Data Consolidation of Disparate Procurement Data Sources for Correlated Performance-Based Acquisition Decision Support

Wednesday, April 26, 2017

by

Samantha Nangia, USN
Dr. Ryan Dickover, USN
Tom Wardwell, USN
Randall Mora, Avum, Inc.

Outline

- Our Team
- The Research Question
  - Big Acquisition Data and Neural Network Modeling
- Methodology—Simple Action (Susman, 1983)
- The DON Acquisition Decision Support Tool
- Further Research
- Cognitive Learning Acquisition Framework (CLAF)

Our Team

- Samantha Nangia
  - ✓ Navy Procurement Data SME
- Dr. Ryan Dickover
  - ✓ Director of DASN (AP)'s eBPO Division
- Tom Wardwell
  - ✓ Navy Acquisition IT Portfolio Manager/FAM
- Randall Mora
  - ✓ President & CEO of Avum

The Research

Can a modern Big Data and Neural Network based statistical modeling technique be confidently relied upon to explore acquisition information to uncover meaningful patterns?

- ✓ The result was positive to the research question.
  - Formulated multiple Hypotheses of which two were tested/proven.
  - Experimented with the Neural Network mode of analysis,
    - Study attempted accurate prediction of vendor performance scores given an input of the hypothesized independent variables.
  - Created an Acquisition Decision Support Tool based on the Cognitive Learning Application Framework developed in our research.

