

# **A Comparison of Leading Data Mining Tools**

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*Elder Research*

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KDD-98: A Comparison of Leading Data Mining Tools

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# Contacting Elder Research

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# Tutorial Goals

- Compare and Summarize Data Mining Tools which:
  - Offer multiple modeling and classification algorithms
  - Support project stages surrounding model construction
  - Stand alone
  - Are general-purpose
  - Cost a lot
  - We could get our hands on
- Include some (focused) Desktop Tools

Other Reports: Two Crows, Aberdeen Group, Elder Research (forthcoming ), Data Mining Journal

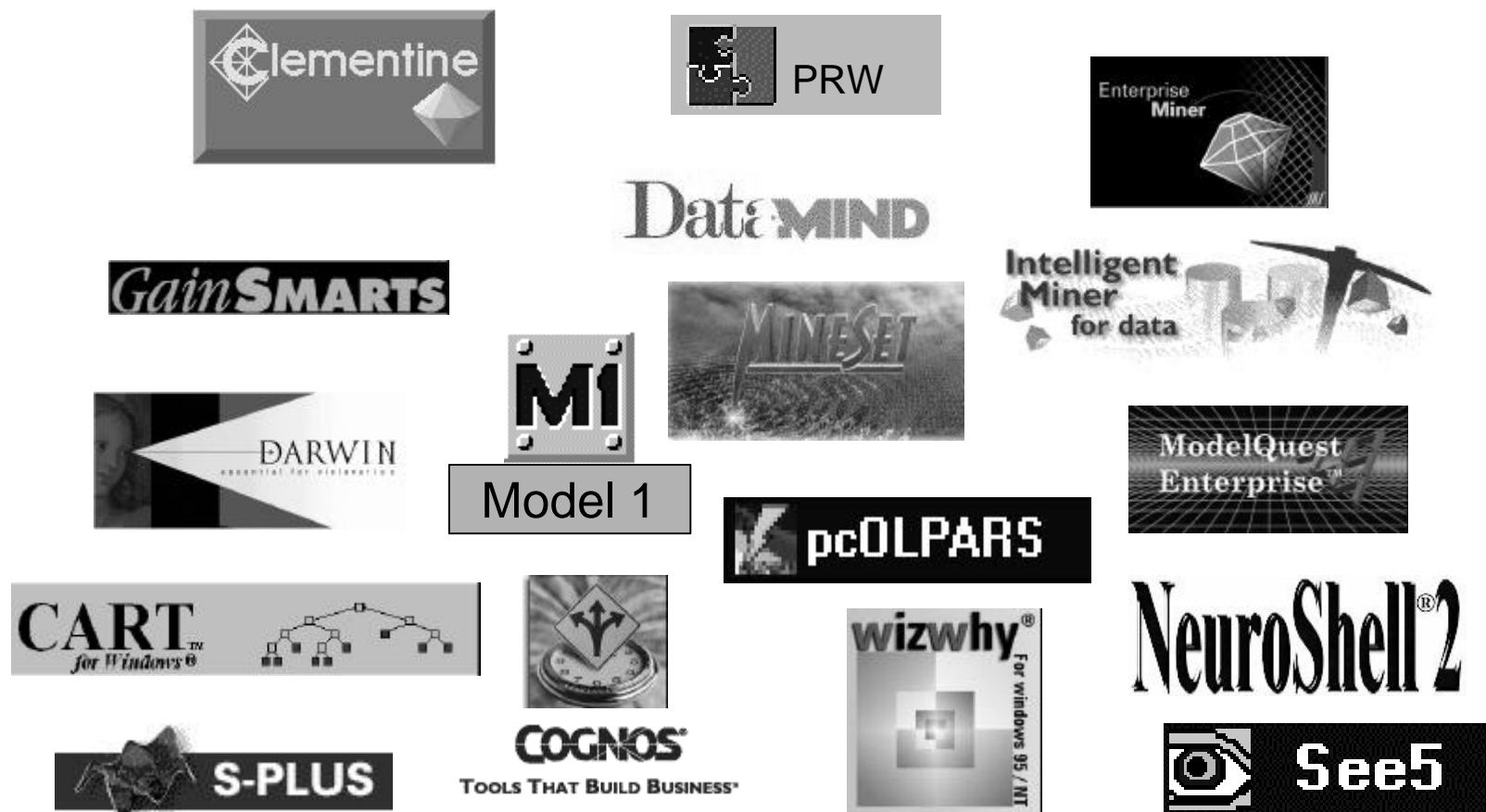
# Topics

- Products covered
- Review of algorithms
- Comparative tables of properties
- Screen shots exemplifying qualities
- Summary of distinctives

## Caveats

- We don't know *every* tool well (and are sure to have missed some!)
  - Level of exposure noted for each tool
- Our background (biasing our perspective)
  - Very technical, “early adopters”
  - Emphasize solving real-world applications
  - More classification than estimation
- Field of tools is quite dynamic
  - New versions appear regularly

# Data Mining Products



# Tools Evaluated

Product	Company	URL	Version Tested	Our Experience
<i>Clementine</i>	Integral Solutions, Ltd.	<a href="http://www.isl.co.uk/clem.html">http://www.isl.co.uk/clem.html</a>	4	Moderate
<i>Darwin</i>	Thinking Machines, Corp.	<a href="http://www.think.com/html/products/products.htm">http://www.think.com/html/products/products.htm</a>	3.0.1	Moderate
<i>DataCruncher</i>	DataMind	<a href="http://www.datamindcorp.com">http://www.datamindcorp.com</a>	2.1.1	High
<i>Enterprise Miner</i>	SAS Institute	<a href="http://www.sas.com/software/components/miner.html">http://www.sas.com/software/components/miner.html</a>	Beta	Moderate
<i>GainSmarts</i>	Urban Science	<a href="http://www.urbanscience.com/main/gainpage.htm">http://www.urbanscience.com/main/gainpage.htm</a>	4.0.3	Low
<i>Intelligent Miner</i>	IBM	<a href="http://www.software.ibm.com/data/iminer/">http://www.software.ibm.com/data/iminer/</a>	2	Low
<i>MineSet</i>	Silicon Graphics, Inc.	<a href="http://www.sgi.com/Products/software/MineSet/">http://www.sgi.com/Products/software/MineSet/</a>	2.5	Low
<i>Model 1</i>	Group 1/Unica Technologies	<a href="http://www.unica-usa.com/model1.htm">http://www.unica-usa.com/model1.htm</a>	3.1	Moderate
<i>ModelQuest</i>	AbTech Corp.	<a href="http://www.abtech.com">http://www.abtech.com</a>	1	Moderate
<i>PRW</i>	Unica Technologies, Inc.	<a href="http://www.unica-usa.com/prodinfo.htm">http://www.unica-usa.com/prodinfo.htm</a>	2.1	High
<i>CART</i>	Salford Systems	<a href="http://www.salford-systems.com">http://www.salford-systems.com</a>	3.5	Moderate
<i>NeuroShell</i>	Ward Systems Group, Inc.	<a href="http://www.wardsystems.com/neuroshe.htm">http://www.wardsystems.com/neuroshe.htm</a>	3	Moderate
<i>OLPARS</i>	PAR Government Systems	<a href="mailto://olpars@partech.com">mailto://olpars@partech.com</a>	8.1	High
<i>Scenario</i>	Cognos	<a href="http://www.cognos.com/busintell/products/index.html">http://www.cognos.com/busintell/products/index.html</a>	2	Moderate
<i>See5</i>	RuleQuest Research	<a href="http://www.rulequest.com/see5-info.html">http://www.rulequest.com/see5-info.html</a>	1.07	Moderate
<i>S-Plus</i>	MathSoft	<a href="http://www.mathsoft.com/splus/">http://www.mathsoft.com/splus/</a>	4	High
<i>WizWhy</i>	WizSoft	<a href="http://www.wizsoft.com/why.html">http://www.wizsoft.com/why.html</a>	1.1	Moderate



# Categories for Comparisons

- Platforms Supported
- Algorithms Included
  - Decision Trees
  - Neural Networks
  - Other
- Data Input and Model Output Options
- Usability Ratings
- Visualization Capabilities
- Modeling Automation Methods

# KDD-98: A Comparison of Leading Data Mining Tools

Platforms	PC Standalone (95/NT)	Unix Standalone	Unix Server / PC Client	NT Server / PC Client	Database Connectivity
<i>Clementine</i>	√	√+			√
<i>Darwin</i>			√		√
<i>DataCruncher</i>	√		√		√
<i>Enterprise Miner</i>	√		√+	√	√
<i>GainSmarts</i>	√	√			√
<i>Intelligent Miner</i>			√		√
<i>MineSet</i>		√			√
<i>Model 1</i>	√		√	√	√
<i>ModelQuest</i>	√	√			√
<i>PRW</i>	√				√
<i>CART</i>	√	√+			
<i>Scenario</i>	√				√
<i>NeuroShell</i>	√				
<i>OLPARS</i>	√	√			
<i>See5</i>	√	√+			
<i>S-Plus</i>	√				√-
<i>WizWhy</i>	√				

## Key

blank

no capability

√-

some capability

√

good capability

√+

excellent capability

# Tool Groupings

## Desktop

- PC (standalone)
- Flat Files
- One or Two Algorithms
- Data Fits into RAM

## High End

- Multiple Platforms, Client-Server
- Flat Files or Direct Database Access
- Multiple Algorithm Types
- Large Databases

# End User Perspectives

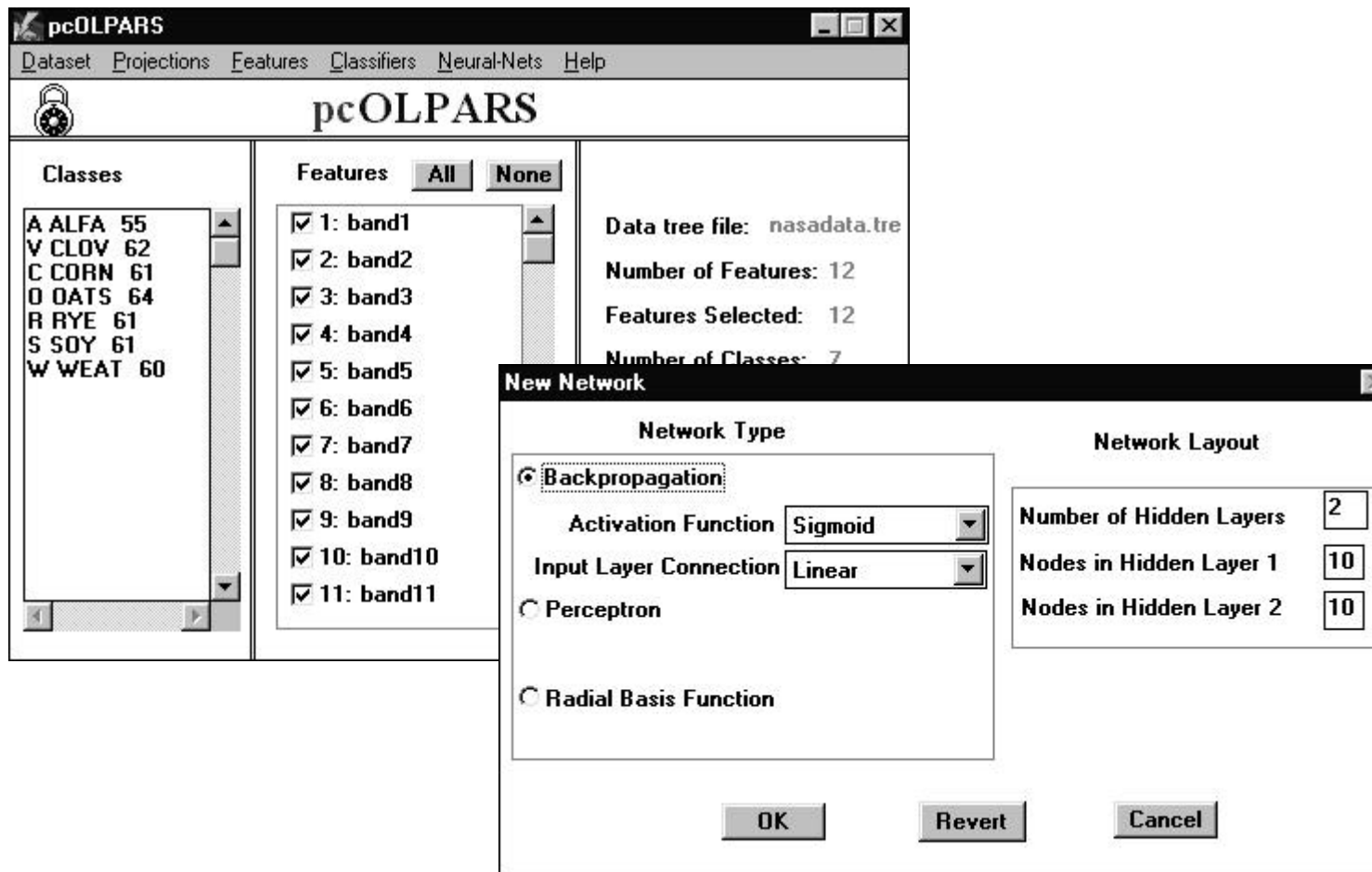
## Business

- Intuitive Interface
  - Clear steps in data mining process
  - Non-technical terminology
  - Familiar environment
- Descriptive Reporting
  - Domain terminology
  - Graphical representations

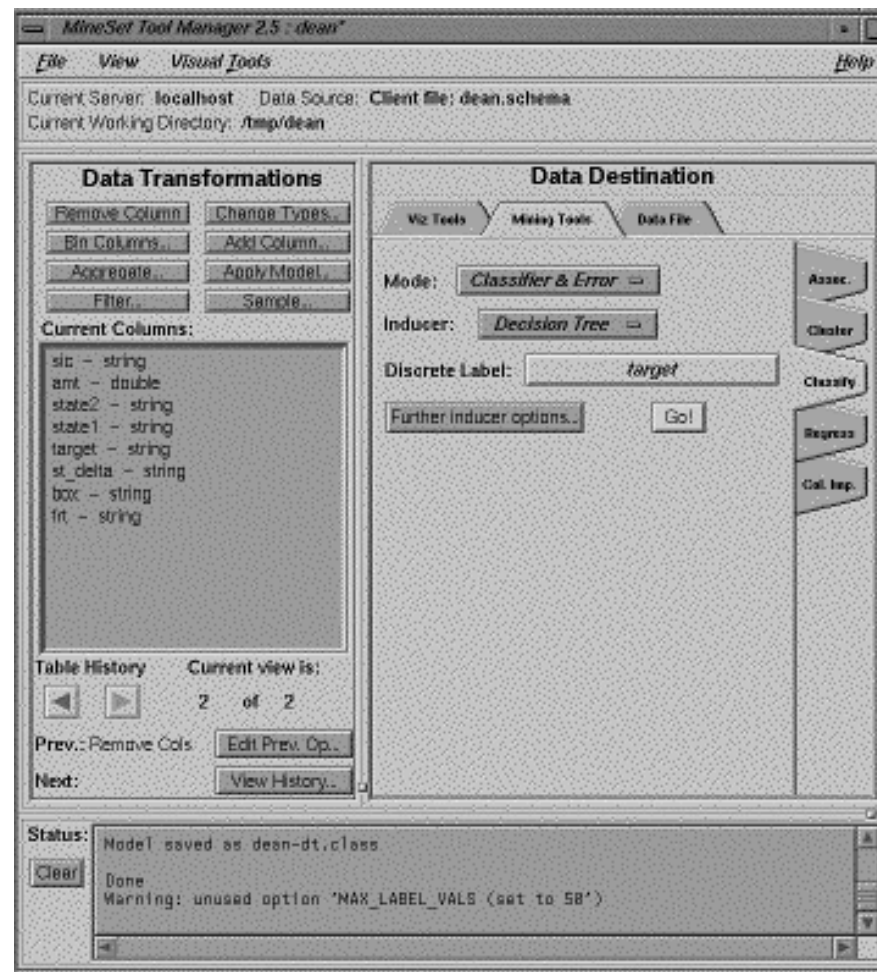
## Technical

- Algorithm Options
  - Knobs to enhance model performance
- Model Automation
  - Simplify model design cycle
  - Documentation of steps used in generating models (repeatability)

