THE MACHINE DESIGN OF TRADING SYSTEMS

YOUR PRESENTER: MIKE BARNA

- Founder and President, Trading System Lab
- Sr.VP Regency Stocks and Commodities Fund, LP,LLC, QEP, CPO, CTA
- BS Mathematics, Arizona State University
- MS Astronautical and Aeronautical Engineering, Stanford University
- Systems Authored or Co-Authored: TSL MACHINE GENERATED SYSTEMS, R-MESA, BIGBLUE, MESA BONDS, MESA NOTES, SIERRA HOTEL
- Former Defense Industry Rocket-Ramjet, Laser and Guidance Engineer
- Star Wars Research and Development Management Engineer
- Series 3, Series 30
- 12 FAA pilot certificates or ratings

Contact: www.tradingsystemlab.com mike@tradingsystemlab.com

Trading System Lab®

OUR TEAM

- Mike Barna: Trading System Lab-Silicon Valley Based trading research and development company with a team of international and domestic programmers, third party developers and testers. Developed the First Commercially available Machine Designed Trading Systems Platform that requires no programming from the user.

  www.tradingsystemlab.com

- Frank Francone: Register Machine Learning, Inc.-US Based company with a team of international and domestic machine learning scientists, IP attorneys, statisticians and programmers. Involved in government contracts. Produces the LAIMGP licensed exclusively to TSL. Authored the leading University Textbook on GP. 1600 citations.

  www.rmltech.com

Trading System Lab®

WHAT IS TSL?

- TSL is a platform for the Machine Design of Trading Strategies
- Linear Automatic Induction of Machine Code with Genetic Programming (LAIMGP) (algorithms are nonlinear)
- Code is exported in different languages
- Strategies are tested OOS “during” design
- Patented and Trademarked
- Single Market Systems: HFT, MFT, LFT
- Daytrading
- Pairs
- Portfolios
- Options

OUR PRODUCT:
The TSL Platform

- Unlimited orthogonal return streams
- Use any data: No Programming Required
- Any time frame
- Very fast
- Code is exported in different languages
- Anti-curve fitted and pre-tested OOS “during” design
- Any trading tactic: Pairs, Portfolios, Options, Daytrading, HFT

TSL CLIENTS AND TRADERS

TSL's JOB IS TO PROVIDE TSL TO CLIENT TRADERS

- Major Wall Street Investment Bank >$100M
- Small and Mid size CTA's: $10M-$100M
- Proprietary Trading Firms: $5M-$50M
- Individual Traders < $5M
- International Traders and Funds
- Strategy Development Engineers
- Beginner to PhD

REQUIRED DISCLAIMER

HYPOTHETICAL PERFORMANCE RESULTS HAVE MANY INHERENT LIMITATIONS, SOME OF WHICH ARE DESCRIBED BELOW. NO REPRESENTATION IS BEING MADE THAT ANY ACCOUNT WILL OR IS LIKELY TO ACHIEVE PROFITS OR LOSSES SIMILAR TO THOSE SHOWN.

IN FACT, THERE ARE FREQUENTLY SHARP DIFFERENCES BETWEEN HYPOTHETICAL PERFORMANCE RESULTS AND THE ACTUAL RESULTS ACHIEVED BY ANY PARTICULAR TRADING PROGRAM. ONE OF THE LIMITATIONS OF HYPOTHETICAL PERFORMANCE RESULTS IS THAT THEY ARE GENERALLY PREPARED WITH THE BENEFIT OF HINDSIGHT. IN ADDITION, HYPOTHETICAL TRADING DOES NOT INVOLVE FINANCIAL RISK, AND NO HYPOTHETICAL TRADING RECORD CAN COMPLETELY ACCOUNT FOR THE IMPACT OF FINANCIAL RISK IN ACTUAL TRADING. FOR EXAMPLE, THE ABILITY TO WITHSTAND LOSSES OR TO ADHERE TO A PARTICULAR TRADING PROGRAM IN SPITE OF TRADING LOSSES ARE MATERIAL POINTS WHICH CAN ALSO ADVERSELY AFFECT ACTUAL TRADING RESULTS.

THERE ARE NUMEROUS OTHER FACTORS RELATED TO THE MARKETS IN GENERAL OR TO THE IMPLEMENTATION OF ANY SPECIFIC TRADING PROGRAM WHICH CANNOT BE FULLY ACCOUNTED FOR IN THE PREPARATION OF HYPOTHETICAL PERFORMANCE RESULTS AND ALL OF WHICH CAN ADVERSELY AFFECT ACTUAL TRADING RESULTS.

MACHINE LEARNING

NEWS

Ballmer says machine learning will be the next era of computer science

Former Microsoft CEO Steve Ballmer. Credit: Reuters/2013 file photo

Former Microsoft CEO makes donation to expand Harvard's computer science department

By Sharon Gaudin FOLLOW

Computerworld | Nov 13, 2014 4:02 AM PT

MACHINES “CRUSHED” HUMAN RIVALS

NetNet

Hedge fund robots crushed human rivals in 2014

Lawrence Delevingne | @ldelevingne
Monday, 5 Jan 2015 | 10:43 AM ET

CNBC

Adam Jeffery | CNBC

David Winton Harding, founder and president of Winton Capital Management

WHAT IS A TRADING SYSTEM EQUITY CURVE?

S&P Futures 1982-2013

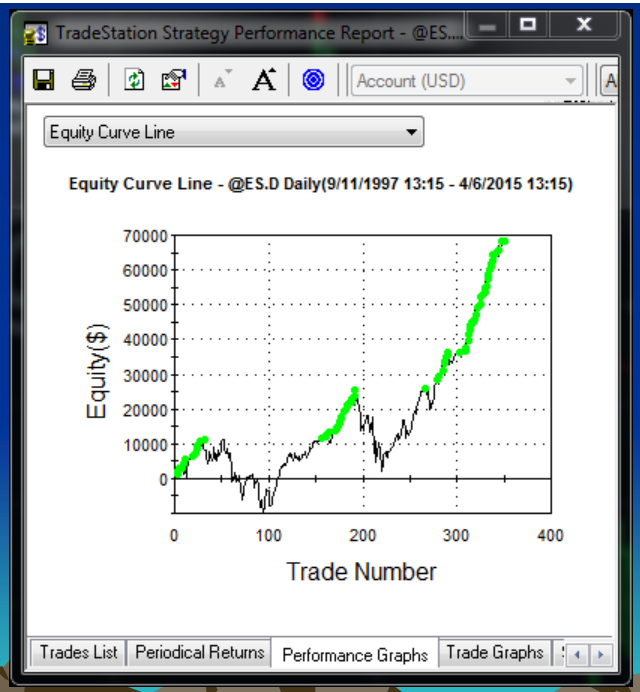
Trading System Lab®

SAMPLE COUNTERTRENDING TRADING SYSTEM

TSL_SampleSystem : Strategy

```
inputs: Length1(10), threshold1(0.2), threshold2(0.2);
vars: atr(0);
  atr = average(truerange, length1);
  if marketposition=0 then buy  next bar at low  - threshold1*atr limit;
  if marketposition>0 then sell next bar at high + threshold2*atr limit;
```

Weak Equity Curve



Trading System Lab®

HUMAN DESIGNED STRATEGIES

COST

TIME

TECHNICAL

MACHINE DESIGNED STRATEGIES

LOWER COST PER STRATEGY
REDUCED TIME TO IMPLEMENTATION
MANY TECHNICAL CAPABILITIES

BAD NEWS/GOOD NEWS

- Brokerage/Software companies do not or cannot provide you with the most important item you need to be successful in the markets with trading systems:

  Robust Trading Strategies that are easy to create

- TSL is interested only in:

  Robust Trading Strategies that are easy to create

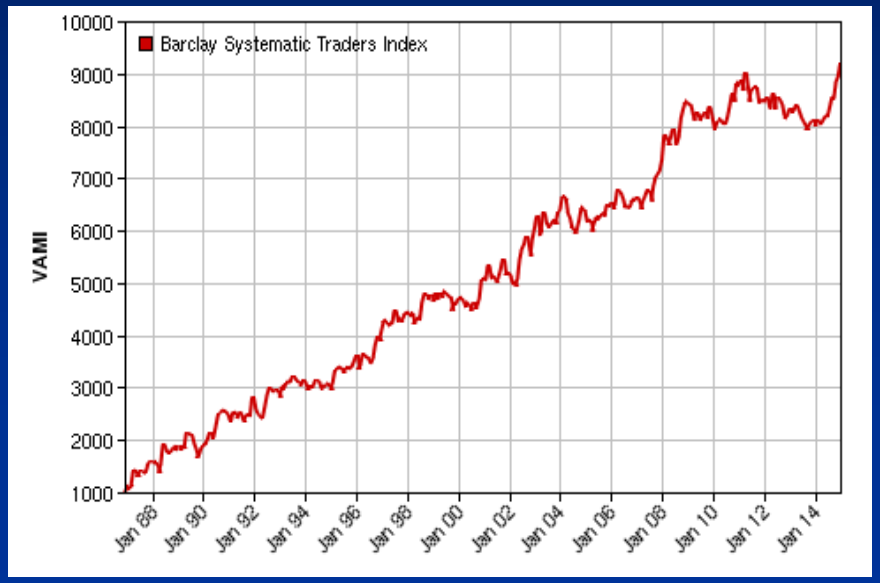
WHAT IS THE PROBLEM TO BE SOLVED?

The problem to be solved is how to construct a Machine that automatically writes better Systems faster and less expensively than humans can create using manual techniques

