virtual join features. They are Employee Master.jmp, Education History.jmp, Predicted Termination.jmp)

The data presented in this first example, contains reporting from a human capital management system for an imaginary High Tech firm. The reporting of data is based on human resources data collected from the time the company began in 1997 to October 2016. This example data contains details for Compensation & Headcount, along with Diversity & Compliance, and other employment factors.

The data tables used here for this example are in the screenshots below.

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	2	2	20Feb2012	35		AMII017	SMSE	10035	10002	Brown Elizabeth B	P O Box 25648	-
	3	3	20Feb2012	33	DTI	DTI008	PDEV	12284	10004	Daniels Robert S	108 Ellis Road	
Columns (93/0)	4	4	20Feb2012	32	HRGI	HRGI010	COMP	4661	10005	Capron Susan S	10208 St. John Street	
HCM_UNIQ_ID ^	5	5	20Feb2012	37	ADII	COPII003	GUI	17180	10006	Nichols John G.	1015 New Hall Court	
VALID_FROM_DT	6	6	20Feb2012	32	SARI	SARI069	SMWC	12586	10008	Keefer Marna N.	2000 Forest Green	
PAY_LEVELUCTURE_CD	7	7	20Feb2012	33	TSII	TSII007	040003	16153	10009	Gregory, Karen M.	1000 North Salem	
	8	8	20Feb2012	35	ADI	ADI028	HRIS	16948	10012	Creech, Charles W.	333 Central Avenue	1
INTORG HR	9	9	20Feb2012	37	MCIII	MCIII027	SMSE	10035	10013	Blakeney, Charla B.	2034-A Goosepond	
INTORG_MGR	10	10	20Feb2012	35	ADI	ADI029	SVC	5473	10015	Alaquines,	1015 New Hall Court	
EMPLOYEE_ID	11	11	20Feb2012	28	CSRII	CSRII042	SMNE	7219	10020	Phillips, Mark B.	10001 Guess Road	
ADDRESS LINE 1 TYT	12	12	02Dec2007	37	AMIII	ACIII037A0	0210	17191	10029	Eubanks, Ben H.	1003 North Academy	
ADDRESS LINE 2 TXT	13	13	20Feb2012	34	HSSII	HSSII012	SVC	5473	10030	Gardner,	108 Ellis Road	
CITY_NM	14	14	20Feb2012	28	TSOIII	TSOIII037	TSFN	11685	10032	Winn, Ella K.	3333 Orchid Lane	
STATE_REGION_CD	15	15	20Feb2012	37	GMGR	SMA078	1400	17130	10035	Zievis, Brian T.	1011 Phillips Hall	
COUNTRY_CD	16	16	20Feb2012	28	CSRII	CSRII010	1400	17130	10036	Elmore, Ruth O.	1000 Six Forks Road	4
CHIZENSHIUNIRY_CD	17	17	20Feb2012	36	QAAI	QAAI039	QAC	4837	10037	Thorpe, Sallie C.	1018 Blueberry Lane	
MARITAL STATUS CD	18	18	15Oct2006	39	CPRIII	CPRIII020	EIS	16872	10047	Smith, Jeffrey P.	1064 Langley Building	
GENDER_CD	19	19	30Nov2006	31	WI	WI002	0520	5469	10048	Nicklas, Michael G.	1015 New Hall Court	
LUNION_CD	20	20	20Feb2012	33	MAI	MAI017	1700	15994	10054	Anthony,	1016 Norwood Road	
MINORITY_FLG	21	21	15Nov2006	35	MAII	MAII020A0	SMNW	1754	10062	Harris, Morgan K.	500 Dogwood Circle	
 Rows 	22	22	20Feb2012	39	ADIII	COPIII035	GUI	17180	10066	Feller, Aaron C.	1000 North Salem	L.
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⊂compensationmaster Source			EMPLOYEE ID	COMPENSATION	PAYMENT DT		EMPLOYEE NAME	COMPENSATION TYPE	
	1	6144	18620	BNUS	20Jun2016	603.36	Proctor, Crystal L.	Bonus	^
	2	10240	7598	BNUS	22Apr2017	433.85	White, Douglas S.	Bonus	
	3	3072	12565	BNUS	12Sep2017	1703.84	Raouf, Gazala E.	Bonus	
	4	7168	2973	BNUS	07Jun2015	969.49	Neff, Dennis R.	Bonus	
	5	4608	16382	BNUS	24Nov2016	2533.49	Ellison, Parkinson J.	Bonus	
Columns (7/0)	6	5120	16941	BNUS	14Dec2016	473.55	Bradley, Anthony	Bonus	
HCM_UNIQ_ID	7	5632	17282	BNUS	11Aug2017	4613.19	Roach, Justin R.	Bonus	
EMPLOYEE_ID	8	768	10647	BNUS	27Nov2016	2580.64	Ayscue, Robin B.	Bonus	
COMPENSATION_TYPE_CD	9	6656	20521	BNUS	29Sep2017	699.48	Ellis, Ray T.	Bonus	
COMPENSATION AMT	10	3584	13067	BNUS	01Sep2017	1164.62	Fan, Steven Q.	Bonus	
IL EMPLOYEE NAME	11	7680	3846	BNUS	26Jan2017	2157.88	Smith, Dick L.	Bonus	
L COMPENSATION_TYPE	12	8704	5907	BNUS	13Sep2014	2752.13	Mitchell, Michael T.	Bonus	
	13	2304	11936	BNUS	13May2014	5074.34	Schick, Jane H.	Bonus	
	14	9728	7034	BNUS	20Dec2016	3079.81	Siebolt, Bonnie M.	Bonus	
	15	9891	7322	BNUS	31Jan2016	2962.80	Tharington,	Bonus	
	16	5376	17095	BNUS	02May2017	2817.01	Cresap, Steven E.	Bonus	
	17	2816	12336	BNUS	01Jul2015	583.94	Bail, Richard T.	Bonus	
	18	5888	17545	BNUS	28Sep2014	1304.51	Medlin, Mark T.	Bonus	
	19	384	10375	BNUS	19Jun2016	1105.98	Crump, David T.	Bonus	
	20	6400	19609	BNUS	24Jan2017	2149.47	Nanavati, Kaajal I.	Bonus	
	21	3328	12807	BNUS	18Sep2016	1083.52	Campos,	Bonus	
	22	6912	2224	BNUS	15Jul2014	684.33	Longford,	Bonus	
 Rows 	23	1792	11560	BNUS	18Mar2015	2658.08	Menchinger,	Bonus	
All rows 12,939	24	7424	3520	BNUS	14Jul2017	1523.45	Harrell, Selma H.	Bonus	
Excluded 0	25	960	10814	BNUS	16Dec2015	3607.63	Parker, Joseph G.	Bonus	
Hidden 0	26	7936	4480	BNUS	01Jun2015	2623.11	Tucker, Vaughn R.	Bonus	
Labelled 0	27	8448	5372	RNHS	01May2017	221844	Walden Brent Δ	Ronus	×
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Using a JMP **Virtual Join** will accomplish what we need and save space and duplication of data. Please refer to the <u>online documentation</u> for more details. Note that virtually joining tables can be done interactively by a simple right-click on data table columns or by scripting in JSL.

