

# *Multiple Regression Modeling and Residential Appraisal*

The Who, What, Where, When, Why, and How...  
but not necessarily in that order

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# WHAT?



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# What is Multiple Regression Modeling?

Process of estimating the relationships between variables

Multiple Independent variables working together to determine one Dependent variable

In our case the property characteristics are independent & value is dependent



# What is Multiple Regression Modeling?

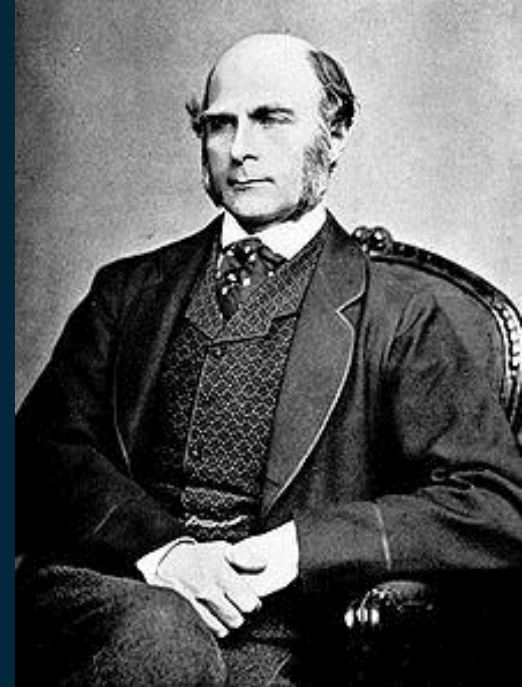
Early 19<sup>th</sup> Century - Least Squares Method

Procedure has been around for hundreds of years but it wasn't really practical until the advent of computers because of the number of calculations involved



# Francis Galton

- English Victorian statistician, progressive, polymath, sociologist, psychologist, anthropologist, eugenicist, tropical explorer, geographer, inventor, meteorologist, proto-geneticist, and psychometrician.\*



- \*Thank you, Wikipedia

# Regression Toward the Mean



# Types of Models

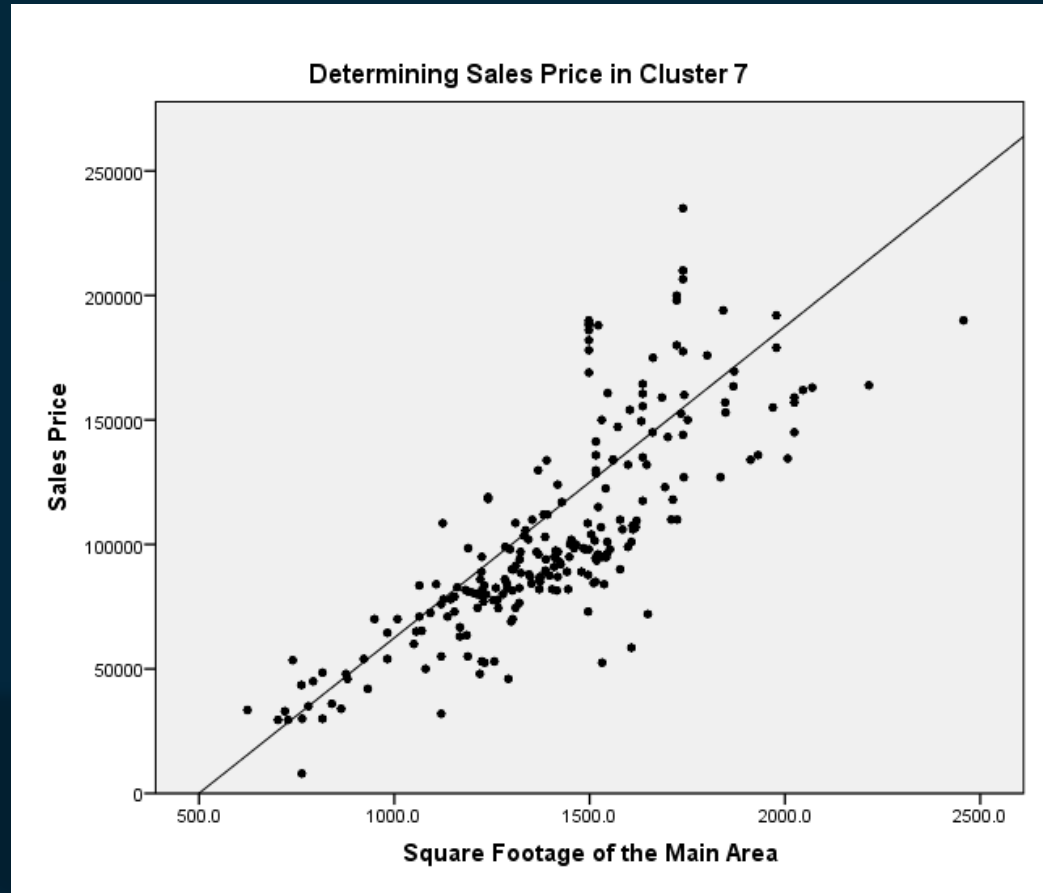
- Non-Linear Models
  - Logarithmic
  - Exponential
- Binary Models (Win / Loss)
  - Logit, Probit, Rare Events
- Boolean Probability Models
  - Monte Carlo Simulations
- Hazard / Slash Survival Models
  - Cancer Research