SYSTEMATIC VERSES DISCRETIONARY CTA VAMI

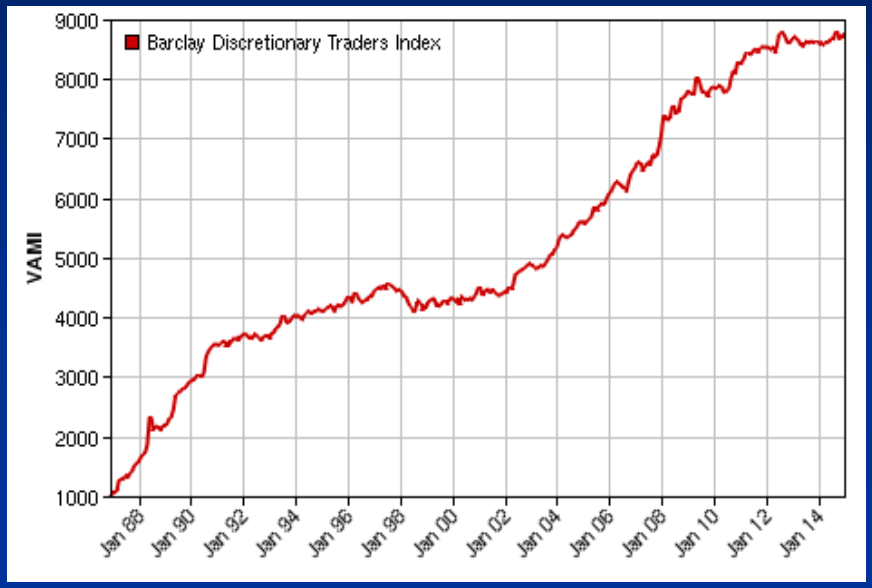
1987-2015

MECHANICAL SYSTEMS



457 programs, $296B

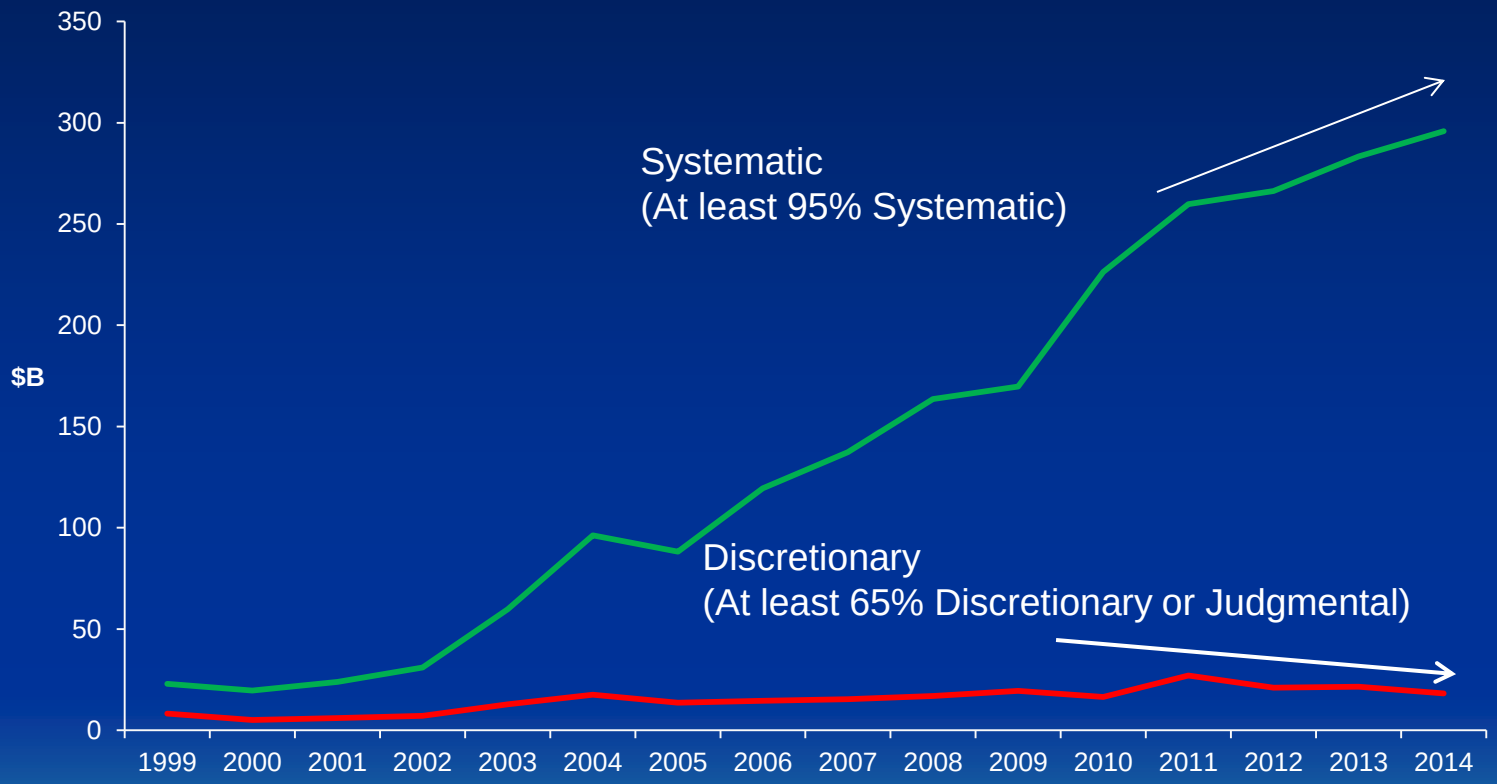
DISCRETIONARY



137 programs, $18B

Source: BarclayHedge

SYSTEMATIC VERSES DISCRETIONARY CTA MUM, $B 1999 to 2014



Source: BarclayHedge

Trading System Lab®

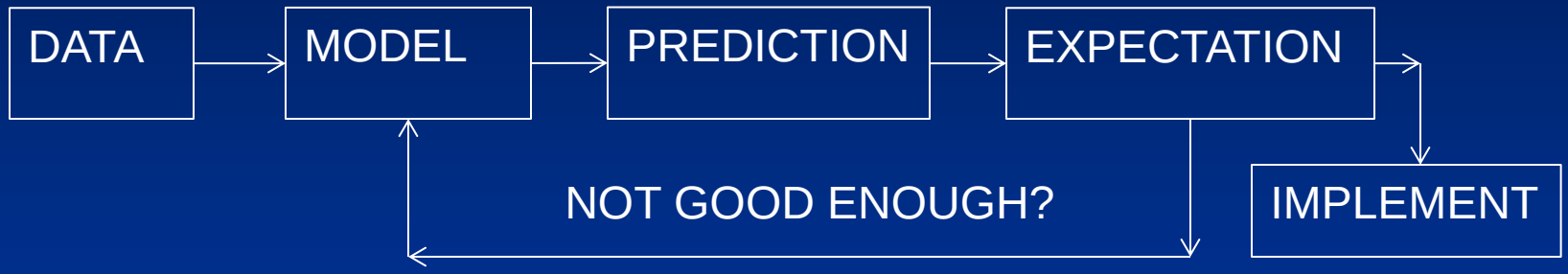
TYPES OF SYSTEMATIC TRADING SYSTEM DESIGN

- If-Then Human (manual) constructs
- Predictive Modeling (ML)
- Self-Evolving Strategy Structure (ML-TSL)

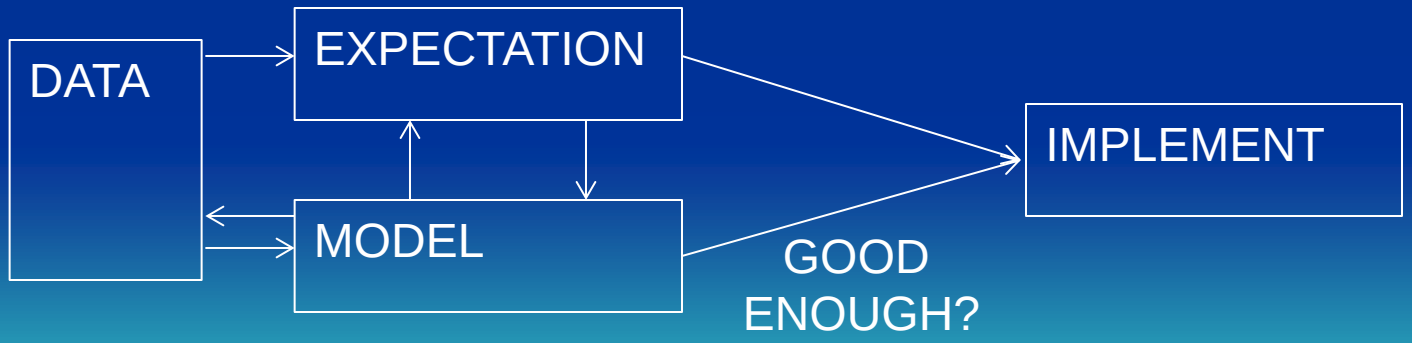
1. Meta-Heuristic Simulation Based
2. Supervised Learning-No Supervisory Signal
3. Single and Multi-Objective
4. Reinforcement Learning

Reference: Statistically Sound Machine Learning for Algorithmic Trading of Financial Instruments: Developing Predictive-Model-Based Trading Systems Using TSSB. David Aronson, Timothy Masters, PhD

PREDICTION APPROACH



EXPECTATION APPROACH



PREDICTION VERSES EXPECTATION

- In the Prediction Approach, Prices or Volatility are forecasted n-steps out. Equity Curves are then generated as an additional step.

  Good Trading Systems may exhibit poor R^2

  Standard prediction models may require further work to generate good Equity Curves.

- In the Expectation Approach, Systems are viewed as Objects and Equity Curves are generated and improved through System Metric Targeting and Objective Function Optimization.

  Good Trading System Equity Curves are thus directly evolved, leveraging the cross metric effect characteristic of Trading Systems and eliminating the need for additional steps.

THE FAILURE OF BACKTESTS

- Are not proof of Robustness
- High Potential for Over-Fitting
- False sense of returns
- Reinforces bad design approaches
- Like trying to find a needle in a haystack

WHAT CAN I DO ABOUT THIS ISSUE?

- Sequestered Data (Tests conducted in the Future)
- Out Of Sample Testing
- Walk Forward Testing
- Walk Backwards Testing
- Differential Market Testing
- Stress and Parametric Testing
- Distribution and Matched Pairs Testing(Null)

Reference:" Pseudo-Mathematics and Financial Charlatanism:
The Effects of Backtest Overfitting on Out-of-Sample Performance, Marcos Lopez de Prado and 3 others.

WHERE IS THE ALPHA?

Machine Designed Trading Strategies can operate in all categories

LFT
Passive
Long Holding Periods
Index Pegged
Long Term Directional
Hedged
Expiration
Derivative
Portfolio Dynamics
Breakout
Macro Pattern
Global Macro
Event Driven
Relative Value

MFT
Short Holding Periods
Short Term Patterns
Trend/Countertrend
Mean Reversion
Intraday Momentum
Cointegration
Cycle analysis
Volatility Breakout
Volume analysis
Daytrading
Swing Trading
Spreads
Options and combinations
Portfolio of Market-Models

HFT
Order Book Plays
Special Order Types
Hide and Light
Queue Jumping
Spam and Cancel
Top of Book
ARB
ISO
Spreads
Best Execution
Options surface

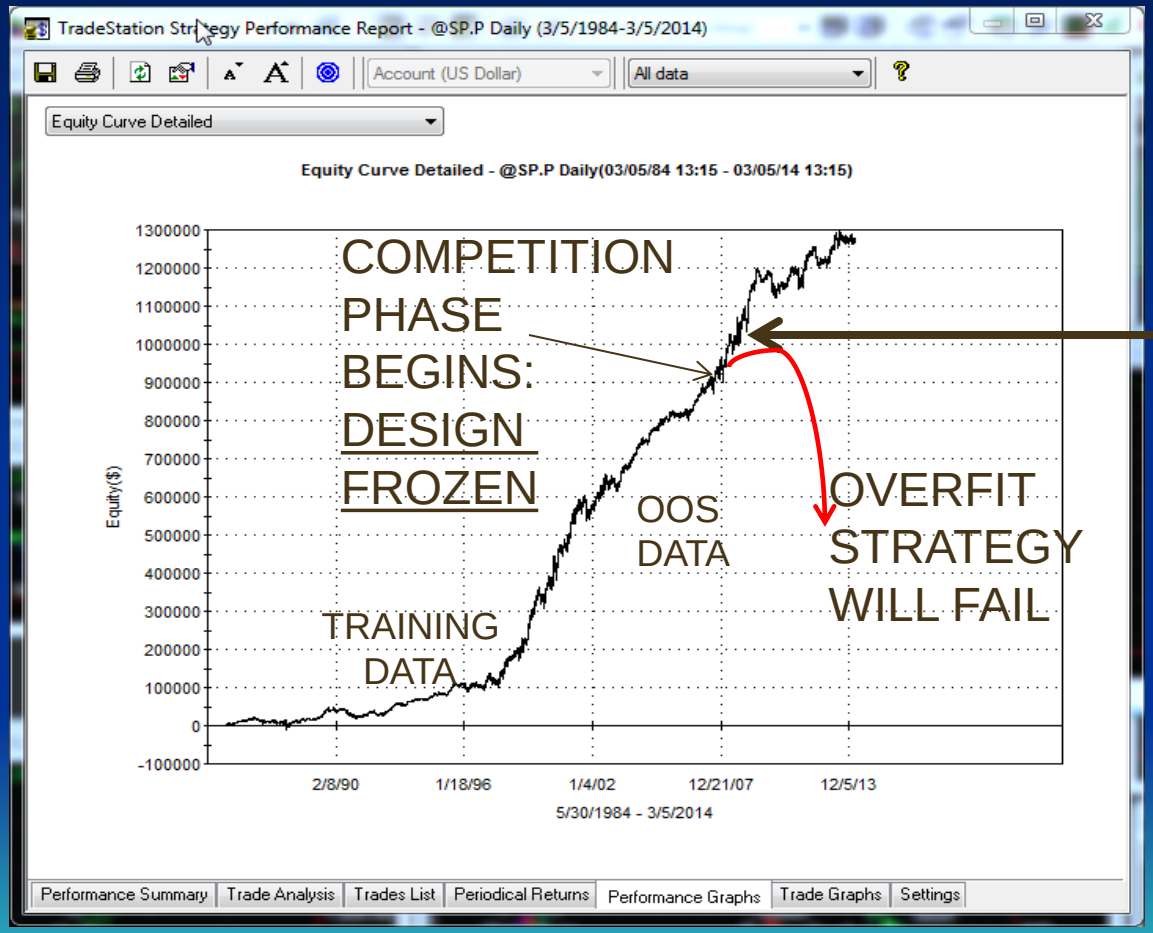
MACHINE BASED STRATEGY DESIGNS

- Operator does not need to be a programmer
- Allows the machine to explore a wide range
- Not limited to existing theory
- Will quickly find what does and does not work
- May be redirected quickly
- May be reengineered easily
- Human controlled and configured