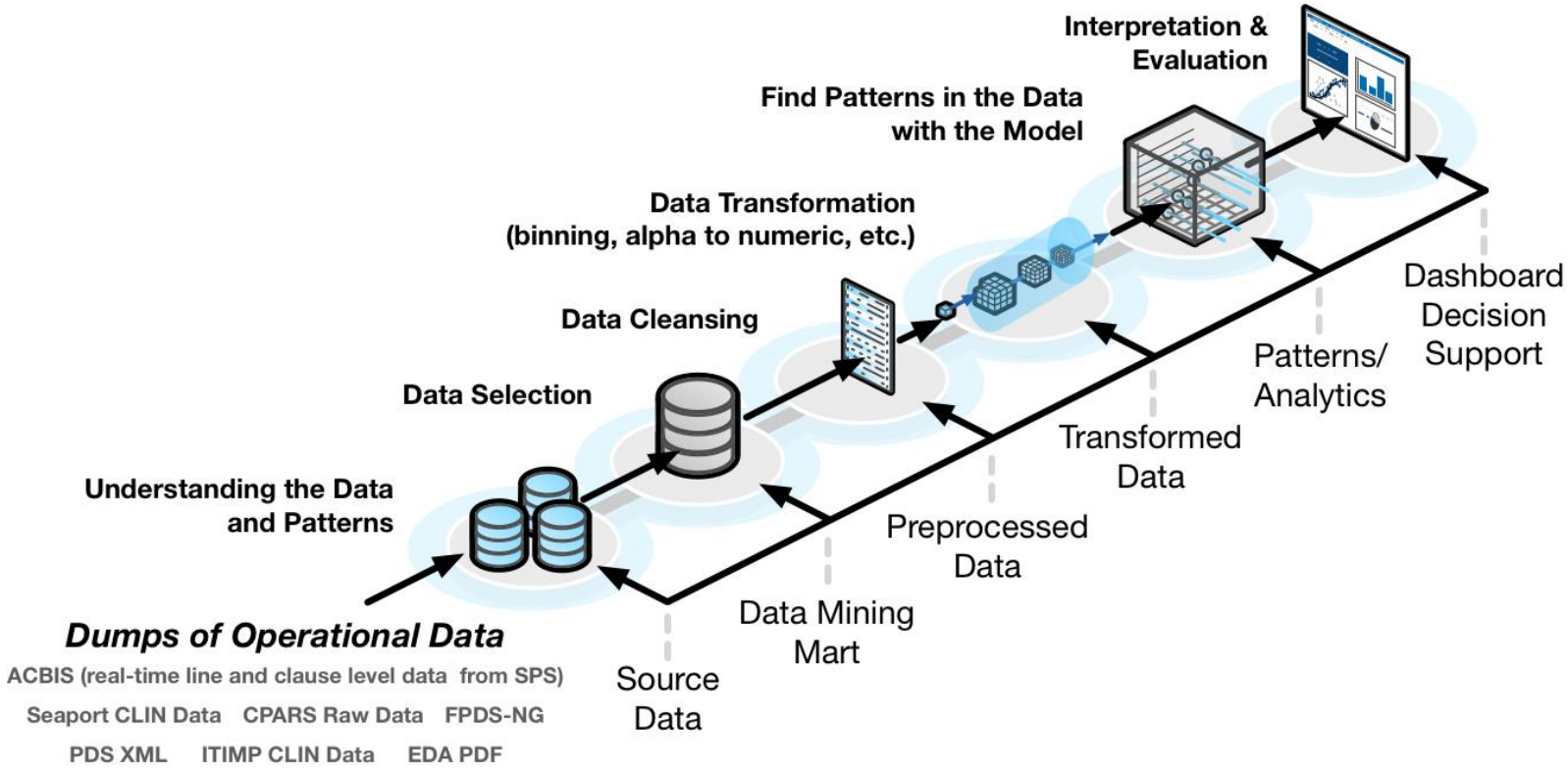
Methodology

Direct Action Methodology

1. Define the problem (i.e. Can Neural Network modeling be applied to Big Data sets in acquisition?),
2. Develop an Action Plan,
3. Execute the Plan,
4. Evaluate our results and learn from our research.

“It is important to note the Simple Action methodology employed here evaluates the research question regarding applicability of Neural Network modeling technique to Big Data in the acquisition environment; as such, the actual statistical correlative output of the Hypotheses are of a secondary value only (i.e. they are for the purpose of experimenting with the Neural Network environment itself, as opposed to for discovery in their own right).” p.6

Action Plan



Note: Cognitive learning methodology is iterative in nature, requiring the team to return to previous steps during model development.

Plan Execution – Step 1, Define the Data

Data Attribute Sources

Attribute	Sourced From
Contract-Type (CLIN mix)	ACBIS (SPS line item details)
Contract-Type (contract-level)	FPDS-NG
Extent-Competed	FPDS-NG
Contract Length	FPDS-NG/CPARS
DFARS Clause Inclusions	ACBIS
CLIN Count	ACBIS (SPS line item details)
CPARS Award Value	CPARS
QUALITY, SCHEDULE, COST_CONTROL, MANAGEMENT, SMALL_BUSINESS	CPARS
SSIP	SSIP from the FY16 review
PSC & Portfolio Group	Defense Procurement and Acquisition Policy (DPAP) office

