



Intelligent Knowledge Acquisition Systems

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My Research

- I work mainly on two different areas:
 1. I have described mathematically a linguistic summarization method called **Qualitative Comparative Analysis (QCA)**
 2. I have developed a novel non-linear regression method called **Variable Structure Regression**
- Today I will present only VS regression method



VS Regression

- Regression models

$$Output = \sum_{R_s} Coefficient \times Terms + Bias$$

Term = Function of Variables

- VS is a **nonlinear regression** model that provides solutions to **four major challenges** of regression models:
 1. Choosing the variables
 2. Choosing each of the Terms in the model
 3. Choosing how many Terms to include in the model
 4. Optimizing the parameters that complete the description of the model



VS Regression Strengths

- Each term in the VS regression model has a **linguistic interpretation**, e.g.
 - Applying VS to prediction of Oil Production gives following rule:

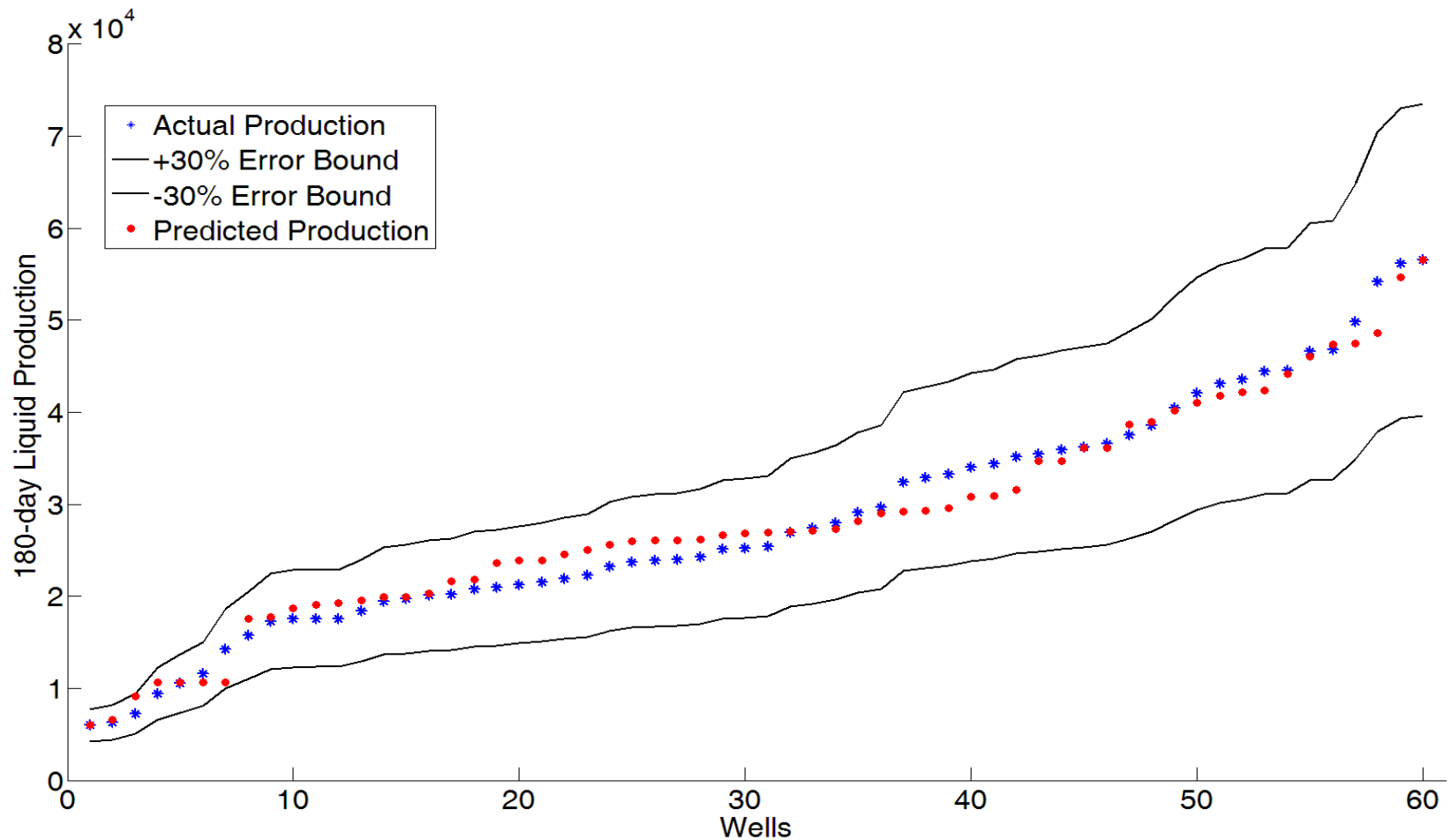
IF *Permeability* is **Low**, *Sand Volume* is **High**, and *Number of stages* is **High** **Then** *Production* is **High**
- The importance of each rule can be determined automatically
 - *By examine the relative size of regression coefficients of each rule*