TSL's CHALLENGE

IN 2007 WE CHALLENGED ANY MANUALLY DESIGNED SYSTEM TO BEAT TSL's MACHINE DESIGNED SYSTEMS IN COMPETETIVE THIRD PARTY RATINGS EVALUATED ON SEQUESTERED DATA

HOW IS THE SEQUESTERED DATA COMPETITION PERFORMED?



2008 WORLD FINANCIAL DISASTER

Trading System Lab®

WE DID IT!

In 2008, and again in 2010, TSL submitted several frozen “Machine Designed” Strategies to Futures Truth. These strategies were initially held for over 18 months, then tested on Sequestered Data, compared and ranked against approximately 700 submissions from over 80 worldwide strategy designers. These systems have not been touched since and reporting on these “Machine Designed” Strategies continues through 2015.

THE RESULTS?

MACHINE CREATED WITH NO PROGRAMMING REQUIRED

2014 Reports

Top 10 S&P Systems

Issue #1 2013 - published in April 2013

Ranking based on performance since their release to us. Some systems have been out for a short period of time. Results based on performance through January 31, 2013. Return is based on three times the required margin.

Rank	System Name	Annual % Return
1.	TSL-SP_1.0Z	63.8%
2.	TSL-CEL_SP1	50.9%
3.	Impetus SP	48.6%
4.	Big Blue 2	36.2%
5.	%C Daybreaker	35.2%
6.	STC S&P Daytrade	35.0%
7.	R-Breaker	34.3%
8.	Tzar	28.4%
9.	VOLPAT	25.1%
10.	AlfaMAXX	24.7%

Top 10 Systems For The Past 12 Months

Issue #1 2013 - published in April 2013

Results based on performance through January 31, 2013. Return is based on three times the required margin.

Rank	System Name	Annual % Return
1	TSL_US1	170.5%
2	Ruggiero Bond	140.3%
3	ATS-3200	92.3%
4	MAR - SP Mini Sync	87.8%
5	Star ES	87.6%
6	FedSwing	83.1%
7	TSL_CEL_NG_1.1	70.8%
8	MAR - NewBondLiveSync	70.7%
9	%C Daybreaker	64.8%
10	MAR - GoldIntra	64.4%

Top 10 Systems Since Their Release Date

Issue #1 2013 - published in April 2013

Systems included in this table must have been released for at least 18 months. Results based on performance through January 31, 2013.
Return is based on three times the required margin.

Rank	System Name	Annual % Return
1.	TSL_CEL_NG_1.1	142.0%
2.	Delphi II EMD	76.9%
3.	MAR - NewBondLiveSync	73.5%
4.	TSL_US1	71.5%
5.	TSL-SP_1.0Z	63.8%
6.	MAR - SP Mini Sync	59.9%
7.	NatGator Silver	53.4%
8.	TSL-CEL_SP1	53.4%
9.	Propero ES	49.0%
10.	Impetus SP	48.6%

Bond Systems	System Name	Sys. #	%Chng Min.Req Cap.
1	*TSL-US-1*	*708*	*39.8%*
2	Ruggiero Bond Sys	694	37.3%
3	MAR-NewBondLiveSync	724	31.5%
4	MESA Bonds	321	43.4%
5	ATS-3200	361	28.4%

S&P 500 Systems	System Name	Sys. #	%Chng Min.Req Cap.
1	*TSL-CEL_SP1*	*670*	*46.6%*
2	TSL-SP_1.0Z	669	45.2%
3	Impetus SP	589	43.2%
4	Big Blue 2	664	33.1%

ES Systems	System Name	Sys. #	%Chng Min.Req Cap.
1	*FedSwing*	*717*	*63.2%*
2	Algo Futures	745	47.1%
3	Propero ES	640	42.8%
4	TSL-CEL_ES1	670	42.1%
5	Impetus ES	589	41.8%
6	TSL-ES_1.0Z	669	39.6%

TSL SP on ES

TOP TEN SINGLE MARKET SYSTEMS SINCE RELEASE DATE

	System	Annual % Ret
1	TSL_CEL_NG_1.1	123.0%
2	Delphi II EMD	71.8%
3	Propero ES	42.8%
4	TSL_CEL_ES1	42.1%
5	Impetus ES	41.8%
6	TSL_US_1	39.8%
7	TSL_ES__1.0Z	39.6%
8	MESA Bonds	37.8%
9	Ruggiero Bond System	37.3%
10	%C DayBreaker	33.3%

TOP TEN SINCE RELEASE DATE

	System	Annual % Ret
1	TSL_CEL_NG_1.1	123.0%
2	Delphi II EMD	71.8%
3	FedSwing	51.3%
4	Propero ES	42.8%
5	TSL_CEL_ES1	42.1%
6	Impetus ES	41.8%
7	TSL_US_1	39.8%
8	TSL_ES_1.0Z	39.6%
9	MESA Bonds	37.8%
10	Ruggiero Bond System	37.3%

TOP TEN FOR PAST 12 MONTHS

	System	Annual % Ret
1	MESA Bonds	98.7%
2	ATS—6400	96.5%
3	Clockwork Maple Leaf	80.2%
4	CTB4 SW	63.4%
5	MeanSwing 2	59.8%
6	The Big Blue	59.4%
7	Mechwarrior—ES	59.1%
8	TSL_CEL_NG_1.1	58.2%
9	Delphi II EMD	54.6%
10	Clockwork—CH3	52.8%

700+ systems, 80+ vendors

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Issue #1 2013 - published in April 2013

Results based on performance through January 31, 2013.

TOP TEN TABLES

TOP TEN SINCE RELEASE DATE

	System	Annual % Ret
1	TSL_CEL_NG_1.1	99.1%
2	Delphi II EMD	63.5%
3	NatGator Silver	52.7%
4	TSL_US_1	44.6%
5	Clockwork-CH3	42.8%
6	Impetus ES	42.1%
7	Propero ES	42.0%
8	TSL_ES_1.0Z	41.6%
9	TSL_US_2	39.4%
10	TSL_CEL_ES1	38.7%

TOP TEN FOR PAST 12 MONTHS

	System	Annual % Ret
1	TSL_US_2	149.8%
2	ATS-6400	94.9%
3	Lil' Dipper	91.8%
4	Trendchannel	84.2%
5	Clockwork-CH3	82.6%
6	STAT (Const.)	80.6%
7	MAR CrudePlus Sync	79.1%
8	TSL_US_1	79.0%
9	25x25	75.3%
10	Golden SX (Const.)	74.9%

Top 10 Sys

Issue #1

Systems included in this table must have been released for at least 18 months. Rest
January 31, 2013.
Return is based on three times the required margin

Rank	System Name	Ar
1.	TSL_CEL_NG_1.1	
2.	Delphi II EMD	
3.	MAR - NewBondLiveSync	
4.	TSL_US1	
5.	TSL-SP_1.0Z	
6.	MAR - SP Mini Sync	
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10	TSL_CEL_ES1	38.7%

Bond Systems System Name	Sys. #	%Chng Min.Req Cap.
	717	63.2%
	745	47.1%
	640	42.8%
	670	42.1%
	589	41.8%
	669	39.6%

TSL SP on ES

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6	TSL_US_1	39.8%
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700+ systems, 80+ vendors

Trading System Lab®

TSL FUTURES TRUTH RATINGS OVER TIME

Highest Position all Categories
SP, NG Systems Designed in 2007 then held for 18 months
Controlled Sequestered Testing
Re-optimization not allowed

YEAR	SP1z	SP1	US1	US2	NG1	DX1
2009	2	3			1	
2010	2	3			1	
2011	1	2			1	
2012	1	2	1	1	1	1
2013	1	2	1	3	1	8
2014	1	2	1	9	1	5
2015	4-ES	5-ES	1	2	1	<10

SP pit closed. Systems now applied to different Symbol

Unfavorable Bias Variance Tradeoff (Retraining needed)

Note: 700+ systems and 80+ developer in competition

Trading System Lab®

TSL MAIN COMPONENTS

LEARNING MACHINE

WHAT IS THE BEST LEARNING ALGORITHM?

Supervised learning
AODE
Artificial neural network Backpropagation
Autoencoders
Hopfield networks
Boltzmann machines
Restricted Boltzmann Machines
Spiking neural networks

GE
GA
GP
LGP
LAIMGP *
GEP
CGP
GADS
IFGP

Bayesian statistics Naive Bayes classifier
Bayesian network
Bayesian knowledge base

Case-based reasoning
Decision trees
Inductive logic programming
Gaussian process regression
Gene expression programming
Group method of data handling (GMDH)
Learning Automata
Learning Vector Quantization
Logistic Model Tree
Minimum message length (decision trees, decision graphs, etc.)
Lazy learning
Instance-based learning Nearest Neighbor Algorithm
Analogical modeling

EM
OLS
KRR
PCA

Probably approximately correct learning (PAC)
Ripple down rules, a knowledge acquisition methodology
Symbolic machine learning algorithms
Subsymbolic machine learning algorithms
Support vector machines
Random Forests
Ensembles of classifiers Bootstrap aggregating (bagging)
Boosting (meta-algorithm)

Ordinal classification
Regression analysis
Information fuzzy networks (IFN)
Conditional Random Field

Statistical classification
ANOVA
Linear classifiers Fisher's linear discriminant
Logistic regression
Multinomial logistic regression
Naive Bayes classifier
Perceptron
Support vector machines

Quadratic classifiers
k-nearest neighbor
Boosting
Decision trees C4.5
Random forests

Bayesian networks
Hidden Markov models

Unsupervised learning
Artificial neural network
Data clustering
Expectation-maximization algorithm
Self-organizing map
Radial basis function network
Vector Quantization
Generative topographic map
Information bottleneck method
IBSEAD

Association rule learning
Apriori algorithm
Eclat algorithm
FP-growth algorithm

Hierarchical clustering
Single-linkage clustering
Conceptual clustering

Partitional clustering
K-means algorithm
Fuzzy clustering
DBSCAN

Reinforcement learning
Temporal difference learning
Q-learning
Learning Automata
Monte Carlo Method
SARSA

Deep learning
Deep belief networks
Deep Boltzmann machines
Deep Convolutional neural networks
Deep Recurrent neural networks

Ref: http://en.wikipedia.org/wiki/Machine_learning

WHAT ARE THE APPLICABLE STATISTICAL TESTS?