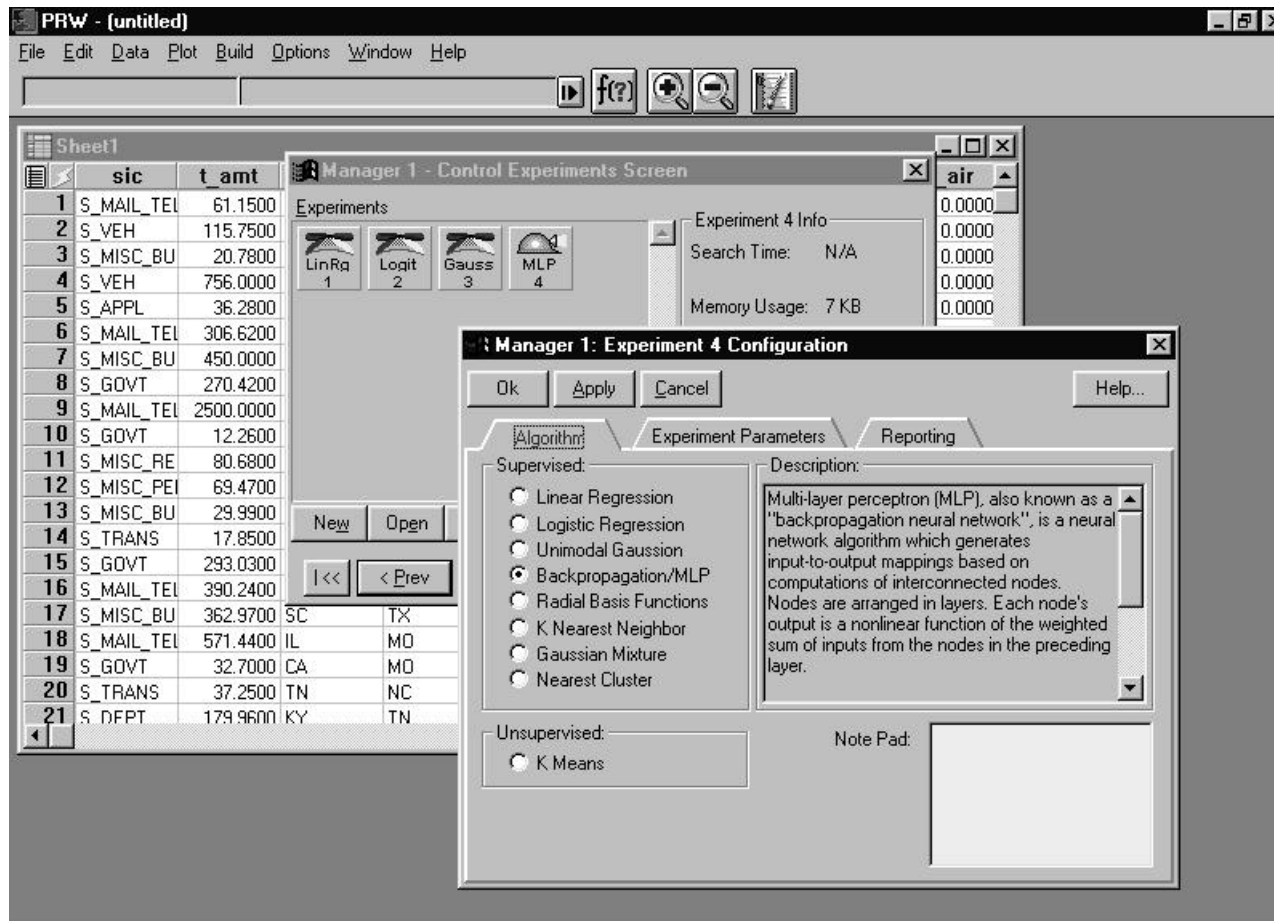
## *OLPARS*: Interface



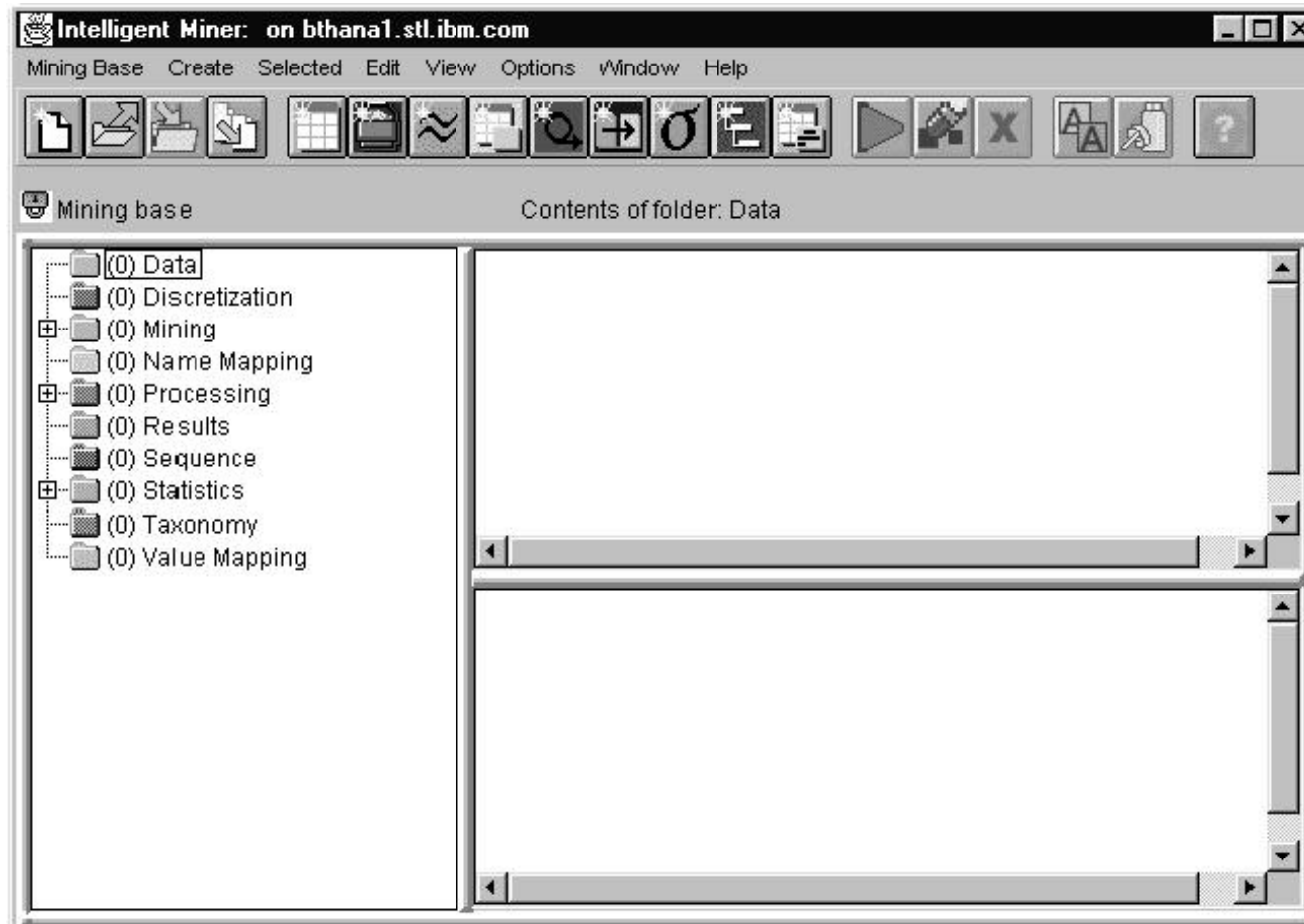
# MineSet: Interface



# PRW: Experiment Manager

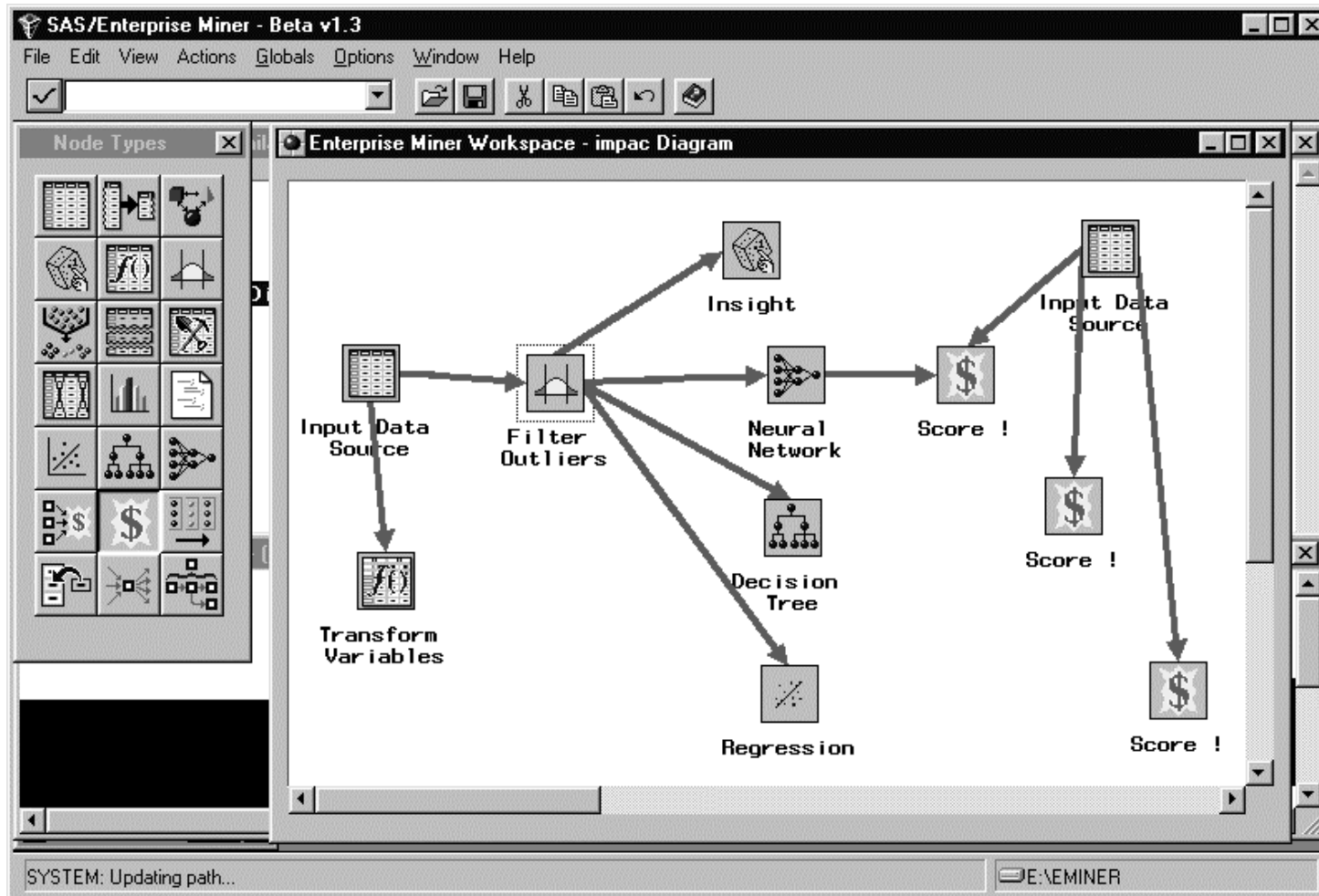


## *Intelligent Miner: “Explorer” Interface*

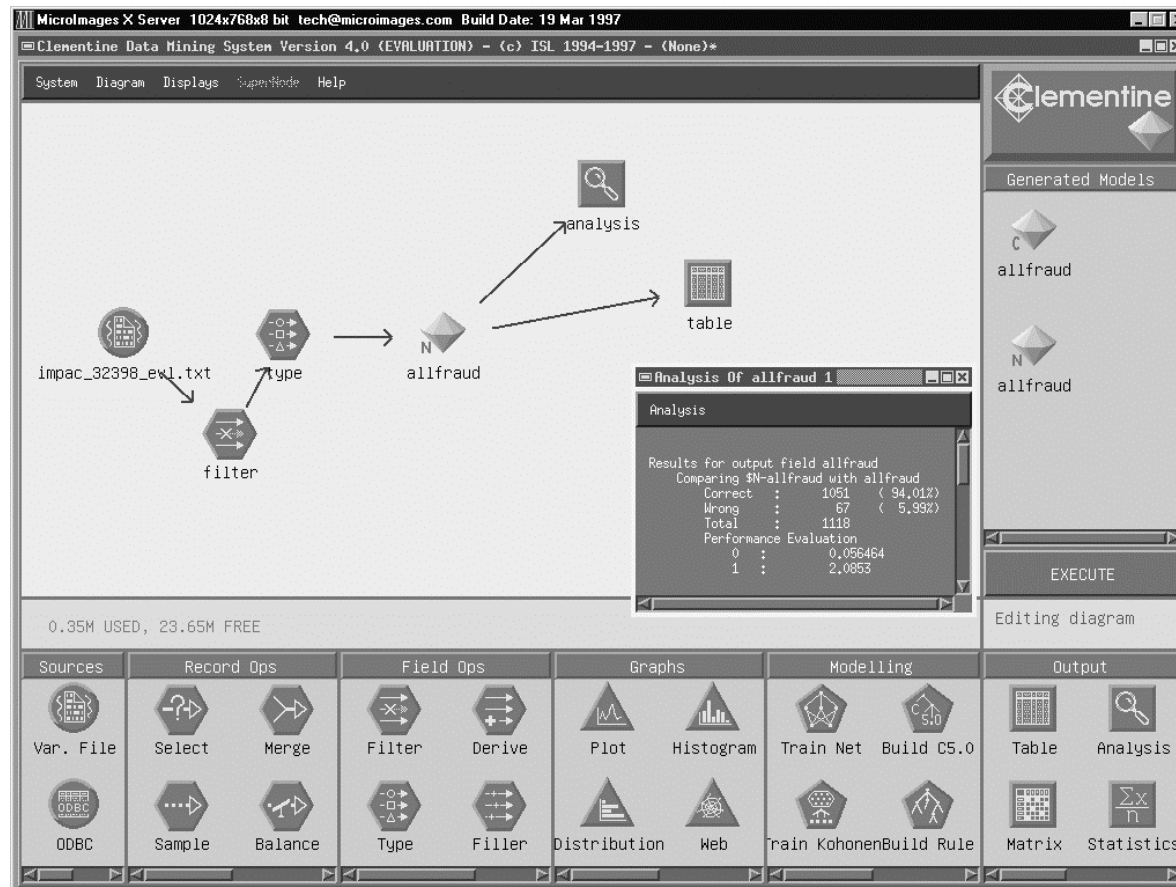




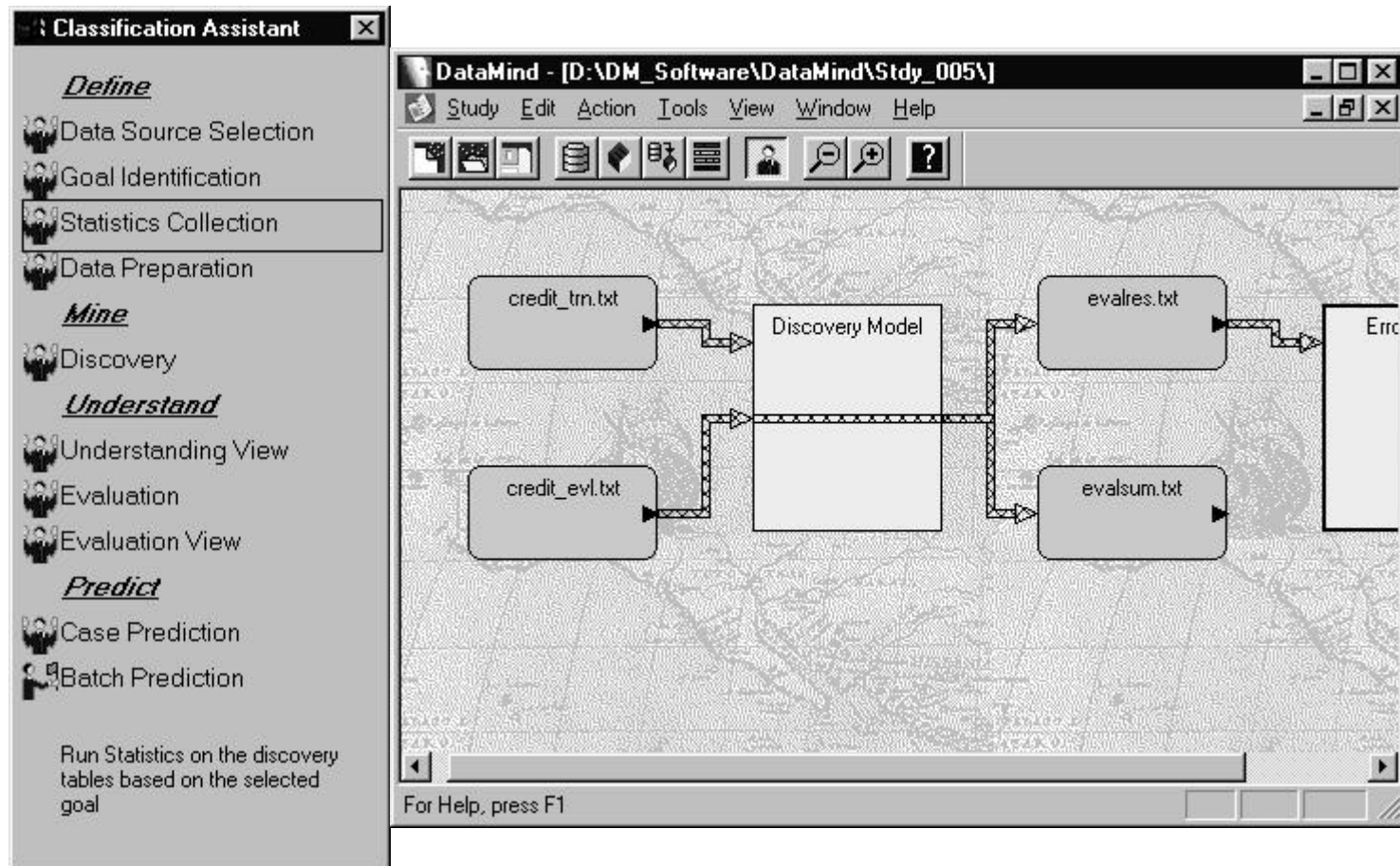
# *Enterprise Miner: Visual Interface*



# *Clementine*: Visual Interface



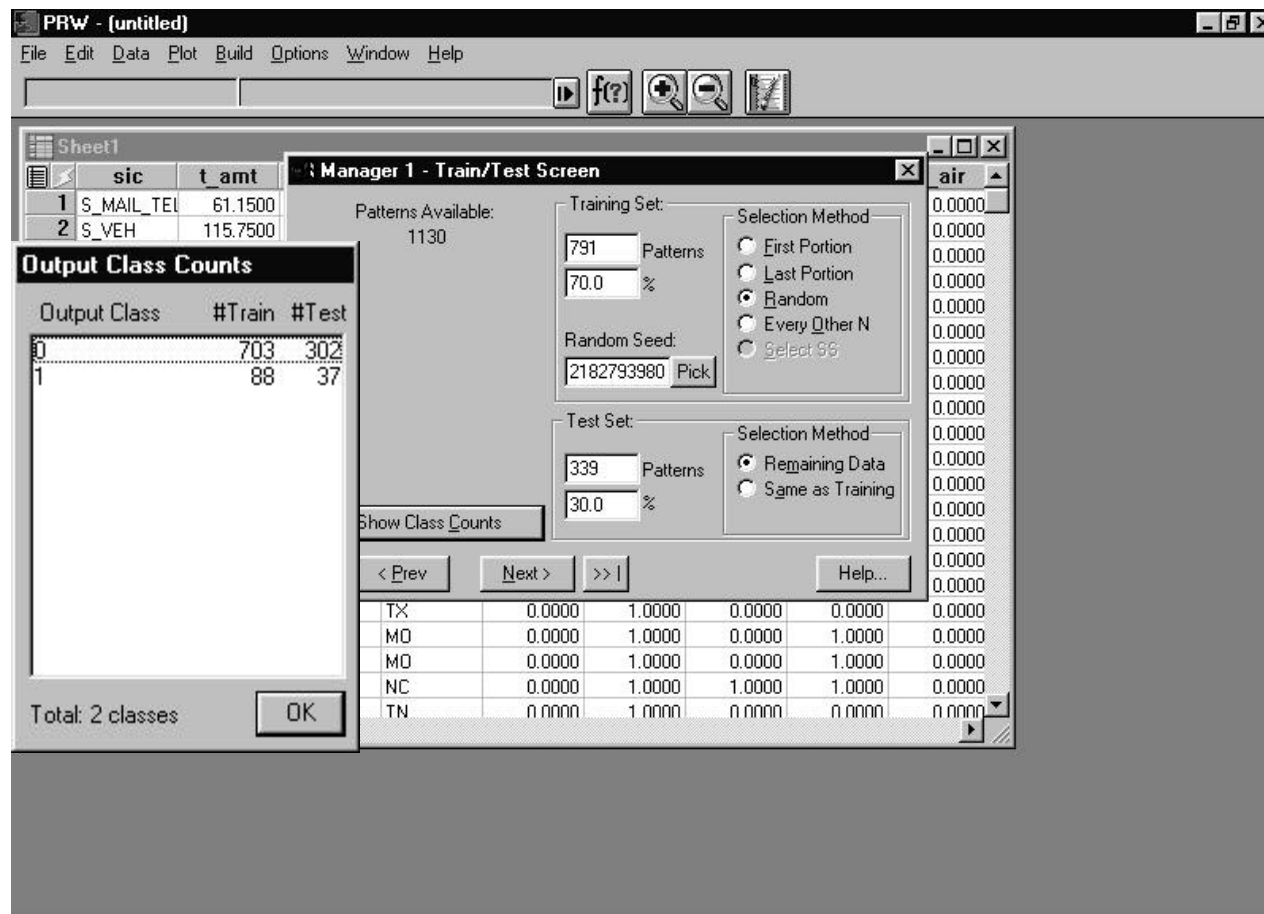
# *DataCruncher*: Process Flow Diagram



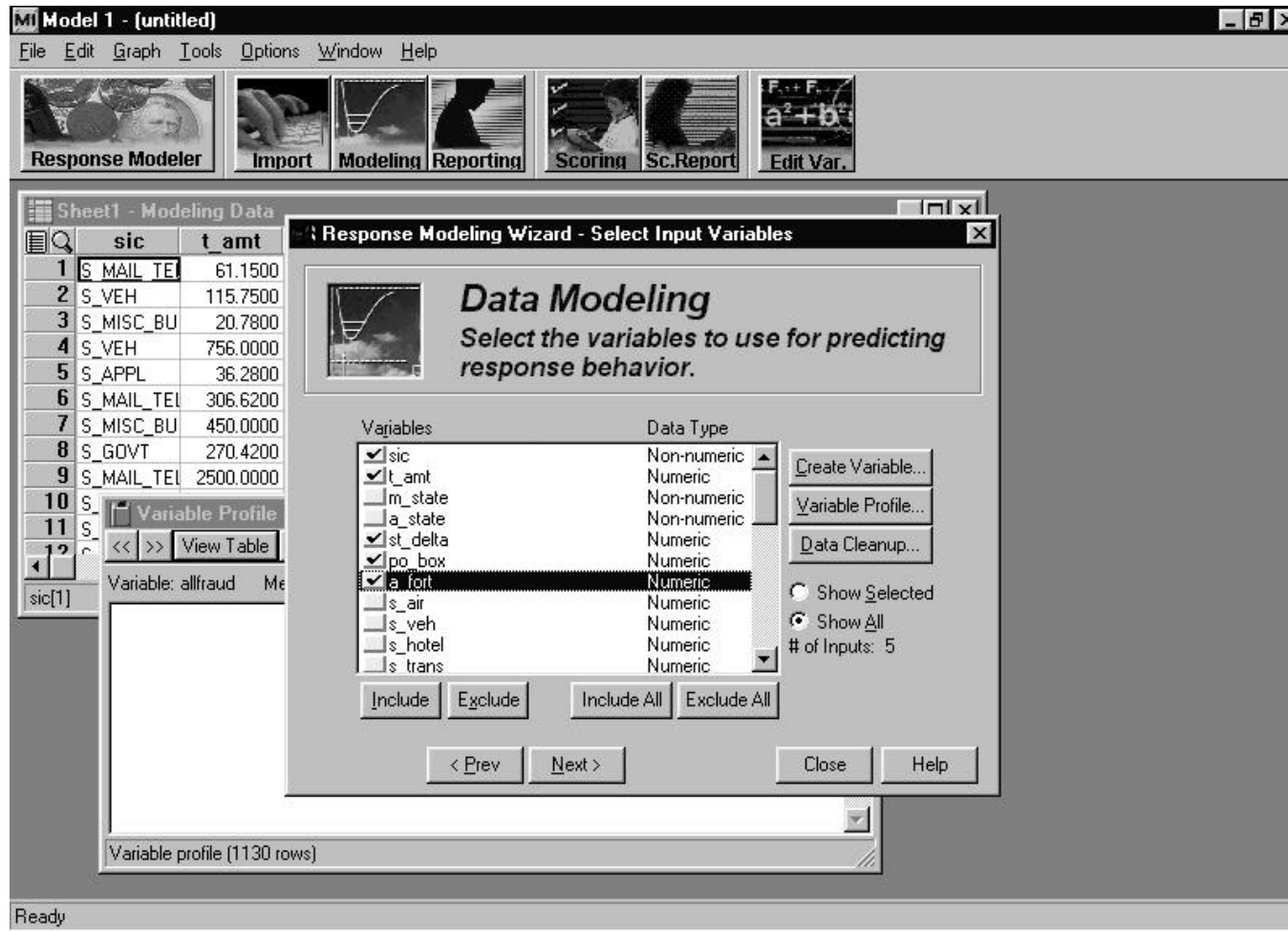
# KDD-98: A Comparison of Leading Data Mining Tools

Data Input & Model Output	Automatic Header	Save Data Format	ODBC	Native Database Drivers	Summary Reports	Output Source Code
<i>Clementine</i>	√		√			√
<i>Darwin</i>		√	√			√
<i>DataCruncher</i>	√	√	√	√	√	
<i>Enterprise Miner</i>	√—		√	√	√—	√
<i>GainSmarts</i>	√	√		√	√	√
<i>Intelligent Miner</i>				√—		√
<i>MineSet</i>		√		√		
<i>Model 1</i>	√	√	√	√	√	√
<i>ModelQuest</i>	√			√	√	√
<i>PRW</i>	√	√	√		√	√
<i>CART</i>	√					
<i>Scenario</i>	√				√	