## Runway



# Linear Modeling 101

- $Y = \alpha + \beta(x) + \mu$   
or  
 $Y = m(x) + B$
- How do the Independent Variables affect the Dependent Variable?





# Linear Stepwise Model

Regression Action Report

CooperLOW					
NAME	ACTION	PARTIAL F	R <sup>2</sup>	Coeff	Calc Coeff
QRSF	ADD	279.1288	0.7930	43.2223	
LV	ADD	159.1088	0.8868	2.4975	
BSMTFINQR	ADD	38.2108	0.8992	34.0984	
NH0722AST	ADD	14.0453	0.9032	-11,315.5881	
NH0722ACC	ADD	9.5448	0.9059	-10,868.5039	
AGELVL	ADD	9.7378	0.9085	-462.7531	
NH0723AHC	ADD	32.3758	0.9171	25,933.7735	
NH0722ACSCR	ADD	13.9157	0.9204	-9,652.6818	
NH0722AFR	ADD	10.3773	0.9228	-8,540.5935	
Pools	ADD	7.6569	0.9246	42.1813	
GARQR	ADD	6.4113	0.9260	13.3748	
FireplaceClass	ADD	3.5649	0.9267	1,684.9461	
NH0722ASRE	ADD	3.1392	0.9274	-6,502.9639	
BathClass	ADD	3.5582	0.9282	2,412.5956	
NH0722ASC	ADD	4.0811	0.9290	-8,727.3092	
Shop	ADD	0.9960	0.9293	31.6312	
NH0723AHG	ADD	0.3852	0.9293	2,304.8653	
NH0722ABM	ADD	0.0427	0.9293	-1,139.3972	
NH0722ASTS	ADD	0.0000	0.9293	15.0087	
NH0722	DEL	-1.0000	0.0000	0.0000	
NH0722A	DEL	-1.0000	0.0000	0.0000	
Shop	CON	0.9732	0.9295	30.0000	31.3944
BathClass	CON	4.7061	0.9262	2,300.0000	2,842.6855
FireplaceClass	CON	5.0101	0.9248	1,500.0000	2,062.4405
Pools	CON	7.8834	0.9247	45.0000	42.8377
GARQR	CON	8.2029	0.9166	15.0000	14.7300
AGELVL	CON	53.6157	0.9081	-860.0000	-1,342.9613
BSMTFINQR	CON	54.0746	0.8996	25.0000	34.4186
LV	CON	229.6962	0.8594	1.0000	2.0575