- Kolmogorov-Smirnov
- Shapiro-Wilk
- Anderson-Darling
- Dickey-Fuller
- Wolcoxon
- Wald-Wolfowitz
- Kruskal-Wallis
- ANOVA
- Median test
- Q-statistic
- Sign test
- Friedman
- Cochran Q test
- McNemar test
- Kendall coefficient of concordance
- Spearman rank order R
- Chi-square
- V-square statistic
- Phi
- Gamma
- Sommer's d
- Paired t-test
- Man-Whitney
- Bootstrap test
- CVAR
- Monte-Carlo Permutation Tests

WHAT IS THE BEST ML SOFTWARE SUITE?

Ayasdi
Angoss KnowledgeSTUDIO
Apache Mahout
Gesture Recognition Toolkit
IBM SPSS Modeler
KNIME
KXEN Modeler
LIONsolver
MATLAB
Mathematica
mlpy
MLPACK library
MCMLL
OpenCV
dlib
Oracle Data Mining
Orange
Discipulus *
Python scikit-learn
R
RapidMiner
Salford Predictive Modeler
SAS Enterprise Miner
Shogun toolbox
STATISTICA Data Miner
Weka

----------Libraries and Tools----------

Accord.NET
ILNumerics
Math.NET Numerics
Wintellect Power Collections
QLNet
Noda Time
R.NET
ALGLIB
LIBSVM

Ref: http://en.wikipedia.org/wiki/Machine_learning

WHAT ARE THE BEST APPLICABLE LANGUAGES OR LIBRARIES?

- AXUM
- F#
- RUBY
- SCALA
- ERLANG
- HASKELL
- PYTHON
- JAVA
- ASSEMBLER
- VB
- C#
- C
- C++
- C++.NET
- C++ AMP
- OPEN MP
- EL
- PL
- WLS
- FORTRAN
- VERILOG
- VHDL
- CUDA
- OPEN CL
- CILK
- CLOURE
- HTML5
- R

REGISTER GENETIC PROGRAMMING

- Based loosely on biological models of evolution and eucaryotic* sexual reproduction
- Simulates the path a biological species goes through as it evolves:

  -Starts off simple

  -Adapts to hostile environment

  -Strong Parents give birth to strong children

  -Random mutations may help
- Works at the *FAST* CPU Register Level, not high level code
- Fast, Accurate, and Writes Code
- Different from GA and Tree Based GP

*Based on complex cells with membranes

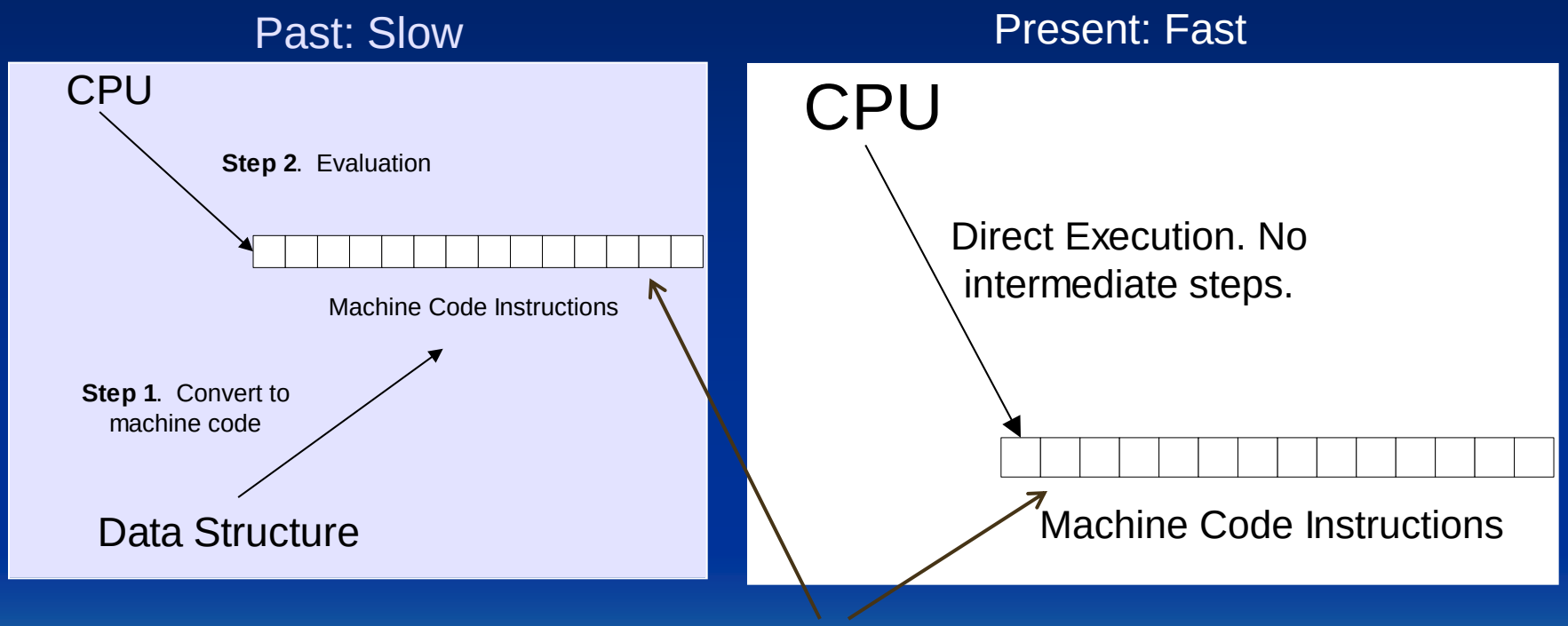
Reference: http://www.tradingsystemlab.com/files/Discipulus%20How%20It%20Works.pdf

TSL GP LEARNING

- Supervised Learning. No supervisory Signal.
- Population is initialized
- Trading Strategies are initialized with random signals
- Tournament is run within population applied to the trading simulator
- Mutation causes random changes in winners
- Crossover exchanges DNA between winners
- Reproduction is applied on remainder
- Demes enhance genetic diversity
- Parsimony Pressure favor simpler solutions
- If n GWI occur then run restarts
- New trading algorithms emerge and improve based on the error
- Algorithms learn to trade better as they trade in simulation
- After x runs or user termination, all runs stop
- Finally, code is exported, translated and ported to a Trading OMS/EMS

EVOLUTIONARY BASED INDUCTION OF MACHINE CODE

TSL's Patented GP is 60-200 times faster than other algorithms.



EVOLVES DIRECTLY ON TRADING SYSTEM CODE

http://www.tradingsystemlab.com/files/Discipulus%20How%20It%20Works.pdf

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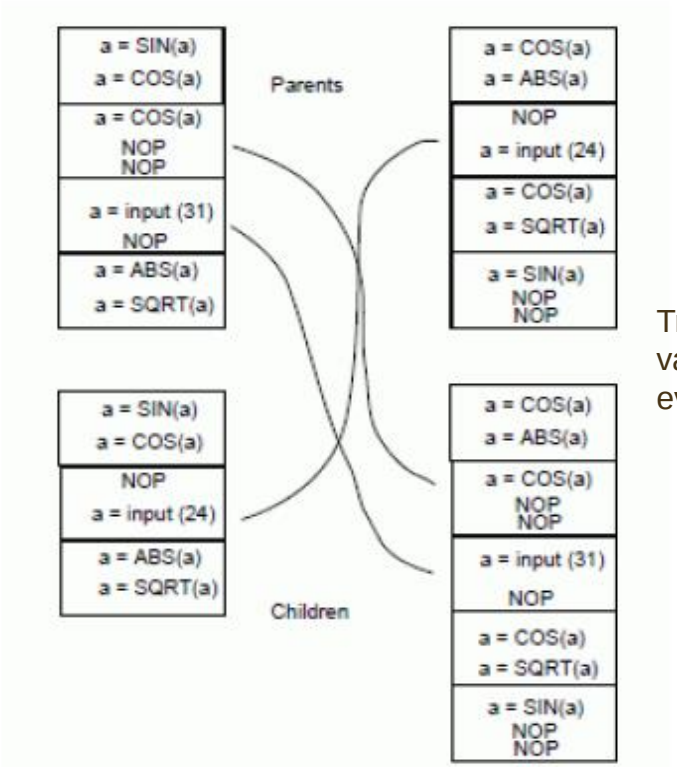
LAIMGP REPRODUCTIVE CROSSOVER

Homologous and Non-Homologous crossover

Trading Algorithm

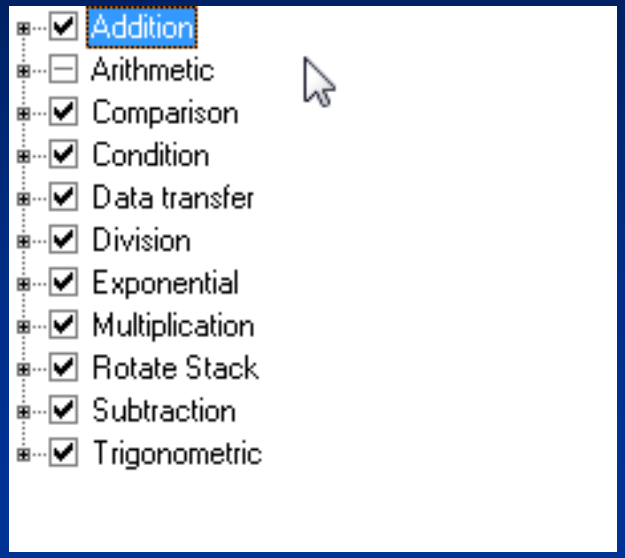


Trading System can vary its size during evolution

Reference: Frank D. Francone Licensiate Thesis (2009)

FUNCTION SETS: DNA

More Function Sets allow deeper and wider ranges of solutions to be explored



TSL's GP is 60-200 times faster than other Algorithms
TSL uses 34 Function Sets including +,-,*,/

http://www.tradingsystemlab.com/files/Discipulus%20How%20It%20Works.pdf

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MACHINE EVOLVED AND WRITTEN CORE LOGIC OF YOUR TRADING SYSTEM

Translation Path:

Machine Code -> Core Logic C Code -> C#, EasyLanguage and others

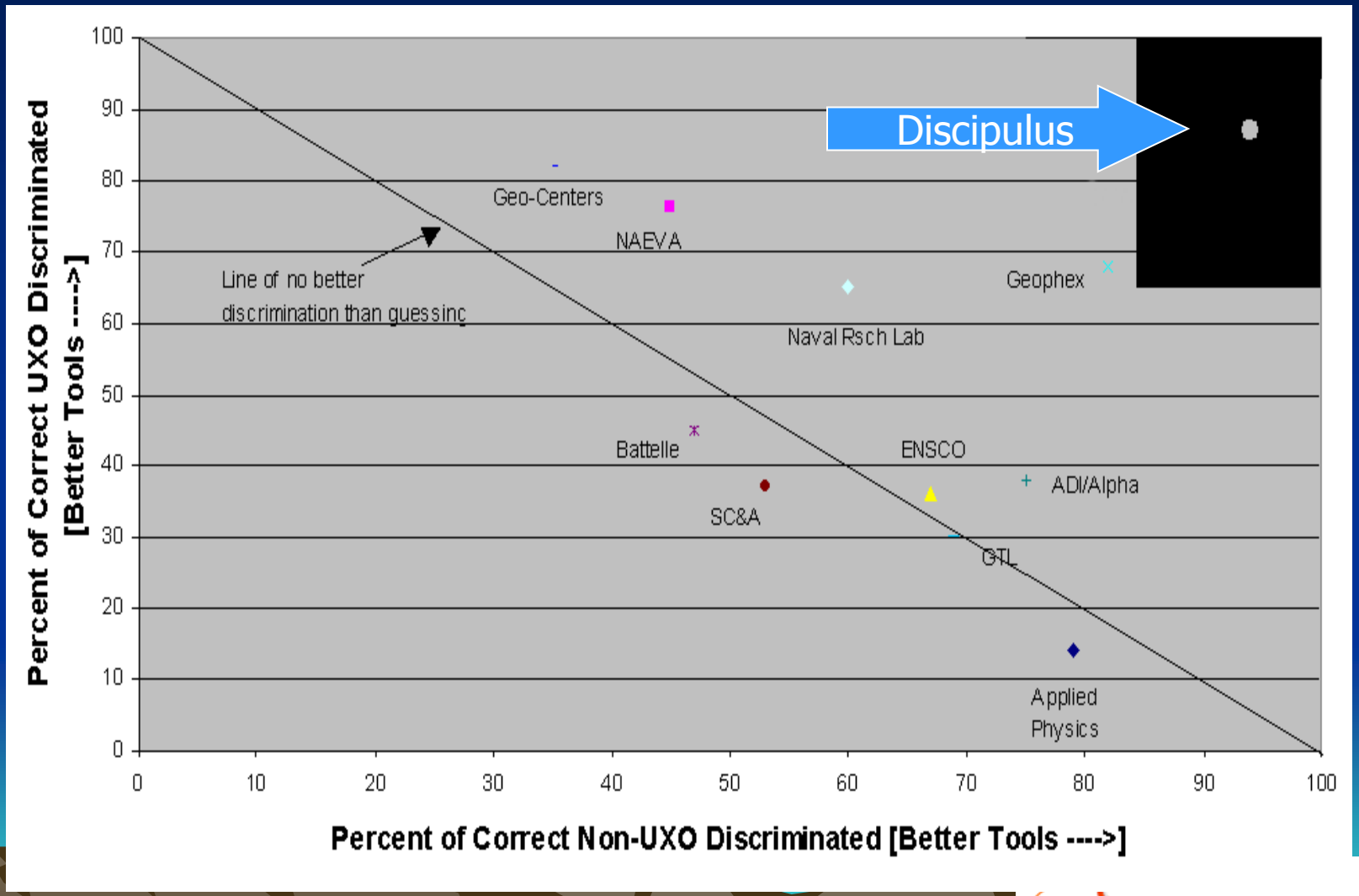
```
long double f[8];
long double tmp = 0;
int cflag = 0;

f[0]=f[1]=f[2]=f[3]=f[4]=f[5]=f[6]=f[7]=0;

L0:     f[0]-=v[25];
L1:     f[0]+=v[43];
L2:     f[0]=fabs(f[0]);
L3:     f[0]-=v[13];
L4:     f[0]-=v[49];
L5:     f[0]-=v[41];
L6:     f[0]*=f[0];
L7:     f[1]-=f[0];
L8:     f[0]+=v[22];
L9:     tmp=f[1]; f[1]=f[0]; f[0]=tmp;
L10:    cflag=(f[0] < f[2]);
L11:    f[0]-=v[39];

if (!_finite(f[0])) f[0]=0;

return f[0];
```

C#, EL, PL, BLOX or many other platforms

Note only 7 inputs are used here out of the Initial 56 fact Terminal Set available

RML'S DISCIPULUS, USED EXCLUSIVELY IN TSL, OUTPERFORMED EXISTING PUBLISHED RESULTS

UXO Discrimination Tests



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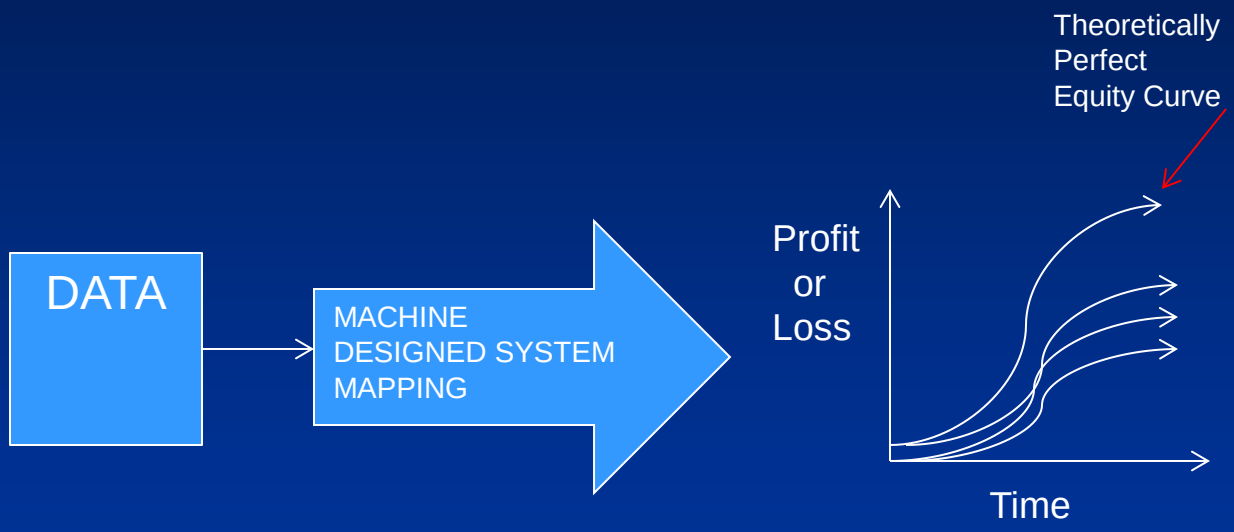
TSL MAIN COMPONENTS

LEARNING MACHINE	TRADING SIMULATOR

A TRADING SYSTEM MAPS DATA TO EQUITY CURVES



The resultant equity stream net profit np[n] is given by:

$$np[n] = \sum_{t=1}^{n} (tp[t]) + opp$$

The resultant net profit at t is given by:

$$np[t] = np[t-1] + tp[t] + opp$$

TSL INPUT PREPROCESSING

10 Built In PP's. Open Code-Fully customizable. 56 Inputs available

Classical and Non-Classical Patterns

- 1, 2 and more bar patterns
- Momemtum Patterns
- Countertrend Patterns
- Trend Patterns
- Gaps and variations
- Adaptive boolean patterns
- Adaptive numeric pattern relationships
- Support and Resistance, adaptations and variations
- Detrended pattern effects and variations

Classical and Non-Classical Indicators

- Normalized variables
- Transforms
- Standard Deviation and variations
- Averages and variations
- Volatility, Volatility Ratios and variations
- Adaptive Channels
- Regressions and variations
- Oscillators and variations
- Detrended prices, oscillators and variations

Other DNA:

- Intermarket data
- Fundamental data
- COT
- Machine readable news
- Social Media
- Exogeneous Data
- Order Book Bid/Ask & Size
- Order Book Movement
- Order Book Stats

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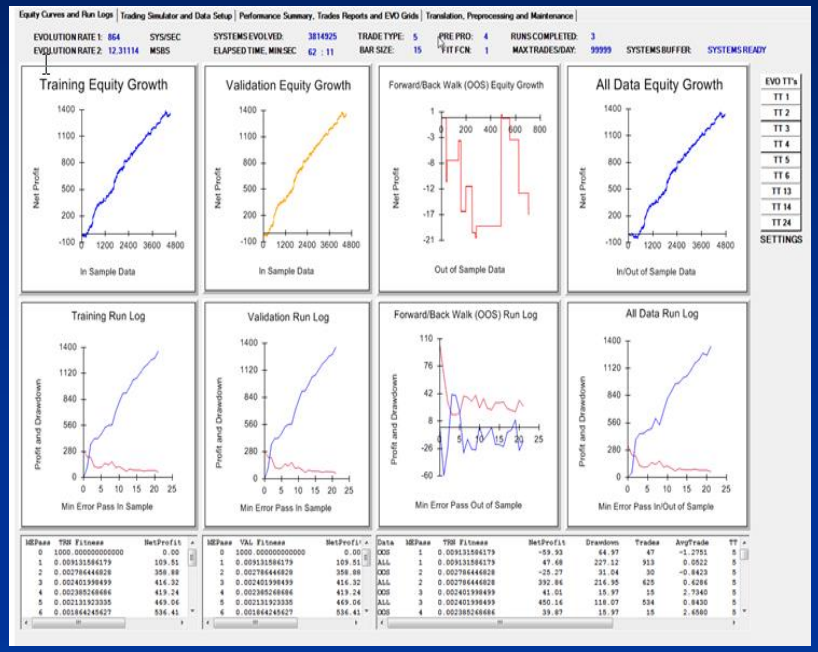
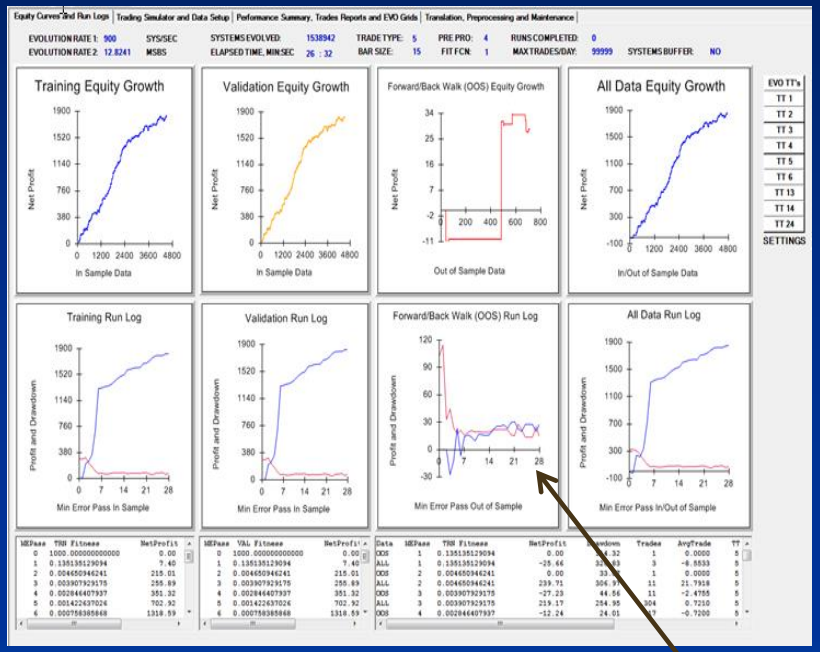
SOCIAL MARKET DATA

TSL AND EOTPRO DEVELOPING TECHNOLOGIES



Without Social Media Data



With Social Media Data

http://www.eotpro.com/

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TSL SIMULATION ROUTINES

- 25 Trade Types including multi-systems
- 40 Fitness Functions - External FF API DLL
- 56 Inputs
- 8 Outputs
- 11 Risk, Size, Stops, Targets
- 5 Preprocessors + 5 ID
- EVORUN™

THE STUDY OF ENTRY TYPES

Each order type has many variations.

Which one has the best EV for your Market under Study?