<i>NeuroShell</i>	√					
<i>OLPARS</i>		√				
<i>See5</i>	√—					
<i>S-Plus</i>	√		√		√	√
<i>WizWhy</i>	√				√	

# PRW: Row Splitting



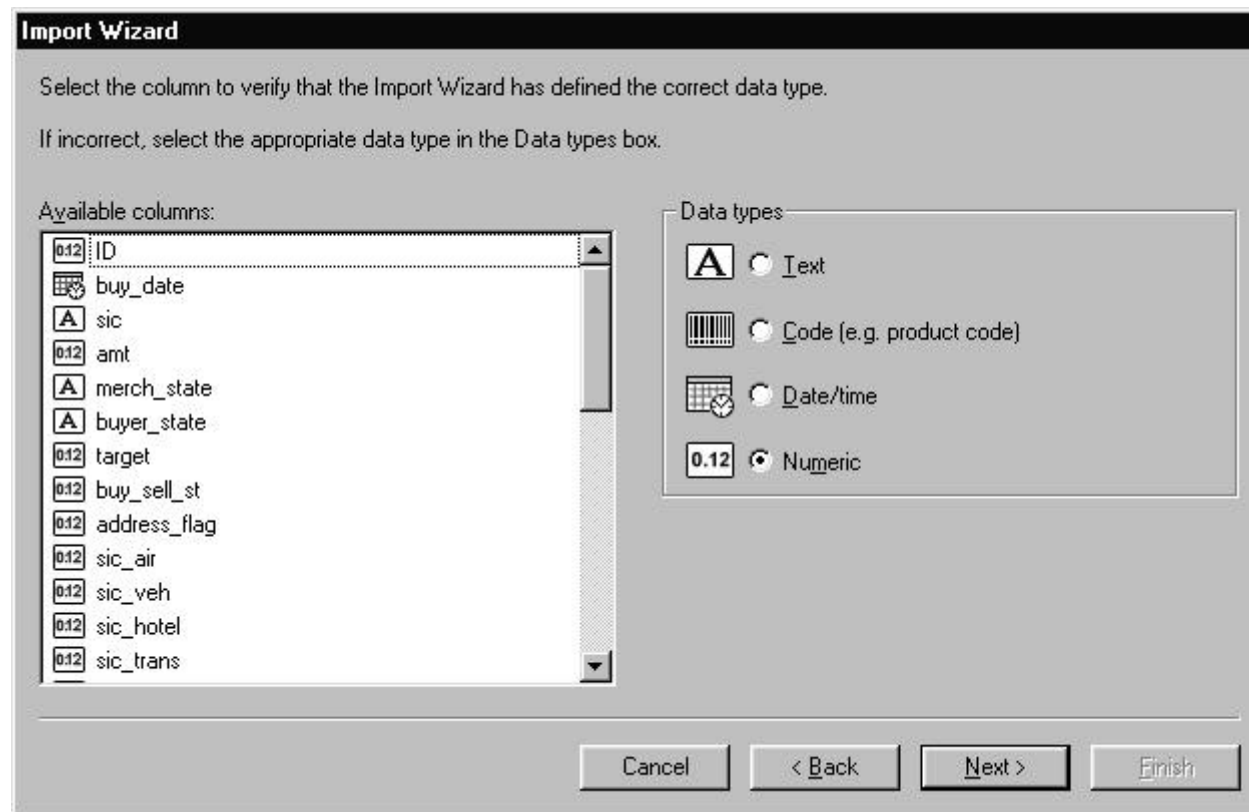
# *Model1: Variable Selection*



## T8-23

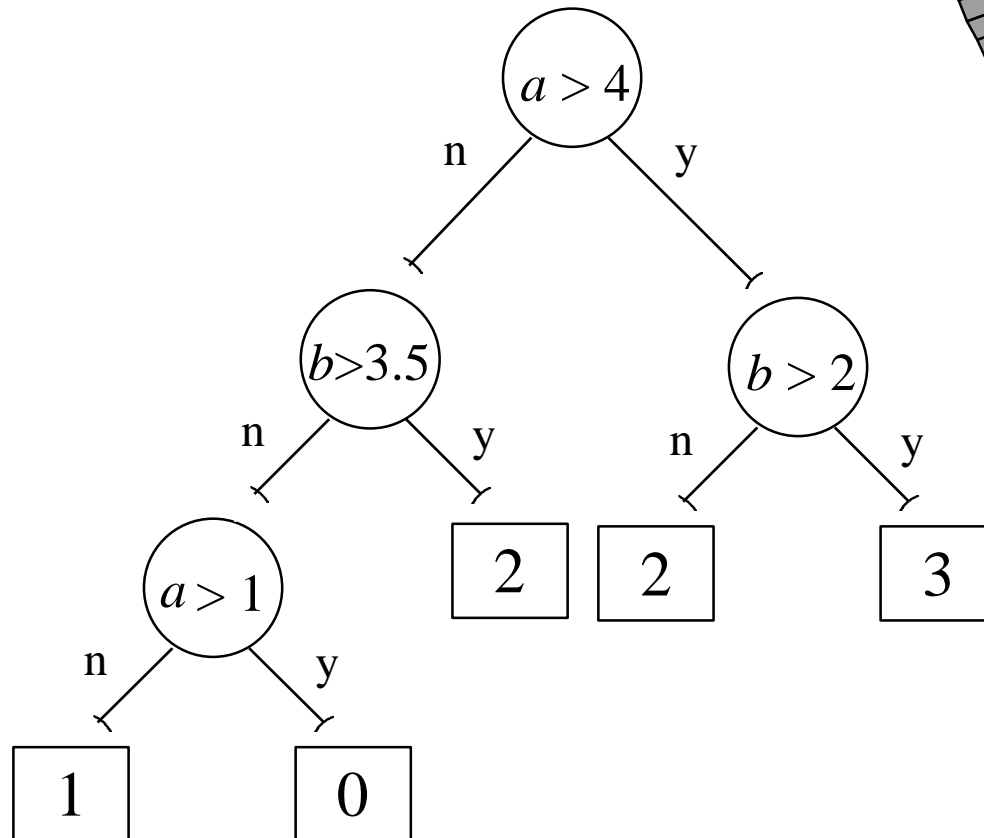
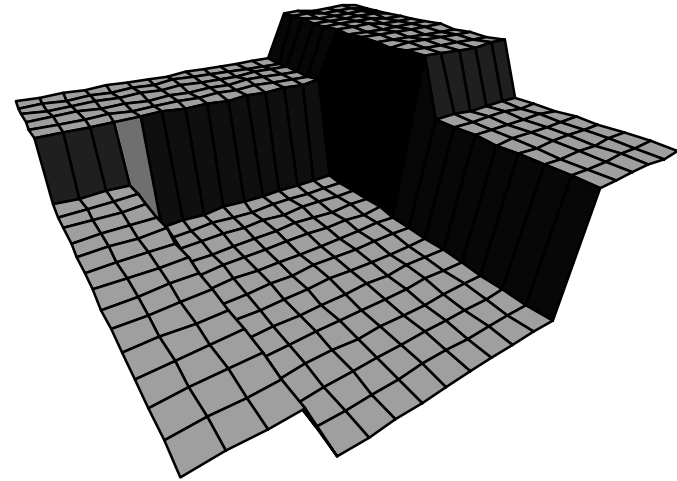


## *Scenario* : Special Data Types

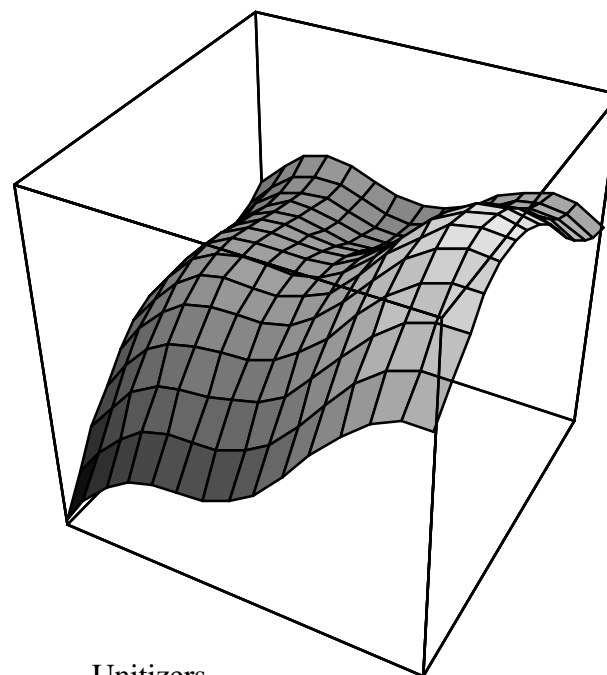
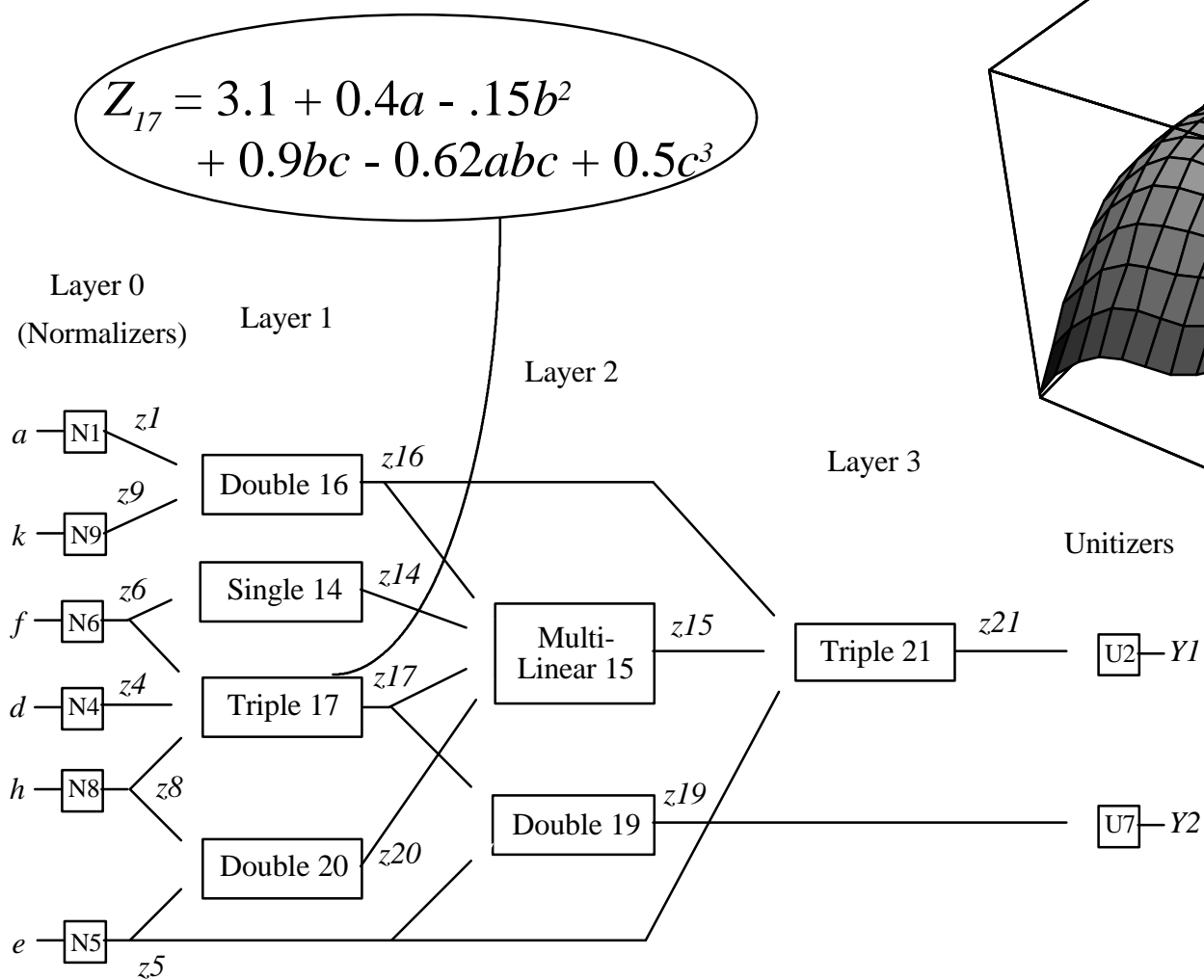




# Decision Trees



# Polynomial Networks

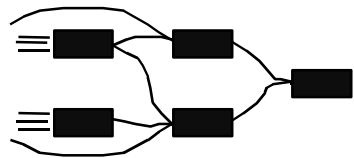
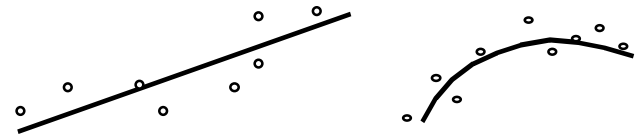


# “Consensus” Models

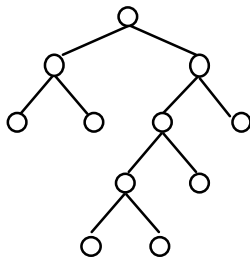
Parametrically Summarize Data Points

orders, terms

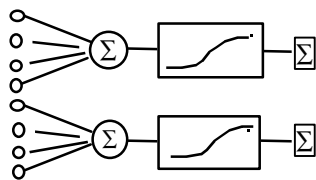
Regression



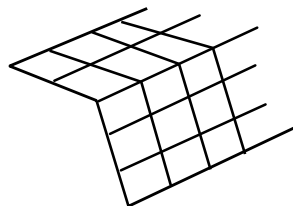
Polynomial Networks  
(e.g. GMDH, ASPN)



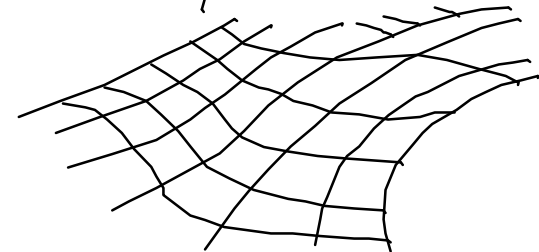
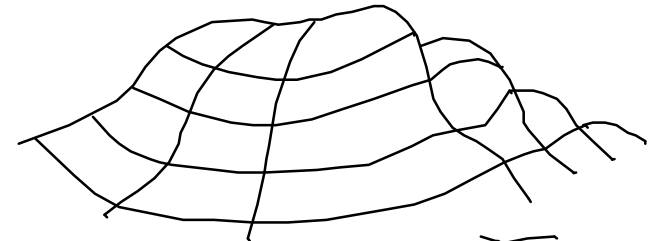
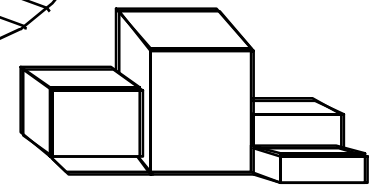
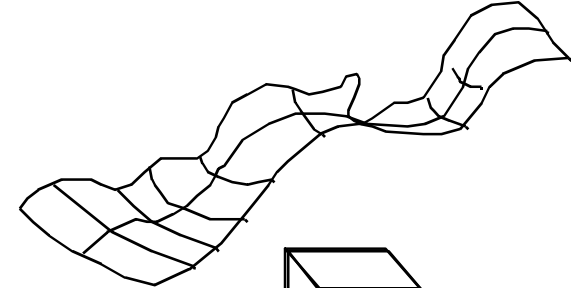
Decision Trees  
(e.g., CART, CHAID, C5)



Logistic or Sigmoidal  
Networks (ANNs)