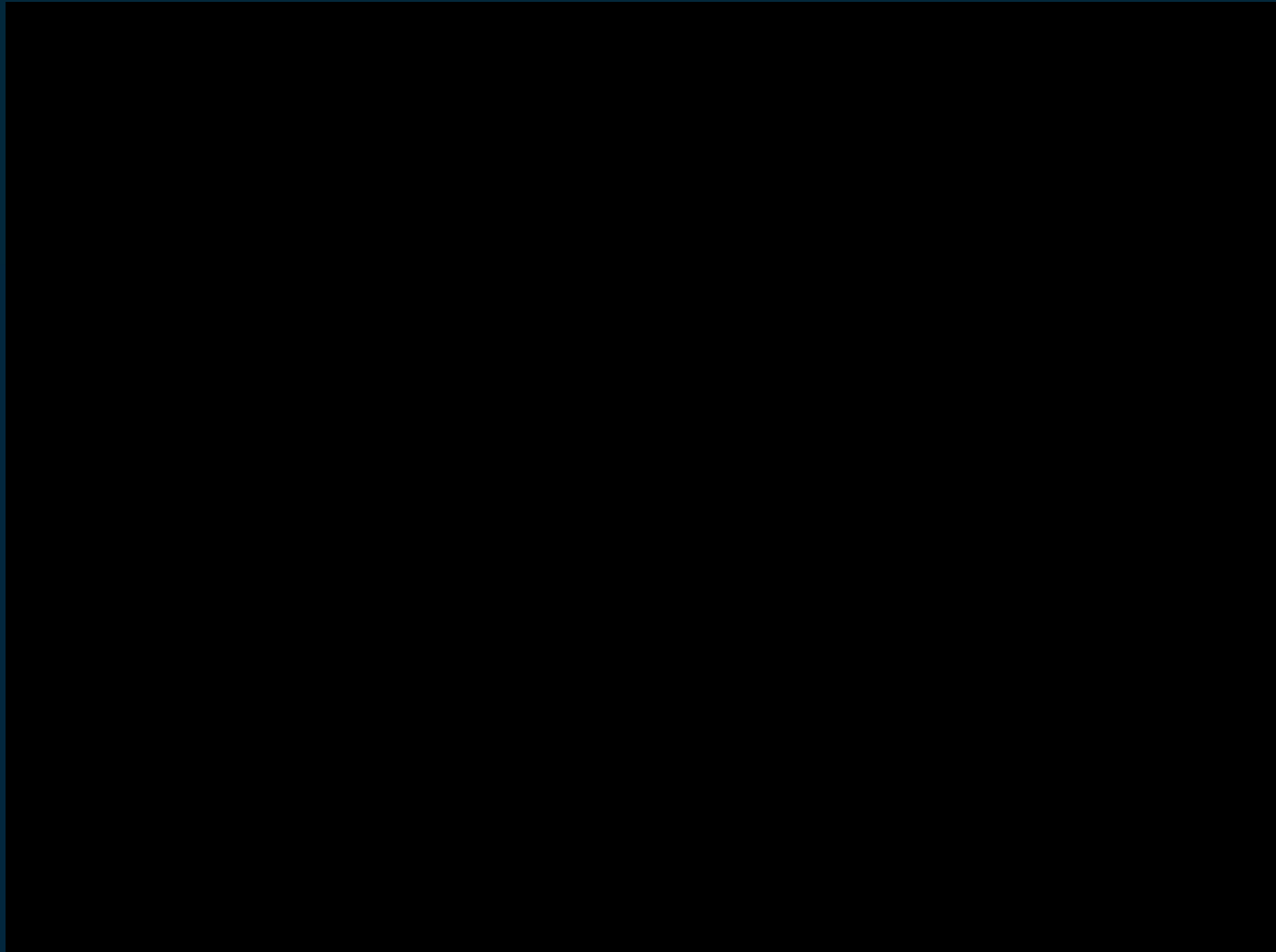




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# Why Use MRM?