Counter Trend

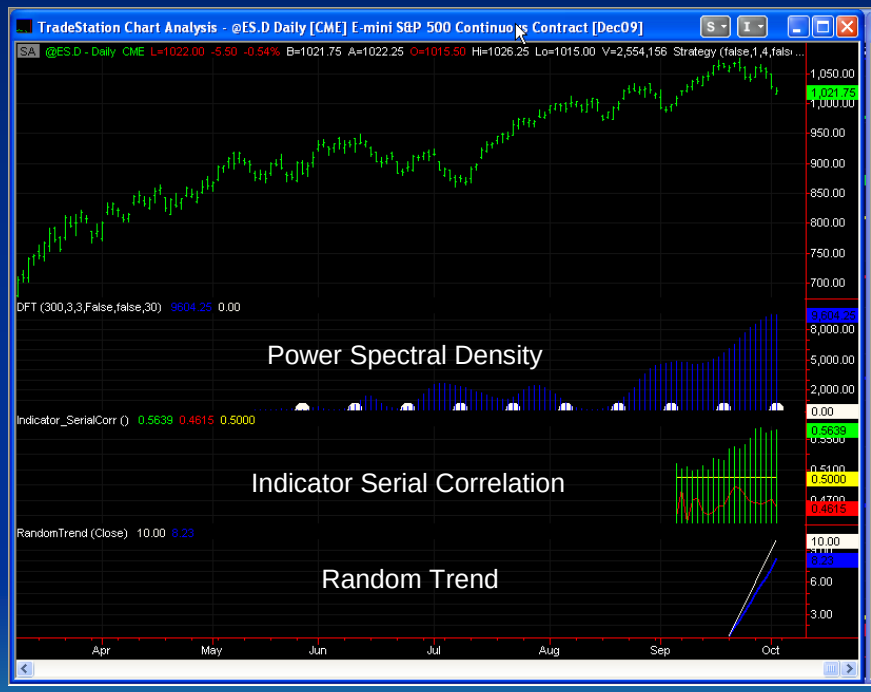
Breakout

Market Order

(TSL has 25 Trade Types)

MARKETS HAVE DIFFERENT DESCRIPTIVE STATISTICS

So Why Design Symmetrical Systems?
TSL will design systems within systems



CME:E-MINI S&P

CBOT:WHEAT

5/6/2015

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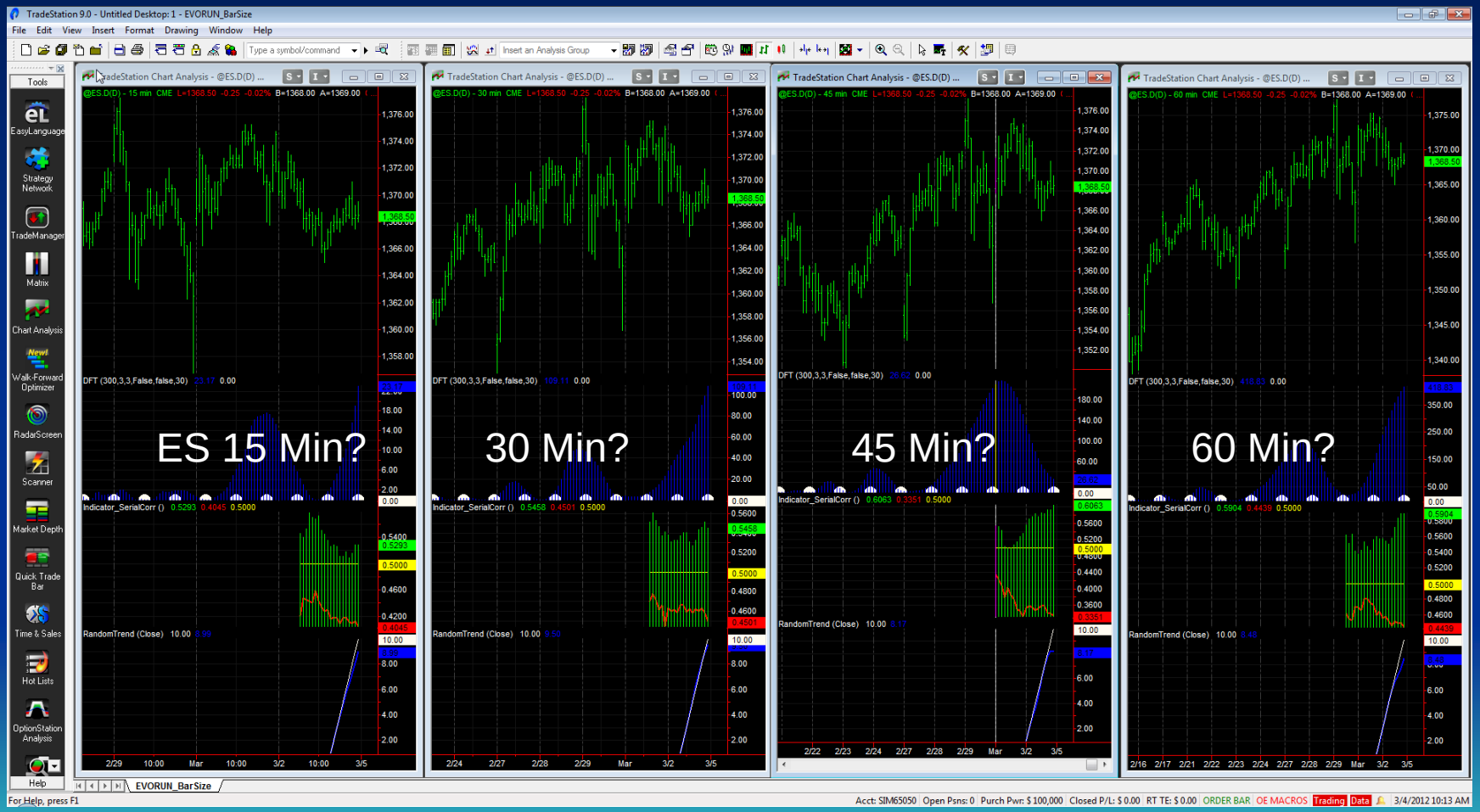
EVORUN™ ON SETUPS

- (TT) Trade Types/Trading Tactics are entry or order techniques.
  Example: Enter on Limit
- (FF) Fitness Functions are “Targets” that TSL attempts to design to.
  Example: NetProfit/Max Drawdown
- (PP) Preprocessors are Patterns, Indicators or other facts used as DNA in TSL. Example: Close>Close[1]
- (TTPD) Trades Per Day. Determines efficient intra day trading frequency.
- (BS) Bar Size. Optimum bar size needs to be stochastically determined.
- There are 25 TT’s, 40 FF’s, 10 PP’s many TTPD’s and BS allowing millions of possible setups to be tested, each allowing millions of systems to be generated for each setup.
- **Clearly there is a need for simplicity and runs reduction**

EVORUN™

WHAT IS THE BEST BAR SIZE?



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WHAT IS EVORUN™?

EVORUN is a TSL multi run iterator:

1. Trade Type
2. Fitness Function
3. Preprocessor
4. Bar Size
5. Max Trades per Day

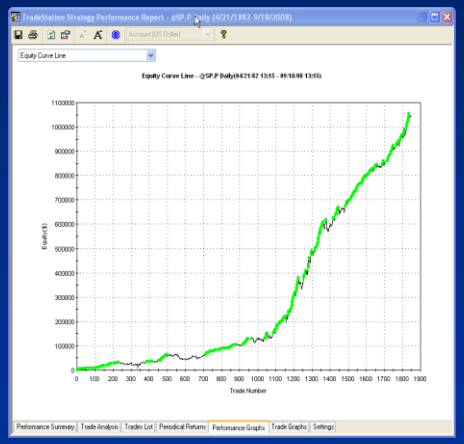
TSL MAIN COMPONENTS

Trading System Lab®

FITNESS CAN BE MULTI GOAL

Machine Design Allows Us to Adjust Critical System Metrics as Targeted Fitness Function

- Net Profit
- Drawdown
- Percent Accuracy
- Profit Factor
- Average Trade

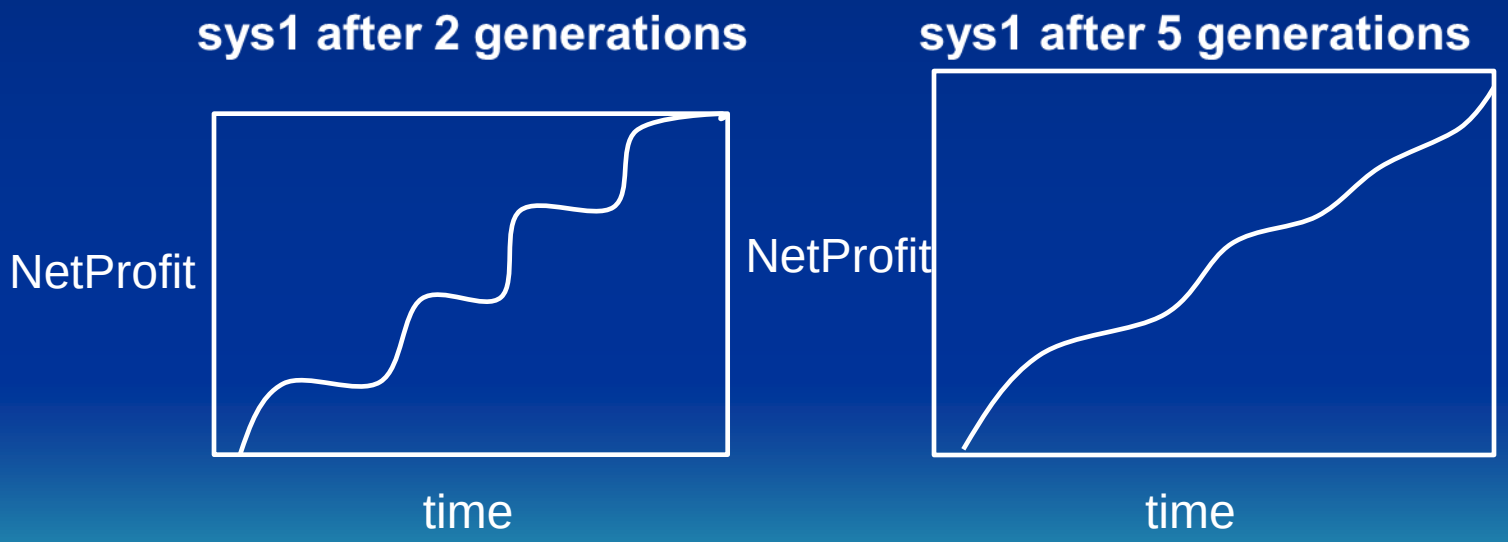


Example fitness:

$$\mathbf{AMR} = (\mathbf{1}/\boldsymbol{n}) \sum_{\boldsymbol{i}=\mathbf{1}}^{\boldsymbol{n}} \mathbf{POS}(\mathbf{MCE}(\mathbf{i}) - \mathbf{TE}(\mathbf{i}))$$