Plan Execution – Step 2, Perform Descriptive Statistics

Contract-Type & SSIP

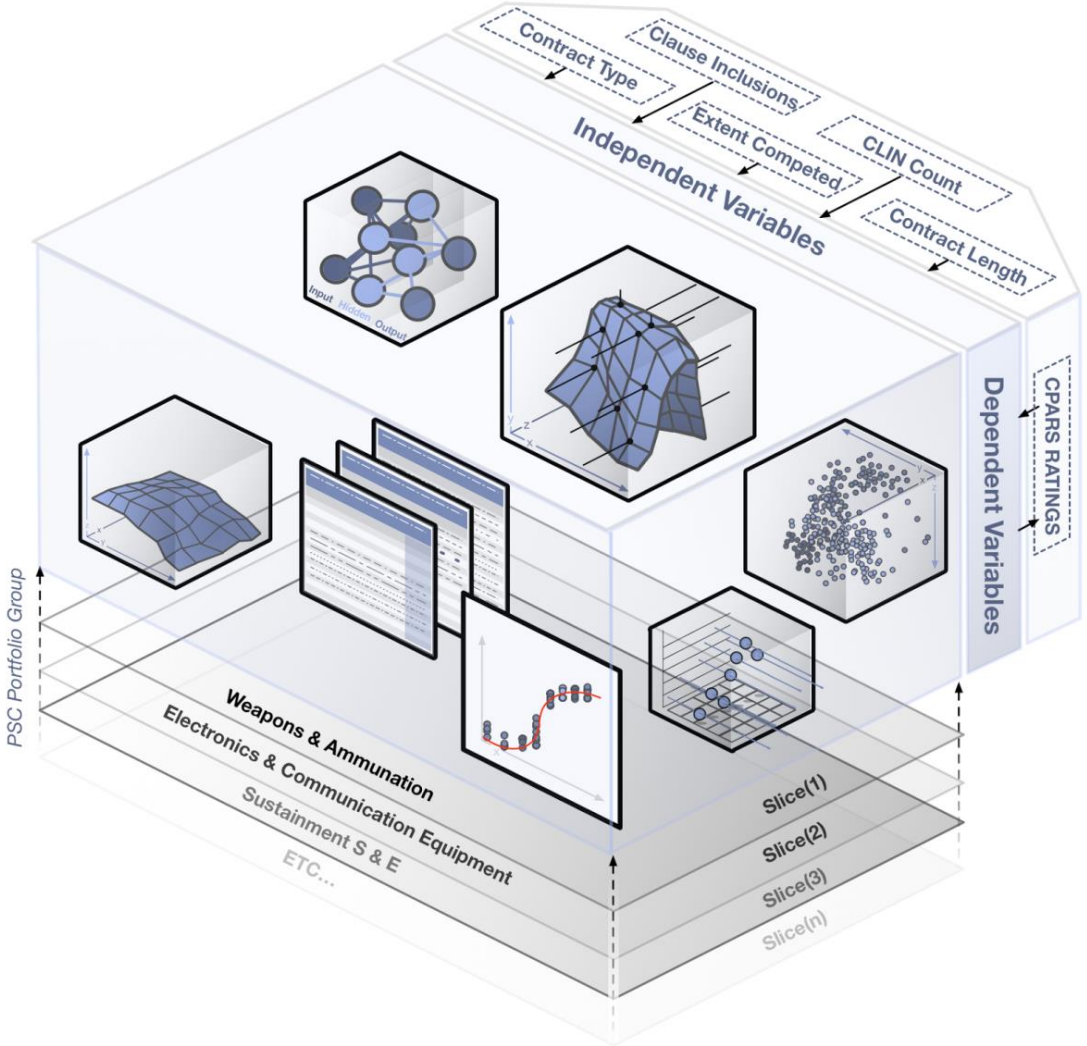
Contract Type Description	Average of ssip	Count of ssip
COMBO	3.17	3,617
COST NO FEE	3.08	9,047
COST PLUS AWARD FEE	3.22	4,801
COST PLUS FIXED FEE	3.05	31,491
COST PLUS INCENTIVE FEE	2.76	3,380
COST SHARING	2.42	17
FIRM FIXED PRICE	2.82	116,660
FIXED PRICE AWARD FEE	3.12	366
FIXED PRICE INCENTIVE FEE	2.76	1,902
FIXED PRICE LEVEL OF EFFORT	2.86	522
FIXED PRICE REDETERMINATION	2.87	175
FIXED PRICE WITH ECONOMIC PRICE ADJUSTMENT	2.84	714
ORDER DEPENDENT	2.43	209
Grand Total	**2.89**	**172,901**

Extent-Competed & SSIP

Extent_Competed	Average of ssip	Count of ssip
COMPETED UNDER SAP	2.71	4,979
FOLLOW ON TO COMPETED ACTION	3.03	260
FULL AND OPEN COMPETITION	2.93	78,917
FULL AND OPEN COMPETITION AFTER EXCLUSION OF SOURCES	2.88	35,975
NOT AVAILABLE FOR COMPETITION	2.98	20,036
NOT COMPETED	2.80	31,516
NOT COMPETED UNDER SAP	2.87	2,150
Grand Total	**2.90**	**173,833**