VS Strengths

- The **expert knowledge** of long-time employees **can be preserved**
 - Each such piece of knowledge contributes one new term to the VS regression model
- We can include expert knowledge for oil prediction in VS method, e.g.,
IF *Permeability* is **High**, *Sand Volume* is **Low**, and *Number of stages* is **High** **Then** *Production* is **High**
can be included as a term in VS regression

Prediction of Oil Production





Comparison

- We have applied the VS regression to **eight different data sets**
- We have **compared** the results of the VS method with the results obtained by the existing **five different methods**
- The VS method gets **smaller average RMSEs** than the other methods
- We can see that the VS regression method has a **smaller average rank** than the other methods



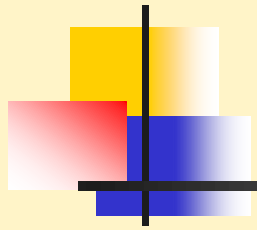
VS Results

	HS Method	CCL Method	CK Method	FRI	Enhanced FRI	VS
Abalone	3.1511	2.6470	3.1599	2.6312	2.5296	2.13837
Concrete Compressive Strength	14.7940	15.6982	15.0666	14.2704	13.6080	5.67068
Concrete Slump Test	6.4636	6.7137	6.3193	6.5963	5.9325	2.11825
Wave force prediction	0.1617	0.1710	0.2164	0.1486	0.1396	0.12661
Chemical Process Concentration reading	0.3705	0.3818	0.3721	0.3375	0.3370	0.3092
Chemical Process Temperature Reading	0.4972	0.5383	0.4911	0.3490	0.2965	0.1772
Gas Furnace	1.2640	2.0914	1.2688	0.8573	0.7787	0.3089
Mackey–Glass	0.0712	0.1609	0.0973	0.0605	0.0475	0.00405



Papers

- **M. M. Korjani** and J. M. Mendel, “Fuzzy Set Qualitative Comparative Analysis (fsQCA): challenges and applications,” *Proc. NAFIPS 2012*, Berkeley, CA, August 2012. (**Won best paper award**)
- **M. M. Korjani** and J. M. Mendel, “Validation of fuzzy set qualitative comparative analysis (fsQCA) by means of a granular description of a function,” *NAFIPS 2012*.
- J. M. Mendel and **M. M. Korjani**, “Charles Ragin's Fuzzy Set Qualitative Comparative Analysis (fsQCA) used for linguistic summarizations,” *Information Sciences*, vol. 202, pp. 1-23, 2012.
- J. M. Mendel and **M. M. Korjani**, “Fast fuzzy set qualitative comparative analysis,” *Proc. NAFIPS 2012*, Berkeley, CA, August 2012.
- J. M. Mendel and **M. M. Korjani**, “Theoretical Aspects of Fuzzy Set Qualitative Comparative Analysis (fsQCA),” *Information Sciences*, 2013.
- **M. M. Korjani** and J. M. Mendel, “Fuzzy love matching by means of perceptual computing ,” *Proc. NAFIPS 2013*, July 2013.
- **M. M. Korjani** and J. M. Mendel, “Challenges and applications of fuzzy set qualitative comparative analysis (fsQCA), in preparation.
- **M. M. Korjani** and J. M. Mendel, “Variable structure fuzzy basis functions, in preparation.



Questions?