# Why Use MRM?

- Accuracy
- Support
- Comp Grid
- Defensible
- The Future





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# Who Should do the MRM?

- Appraiser?
- Statistician?
- Team Approach?



# Appraiser as Modeler

## Pros

- Understands appraisal and your market
- Solution already in house

## Cons

- Takes away from existing head count
- Need statistical / modeling expertise to train
- Time to get up to speed

# Statistician as Modeler

## Pros

- Superior statistical knowledge
- Does not detract from appraisal duties

## Cons

- Additional head count
- Needs training on appraisal theory and local market
- Can you build appraisal models without sound appraisal judgment?
- What do you do when the project is over?





# Team Approach to Modeling

## Pros

- Appraiser and modeler build off each other's expertise
- Continue appraisal work
- “Best of both worlds”

## Cons

- Additional head count
- A good statistician is hard to find
- What do you do when the project is over?

# WHERE?



# Where should You Model?

## In-CAMA:

- No need to extract data
- Automated Reporting tools
- Comp Grid
- Explainable - manipulate constants and coefficients

## 3<sup>rd</sup> Party Software:

- Easier to look at data
- Non-specific programming language
- Unlimited potential
- Generally faster





## How did we Model Residential Properties?

- Start by pairing an appraiser with a statistician
- 3-Day Boot Camp with expert from our CAMA vendor
- Scrub the data (GIGO)
  - Tedious and time-consuming but VERY important



# Next Steps

- Created 22 Market Models, similar to NBHD Clusters
- Created variables to be assigned value based on actual market contribution
- Combined variables with class for best results
  - Example: sf, ag



# Independent Variables (Residential)

- (Square Footage X Class)
- (Age X Class)
- Bathrooms (Baseline = 2)
- Condition: (Poor, Average, Good, Etc.)
- Fireplaces
- Central Heat and Air
- Pool
- Basement
- Garage
- Shop



# Next Steps

- Trial & error, run & rerun
- Clean the data again
- Check for deviation
- At each step, appraiser knowledge and statistical knowledge work hand in hand