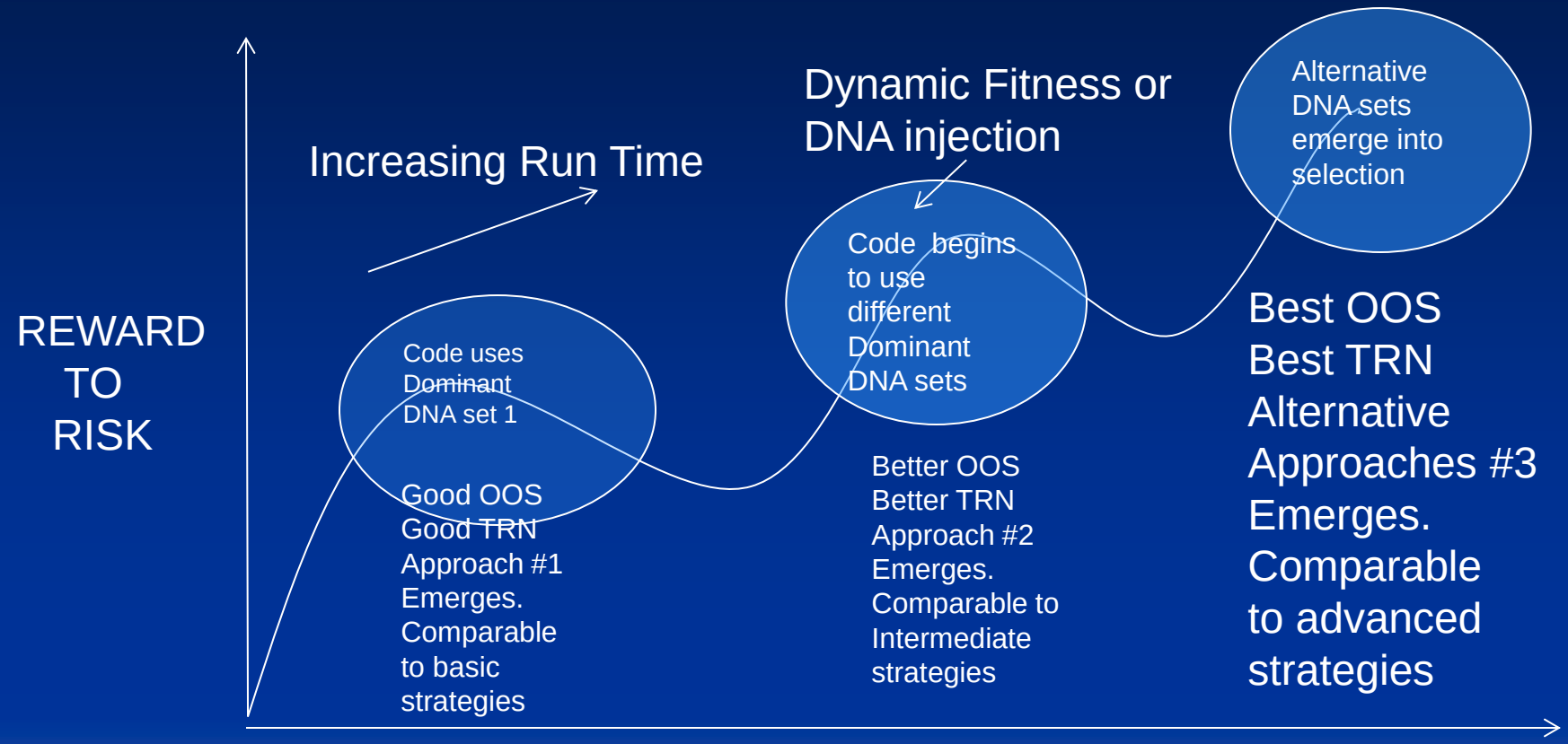
SYSTEMS AS OBJECTS: FITNESS AS EXPRESSIONS

$$error = \frac{1}{NETPROFIT}$$



Notice drawdown improved even though DD was not part of fitness

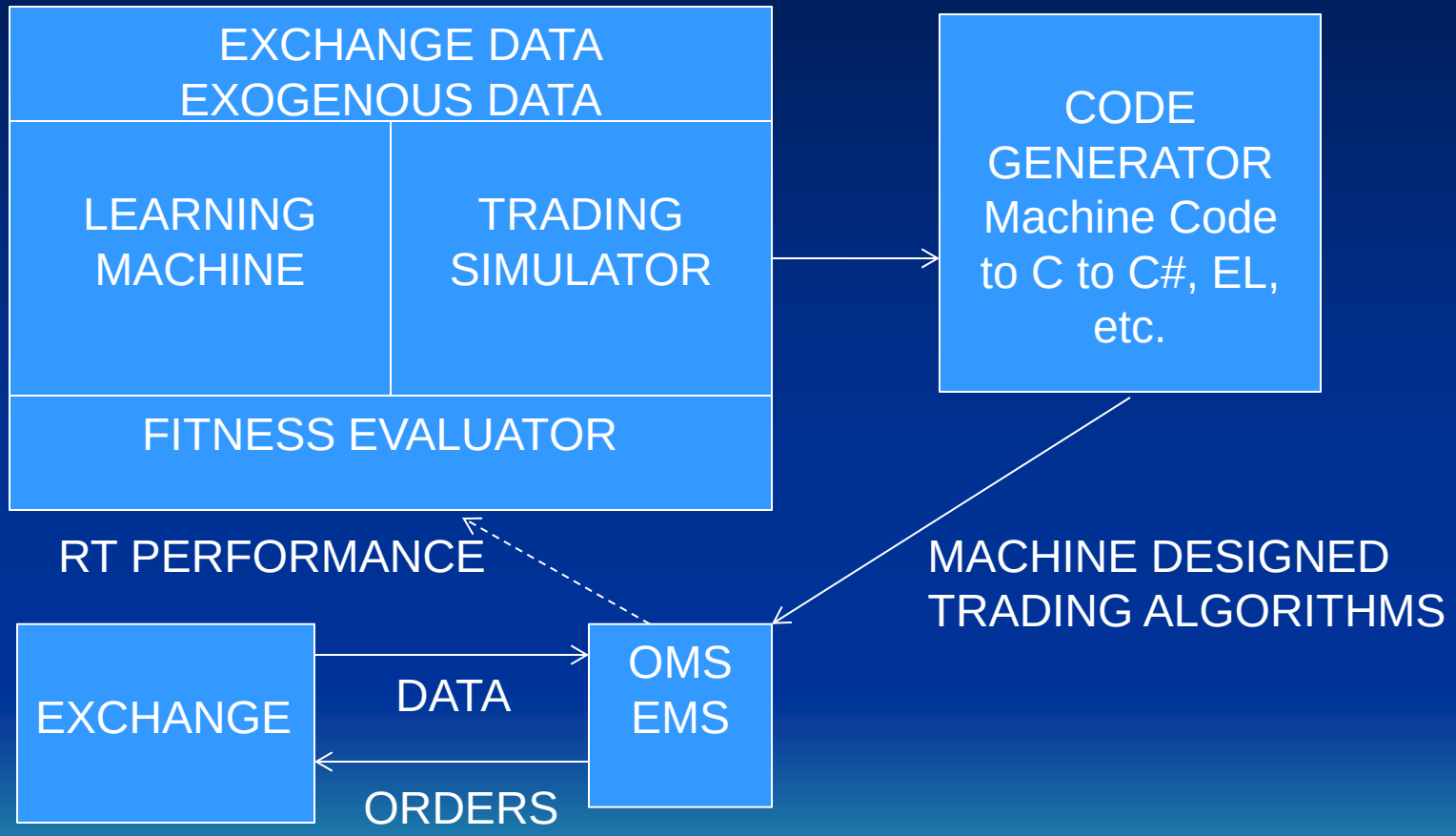
FITNESS GAMES



How, what, where, when, why it learns

TSL MAIN COMPONENTS

9 Languages, > 1 million lines of code, 2 companies, 10+ years in development



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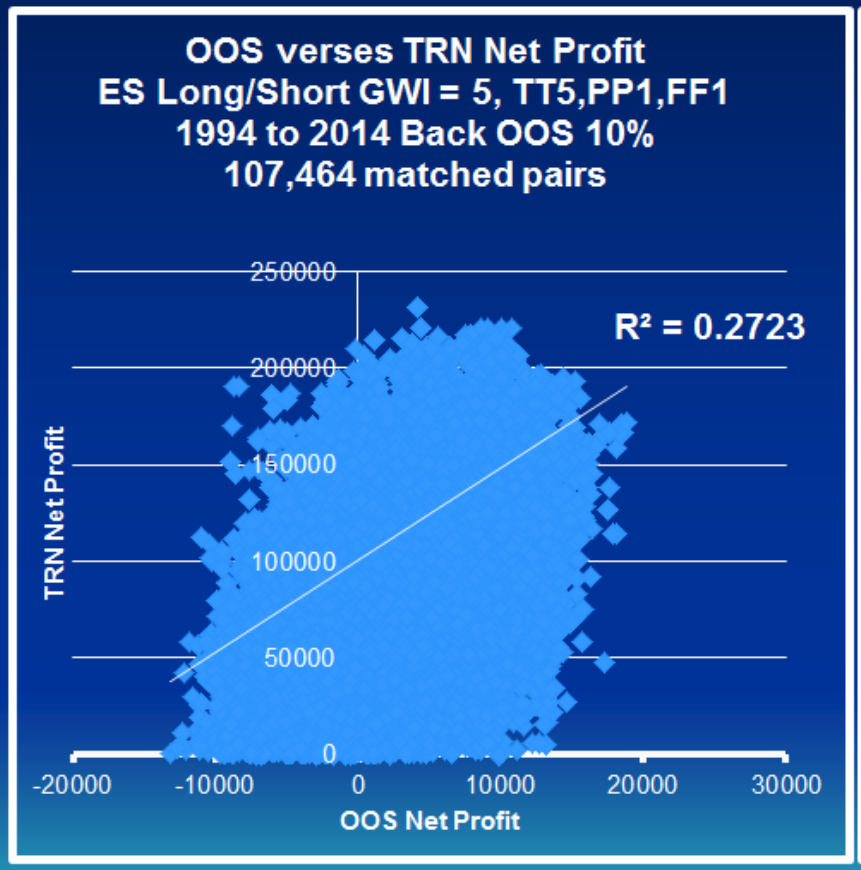
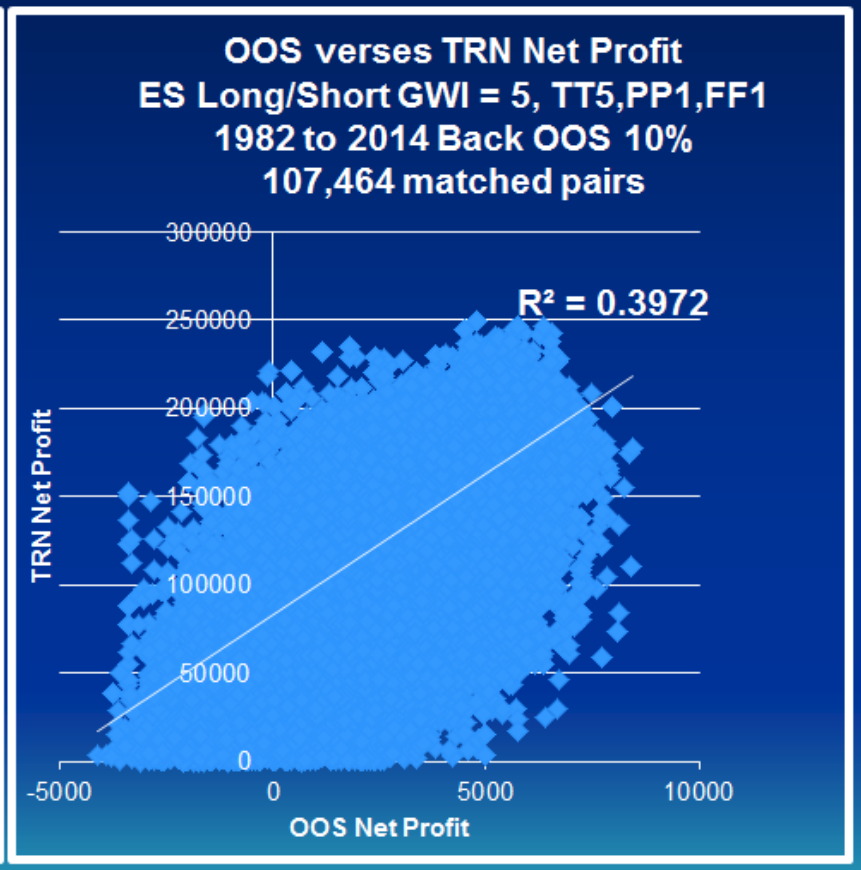
IMPORTANCE OF DATA LENGTH