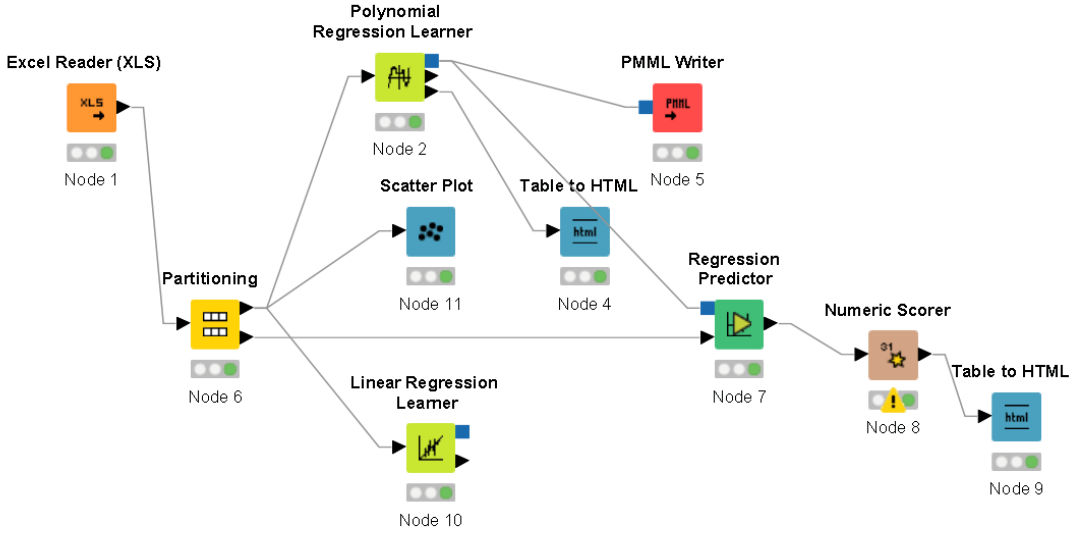
Plan Execution – Step 3, Develop a Model and Analyze

Analytics & Modeling Paradigm



Plan Execution – Step 4, Look for Correlations

Initial Polynomial and Linear Regression Model



Numeric Score Results

Prediction (ssip_raw)	
R^2	0.019
Mean absolute error	0.55
Mean squared error	0.458
Root mean squared error	0.676
Mean signed difference	-0.018