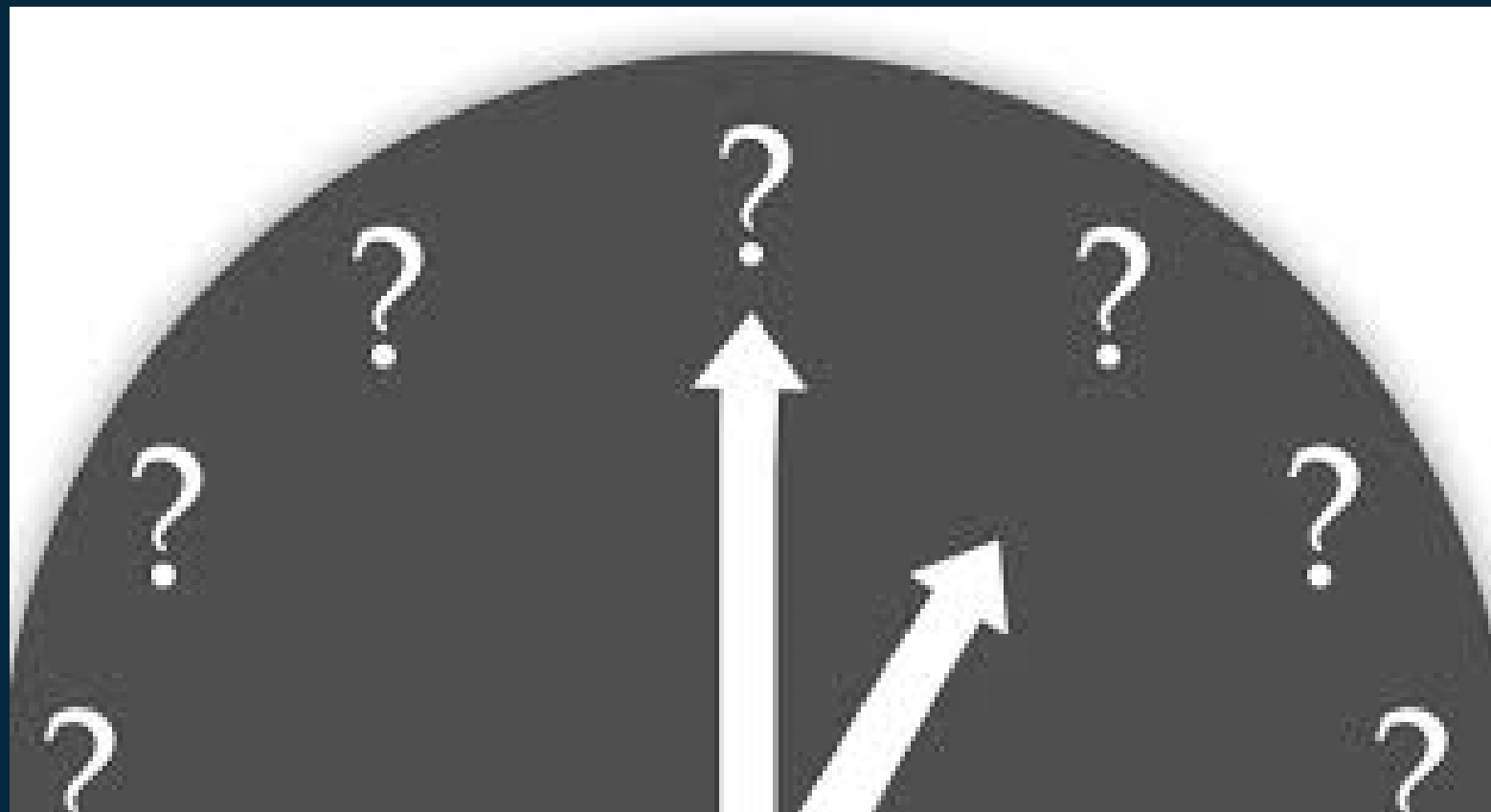


# Conditions

- You must have significant variation in values for a variable to be useful
- You must consider all variables that are meaningful
- You must constrain variables to fit reality
- You must avoid closely correlated variables
- Appraisal sense trumps statistics every time
- Don't be too quick to eliminate outliers
- Fewer models is better