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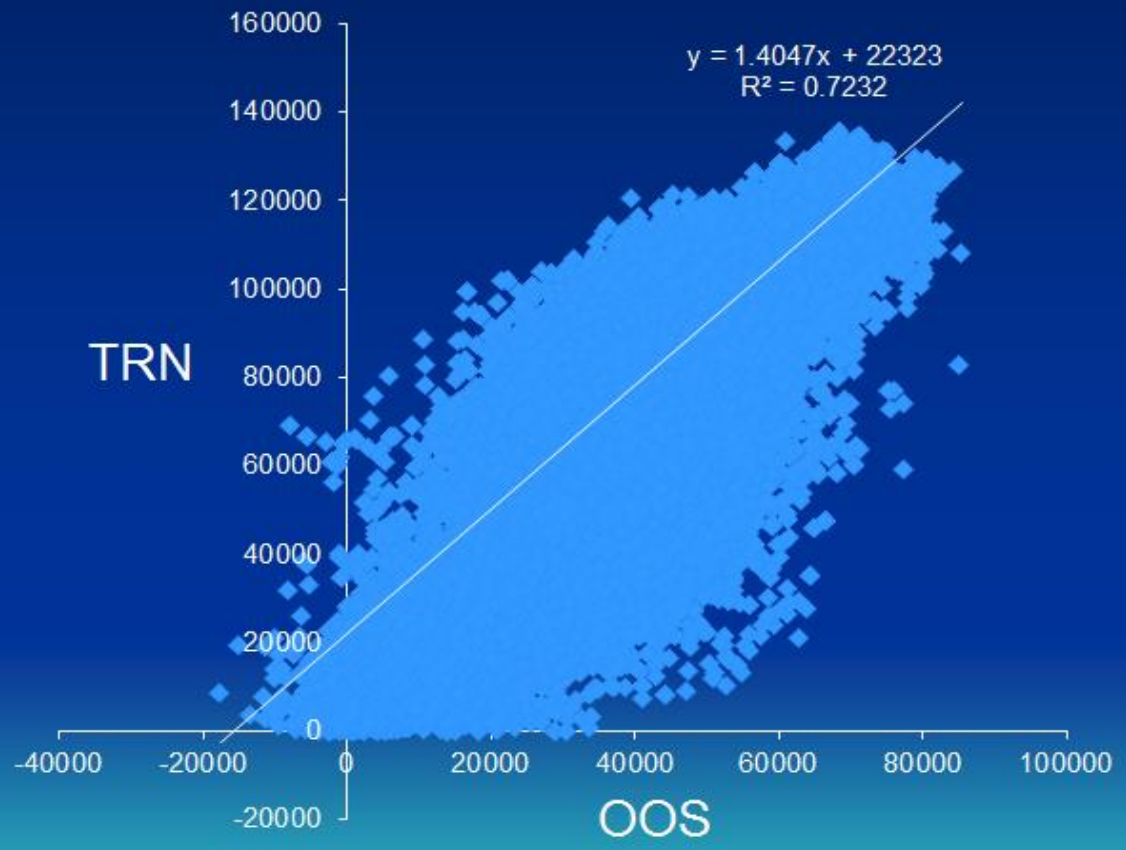
A DISTRIBUTION OF UNIQUE SYSTEMS FROM TSL



OOS verses TRN Net Profit
ES Long
TT5, PP1, FF1
1982 to 2014 20% FWD OOS
114,150 matched pairs

Systems are unique and novel. Evolves different systems for each user even with same setup due to Stochastic nature of process.

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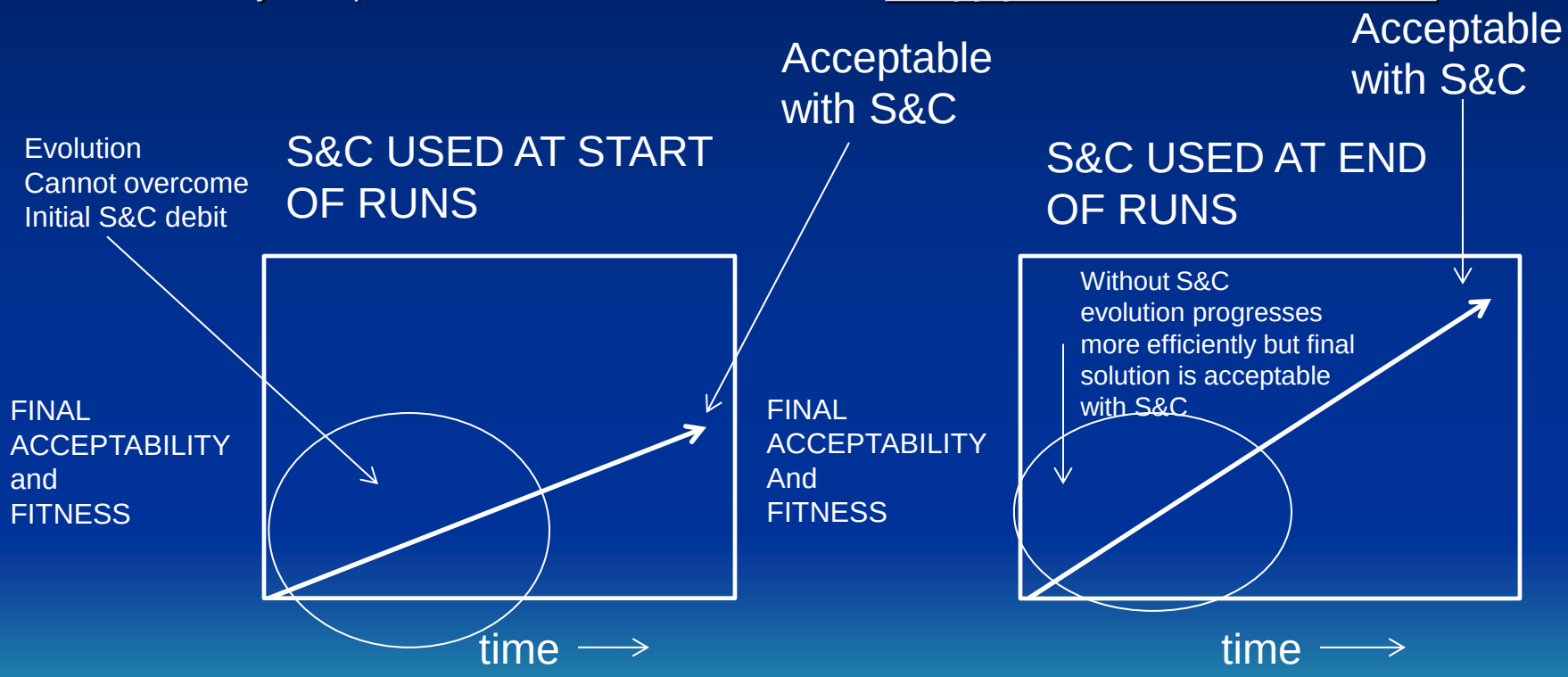
A WORD ON SLIPPAGE AND COMMISSION IN TSL-GP

Average Trade is often the limiting issue as trading frequency increases
Using S&C at the start of the run prevents potential good material from evolving into very acceptable end solutions and structures, **so apply S&C at the end of the run.**



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ROBUSTNESS

(Over Fit Avoidance)

- Forward and Back OOS Testing (Walk either)
- Run Path Logs (Path intelligence)
- Unbiased Terminal Set (Directionless inputs)
- Multi-Run, Randomized Criteria (Global optimum)
- Zero Point Origin (No predefined initial point)
- Parsimony Pressure (Occam’s razor)
- Stat Tests-Distribution is exported (Reject Null)
- TTPR (Degrees of Freedom)
- Data duration and choice (More is better)
- Post Design/Post OOS tests (Second Blind)
- Sequestered Data Testing (Extreme testing)

A FEW OMS/EMS THAT CAN HOST TSL TRADING STRATEGIES

- TradeStation (EL)
- MultiCharts (PL)
- Deltix (C#)
- QuantHouse (C#)
- SmartQuant(C#)
- Systemathics(C#)
- LightSpeed(C#)
- OneMarketData(C++)
- NYSE API(C++)
- Mantara (C#)
- WaveRules (C++)
- AB2000 (C++)
- Trading Blox(Blox)
- Ninja(C#)
- WealthLab (WLS)
- Others via native languages or TSL DLL

TRADING STRATEGY DESIGN REDUCED TO 3 SIMPLE STEPS

No Programming Required

1. Preprocess
2. Evolve
3. Translate

PROBLEMS EVERYWHERE

- The world is getting smaller and interconnected
- Inter-market Correlations are increasing
- Co-holding risk is largely hidden, expensive to hedge and difficult to diversify against
- The markets keep changing dynamically while systems are not adaptive enough, difficult and expensive to create
- Returns are elusive and require deeper mining
- The worst risks are potentially unknown and unknowable
- Money Managers are typically slow to adapt

TSL MAJOR PROJECTS

- TSL - Current Commercial Platform Product
- Limited External Strategic Consulting
- Internal R&D supporting:
- Quant Systems Lab (TSL Next Gen)

WHAT IS THE BOTTOM LINE?

There is no way a Human can design as many unique and novel Trading Strategies as TSL …and then have the code written for you

CONCLUSION

MACHINE LEARNING IN TRADING WILL CONTINUE TO "EVOLVE"

www.tradingsystemlab.com
408-356-1800

Check out the Kindle Book: Best Trading Strategies and
our section on Machine Designed Trading Strategies

Join our Silicon Valley Machine Learning for Trading Strategies MeetUp Group

Trading System Lab®

TSL RECENT ADDITIONS

- New Fitness Functions :

  Net Profit/Average Max DD
  Net Profit/Average Trade Duration
  External API User Defined e.g.:
  If Fitness Calls<100000 Fitness = Net Profit/ Avg Max DD
  else Fitness = NetProfit

- Multi Asset Robo Advisor:

  Long Only Portfolio
  Short Only Portfolio
  with Constant Dollars

- GUI Enhancements:

  Quick Save/Quick Load Settings
  Save/Load Any Settings

TSL RECENT ADDITIONS

- EVORUN:
  - Performs run iteration on:
    - BarSize
    - TradeTypes
    - PreProcessor
    - Fitness Function
    - Max Trades Per Day
- SOFT Fitness Targets:
  - Average Trade
  - MAX Drawdown
- QUANT SYSTEMS LAB

SOLUTION SPACE

What do you do for each of these cases?

- Poor TRN, Poor OOS
- Good TRN, Poor OOS
- Poor TRN, Good OOS
- Good TRN, Good OOS

WHAT IS TSL'S MACHINE DOING NOW?

- TSL is Learning to trade better as it is trading in the Simulator
- Systems are being tested OOS DURING Evolution
- Parameter reduction is automatic
- Strategies are being simplified due to Parsimony Pressure
- Equations are being written and manipulated
- Strategies are improving
- Machine code blocks are being manipulated in FPU's
- Finally code is up translated from register machine code.