Virtual Join: Human Resources Employee data & Compensation

 Right Click on HCM_UNIQ_ID from Empscores.jmp and Compensationmaster.jmp tables and set up LINK ID and LINK REFERENCE respectively.

Empscores.jmp becomes the **"Source Table"** that has unique row values of HCM_UNIQ_ID (a generic system key). This becomes the **Link ID Column**

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 Professional Skill Level - Diversity, Gender COMRATIO within GENERATION by EEO Class 	•	3		Column Properties	+	DTI008	PDEV	12284	10004	Daniels, Robert S.
	•	4		Becode	GI	HRGI010	COMP	4661	10005	Capron, Susan S.
	•	5			U	COPII003	GUI	17180	10006	Nichols, John G.
	•	6		New Formula Column	▶ RI	SARI069	SMWC	12586	10008	Keefer, Marna N.
	•	7		Insert Columns		TSII007	040003	16153	10009	Gregory, Karen M.
	•	8		Delete Celument		ADI028	HRIS	16948	10012	Creech, Charles W.
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	•	10		Label/Unlabel		ADI029	SVC	5473	10015	Alaquines, Consu
ACID_TROM_DI	•	11			RII	CSRII042	SMNE	7219	10020	Phillips, Mark B.
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Restriction_CD	•	13		Link Reference	► SII	HSSII012	SVC	5473	10030	Gardner, Chalotte
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L CITY_NM		19		Copy Columns		WI002	0520	5469	10048	Nicklas Michael G
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COMPENSATION_TYPE *	▼ 19			opy columns	01100	1	1977	19Jun2016	1105.98	Crump, Da	vid T.
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	24		7424	3520	BNUS			14Jul2017	1523,45	Harrell, Sel	ma H.
	▼ 25		960	10814	BNUS		1953	16Dec2015	3607.63	Parker, Jos	eph G.
	26		7936	4480	BNUS			01Jun2015	2623.11	Tucker, Va	Jahn R.
	27		8448	5372	BNUS			01May2017	2218.44	Walden Br	ent A.
 Rows 	28		4352	16103	BNUS			29Sep2017	4421.00	Hill Aaron	Δ.
All rows 12,949	29		8960	6267	BNUS			250ct2014	4421.00	McShea S	ean M.
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Hidden 0	▼ 21		2369	11996	BNUS		1974	20May/2015	1730.07	Reid David	i F
Labelled 0	·	<	1016	11052	DNILIC		1077	1614-0016	202204	Maria	
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Compensationmaster.jmp is a **"Referencing table"** by setting up a **Link Reference** to Empscores.jmp on HCM_UNIQ_ID.



All columns in Empscores.jmp are now available to be used in analysis with Compensationmaster.jmp data table.

No more preparation needed! That was the trick, and now we're ready to prepare an analysis using combined information from these tables.

Next run the "Tabulate of Compensation by Gender, Years of Service" table script to see a table listing compensation pay by sex and years of service (from Compensationmaster.jmp).

Tabulate			
		GENDER CDIH	
LENGTH_OF_SERVICE[HCM_UNIQ_ID]	COMPENSATION_TYPE	F	N
0 to 1 yrs	Bonus	0	1
1+ to 3 yrs	Bonus	181	217
	Commission	15	1(
	Cost-of-Living Adjustment	23	36
3+ to 5 yrs	Bonus	239	270
	Commission	19	24
	Cost-of-Living Adjustment	35	58
5+ to 10 yrs	Bonus	651	743
	Commission	41	62
	Cost-of-Living Adjustment	99	87
10+ yrs	Bonus	296	386
	Commission	25	35
	Cost-of-Living Adjustment	45	50

Notice the long column names in the Tabulate report above. One of the NEW changes for virtual join in JMP 14 was the ability to use the shorter column names. This selection can be changed from the Column Info dialog or with JSL scripting.