# WHEN?



# When Should You Start Modeling?

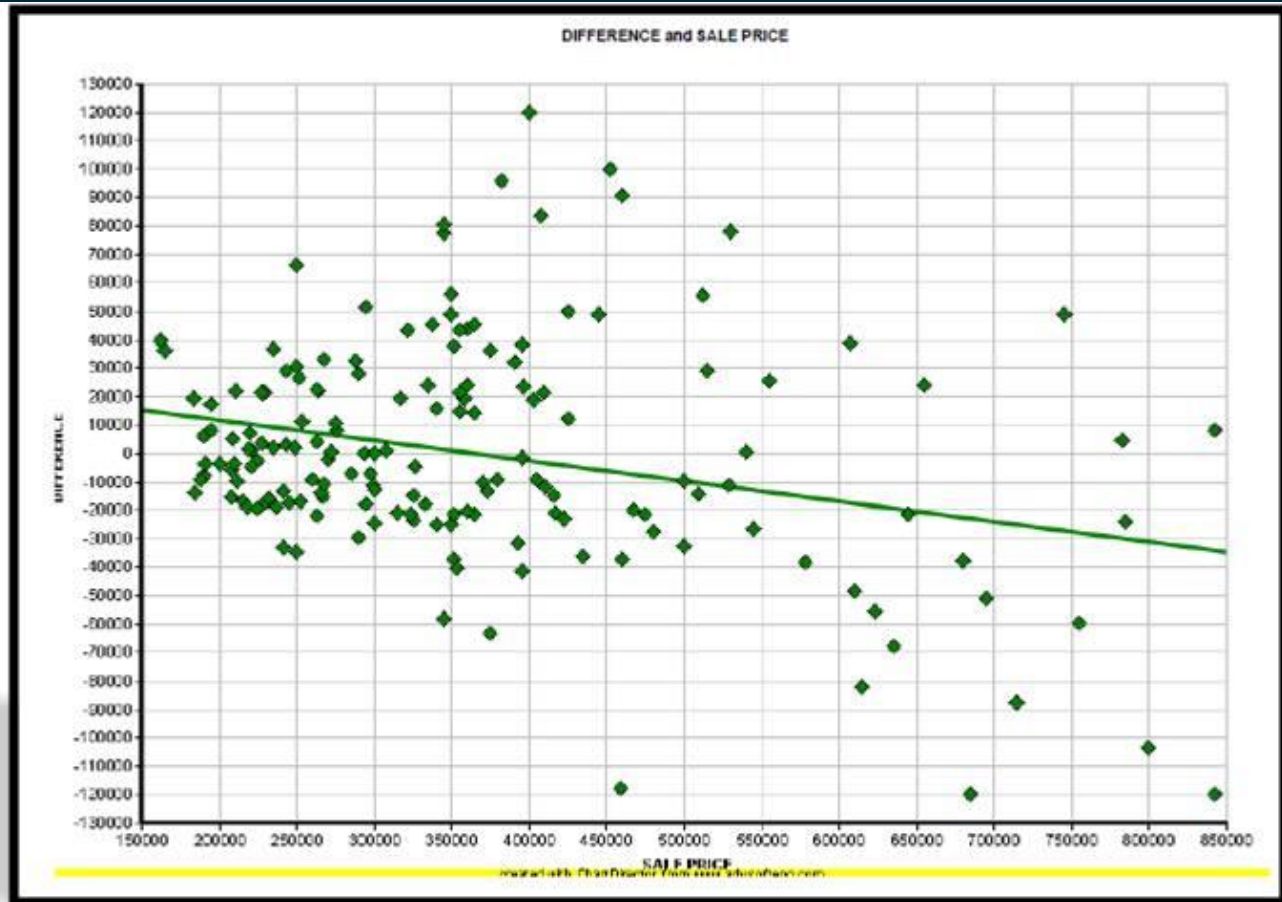
- Now is good.



# Accuracy

Comparing Values					
	Mean Ratio	Weighted Mean Ratio	Median Ratio	Price Related Differential	Coefficient of Dispersion
<b>Appraised</b>	0.9807 (-0.0913%)	0.9915 (-0.0085)	0.9799 (-0.0201%)	0.9891 (Good)	0.0873 (Good)
<b>Model</b>	1.0096 (+0.0096%)	0.9999 (-0.0001%)	1.0000 (0.0000%)	1.0097 (Better)	0.0764 (Better)

# Graphs



# Reporting

Statistical Summary							
CooperLOW							
Name	Mean (nz)	Std Dev (nz)	Mean	Std Dev	Low Value	High Value	Occurrences
Plumbing	2.1353	0.3838	2.1293	0.3807	0.00	4.00	351
Pools	490.0000	96.4365	4.1761	45.6907	0.00	600.00	3
QRSF	3,282.5227	935.2762	3,282.5227	935.2762	1,529.00	8,534.00	352
SalePricePerArea	93.1703	11.8537	93.1703	11.8537	62.81	161.74	352
SalesRatio	0.9924	0.0617	0.9924	0.0617	0.81	1.24	352
Shop	400.0000		1.1364	21.3201	0.00	400.00	1
SP	174,000.8523	45,396.0470	174,000.8523	45,396.0470	76,000.00	449,950.00	352
StyleTraditional	1.0000	0.0000	0.9290	0.2572	0.00	1.00	327
TotSqFtofMA	1,855.9943	360.8060	1,855.9943	360.8060	1,026.00	3,734.00	352
TV	172,226.1023	45,075.4914	172,226.1023	45,075.4914	82,992.00	446,559.00	352
UFLA	753.7333	349.1184	32.1193	167.6462	0.00	1,382.00	15
Year	2,006.3210	6.8273	2,006.3210	6.8273	1,978.00	2,014.00	352
Total	54 variables						