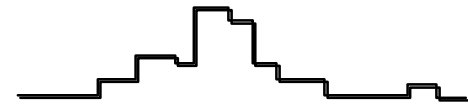
Hinging Hyperplanes,  
MARS



## “Consensus” Models (continued)

orientation, bin width

Histogram



function

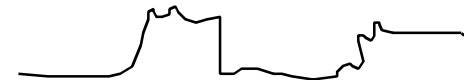


Radial Basis Function



family, order

Wavelets



## “Contributory” Models

retain data points; each potentially affects estimate at new point

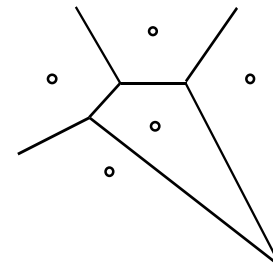
shape, spread

Kernels



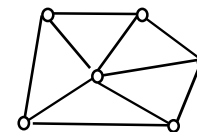
k, distance metric

k-Nearest Neighbor



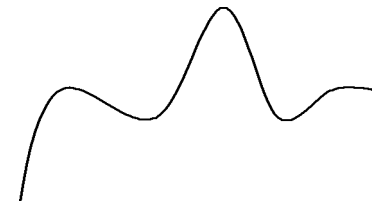
Goal, iterations

Delaunay Planes



Spread, index

Projection Pursuit Regression



# Properties of Algorithms

Algorithm	Accurate	Scalable	Interpret-able	Useable	Robust	Versatile	Fast	Hot
Classical (LR, LDA)	—	👍	👍—	👍	—	—	👍	👎
Neural Networks	👍	👎	👎	👎	—	👎	👎👎	👍
Visualization	👍	👎👎	👍	👍	👍👍	👎	👎👎👎	👍—
Decision Trees	👎	👍	👍	👍—	👍	👍	👍—	👍—
Polynomial Networks	👍	—	👎	👍—	—👎	—	—👎	—
K-Nearest Neighbors	👎	👎👎	👍—	—	—👎	👎	👍	👎
Kernels	👍	👎👎	👎	—👎	👎	👎	👍	👎

## Key

- 👍 good
- neutral
- 👎 bad

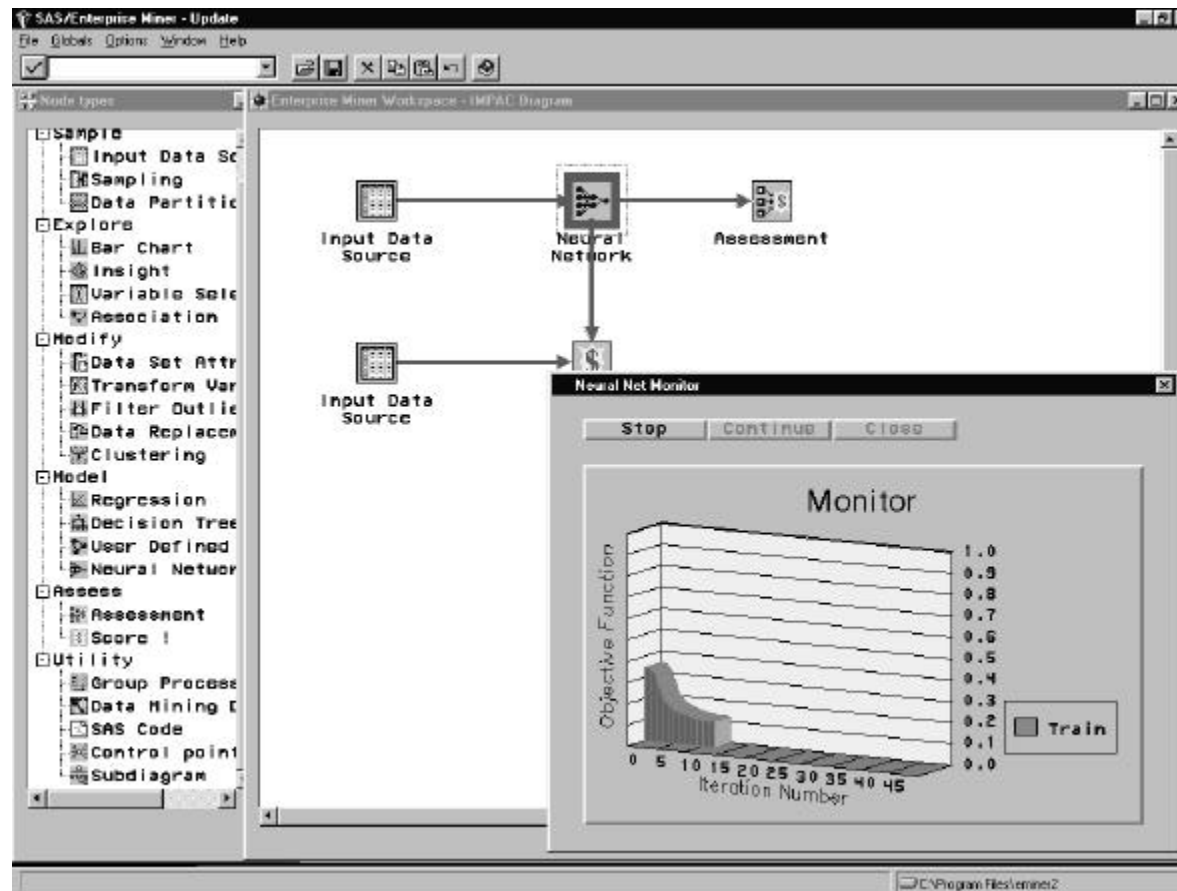
# KDD-98: A Comparison of Leading Data Mining Tools

Algorithms	Decision Trees	Linear/Statistical	Multi-layer Perceptrons	Nearest Neighbor	Radial Basis Functions	Bayes	Rule Induction	Polynomial Networks	Generalized Linear Models	Time Series	Sequential Discovery	K Means	Association Rules	Kohonen
<i>Clementine</i>	√	√	√				√					√	√	√
<i>Darwin</i>	√		√	√										
<i>Datamind</i>							√							
<i>Enterprise Miner</i>	√	√	√		√				√	√		√	√	
<i>GainSmarts</i>	√	√+												
<i>Intelligent Miner</i>	√	√-	√		√-					√	√	√+	√	
<i>MineSet</i>	√					√						√	√	
<i>Model 1</i>	√+	√	√									√		
<i>ModelQuest</i>	√	√		√				√		√-				
<i>PRW</i>		√+	√	√	√	√						√		
<i>CART</i>	√													
<i>Cognos</i>	√													
<i>NeuroShell</i>			√+		√					√-				
<i>OLPARS</i>		√	√	√	√	√						√		√
<i>See5</i>	√						√							
<i>SPlus</i>	√	√+							√	√		√		
<i>WizWhy</i>							√							

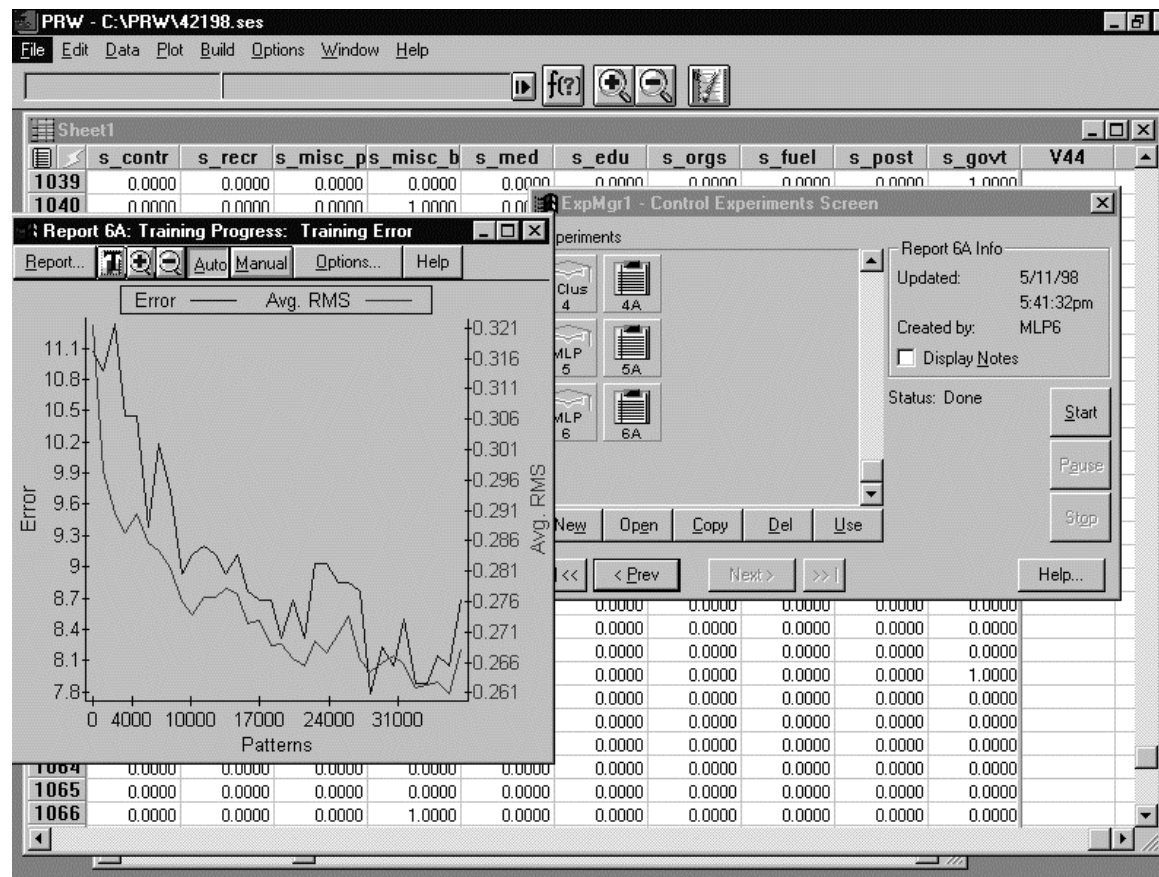
Multi-Layer Perceptrons	Learning Rate	Learning Rate Decay	Momentum	Multiple Activation Functions	Multiple Stop Criteria	Cross-Validation	Normalize Inputs	Advanced Learning Alg.	Other Cost functions	Automatic Model Selection	Network Visual	Parameter Summary
<i>Clementine</i>	✓	✓	✓							✓		
<i>Darwin</i>	✓			✓		✓		✓	✓			✓
<i>Enterprise Miner</i>	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓
<i>Intelligent Miner</i>	✓									✓		
<i>Model 1</i>	✓		✓			✓	✓			✓	✓	✓
<i>PRW</i>	✓		✓		✓	✓	✓			✓	✓	✓
<i>NeuroShell</i>	✓	✓	✓	✓	✓							
<i>OLPARS</i>	✓		✓	✓	✓		✓				✓	✓



# *Enterprise Miner*: Neural Network Training



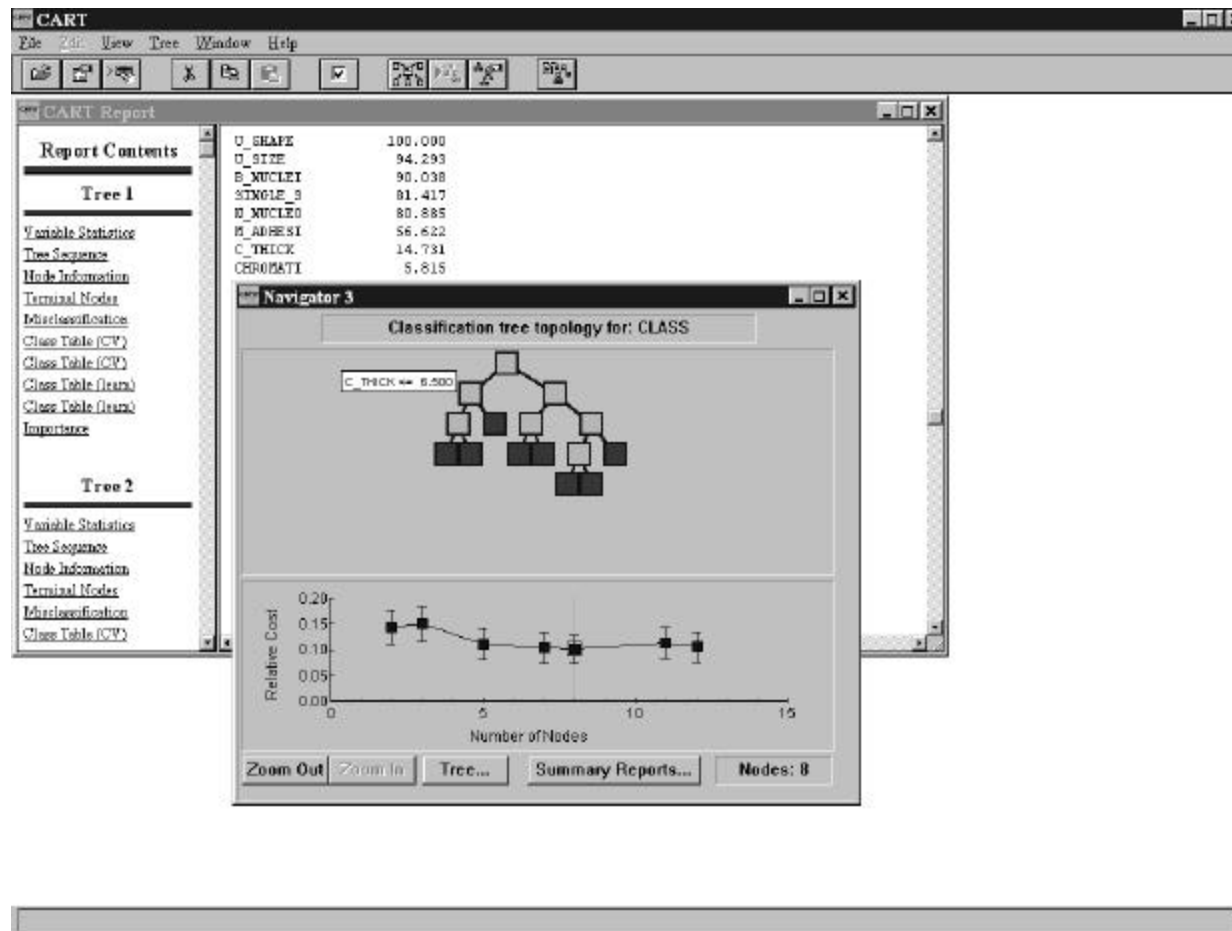
# PRW: Neural Network Training



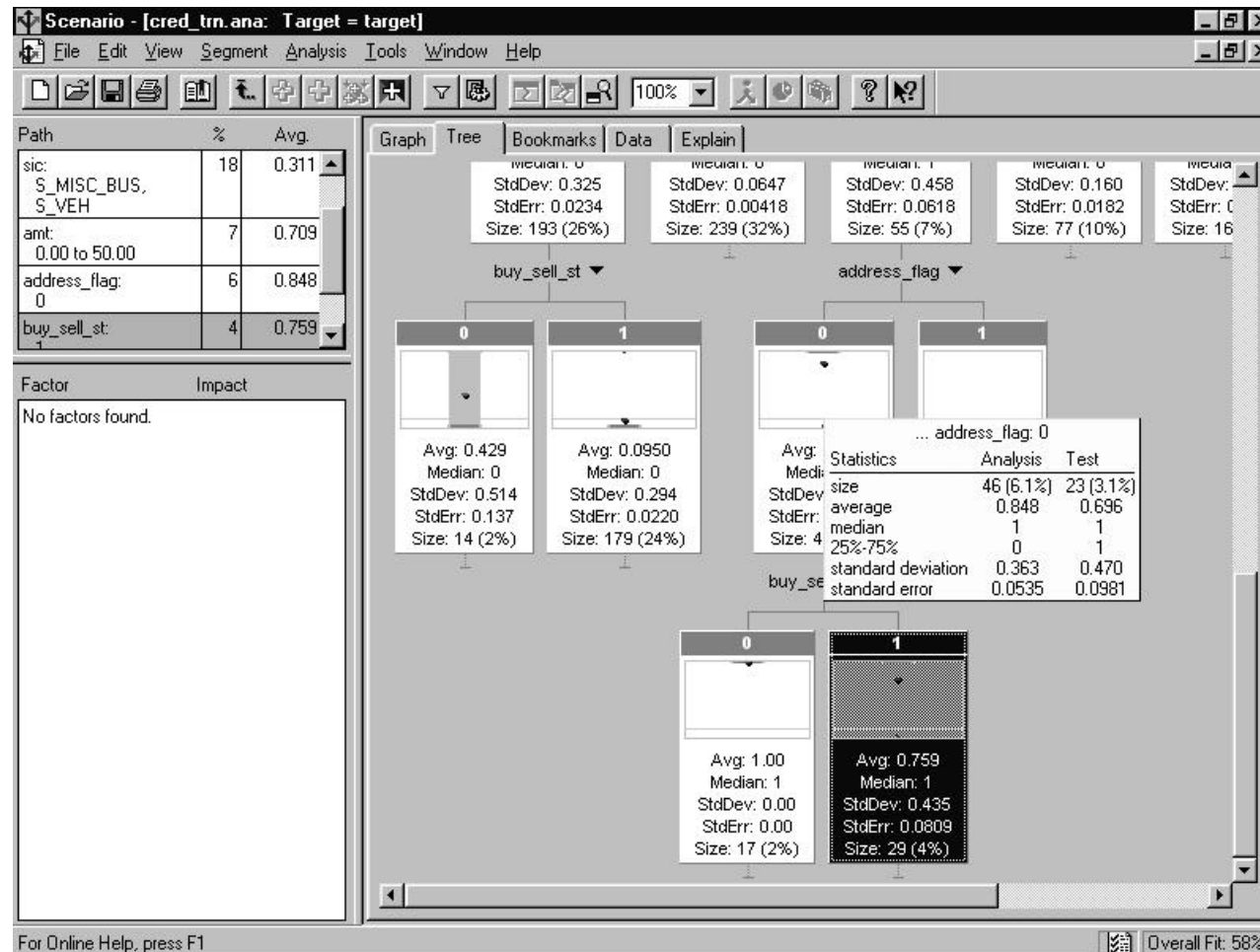
KDD-98: A Comparison of Leading Data Mining Tools

Decision Trees	"CART"	C5 or C4.5	CHAID	Other	Priors	Classification Costs	Missing Data	Pruning Severity	Visual Trees
<i>Clementine</i>		✓				✓	✓	✓	✓-
<i>Darwin</i>	✓				✓	✓	✓		
<i>Enterprise Miner</i>	✓	✓-	✓		✓+	✓	✓	✓	✓
<i>GainSmarts</i>	✓		✓	✓			✓		✓
<i>Intelligent Miner</i>				✓			✓		✓
<i>MineSet</i>	✓		✓			✓	✓	✓	✓
<i>Model 1</i>	✓		✓				✓-		
<i>ModelQuest</i>		✓-					✓	✓	
<i>CART</i>	✓+				✓	✓	✓		✓
<i>Scenario</i>				✓			✓		
<i>S-Plus</i>	✓						✓	✓	✓
<i>See5</i>		✓+				✓	✓	✓	