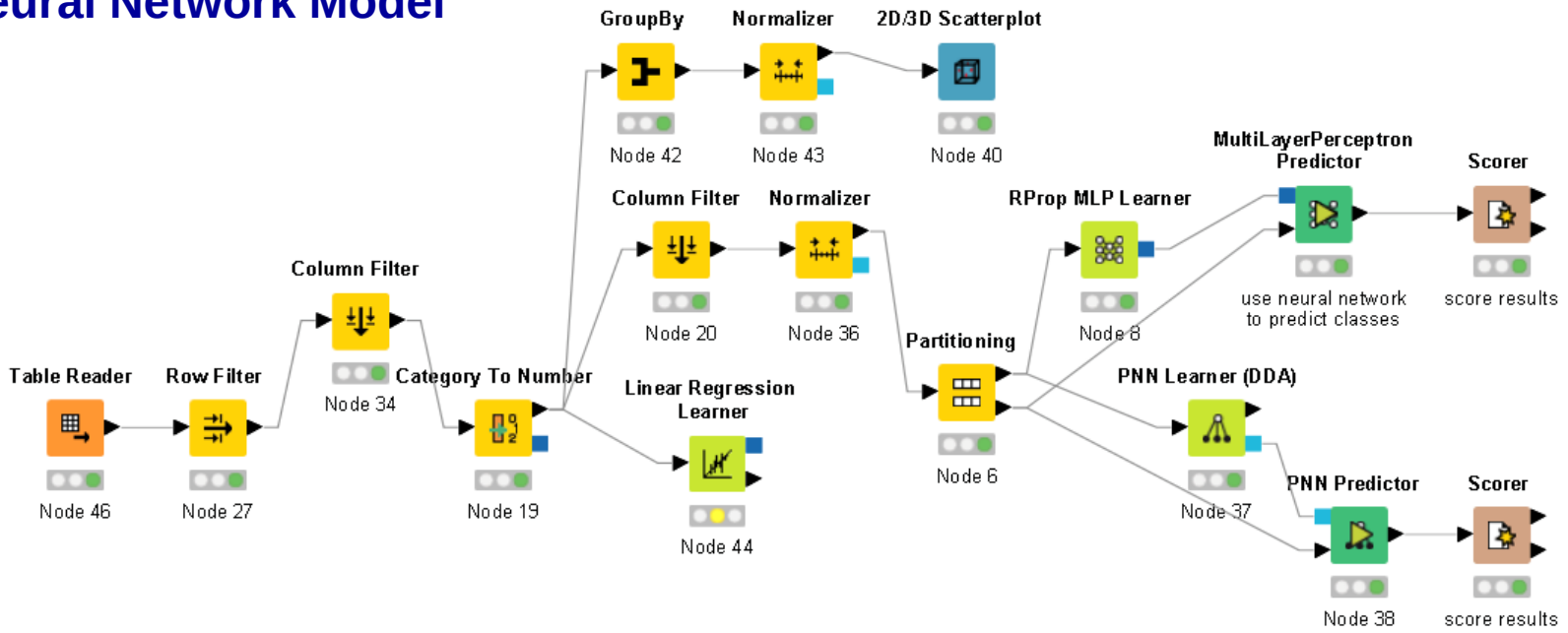
Statistics on Polynomial Regression

Variable	Coeff.	Std. Err.	t-value	P>|t|
Contract_type_numeric	0.0528	0.0501	1.0537	0.2922
Extent_competed_numeric	0.0682	0.0806	0.8459	0.3977
Contract_type_numeric^2	-0.0114	0.0074	-1.5413	0.1235
Extent_competed_numeric^2	-0.0216	0.0177	-1.2241	0.2211
Intercept	2.4667	0.1129	21.8573	0.0

Multiple R-Squared: 0.4437
Adjusted R-Squared: 0.0047

Plan Execution – Step 5, Build the Neural Network

Neural Network Model



MultiLayerPerceptron Predictor

Confusion Matrix - 0:16 - Scorer (score results)

File Hilite

quality \ Pr...	V	S	E	U	N	M
V	25	166	0	0	0	0
S	10	271	0	0	0	0
E	22	106	2	0	0	0
U	0	1	0	0	0	0
N	2	27	0	0	0	0
M	1	23	0	0	0	0

Correct classified: 298 Wrong classified: 358

Accuracy: 45.427 % Error: 54.573 %

Cohen's kappa (κ) 0.067

PNN Predictor

Confusion Matrix - 0:39 - Scorer (score results)

File Hilite

quality \ Pr...	U	V	S	E	N	M
U	0	0	1	0	0	0
V	0	14	164	13	0	0
S	0	8	267	6	0	0
E	0	9	87	34	0	0
N	0	2	27	0	0	0
M	0	1	22	1	0	0

Correct classified: 315 Wrong classified: 341

Accuracy: 48.018 % Error: 51.982 %

Cohen's kappa (κ) 0.13

Results & Findings

Results

This study determined that there's evidence that the Neural Network modeling technique is applicable to Big Data sets in acquisition.