Right-click on the HCM_UNIQ_ID column and select Column Info and the screenshot below appears:

HCM_UNIQ_ID - JMP Pro		
- 'HCM_UNIQ_D' in table 'compensationmaster1' Column Name HCM_UNIQ_D Lock Data Type Numeric v	OK Cancel Apply Help	"Use Linked Column Names" was a new feature for JMP 14
Modeling Type Continuous Format Best Width 12 Use thousands separator (.) Column Properties SAS Shormat SAS Shormat Link Reference Auto Open Auto Open V Use Linked Column Name Remove Row States Synchronization with Reference Table		<pre>JSL Script: Set Property("Link Reference",</pre>
Cccept Dispatch Row States		
Select Exclude Hide		

Now, rerun the Tabulate script from above and notice the report column headers are a bit shorter, not having the brackets [] in the column names.

Tabulate			
		GENDE	R_C
LENGTH_OF_SERVICE	COMPENSATION_TYPE	F	_
0 to 1 yrs	Bonus	0	
1+ to 3 yrs	Bonus	181	2
	Commission	15	
	Cost-of-Living Adjustment	23	3
3+ to 5 yrs	Bonus	239	2
	Commission	19	2
	Cost-of-Living Adjustment	35	1
5+ to 10 yrs	Bonus	651	74
	Commission	41	(
	Cost-of-Living Adjustment	99	
10+ yrs	Bonus	296	38
	Commission	25	1
	Cost-of-Living Adjustment	45	1

2. By using virtual joins and the new features around row state synchronization the ability to enhance your reporting just got even better. There IS no data manipulation, no stacking/joining/merging, just straight to data exploration and analysis!

Besides simplicity, why else should we use virtual joins? A quick distribution of the employee diversity variables (using the Compensationmaster.jmp table to access the referenced columns) is shown in the next screenshot.



There are 3650 employees in this example of human resources data! These numbers are not correct! They represent all the times that employees' records are duplicated because Compensationmaster.jmp has multiple records for each employee. So how would we get the correct Distribution? We need to run the analysis in another direction, and use another new feature for virtual join, *accept/dispatch row states*. Bringing the column info dialog back up for the HCM_UNIQ_ID column, the selection is seen here:

🖶 HCM_UNIQ_ID - JMP Pro	– 🗆 X	
'HCM_UNIQ_ID' in table 'compensationmaster'	OK Cancel	
□ Lock Data Type Numeric ∨ Modeling Type Continuous ∨ Format Best ♥ Width 12 □ Use thousands separator (,) Column Properties ♥	Apply Help	Row State Synchronization is listed here. Dispatch selected for Select, Color and Marker will send those row states to Empscores.jmp
SAS Name Link Reference SAS Format Reference Table SAS Informat Impscores.jmp Ink Reference Auto Open Vuse Linked Column Name Row States Synchronization with Reference None Accept O Dispatch Row States V Select Exclude Hite Label	nced Table	<pre>JSL Script: Set Property("Link Reference", {Reference Table("empscores.jmp"), Options("Use Linked Column Name"(1), Row States Synchronization with Referenced Table(Dispatch(1), Row States(Select, Color, Marker)))});</pre>

From Compensationmaster.jmp, run the script "Color/Mark by EEO_Class" to set the color and marker row states, to dispatch to the Empscores.jmp table. Then, from Empscores.jmp table run the script entitled, "Distribution SHORT Names – CORRECT numbers!"

These numbers are correct in the Distribution shown below, counting records for employees only once from the Empscores.jmp table.



Let's pose a NEW analysis question. What if I want to check salary ranges by using the COMRATIO within a GENERATION LABEL that was created based on BIRTH_DT, then at the same time gain the row states from Compensationmaster.jmp table based on EEO_CLASS? This should help us understand a few things about employees across generations. Compa-ratio(COMRATIO) is calculated as the employee's current salary divided by the current market rate as defined by the company's competitive pay policy. Compa-ratios are position specific. Each position has a salary range that includes a minimum, a midpoint, and a maximum.

This is an analysis that must be done on Empscores.jmp table to be done correctly. A local data filter to select which job class to focus on is also helpful in looking at data ranges. A screenshot of such an analysis is below:



The EEO_CLASS_CD is a classification code that is used for job category, and in the screenshot above, the Professional and Technical jobs seem to provide the highest salaries. The EEO_CLASS_CD row states show in this next graph the color and markers that were dispatched from the Compensationmaster.jmp table.



A local data filter using JOB_GROUP_DESC variable to select just a few of the descriptions, the colors and markers that are being used in this graph appear clearly from the row states from Compensationmaster.jmp table. For more information on Accept/Dispatch row states with virtual join, refer to the <u>online documentation</u> here.

Compensationmaster.jmp table contains a column, **Birth Year FORMULA**. It contains a formula with a linked column from Empscores.jmp, called BIRTH_DT.

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	0	5120	10941	BINUS	•	14Dec2016	4/3.55	Bradley, Ar
	7	5632	17282	BNUS	•	TTAug2017	4613.19	Koach, Jus
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L COMPENSATION_TYPE_CD		Lock			мро	20Dec2016	3079.81	Siebolt, Bo
📑 Birth Year FORMULA 🖶	Data Type	Numeric Y			Help	31Jan2016	2962.80	Tharingtor
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		E	dit Formula	Ignore Errors		14Jul2017	1523.45	Harrell, Sel
			,	`		16Dec2015	3607.63	Parker, Jos
		Ye	ar (BIRTH_D	г)		01Jun2015	2623.11	Tucker, Va
				,		01May2017	2218.44	Walden, Br
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All rows 12,949	L					25Oct2014	4494.71	McShea, Se
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Labelled 0	-	1016	11050	DAILIC	1077	1614-0016	202704	M.I
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When using formulas and closing virtually joined tables, it is a best practice to close the **"source"** table first (Compensationmaster.jmp), because there is a link between that table and another table. Closing them in a different order might display a prompt indicating that the table you are closing has other windows open. You might want to cancel and consider saving and closing your tables in a different order.