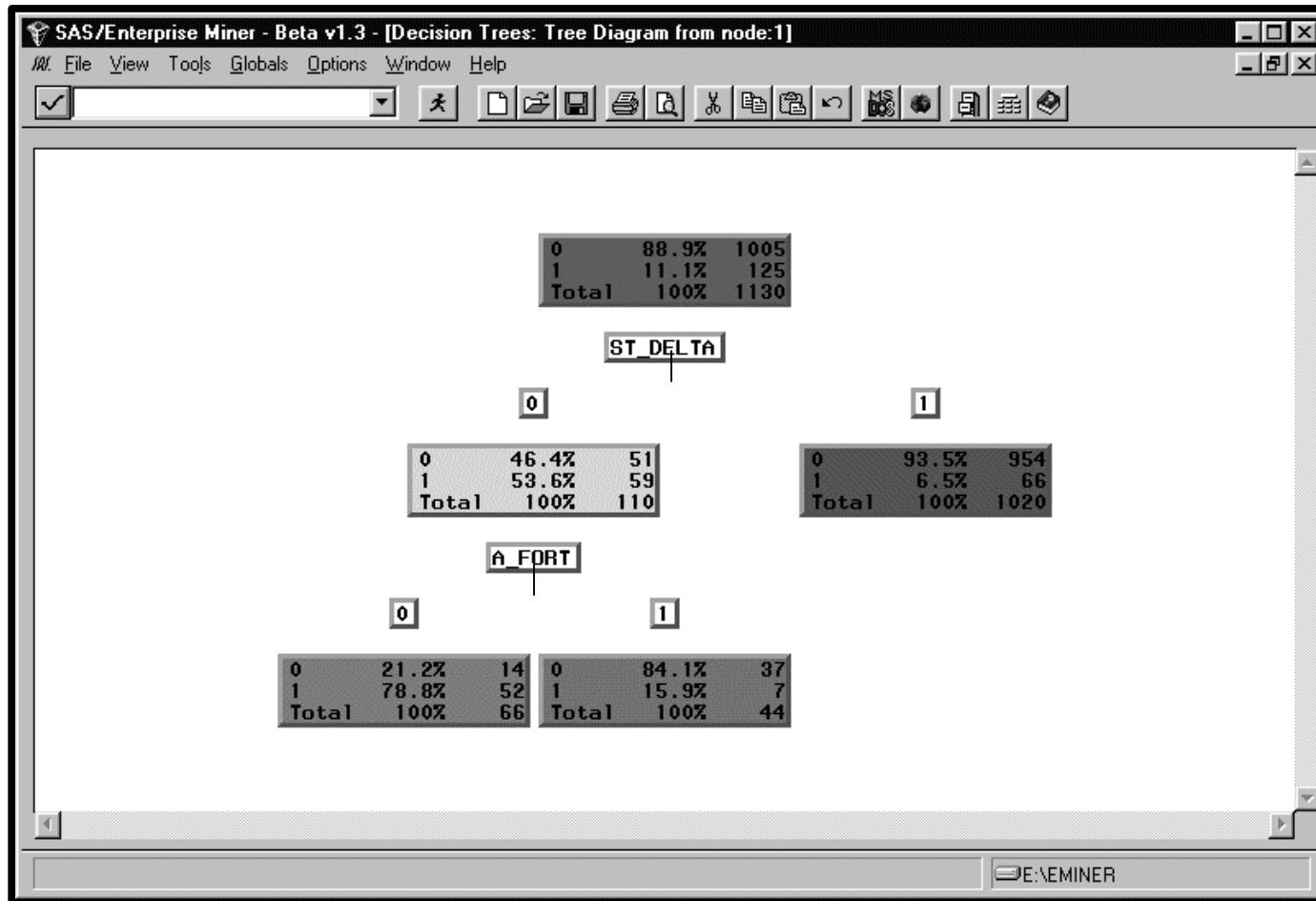
# *CART*: Tree Browsing



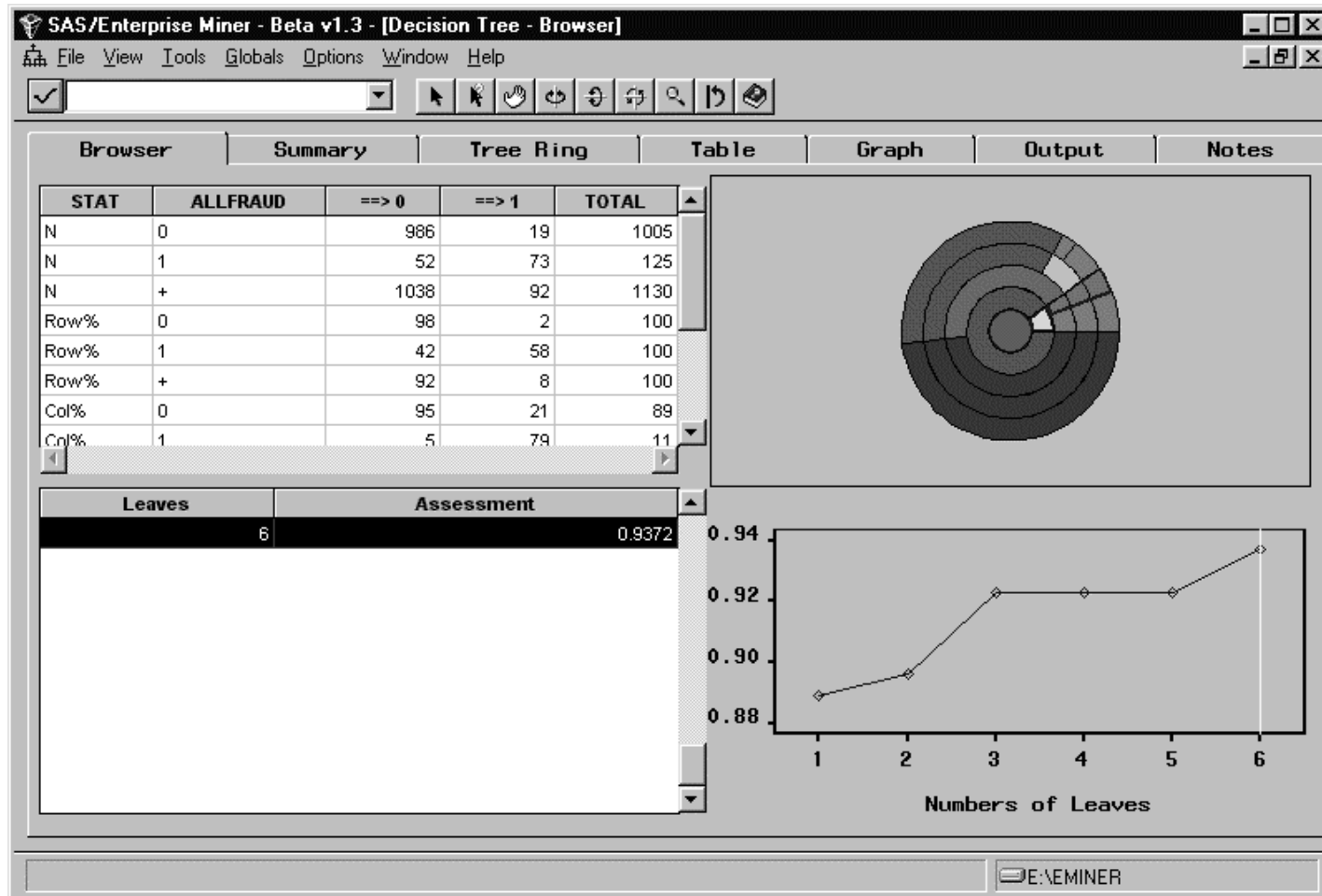
# Scenario: Tree Browsing



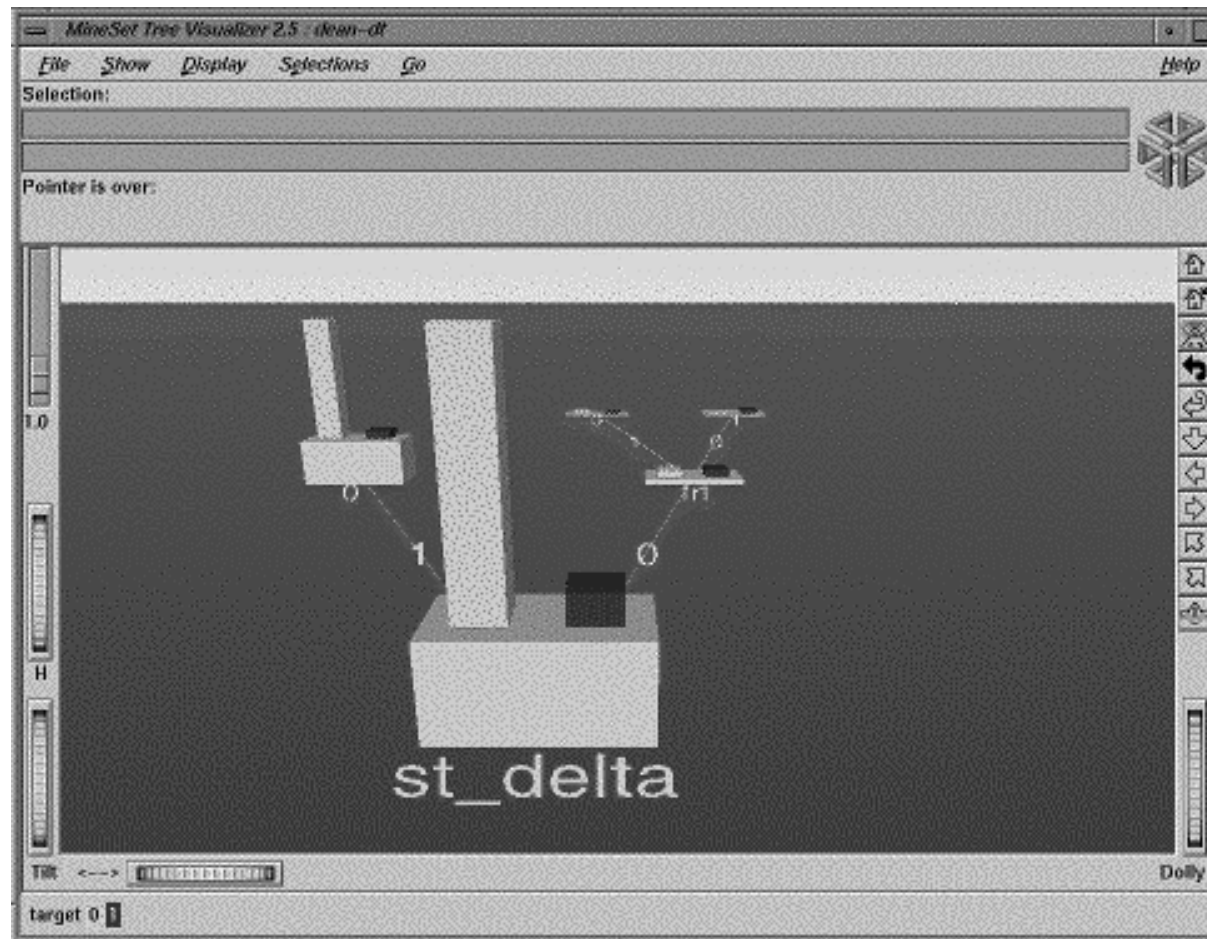
## *Enterprise Miner: Tree Browsing*



# *Enterprise Miner: Tree Results*



## *MineSet*: Tree Browser

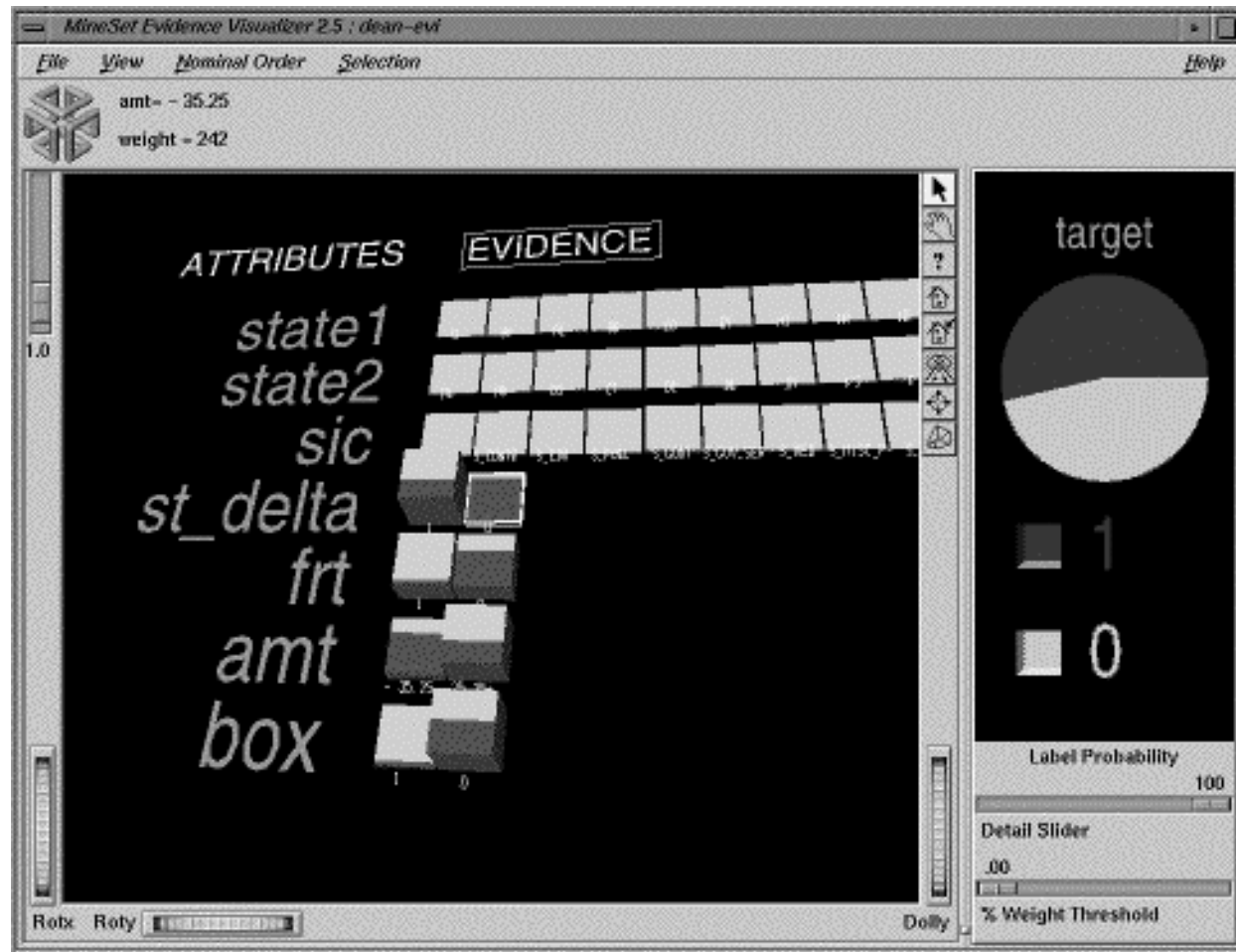




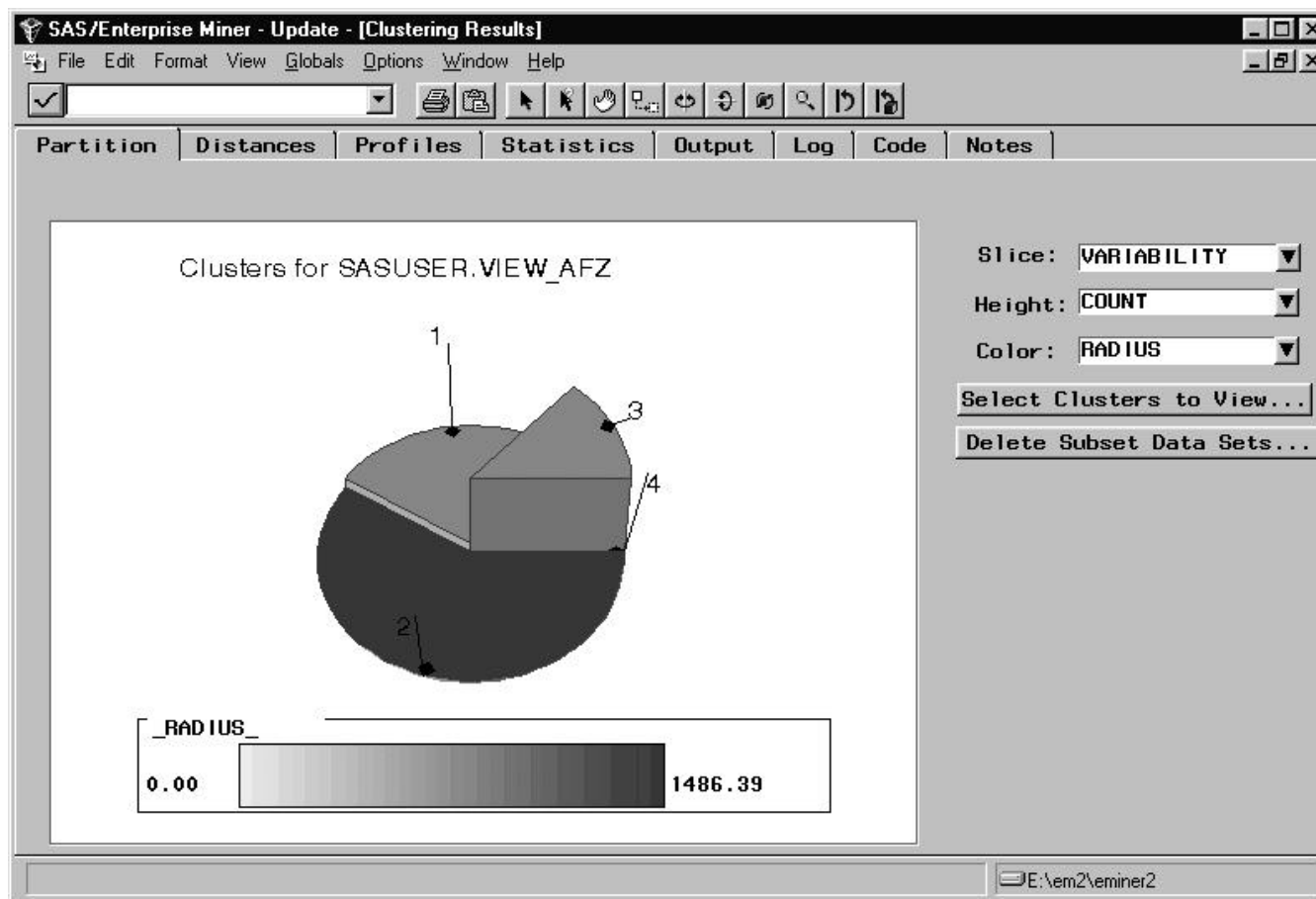
# KDD-98: A Comparison of Leading Data Mining Tools

Regression / Stats	Linear	Logistic	Complexity Penalty	Cross- Validation	Input Selection	Factor Analysis
<i>Clementine</i>	√					
<i>Enterprise Miner</i>	√+	√+	√	√	√	√
<i>GainSmarts</i>	√+	√+	√			
<i>Intelligent Miner</i>	√-				√	√
<i>MineSet</i>	√					
<i>Model 1</i>	√	√		√	√+	
<i>ModelQuest Enterprise</i>	√	√	√	√	√	
<i>PRW</i>	√	√		√	√+	
<i>S-Plus</i>	√+	√+	√	√	√	√
<i>Scenario</i>						√