# Comparable Sales Grid

Comparable Sales Report				Tax Year: 2015		
For Property: R854850-00000-00100-000		Comp Sheet Format: Newest Comp Sheet w/ MRA and Pics		Market Area: Cooper ISD		
	Subject	Comp1	Comp2	Comp3	Comp4	Comp5
QuickRef ID	R310499	R310499	R317372	R310506	R317362	R310507
Situs	10 TUSCAN VILLAS CIR LUBBOCK	10 TUSCAN VILLAS CIR LUBBOCK	56 TUSCAN VILLAS CIR LUBBOCK	17 TUSCAN VILLAS CIR LUBBOCK	46 TUSCAN VILLAS CIR LUBBOCK	18 TUSCAN VILLAS CIR LUBBOCK
NBHD	0723ATNV	0723ATNV	0723ATNV	0723ATNV	0723ATNV	0723ATNV
Subdivision	S854850	S854850	S854850	S854850	S854850	S854850
Sale Price		\$250,000	\$276,000	\$267,500	\$349,900	\$263,000
Sale Date		12/11/2014	4/2/2014	9/23/2014	10/3/2014	10/1/2014
Sale Price Per Sq Ft		\$99.88	\$114.86	\$99.74	\$106.13	\$123.30
Market Value	\$288,676	\$288,676	\$252,376	\$272,910	\$346,521	\$240,971
Value Per Sq Ft	\$115.33	\$115.33	\$105.03	\$101.76	\$105.10	\$112.97
Land Value / Size in Acres	41584 / Acres= 0.120	41584 / Acres= 0.120	46592 / Acres= 0.130	44440 / Acres= 0.130	45696 / Acres= 0.130	44440 / Acres= 0.130
Class / Condition	RV9 / A	RV9 / A	RV8 / A	RV8 / A	RV9 / A	RV8 / A
Living Area	2503	2503	2403	2682	3297	2133
Finished Basement	0	0	0	0	0	0
Bed / Bath / Fireplace	2 / 2 / 1	2 / 2 / 1	3 / 3 / 1	3 / 2 / 0	3 / 3.5 / 1	3 / 3 / 0
Garage / Carport / Shop Area	572 / 0 / 0	572 / 0 / 0	442 / 0 / 0	506 / 0 / 0	751 / 0 / 0	529 / 0 / 0
Heating Type	Central Heat/air	Central Heat/air	Central Heat/air	Central Heat/air	Central Heat/air	Central Heat/air
Pool SF	0	0	0	0	0	0
Year Built	2008	2008	2011	2014	2009	2014
BV	\$247,092	\$247,092	\$205,784	\$228,470	\$300,825	\$196,531
ADJUSTMENTS						
Condition						
Quality and Size			39793	19628	-67670	59294
Finished Basement		0	0	0	0	0
Age			-5400	-10800	-1800	-10800
Bathrooms			-5257		-9305	-5257
Carport		0	0	0	0	0
Garage		0	7,462	5,404	-6,748	4,676
Fireplaces			617	4046		4046
No Central Air		0	0	0	0	0
Pool		0	0	0	0	0
Shop		0	0	0	0	0
Land Value			-5008	-2856	-4112	-2856
Adjusted Sales Price		\$250,000	\$308,207	\$282,921	\$260,265	\$312,103
Indicated MKT Value	\$282,921					