NEW to 15

JMP 15 added a few more enhancements to Virtual Joins, and this final example will use new tables added to the sample data library. This data is also part of the High Tech HR company we mentioned before. In any company, employee information may be in multiple files or tables and may also be updated on a regular basis. When data may change, be updated or eliminated, using the virtual join is the best way to gather the information you may need for analysis.

One of the new features in JMP 15 for virtual join is **when one table of the set of linked tables is opened, others will be automatically opened as well**.

For this example, open Employee Master.jmp table.

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		8	8	10012	ADI	ADI028	HRIS	16948	
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	🔥 Position Code	13	13	10030	HSSII	HSSII012	SVC	5473	
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	🖺 Intorg Mgr			40005	-	C1 11 0 7 0	4.400	17100	

Auto Open is set in the Column info dialog for the **Link Reference** column, Employee Id. This can also be done with JSL.



To gain this employee information from multiple tables, they can now be linked together by **a single column that has both a** *Link ID* **and a** *Link Reference* **property.** This feature allows a type of look through ability, from one table to the next, where you can access information for an employee, doing your analysis from the "source" table.

- Employee Master.jmp has information about each employee
- Education History.jmp has information about the education of each employee
- Predicted Termination.jmp has job performance information about each employee

In Employee Master.jmp, select the Employee ID column and select **Columns > Column Info**.



Notice that the column has a **Link ID** column property and a **Link Reference** to Education History.jmp. Now, open Education History.jmp from the Home window list, select **Columns > Column Info** for the Employee ID column.

'Employee ld' in table 'Ed	ucation History'	OK
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As shown above, Employee Id has a **Link ID** and a **Link Reference** to Predicted Termination.jmp. The Employee Id column of Employee Master.jmp references Education History.jmp, which also references Predicted Termination.jmp. All of the data is available through virtual join from the **"source"** data table, which in this case is Employee Master.jmp.

🔛 Employee Master - JM	IP Pro				—	\Box \times
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🚑 🤮 💕 🗔 🐰 🗈	🚨 ₌	Education History - JMP Pro)			
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Intorg Mgr		Terminal Degree Flag	12	Intorg Hr	9	2906
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Hover tips now let you determine a linked column's source table. In this example, the tables are linked by Employee Id, making it difficult to determine in which table a given linked column resides. JMP 15 added this hover tip ability from the columns pane display, so you can see which table contains a given column.

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Running the scripts from the **"source"** table, Employee Master.jmp, now shows the data from all the tables.



Education History.jmp, also a **"source"** table, accesses the data from Predicted Termination.jmp. Run the script attached in this example called "Graph Builder for Education History" to see Performance by Training Dollar %.



For more information on Link ID and Link Reference on a single column in virtual join, refer to the <u>online documentation</u> here.

Part 2: Application of Virtual Joins in Clinical Trial Analysis

The data presented here is a subset of data collected on patients enrolled in a clinical trial to evaluate the safety and efficacy of the drug Nicardipine hydrochloride as a medication to treat subarachnoid hemorrhage¹. Clinical trial data is commonly collected following global <u>CDISC</u> data standards using a Study Data Tabulation Model (<u>SDTM</u>). This format means patient data is collected in multiple normalized data sets or "domains" such as patient demography (one record per patient with patient characteristics and clinical treatment given), adverse events occurring during a trial (stacked multiple records per subject indicating occurrence), and laboratory measurements taken during clinical visits (multiple quantitative results for each lab also in a stacked data format).