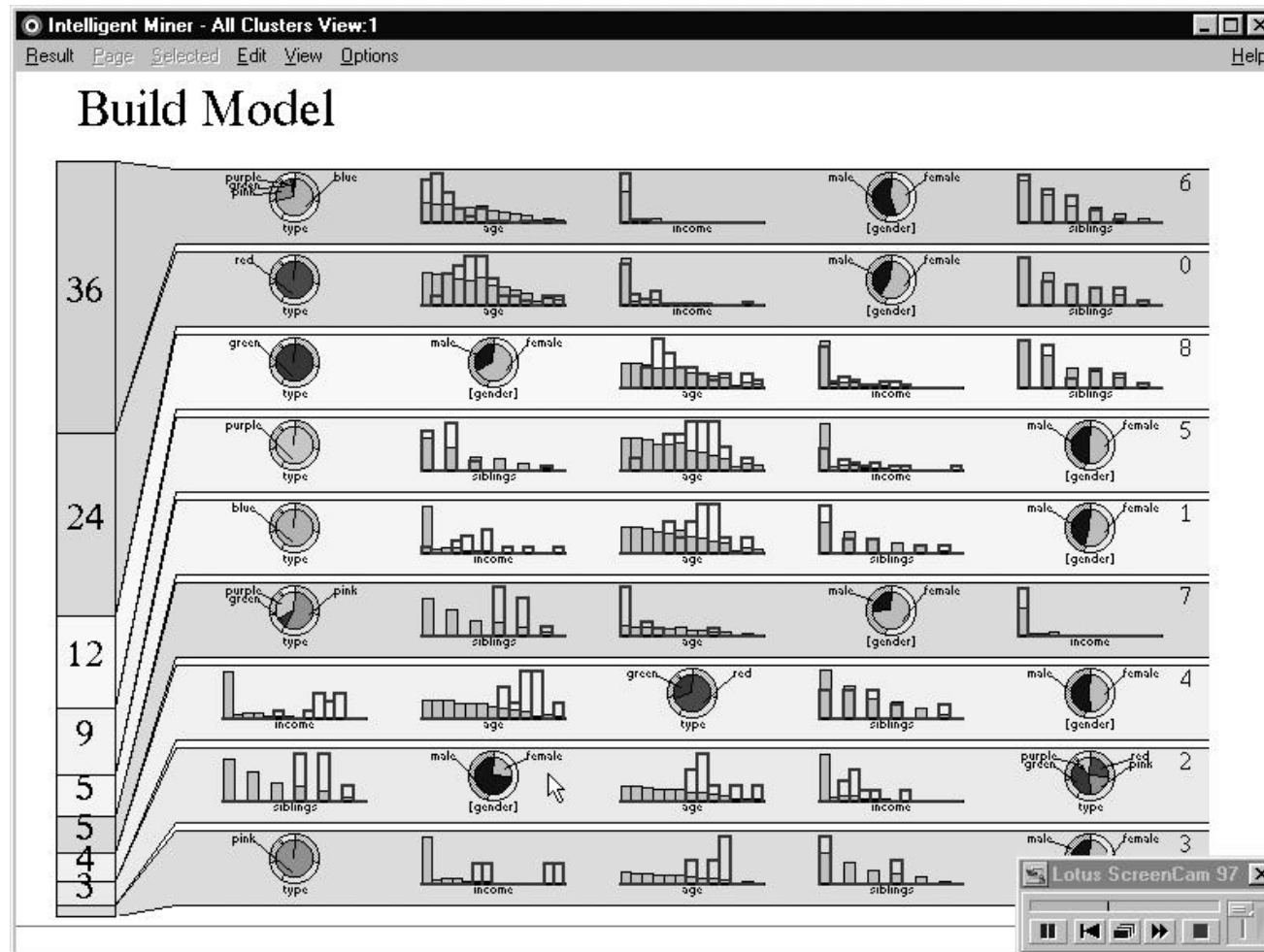
# *MineSet*: Bayes Distributions



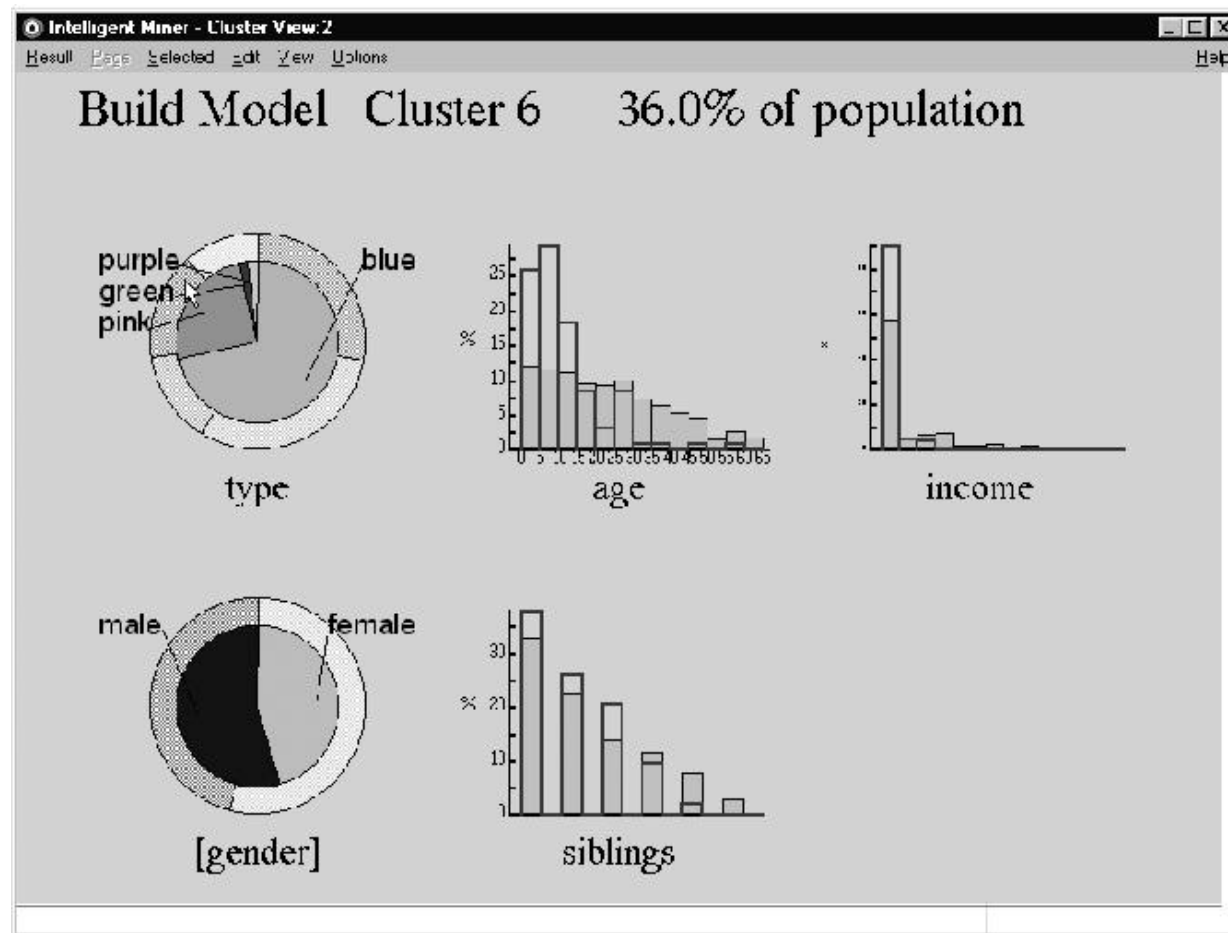
## *Enterprise Miner*: Clustering Results



# *Intelligent Miner: Clustering Results*



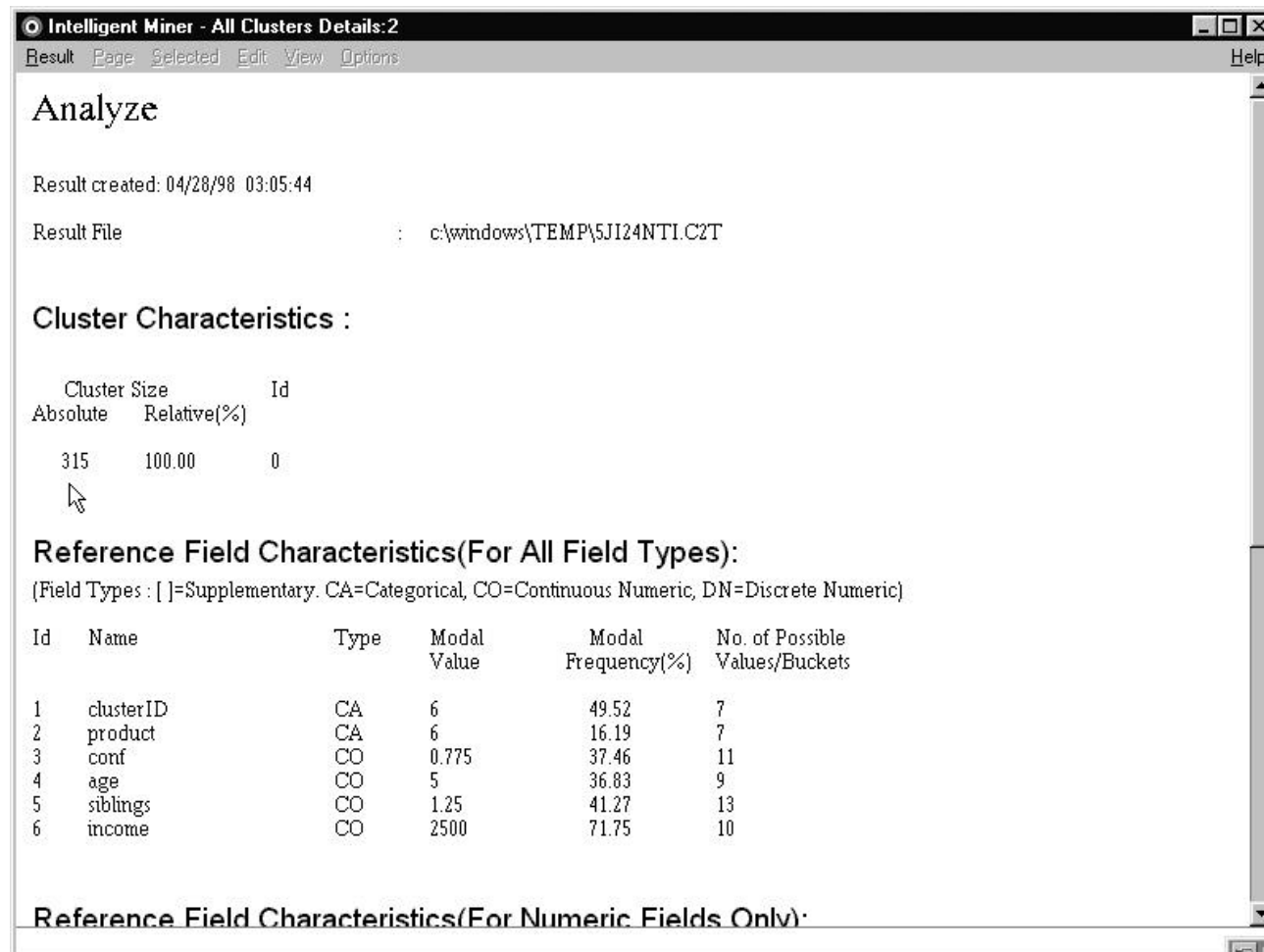
## *Intelligent Miner: Cluster Explode*



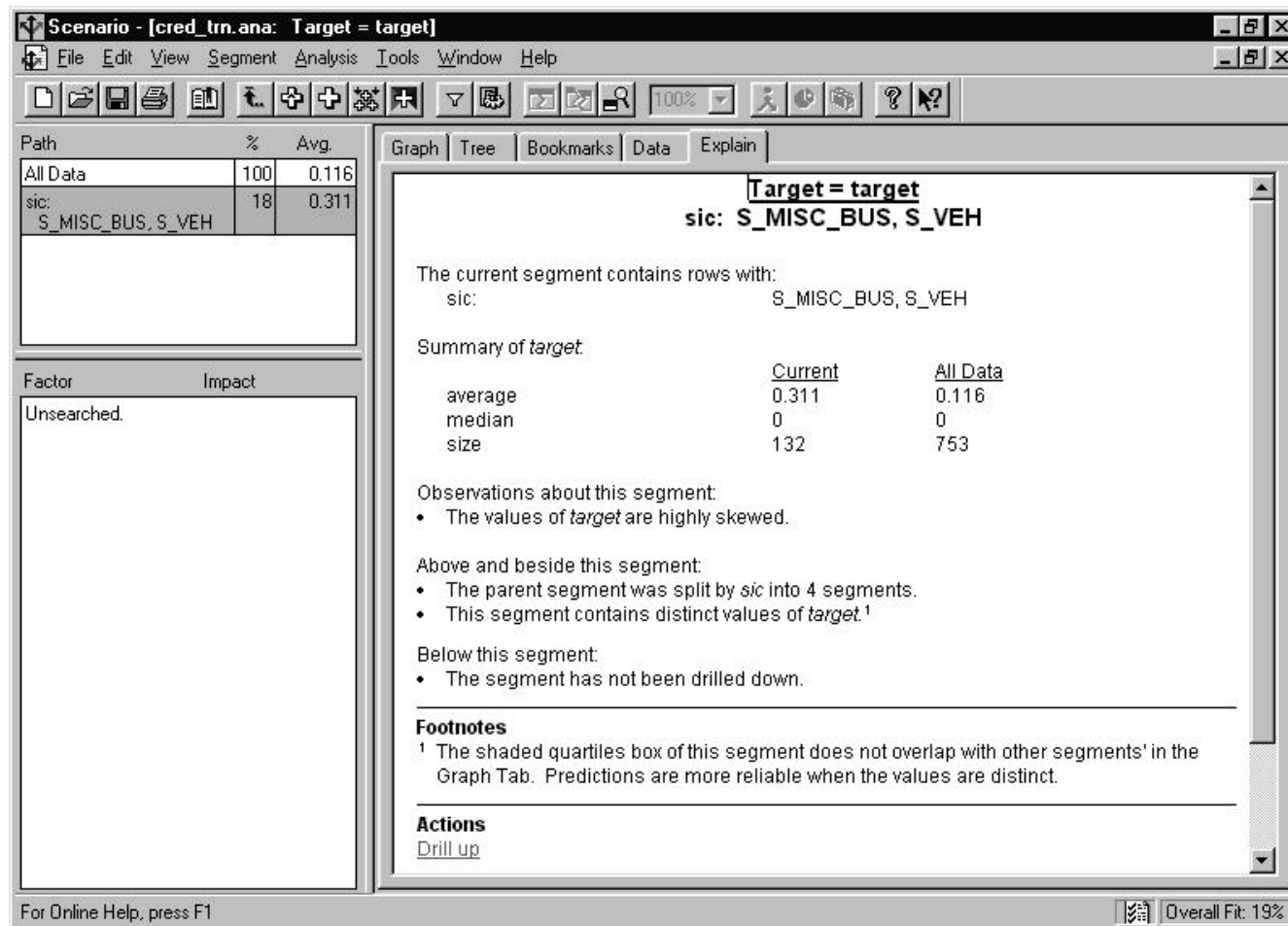
# KDD-98: A Comparison of Leading Data Mining Tools

Usability	Data Loading and Manipulation	Model Building	Model Understanding	Technical Support	Overall
<i>Clementine</i>	√+	√+	√+	√+	√+
<i>Darwin</i>	√	√	√+	√	√
<i>DataCruncher</i>	√+	√+	√	√	√
<i>Enterprise Miner</i>	√	√	√	√	√
<i>GainSmarts</i>	√+	√	√	√	√
<i>Intelligent Miner</i>	√	√	√	√	√
<i>MineSet</i>	√	√+	√+	√	√+
<i>Model 1</i>	√+	√+	√+	√+	√+
<i>ModelQuest Enterprise</i>	√	√+	√+	√+	√+
<i>PRW</i>	√+	√+	√+	√+	√+
<i>CART</i>	√−	√	√	√	√
<i>Scenario</i>	√	√+	√+	√	√+
<i>NeuroShell</i>	√	√	√	√	√
<i>OLPARS</i>	√−	√	√	√	√
<i>See5</i>	√	√	√	√	√
<i>S-Plus</i>	√	√	√+	√	√
<i>WizWhy</i>	√	√	√+	√	√