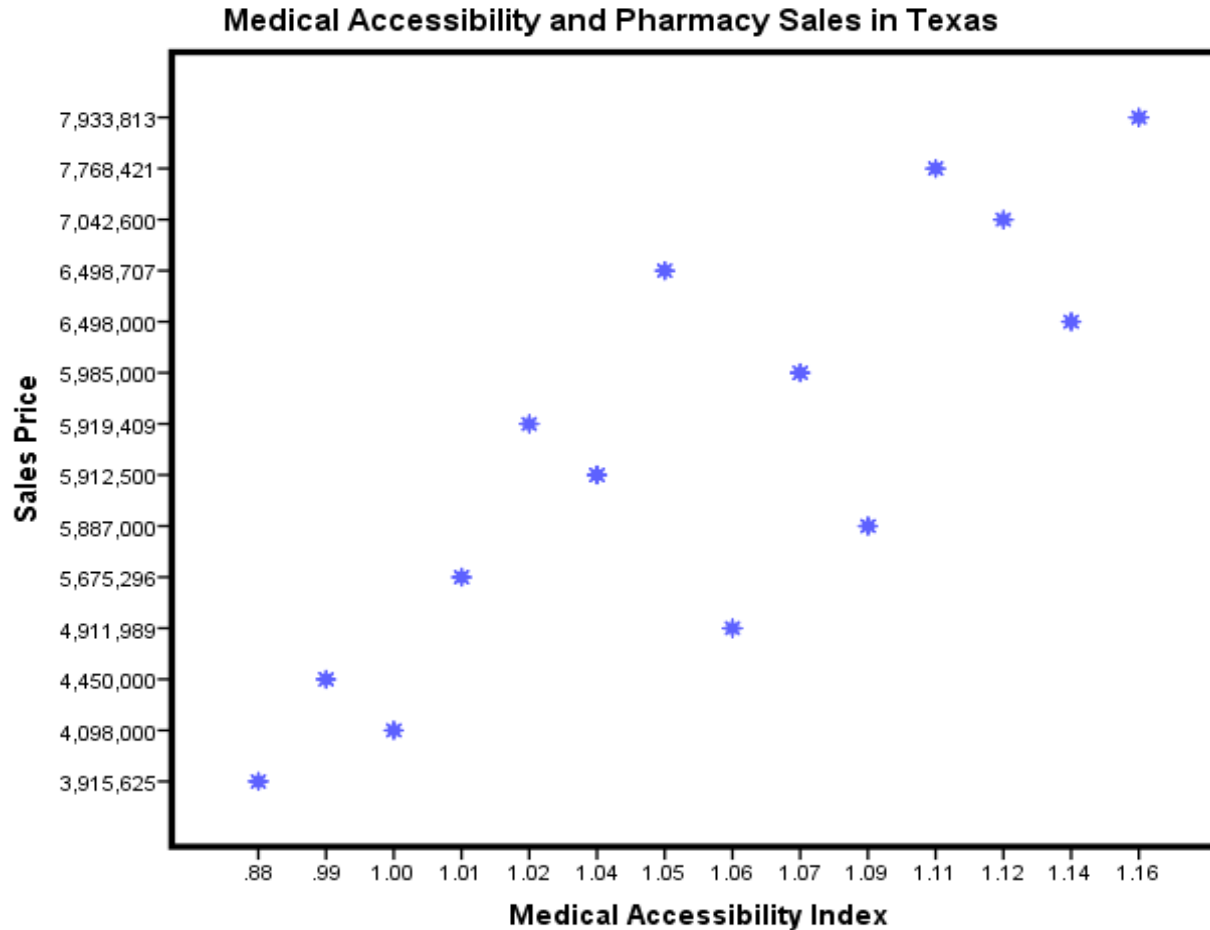


# The Future

- Commercial Modeling
  - Traffic Density
  - Median Age
  - Median Income
  - Home Ownership
  - Quality of Schools
  - Medical Accessibility
  - Proportion of Population at Retirement Age



# Thinking Outside the Box



# The Future

- Improved In-CAMA modeling options
- Vast potential
- Use Modeled values as Appraised?



# Open Forum

- Questions?
- Comments?
- Concerns?
- Funny limericks?



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# IAAO Annual Conference

Tampa, Florida

August 28-31, 2016



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