Demography P lotes The Unique Subject Identifi		Study Identifier	Domain Abbreviation	Unique Subject Identifier	Subject Reference Start Date/Time	Subject Reference End Date/Time	Study Site Identifier	Date/Time of Birth	Age	Sex	Race
Reference These data were derive Age By Study Site Scatter Plot	1	NICSAH1	DM	101001	1988-01-21T17:15:00	1988-02-02T17:11:00	10	1924-03-02	63	F	WHITE
	2	NICSAH1	DM	101002	1988-01-26T11:30:00	1988-02-05T12:00:00	10	1921-08-11	66	м	WHITE
	3	NICSAH1	DM	101003	1988-01-26T15:10:00	1988-02-04T15:30:00	10	1956-08-03	31	F	BLACK OR
	4	NICSAH1	DM	101004	1988-01-28T16:00:00	1988-01-28T16:33:00	10	1939-08-17	48	F	WHITE
	5	NICSAH1	DM	101005	1988-04-05T14:45:00	1988-04-17T13:45:00	10	1920-11-14	67	F	WHITE
Columns (17/0)	6	NICSAH1	DM	101006	1988-04-28T13:40:00	1988-05-08T14:00:00	10	1955-08-10	32	М	BLACK OR
Domain Abbreviation	7	NICSAH1	DM	101007	1988-06-25T11:05:00	1988-06-27T12:00:00	10	1925-05-29	63	м	WHITE
Unique Subject Identifier	8	NICSAH1	DM	101010	1988-08-08T20:00:00	1988-08-19T12:00:00	10	1939-09-08	48	F	BLACK OR
Subject Referetart Date/Time	9	NICSAH1	DM	101011	1988-08-17T13:30:00	1988-08-29T08:00:00	10	1955-02-03	33	F	BLACK OR
Subject RefereEnd Date/Time	10	NICSAH1	DM	101012	1988-12-14T22:00:00	1988-12-23T15:00:00	10	1939-07-03	49	м	WHITE
Study Site Identifier	11	NICSAH1	DM	101013	1989-01-12T20:00:00	1989-01-22T22:00:00	10	1956-03-17	32	М	WHITE
Age	12	NICSAH1	DM	101014	1989-03-16T17:00:00	1989-03-20T09:00:00	10	1914-07-23	74	F	WHITE
Sex	13	NICSAH1	DM	101015	1989-03-28T21:20:00	1989-04-09T22:00:00	10	1942-02-28	47	F	WHITE
Race	14	NICSAH1	DM	101016	1989-04-23T14:00:00	1989-05-05T06:00:00	10	1911-03-20	78	F	BLACK OR
Description of Planned Arm	15	NICSAH1	DM	101017	1989-05-11T23:00:00	1989-05-20106:15:00	10	1953-07-09	35	м	WHITE
Country	16	NICSAH1	DM	11001	1987-10-12T23:25:00	1987-10-24T10:00:00	01	1968-10-24	18	м	WHITE
Blood Transfusion Flag	17	NICSAH1	DM	11002	1987-10-14T16:30:00	1987-10-21T10:30:00	01	1908-07-20	79	М	WHITE
Induced Hypertension Flag	18	NICSAH1	DM	11003	1987-11-10T18:00:00	1987-11-23T19:00:00	01	1941-01-03	46	м	WHITE
Patient Died Flag	19	NICSAH1	DM	11004	1987-12-02T06:10:00	1987-12-14T18:00:00	01	1915-09-18	72	F	WHITE
Patient had Vaonsription Flag	20	NICSAH1	DM	11005	1987-12-08T10:15:00	1987-12-19T00:30:00	01	1907-07-10	80	F	WHITE
	21	NICSAH1	DM	11006	1987-12-15T21:00:00	1987-12-27T20:00:00	01	1934-08-11	53	F	WHITE
	22	NICSAH1	DM	11007	1987-12-30T16:15:00	1988-01-12T16:15:00	01	1944-03-27	43	М	WHITE
	23	NICSAH1	DM	11008	1988-01-09T11:35:00	1988-01-22T08:00:00	01	1931-11-28	56	F	WHITE
	24	NICSAH1	DM	11009	1988-02-24T21:30:00	1988-03-09T00:00:00	01	1922-06-25	65	F	WHITE
r Rows	25	NICSAH1	DM	11010	1988-03-01T21:00:00	1988-03-13T19:40:00	01	1943-04-06	44	F	WHITE
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lidden 0	28	NICSAH1	DM	11013	1988-04-05T2000:00	1988-04-18T180000	01	1924-01-09	64	F	WHITE

You can see screenshots of these data below.

¹ Haley EC, Kassell NF & Torner JC. (1993). A randomized controlled trial of high-dose intravenous nicardipine in aneurysmal subarachnoid hemorrhage. Journal of Neurosurgery 78: 537-547.

| AdverseEvents D | | Study Identifier | Domain
Abbreviation | Unique Subject
Identifier | Dictionary-Derived Term
 | Body System or Organ Clas
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| Reference These data were derive | 1 | NICSAH1 | AE | 101001 | Hydrocephalus
 | NERVOUS SYSTEM DISORDER
 | S MILD
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| Dictionary-Derived Term | 2 | NICSAH1 | AE | 101001 | Pyrexia
 | GENERAL DISORDERS AND
 | MILD
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| | 3 | NICSAH1 | AE | 101001 | Vasoconstriction
 | VASCULAR DISORDERS
 | MODERATE
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 | | |
| | 4 | NICSAH1 | AE | 101001 | Vomiting
 | GASTROINTESTINAL
 | MILD
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| olumns (15/0) 5 NICSAH1 | | NICSAH1 | AE | 101002 | Alveolitis
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| Study Identifier | 6 | NBCSAH1 | AE 101002 | | Hydrocephalus
 | NERVOUS SYSTEM DISORDER
 | S MODERATE
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 | | |
| Domain Abbreviation | 7 | NICSAH1 | AE | 101002 | Hyperglycaemia
 | METABOLISM AND
 | MODERATE
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| Unique Subject Identifier | 8 | NICSAH1 | AE | 101002 | Pulmonary oedema
 | RESPIRATORY, THORACIC
 | MODERATE
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| Dictionary-Derived Term | 9 | NICSAH1 | AE | 101002 | Urinary tract infection
 | INFECTIONS AND
 | MODERATE
 | | | | | | | | |
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 | | |
| Severity/Intensity | 10 | NICSAH1 | AE | 101002 | Vasoconstriction
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| Serious Event | 11 | NICSAH1 | AE | 101002 | Ventricular extrasystoles
 | CARDIAC DISORDERS
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| Action Takentudy Treatment | 12 | NICSAH1 | AE | 101004 | Brain oedema
 | NERVOUS SYSTEM DISORDER
 | IS MILD
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| Causality | 13 | NICSAH1 | AE | 101004 | Hydrocephalus
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| Outcome of Adverse Event | 14 | NICSAH1 | AE | 101004 | Hyperglycaemia
 | METABOLISM AND
 | MILD
 | | | | | | | | |
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 | | |
| Start Date/Tim Adverse Event | 15 | NICSAH1 | AE | 101004 | Hypotension
 | VASCULAR DISORDERS
 | SEVERE
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| Study Day of S. Adverse Event | 16 | NICSAH1 | AE | 101004 | Intracranial pressure
 | NERVOUS SYSTEM DISORDER
 | S SEVERE
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| Study Day of E Adverse Event | 17 | NICSAH1 | AE | 101004 | Subarachnoid
 | NERVOUS SYSTEM DISORDER
 | S SEVERE
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| Total Count | 18 | NICSAH1 | AE | 101004 | Vasoconstriction
 | VASCULAR DISORDERS
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| | 19 | NICSAH1 | AE | 101005 | Alveolitis
 | RESPERATORY, THORACIC
 | MODERATE
 | | | | | | | | |
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| | 20 | NICSAH1 | AE | 101005 | Anaemia
 | BLOOD AND LYMPHATIC
 | MILD
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| | 21 | NICSAH1 | AE | 101005 | Heart rate increased
 | INVESTIGATIONS
 | MILD
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| | 22 | NICSAH1 | AE | 101005 | Hydrocephalus
 | NERVOUS SYSTEM DISORDER
 | IS MILD
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| - Owner | 23 | NICSAH1 | AE | 101005 | Hyperglycaemia
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NOTE: A similar example to what is shown in this document is also found in the JMP Sample Data Library:

- Open "Nic Demographics.jmp" and run the "Patient Safety Dashboard" script

A natural analysis of laboratory findings data would be to look for differences in lab test results for patients under different treatment conditions. This could be done easily in JMP with **Tables** -> Join to merge the two data tables together. Doing so has key consequences:

1. Requires making a new table, whose size nearly DOUBLES.

📑 Demography.jmp	3/7/2018 9:59 AM	JMP Data Table	105 KB
🖼 Labs.jmp	3/6/2018 3:04 PM	JMP Data Table	875 KB
🛄 MergedLabswithDM.jmp	3/7/2018 4:59 PM	JMP Data Table	1,631 KB

- 2. The new columns have extensive duplication of data values, since there were multiple laboratory tests taken at multiple clinical visits.
 - a. This makes any desired patient-population analysis like ensuring a balanced patient treatment design across age/sex/race impossible. This analysis would still need to be done on the original demography table separately.

We will use these data to show two examples of a multi-table analysis using virtual joins and row state dispatch/acceptance.

DISPATCH EXAMPLE: Use patient demography table to create a distribution of patients' age across different clinical study sites. In Clinical trial analysis, two important factors are to flag or mark any patients that had abnormal lab test results or serious adverse events.



I want to annotate this **Age** by **Study Site Identifier** plot (demography.jmp) by coloring any patient (point) **RED** if they ever had an abnormally HIGH lab test result for the Lab Test "Alanine Aminotransferase" (information from Labs.jmp). I want to also mark any patient with an * if they had a serious adverse event occur while on trial (record information in AdverseEvents.jmp). How would we do this with JMP?

The virtual join alone doesn't help us because only the referencing tables (Labs.jmp or AdverseEvents.jmp) can access the columns in Demography.jmp. In JMP 13, we would have to select those rows/records with abnormal results, subset, create a new flag or indicator variable, merge into Demography. Now we can use JMP features of row state synchronization to DISPATCH row states from Labs.jmp and AdverseEvents.jmp back to the source table.

Row State Synchronization: DISPATCH

- 1. First we need to open Labs.jmp and AdverseEvents.jmp and set up **Unique Subject** Identifier as the Link Reference to Demography.jmp with a virtual join for both tables.
- Now both Lab and AdverseEvent tables are linked by the subject ID to the patient demography. Note both tables were saved with row states corresponding to the lab abnormalities (records colored red) and serious adverse event occurrence (records are marked with *) we are interested in using in patient age analysis.
- 3. In the Labs.jmp table
 - a. Right Click on **Unique Subject Identifier** in the Labs.jmp data table. In the screenshot below, you see that this Link Reference Points to Demography.jmp and here we see the options to set Row State Synchronization.

📴 Unique Subject Identifie	r - JMP Pro	- • ×
ˈ'Unique Subject Identifie	r' in table 'Labs'	ОК
Column Name Unique	Subject Identifier	Cancel
Lock	c .	Apply
Data Type Charac	ter 🔻	Help
Modeling Type Nomin	al 👻	
Column Properties 💌		
SAS Name SAS Label SAS Format	Link Reference Reference Table Select Table	
Link Reference optional item	Demography.jmp Use Linked Column Name	
Remove	Row States Synchronization with Referenced Table None Accept Dispatch Row States Select Exclude Hide Label Color Marker	

4. Click "Apply". The Labs.jmp table had been saved previously with row state colors for records that had HIGH abnormal results for the lab test in our **Analysis Goal 1** to save time here. The new screenshot below shows the results.