# *Intelligent Miner: Statistics Report*

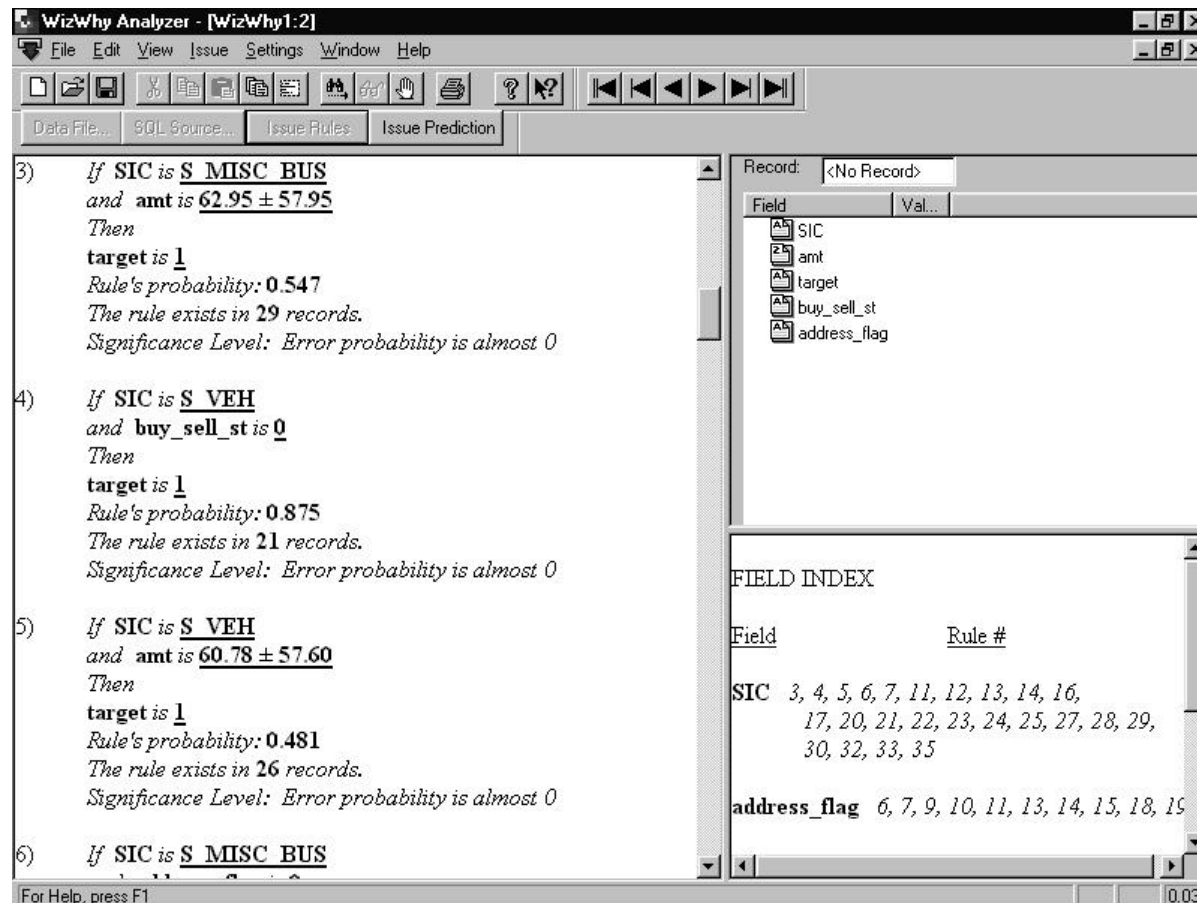


# Scenario: Result Reporting

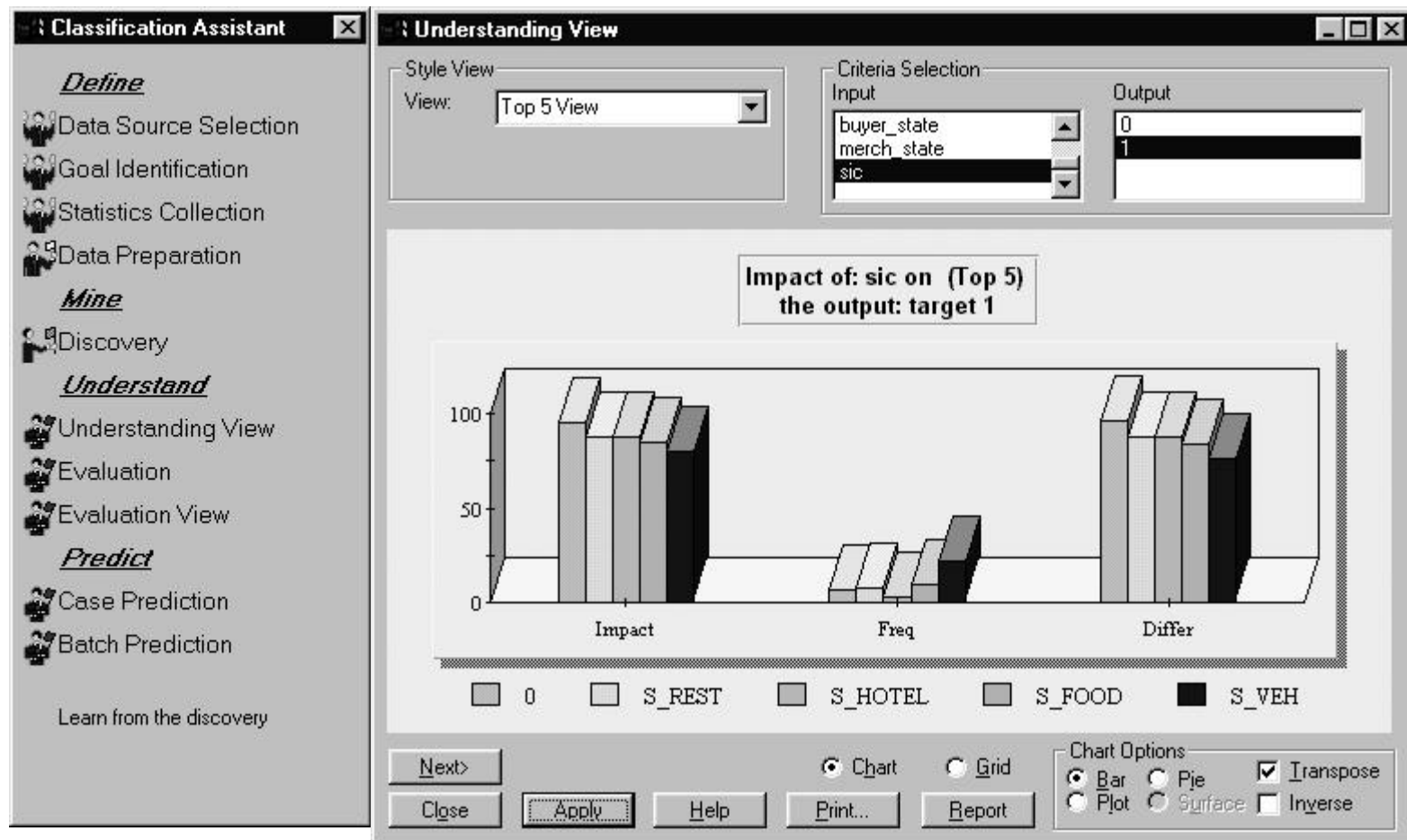




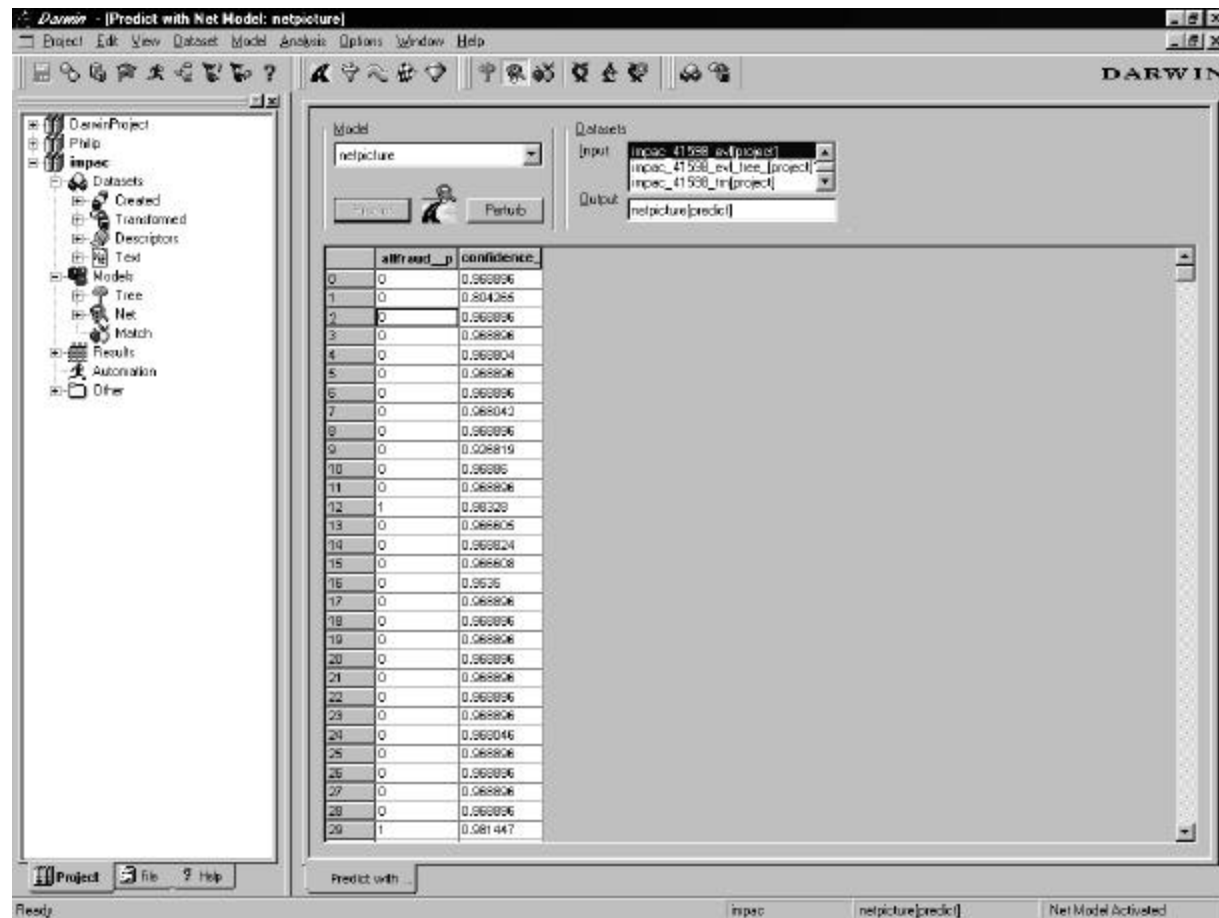
# WizWhy: Reporting



## *DataCruncher*: Output Sensitivities



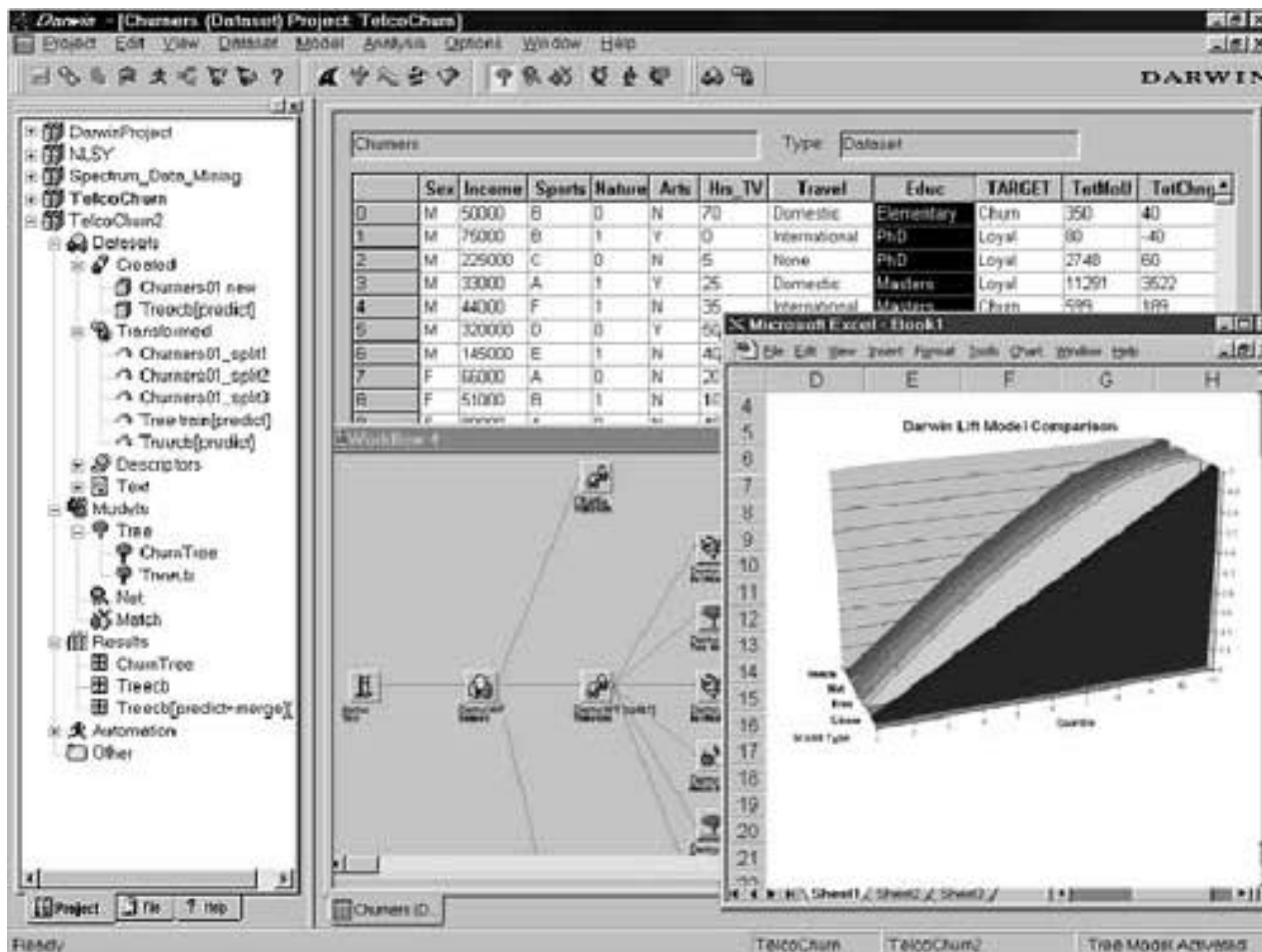
# *Darwin*: Predictions



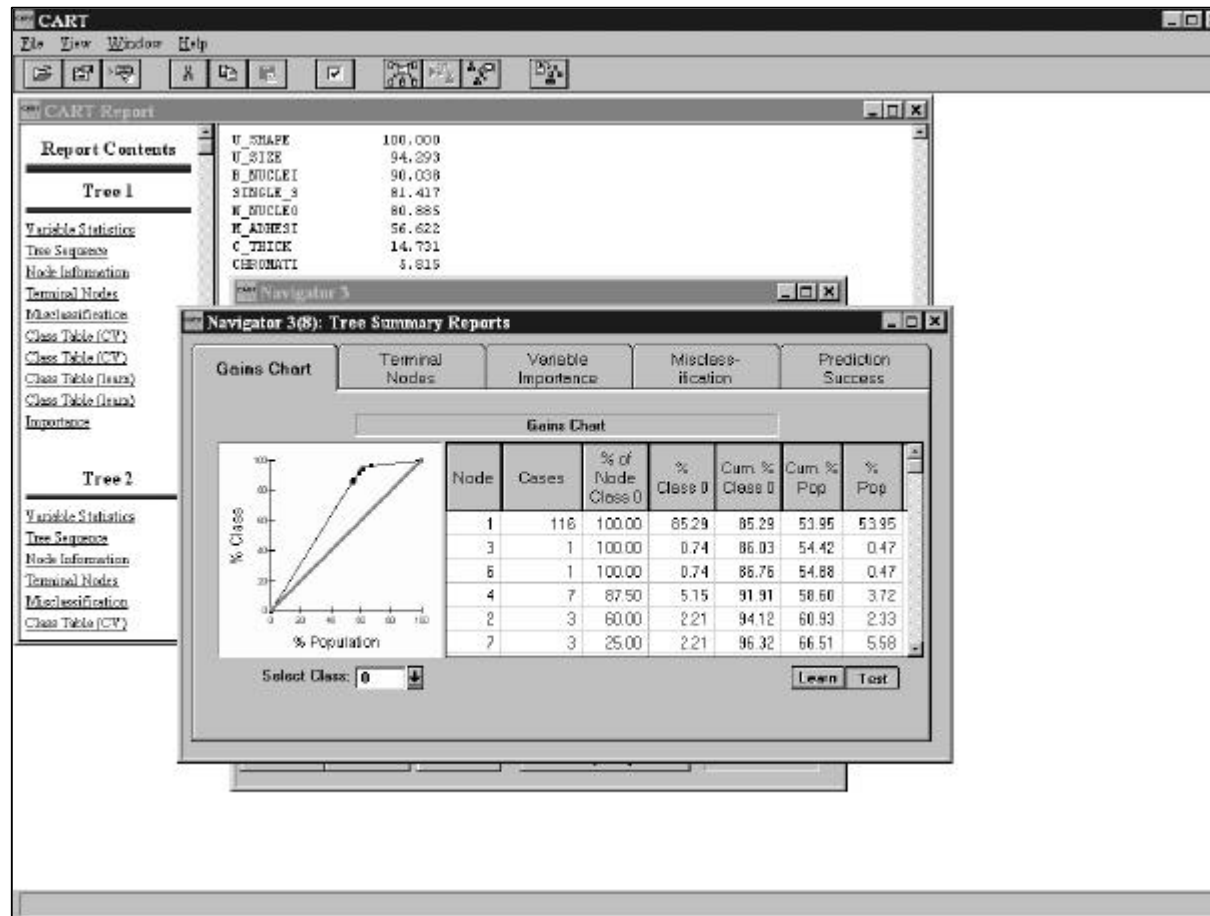
The screenshot shows the Darwin software interface. On the left is a project tree with folders like 'DarwinProject', 'Philip', 'impec', 'Datasets', 'Models', 'Results', and 'Automation'. The main window is titled 'Model: netpicture'. It has a 'Predict' button and a 'Perturb' button. Below these is a table with two columns: 'affraud\_p' and 'confidence'. The table contains 30 rows of data. At the bottom, there is a status bar with 'Ready', 'impec', 'netpicture[predict]', and 'Net Model Activated'.

	affraud_p	confidence
0	0	0.968896
1	0	0.804265
2	0	0.968896
3	0	0.968896
4	0	0.968894
5	0	0.968896
6	0	0.968896
7	0	0.968894
8	0	0.968896
9	0	0.968899
10	0	0.968896
11	0	0.968896
12	1	0.96328
13	0	0.968895
14	0	0.968894
15	0	0.968898
16	0	0.9635
17	0	0.968896
18	0	0.968896
19	0	0.968896
20	0	0.968896
21	0	0.968896
22	0	0.968896
23	0	0.968896
24	0	0.968896
25	0	0.968896
26	0	0.968896
27	0	0.968896
28	0	0.968896
29	1	0.981447

## *Darwin*: Lift Chart (Excel)



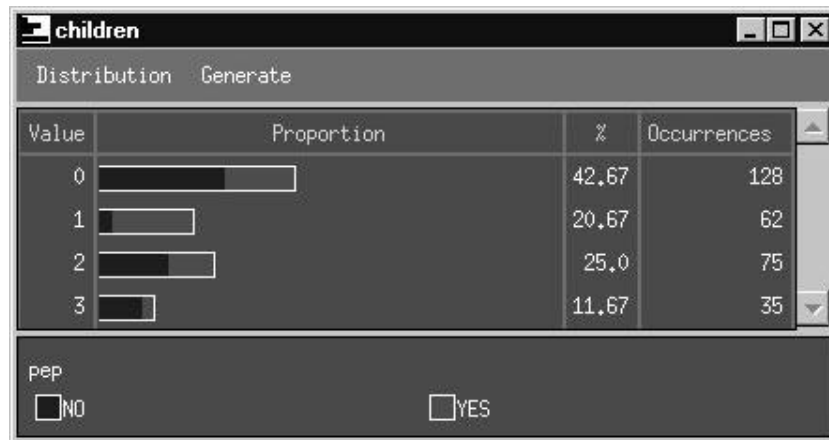
# CART: Gains Chart



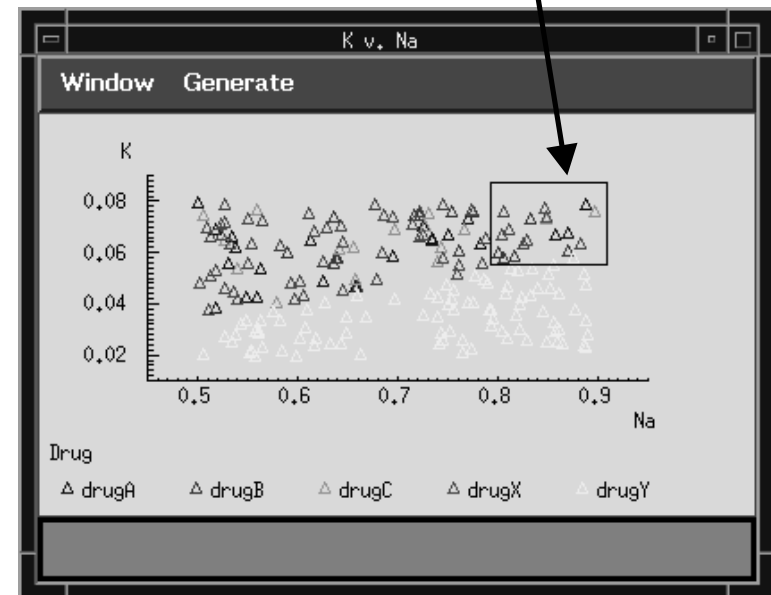
# KDD-98: A Comparison of Leading Data Mining Tools

Visualization	Histograms	Pie Charts	Scatter/ Line Plots	Rotating Scatter	Conditional Plots	Classification Decision Regions	Correlation Plots
<i>Clementine</i>	√		√		√	√—	√
<i>Darwin</i>	√—	√—	√—				
<i>DataCruncher</i>	√	√	√		√		
<i>Enterprise Miner</i>	√	√	√	√—	√		√
<i>GainSmarts</i>	√—		√—				
<i>Intelligent Miner</i>	√	√	√		√		
<i>MineSet</i>	√	√	√	√	√		
<i>Model 1</i>	√		√	√			
<i>ModelQuest Enterprise</i>	√		√				
<i>PRW</i>	√		√	√			
<i>CART</i>							
<i>Scenario</i>							√
<i>NeuroShell</i>			√				
<i>OLPARS</i>	√	√	√	√—	√	√	
<i>See5</i>	√						
<i>S-Plus</i>	√	√	√		√		√
<i>WizWhy</i>							