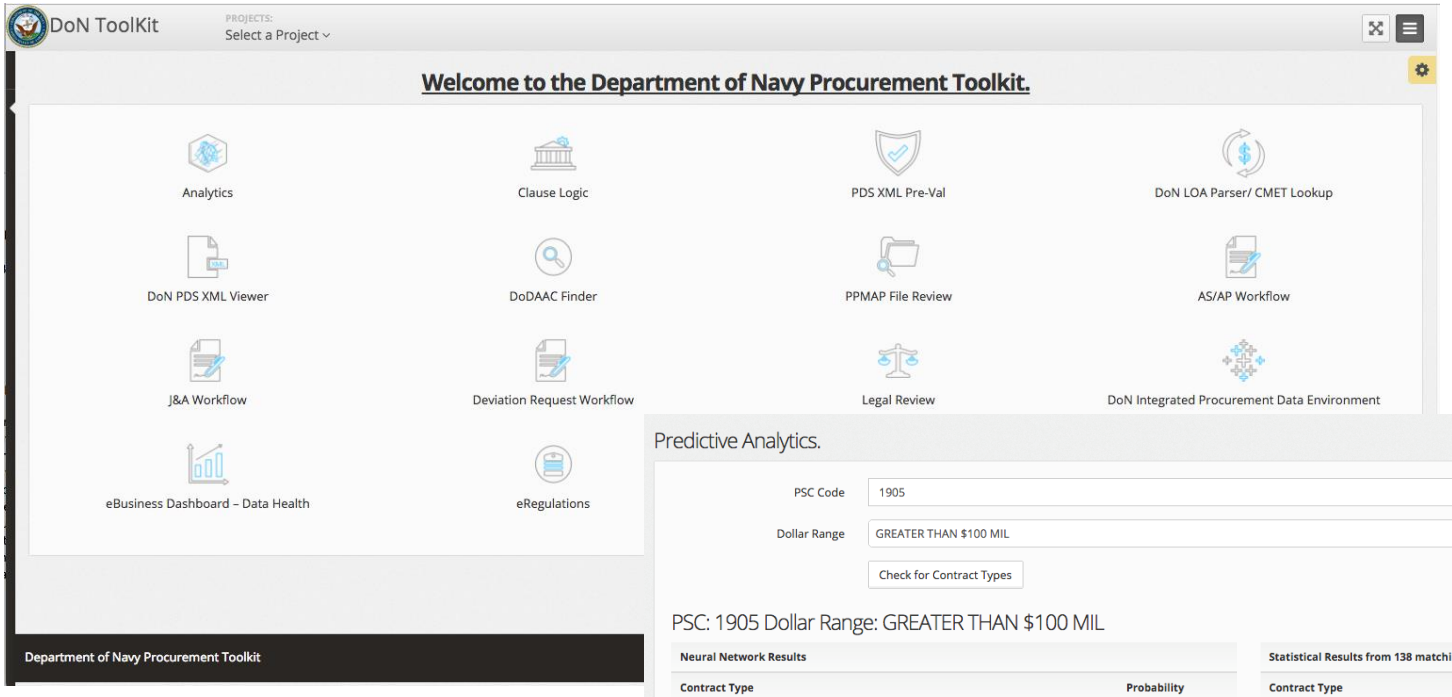
- The demonstrated Hypotheses were effectively tested using the technique
  - H1 (incentivized contract-types correlate with higher vendor performance scores) and H3 (competed contracts correlate with higher vendor performance scores) were thoroughly evaluated.
    - Results were inconclusive via initial standard regression technique,
    - Experimenting with the Neural Network mode of analysis obtained a maximum accuracy score of 49% and demonstrated the ability to produce more reliable networks through model refinement.

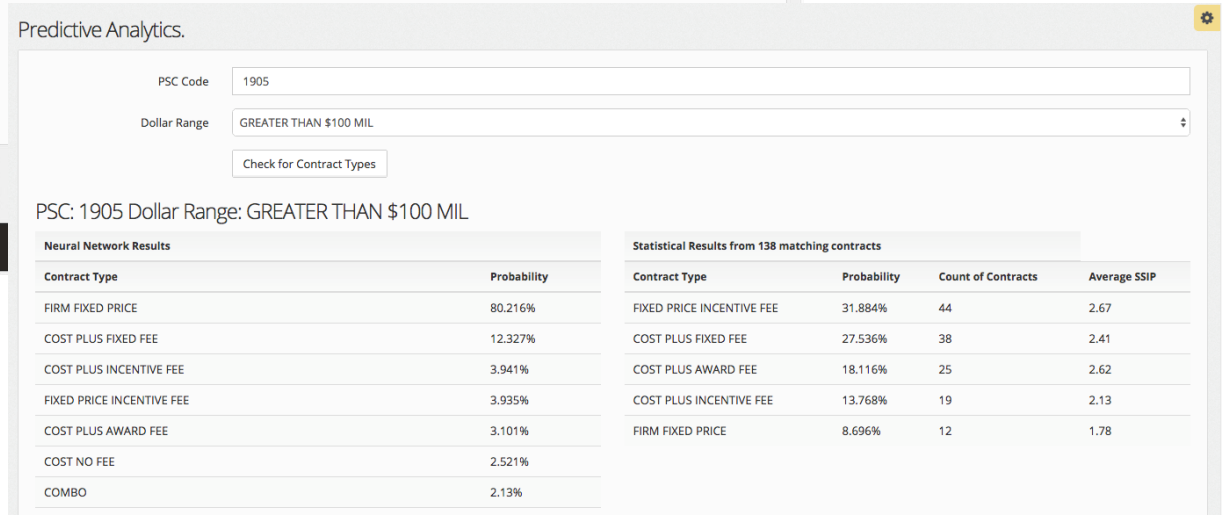
Findings

- Cognitive computing (Neural Network modeling) solutions promise better-informed buying and increased compliance.
- Integrating a PMML into developed statistical and Neural Network models enables rapid prototyping of cognitive learning components for acquisition support.
- The Integrated Data and Analytics environment established through the research can be further leveraged to rapidly produce new applicable models and incorporate resulting PMML outputs into future Navy applications.