🔛 Demography - Graph Builder - JMP Pro	
⊿ 💌 Local Data Filter	a 💌 Graph Builder
Clear Favorites 🕶	Age vs. Study Site Identifier
📝 Show 📝 Include	
Inverse	100-
■ 18 ≤ Age ≤ 108	90-
Sex (2) F M	
Race (4) ASIAN (15) BLACK OR AFRICAN AME	╷╴ [┯] ┋┥ <mark>┯┋╴┊┥┑┇╶╧╪╪┯</mark> ┥┆╴╤┥ <u>╡</u> ╴ <u></u> ╪╬╖ _┍ ╝┯╎┯╖╎╀╴╎ <u>┇</u> ┯┰
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Screen Failure (2) Patient Died Flag (2)	▌▏▝▘ <mark>┋┇┇┋╴╶╷╎┊</mark> ┾╢╝ ┇ ┺┟╢┑┼┺╷╽╝┼┺╝╷╷┇┟╦╻╖╝╝╝
Patient had Vasoconsription Flag (2) N Y	╡ <mark>╴</mark> ╕╸╡┋┋╡┧╴╶ [╸] ╴╵╨╵┟╨┟┨┇╎╨╵╵╫┼┇╽╷╝╴╵╵╵╫╎╵╵┥┼╵╽╵╵╵╴┧┇┇╪╪╶┇
AND OR	
	01 02 03 04 05 06 07 08 09 10 12 14 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 39 40 42 44 45 46 Study Site Identifier

- 5. Go back to AdverseEvents.jmp table.
 - a. Right Click on **Unique Subject Identifier** again -> **Column Info.** Here we once again set up a new Dispatch call of the **Marker** row state. Screeshot below.

🖶 Unique Subject Identifier - JMP Pro	- • •
Unique Subject Identifier' in table 'AdverseEvents'	ОК
Column Name Unique Subject Identifier	Cancel
Lock	Apply
Data Type Character 💌	Help
Modeling Type Nominal 👻	
Column Properties 💌	
SAS Name Link Reference	_
SAS Label Reference Table Select Table	
optional item Demography.jmp	
Use Linked Column Name	
Remove Row States Synchronization with Referenced Table —	
 None Accept Dispatch 	
Row States	
Select Exclude Hide	
🔲 Label 🔲 Color 🔍 Marker	

6. Look back at the **Demography.jmp** table and review the new analysis! We can use the Local Data filter on this Age Plot to filter show only patients who died on the trial and gain quick insights by joining the information from the labs and the adverse events data tables.



This analysis highlights a powerful new feature to use virtual joins with row state dispatch to perform a richer analysis on the **SOURCE TABLE** as opposed to the **Referencing Tables**.

Something that could NOT have been done without quite a bit of data manipulation previously.

DISPATCH USE CAUTIONS: Using "Dispatch" row synchronization can get very complicated and lead to unexpected/unintuitive results quickly if you are not careful!

In order to **Dispatch** row states back to the **Source Table** from the **Referencing Table**, JMP is doing a **Many-to-One** comparison that operates on tracking **Row State Change**. It becomes very easy to lead to un-interpretable results with this! For example: If you chose to dispatch both Color and Marker row states from Labs (which has multiple values for each ID value) but the same value of the **Link ID Variable** (Unique Subject Identifier in our case) had a mixture of differing states, there is no way for JMP to know what to set the row state of the single record of that ID value in the **Source Table**.

For the example shown above, this is safest to do as a "static" analysis question, not a typical continual exploratory JMP analysis.

Dispatch Warnings

- 1. All tables must be virtually joined before you start setting dispatch calls.
- 2. Dispatching multiple row states from the single table should be avoided.
- 3. Setting up dispatch and then interactively changing the states dispatched can lead to inconclusive results
- 4. Saving tables with dispatch and re-opening them may trigger a row state message that could change results.

The rest of this paper focuses on the easier, more intuitive and likely more common use of row state synchronization: Accepting row states from the source table to allow you to link results across multiple tables, driven by selection/exploration in the source table.

• Note also that you cannot set up both **Dispatch** and **Accept** of row states on a referencing table to avoid infinite row state loops.

ACCEPT EXAMPLE: Create a comprehensive safety analysis of labs test results, adverse events and patient demographics to explore and understand safety of the Nicardipine drug for different patient populations.

Virtual joins are generally useful to avoid a manual merge, save time and space and quickly do an analysis on the main **Referencing** table. But in many analyses, we have tasks that need to be performed on each of the tables involved. A critical part of clinical trial safety review is to look at laboratory results AND adverse events occurring to different patient subpopulations based on demography. For example, are there systematic differences for males vs. females across

patient trial signals? Does a certain medical history or other medications taken during trial lead to abnormal or serious adverse events?

In modern clinical trials, <u>subgroup analysis</u> has become very popular. Many new drugs in development no longer aim to treat large populations, and drug labels will include specific indications of who may be treated with a drug (e.g. who may benefit and who may actually be harmed by treatment). Advances in genomic technology advance this even further to enable clinical trials to deliver <u>precision medicine</u> by including biology and known genetic mutations to influence how a person may respond to a treatment.

The rest of this paper will show how quickly we can explore a complex multi-table analysis using JMP interactivity, because we can now make our tables literally "talk" to each other with virtual joins and row state synchronization.

Row State Synchronization: ACCEPT

- With all three tables open in JMP (Demography.jmp, Labs.jmp, AdverseEvents.jmp), we need to change the Column Property on Unique Subject Identifier on the **Referencing Tables** (Labs and AdverseEvents) to **Accept** row states from the **Source Table** (Demogaphy).
- 2. Right Click on Unique Subject Identifier -> Column Info and choose **Accept**, then choose to accept **Select**, **Exclude**, and **Hide** on BOTH the **Referencing Tables** respectively.