## *Clementine*: Visualization



User-created sub-region

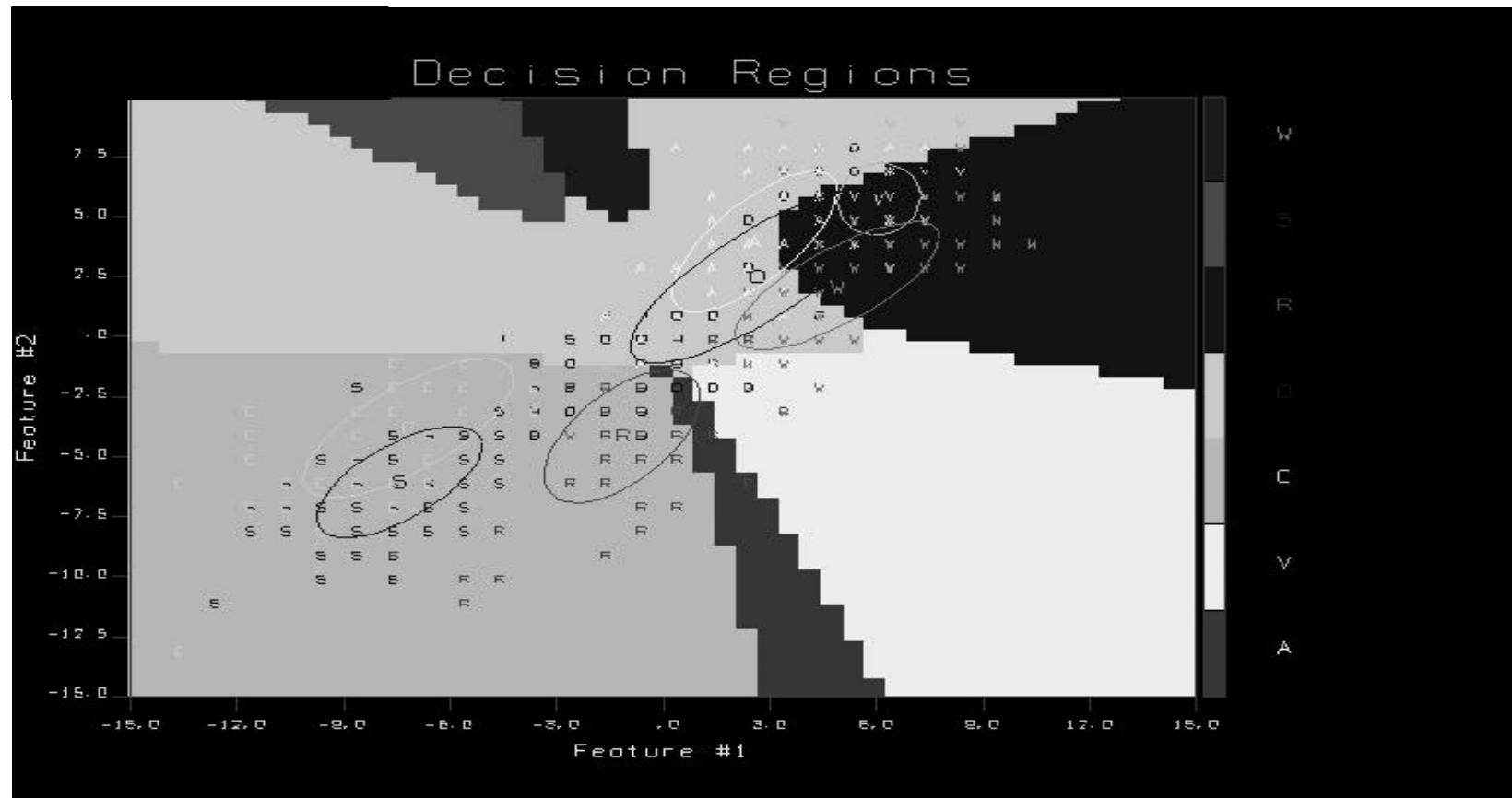


# *OLPARS*: Visualization

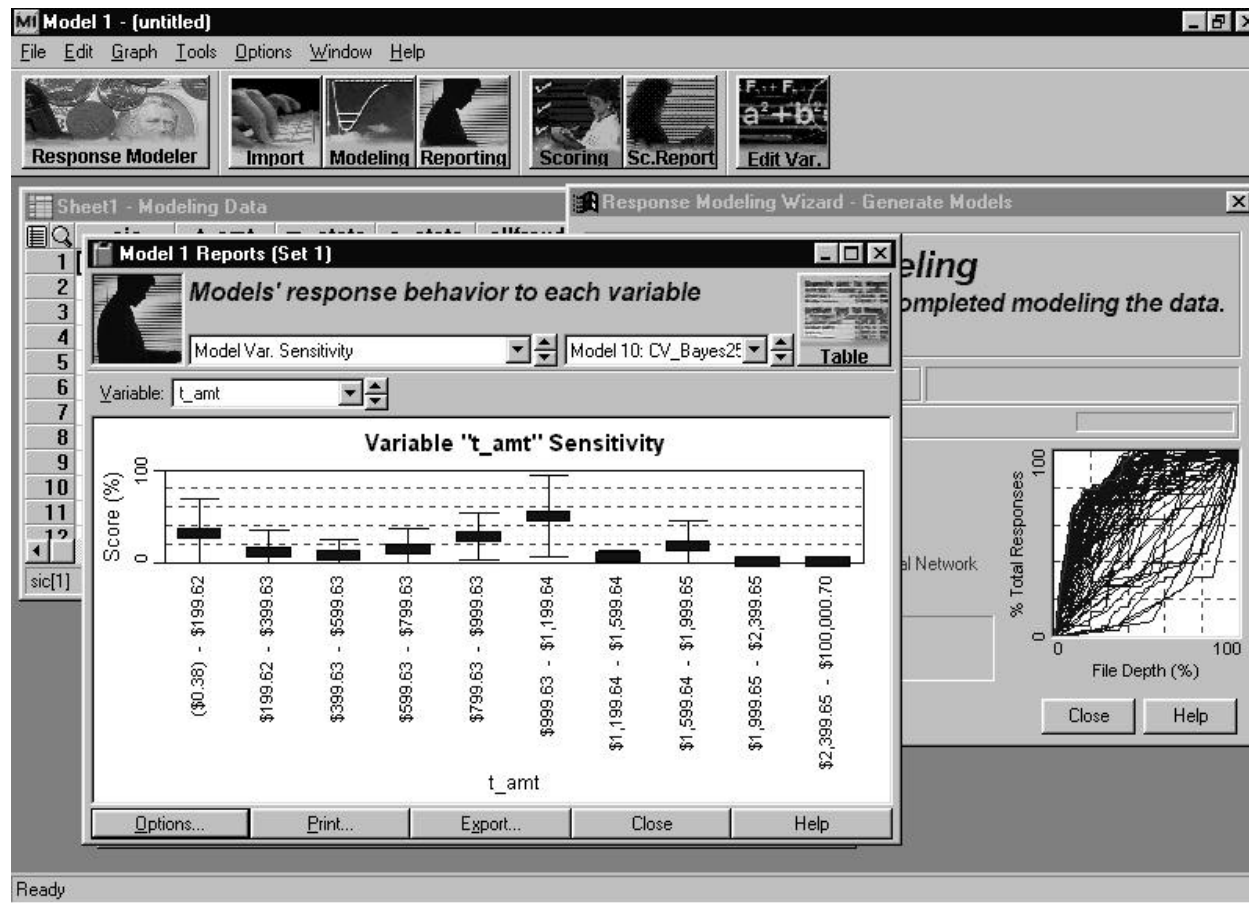




## *OLPARS*: Decision Space



# *Model 1: Target Sensitivities*



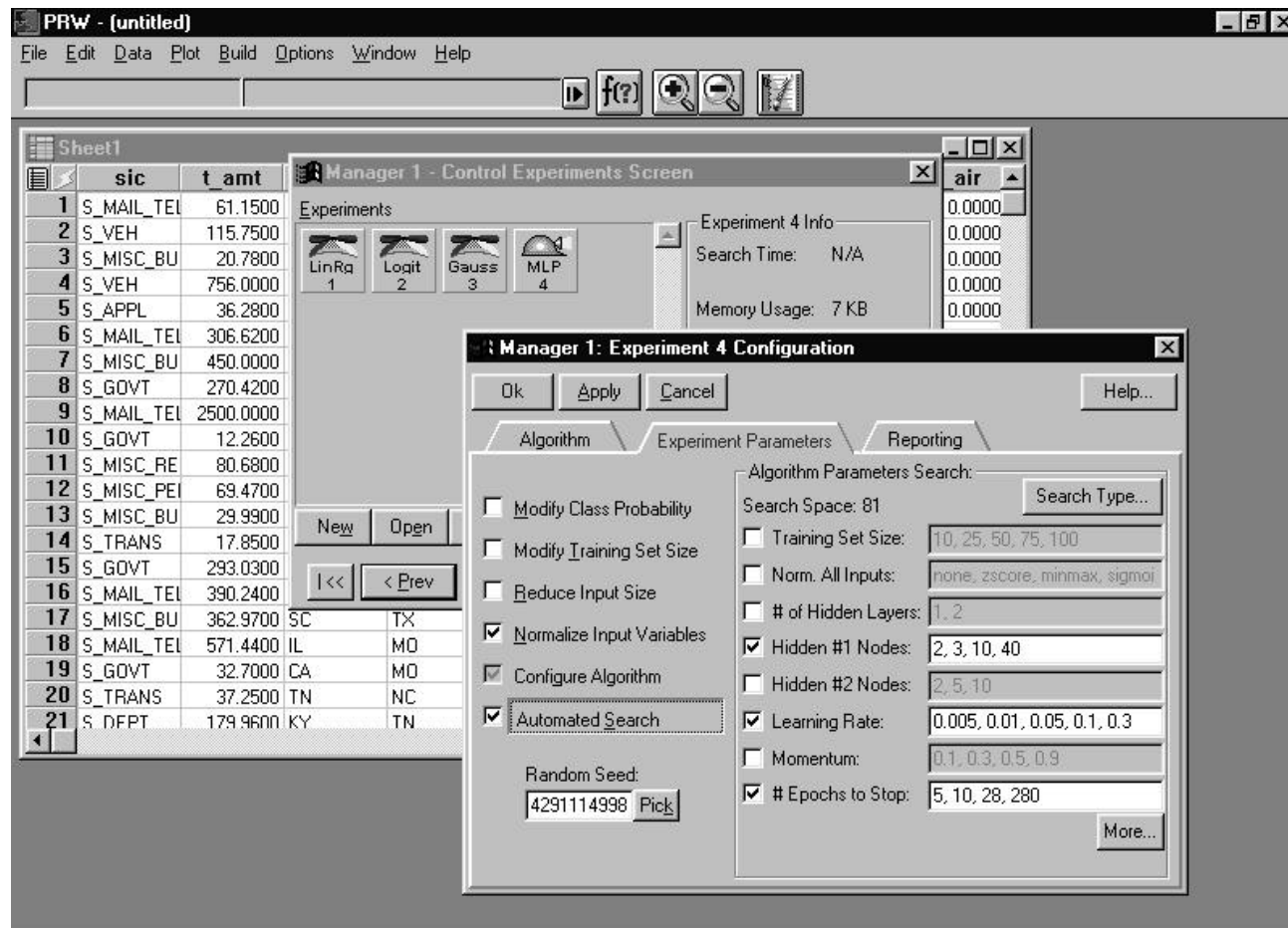
# *MineSet*: Geographical Visualization



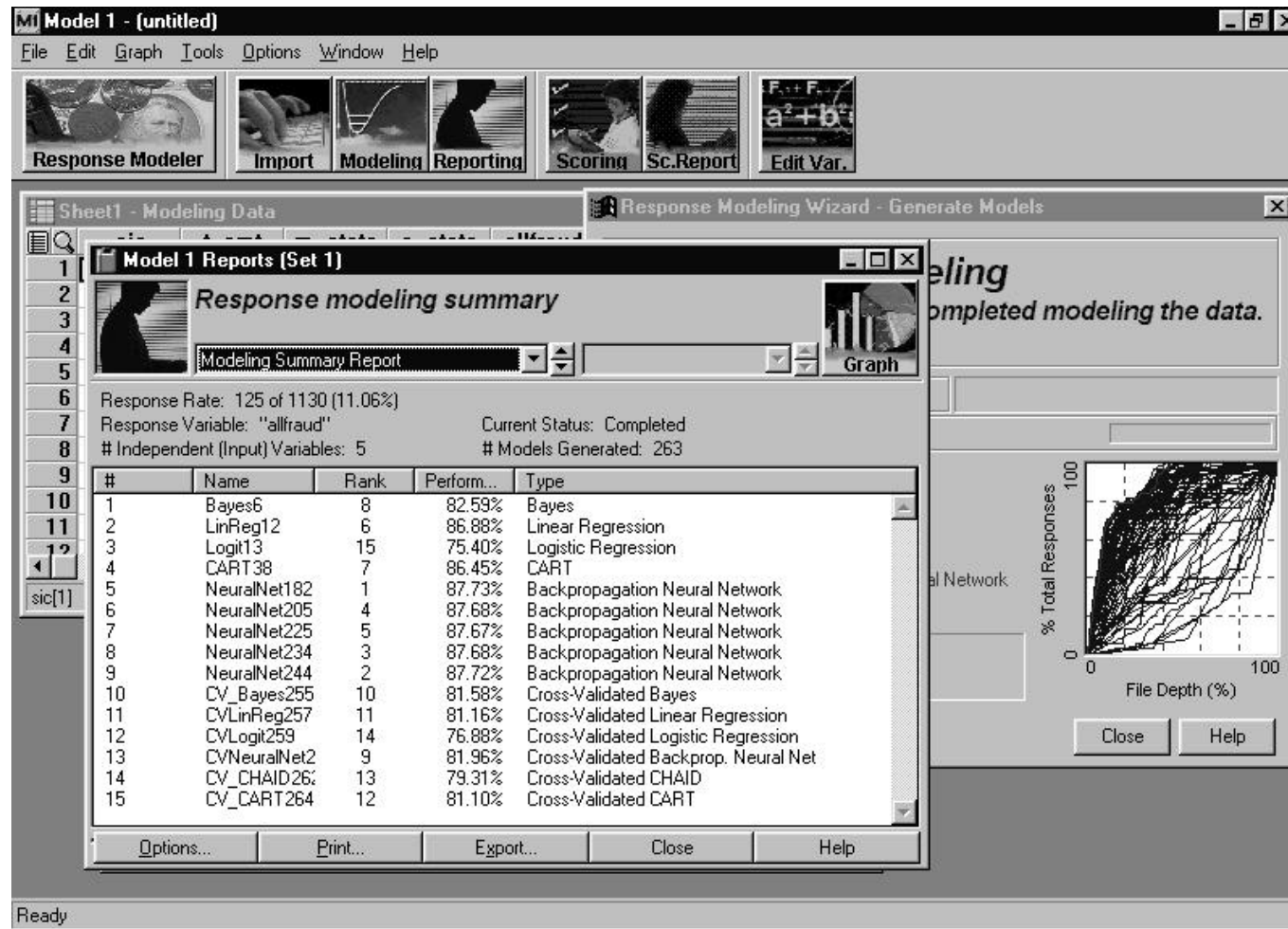
# KDD-98: A Comparison of Leading Data Mining Tools

Automation	Method of Automation	Free Text Annotation of Steps
<i>Clementine</i>	Visual Programming, Programming Language	√
<i>Darwin</i>	Programming Language	√
<i>DataCruncher</i>	(Task manager)	
<i>Enterprise Miner</i>	Visual Programming, Programming Language	√
<i>GainSmarts</i>	Macro Language, Wizards	√—
<i>Intelligent Miner</i>	(Wizards)	
<i>MineSet</i>	Data History, Log	
<i>Model 1</i>	Model Wizard	
<i>ModelQuest</i>	Batch Agenda	
<i>PRW</i>	Experiment Manager; Macros	√
<i>CART</i>	Built-in Basic Scripting	
<i>Scenario</i>		
<i>NeuroShell</i>		
<i>OLPARS</i>		
<i>See5</i>		
<i>S-Plus</i>	Scripting (S); C/C++	
<i>WizWhy</i>		

# *PRW*: Experiment Manager



# Model 1: Model Summary



## A Recent Breakthrough: Bundling

- 1) Construct varied models, and
- 2) Combine their estimates

Generate component models by varying:

- Case Weights
- Data Values
- Guiding Parameters
- Variable Subsets

Combine estimates using:

- Estimator Weights
- Voting
- Advisor Perceptrons
- Partitions of Design Space

## Example Bundling Techniques

- *Bayes*: sum estimates of possible models, weighted by priors
- *GMDH* (Ivakhenko 68) -- multiple layers of quadratic polynomials, using two inputs each, fit by LR
- *Stacking* (Wolpert 92) -- train a 2nd-level (LR) model using leave-1-out estimates of 1st-level (neural net) models
- *Bagging* (Breiman 96) (*bootstrap aggregating*) -- bootstrap data (to build trees mostly); take majority vote or average
- *Bumping* (Tibshirani 97) -- bootstrap, select single best
- *Boosting* (Freund & Shapire 96) -- weight error cases by  $\beta\tau = (1-e(t))/e(t)$ , iteratively re-model; weight model  $t$  by  $\ln(\beta\tau)$
- *Crumpling* (Anderson & Elder 98) -- average cross-validations
- *Born-Again* (Breiman 98) -- invent new X data...



# KDD-98: A Comparison of Leading Data Mining Tools

Distinctives	Strengths	Weaknesses
<i>Clementine</i>	visual interface; algorithm breadth	scalability
<i>Darwin</i>	efficient client-server; intuitive interface options	no unsupervised; limited visualization
<i>DataCruncher</i>	ease of use	single algorithm
<i>Enterprise Miner</i>	depth of algorithms; visual interface	harder to use; new product issues
<i>GainSmarts</i>	data transformations, built on SAS; algorithm option depth	no unsupervised; limited visualization
<i>Intelligent Miner</i>	algorithm breadth; graphical tree/cluster output	few algorithm options; no automation
<i>MineSet</i>	data visualization	few algorithms; no model export
<i>Model 1</i>	ease of use; automated model discovery	really a vertical tool
<i>ModelQuest</i>	breadth of algorithms	some non-intuitive interface options
<i>PRW</i>	extensive algorithms; automated model selection	limited visualization
<i>CART</i>	depth of tree options	difficult file I/O; limited visualization
<i>Scenario</i>	ease of use	narrow analysis path
<i>NeuroShell</i>	multiple neural network architectures	unorthodox interface; only neural networks
<i>OLPARS</i>	multiple statistical algorithms; class-based visualization	dated interface; difficult file I/O
<i>See5</i>	depth of tree options	limited visualization; few data options
<i>S-Plus</i>	depth of algorithms; visualization; programable/extendable	limited inductive methods; steep learning curve
<i>WizWhy</i>	ease of use; ease of model understanding	limited visualization

## Closing Observations

- Data Mining Tools Can:
  - Enhance inference process
  - Speed up design cycle
- Data Mining Tools Can Not:
  - Substitute for statistical and domain expertise
- Users are advised to:
  - Get training on tools
  - Be alert for product upgrades

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## Forthcoming Report

- Report provides detailed comparison of high-end data mining tools, including capabilities, ease of use, and practical tips.
- Available for \$695 from Elder Research (<http://www.datamininglab.com>), Q4 1998.
- Purchasers receive brief free consulting session to explore report findings in more detail, if desired.

Note: The analyses and reviews were performed completely independently, and were made possible by the cooperation of the vendors, for which Elder Research is very grateful. The companies, however, provided no financial support, and had no influence on its editorial content.