Acquisition Decision Support Tool

- **PMML Integrated Decision Support Tool Kit**
  - The combination of the Cognitive Learning Acquisition Framework and a Big Data archive together form a methodology for an Application Framework, enabling a dynamic information analysis space to build intelligence into decision support tools.

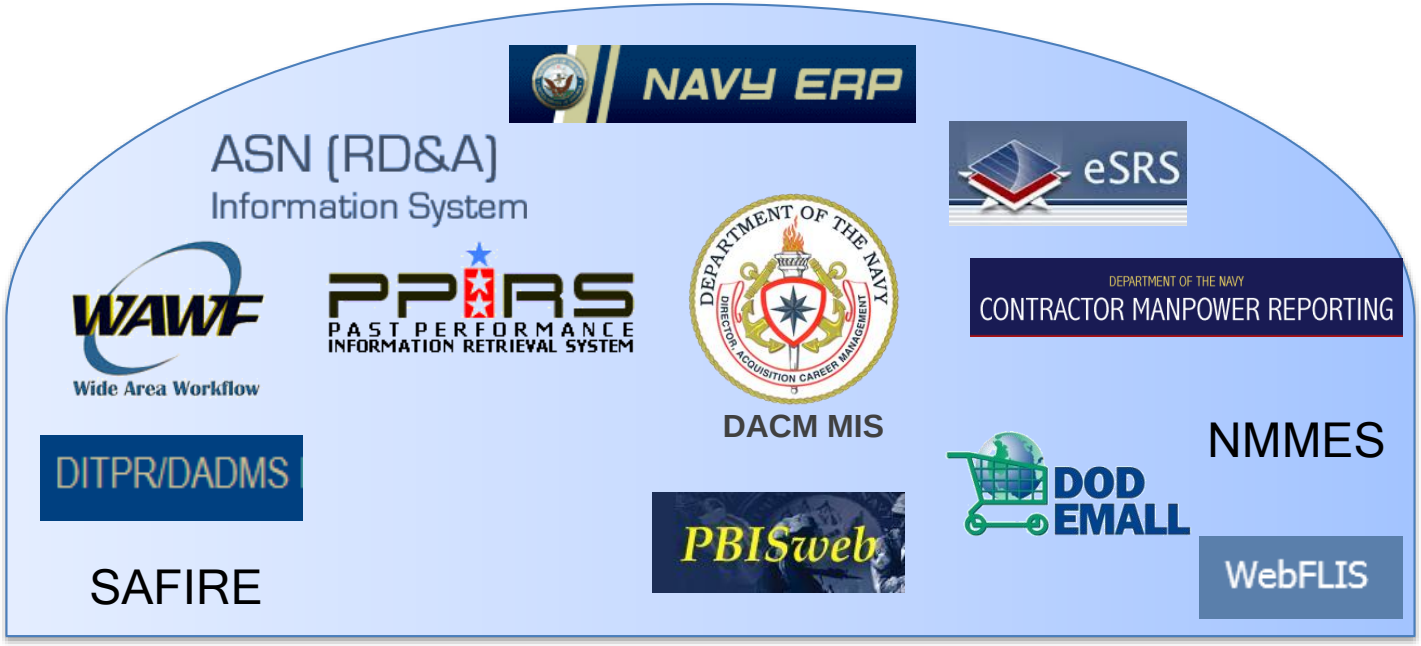




Areas for Further Research

Future Practical Research Opportunities

The incorporation of additional public and Defense datasets within the financial, logistics, and commercial spaces into the Big Data Archive is warranted to provide opportunities for further exploration of data relationships for use in Acquisition decision making.



Cognitive Learning Acquisition Framework (CLAF)