🔂 Unique Subject Identifier - JMP Pro 📃 🖸 😫	🖶 Unique Subject Identifier - JMP Pro
'Unique Subject Identifier' in table 'Labs' OK Column Name Unique Subject Identifier Lock Lock Data Type Character • Modeling Type Nominal • Column Properties • Link Reference SAS Name Reference SAS Shame Penography.jmp Optional item Ise Linked Column Name Remove Row States Synchronization with Referenced Table Obspatch Row States Obspatch Row States Obspatch Row States Obspatch Row States Oale Color Marker	'Unique Subject Identifier' in table 'AdverseEvents' OK Column Name Unique Subject Identifier Lock Apply Data Type Character ▼ Modeling Type Nominal ▼ SAS Name SAS Label Link Reference Inik Reference Demography.jmp ♥ Use Linked Column Name Rew States Synchronization with Referenced Table None Accept Dispatch Row States ♥ Select ♥ Exclude ♥ Hide Label Color

Notice that both tables hve the same settings for Accepting Row States Corresponding to Filtering Options

- 3. Notice above we have also checked the option **Use Linked Column Name**. This will make our resulting dashboards cleaner to use Columns such as **Sex**, in our results instead of **Sex[Unique Subject Identifier]**.
 - a. This is a nice formatting option when you have only one source table and one Link ID column.
- 4. No further table manipulation needed. Our Demography.jmp table is now going to "talk" to each of the tables that is referencing it. Making it easy to do consistent, comprehensive patient subpopulation exploration.
- 5. Each of our tables have some scripts attached. Let's run them and see how we can benefit from virtually joined talking tables...



If we run the **Distributions, Liver Lab Results By Visit**, and the **Adverse Event Occurrence** scripts for each table respectively. We can review three essential pieces of a clinical trial analysis:

- Counts of patient demographic characteristics and check for balanced treatment arms
- Trends and Box Plots of a Liver Laboratory test results (an essential part of checking drug safety)
- Counts of adverse events occurring to subjects by severity with a Local filter to explore event outcomes



If you select "Y" for **Patient Died Flag** in the Distributions...you'll immediately be able to see outliers in the lab test analysis get selected.

Many of our analyses here are summary level though, to really realize the power of this new feature, we would want to use a single data filter that controls all our results. Using a Data Filter on the Demography.jmp table combined with the row state synchronization will do exactly that.

When we run the Comprehensive Safety Profile, we have used a little bit of JSL to place all these components into a single window with a data filter. Because our tables are virtually joined and Labs and AdverseEvents are "listening" to Demography, we can now easily explore patient subpopulations.

In the screenshot below, we see a snapshot of exploring this data analysis. We can see very quickly the patient counts, lab tests results, and adverse events that occurred to White Females who were treated with Nicardipine drug and were also taking Anticonvulsants.

AND... we got there with 4 mouse clicks...

Let's Talk Tables JMP Discovery Conference – Cary (US 2020) Mandy Chambers, Kelci Miclaus – SAS/JMP



Virtual joins, when introduced in JMP 13, provided an excellent new framework to analyze data without making manual joins. This is a great convenience; a time and memory saver. With JMP 14, **row state synchronization** features provide capabilities for complex, multi-table data exploration previously impossible.

This feature is so powerful that **JMP Clinical software**, a vertical solution devoted to the analyses shown above, now produces clinical reviews entirely relying on virtual joins and row state synchronization to enable a global subject review architecture.

The tables used for this document are packed in an accompanying ZIP file: "Randomized Clinical Trial Example.zip".

This zip file contains Demography.jmp, Labs.jmp, and AdvserseEvents.jmp. These tables are currently NOT virtually joined. You can use this document to interactively reproduce the results of this document.

The zip also contains a JSL script "ScriptingVirtualJoins.jsl". All of the interactive steps done above to join tables, use the (short) Linked Column Name, and set up row state synchronization can be done with scripting.

In JMP 14 or 15, if you open only the script referenced the tables will be opened, the virtual join made, and the options to set up communication as well as running the comprehensive safety profile shown above will be done automatically.

The code to perform this is copied to this document. Please consider the length of this script and compare it to the amount of work to manually manipulate these tables to perform the analysis...

Virtual Join and Row State Synchronization: JSL CODE

```
/*
JMP Discovery 2020 Example
Name: ScriptingVirtualJoins.jsl
Author: Kelci Miclaus, SAS Institute Inc.
Description:
       Script showcases JMP features to use row state synchronization with virtually joined
tables. Allows for complex multi-table exploration and analysis.
*/
//Open and Set up LinkID Column in Demography;
dmdt = Open( "Demography.jmp" );
dmdt:Name( "Unique Subject Identifier" ) << Set Property( "Link ID", 1 );</pre>
//Open and set up LinkReference with Options to use the linked column name, and accept rows
states for select, exclude, hide;
lbdt = Open( "Labs.jmp" );
lbdt:Name( "Unique Subject Identifier" ) << Set Property(</pre>
       "Link Reference",
       {Reference Table( "Demography.jmp" ), Options(
               "Use Linked Column Name",
               Row States Synchronization with Referenced Table( Accept, Row States( Select,
Exclude, Hide ) )
       )}
);
aedt = Open( "AdverseEvents.jmp" );
aedt:Name( "Unique Subject Identifier" ) << Set Property(</pre>
       "Link Reference",
       {Reference Table( "Demography.jmp" ), Options(
               "Use Linked Column Name",
               Row States Synchronization with Referenced Table( Accept, Row States( Select,
Exclude, Hide ) )
       )}
);
/*
Run the "Comprehensive Safety Profile" Table Script using all virtually joined talking
tables.
The data filter in the report only acts on the Demography.jmp table.
The options to accept row states from the referencing tables allows those changes to
propogate the each of the domain tables.
*/
dmdt<<RunScript("Comprehensive Safety Profile");</pre>
```