Encoding Trader 'Horse-Sense':
Ideas and Experiments using Historical Foreign Exchange Data

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Introduction

- **horse-sense** *colloq. (orig. U.S.)*
  "A coarse, robust, and conspicuous form of shrewdness."
- Early reference: 1870 Nation (N.Y.) 18 Aug. 105
  "The new phrase – born in the West, we believe – of 'horse-sense', which is applied to the intellectual ability of men who exceed others in practical wisdom." (OED)

Introduction

- A classical (pre-connectionist, pre-Bayesian network) artificial intelligence paradigm:
  - Logical or algorithmic encoding of common-sense information and heuristic procedures.
  - Incorporation into computational processes.

Introduction

- *Trade with the trend.*
- *Cut losses short.*
- *Let gains run.*

These three trading dictums, which we characterize as "horse-sense" trading principles, are often found explicated in lay-audience treatments of trading, and elsewhere.

Introduction

Tools and Tactics for the Master Day Trader
– Oliver L. Velez, Greg Capra

Trader Vic–Methods of a Wall Street Master
– Victor Sperandeo and T. Sullivan Brown

The Four Cardinal Principles of Trading
– Bruce Babcock

Lessons from the Greatest Stock Traders of All Time
– John Bok

How to Trade Stocks
– Jesse Livermore

Introduction

- What do they mean?
- Can they can be gainfully incorporated into computational trading?
- This approach would be qualitatively different from traditional price-series modeling and prediction techniques involving:
  - autoregressive moving-average
  - conditional heteroscedastic models
  - others

Spoiler

- We find some evidence that suitable encoding and application of the three principles can result in a parameterized trading model in which historically-inferred parameter values yield computationally-driven returns exceeding those of the analogous strategy with randomized parameters; that is:
  - A strategy that chooses parameters by inspecting historical data behaves differently vs.
  - A strategy that ignores the historical data.

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Formulating "Cutting Losses Short"

- What does this mean?
  - Don't allow an (unrealized) loss on a position to influence a decision to close.
  - A natural emotional reaction to an unrealized loss is to hope that it will reverse.
  - In fact, the greater the unrealized loss, the more difficult it is to close the position – converting an unrealized loss to a realized loss is painful.
  - Maintain a loss threshold, and if it is exceeded, cut the loss short and take the hit.

Formulating "Letting Gains Run"

- What does this mean?
  - Don't allow an (unrealized) gain on a position to influence a decision to close.
  - A natural emotional reaction to an unrealized gain is to fear that it will vanish.
  - Maintain a gain threshold, and until it is exceeded, hold the position.
  - If the gain evaporates, so be it.

Asymmetric Trading – the Trailing Stop

Asymmetric Trading – the Trailing Stop

Sometimes very helpful:

(Note that vertical scale is log!)

Asymmetric Trading – the Trailing Stop

- Use of trailing stop could be regarded as a single mechanism that captures both sides of:
  - cut losses short
  - let gains run

  in a disciplined way.

Formulating "The Trend"

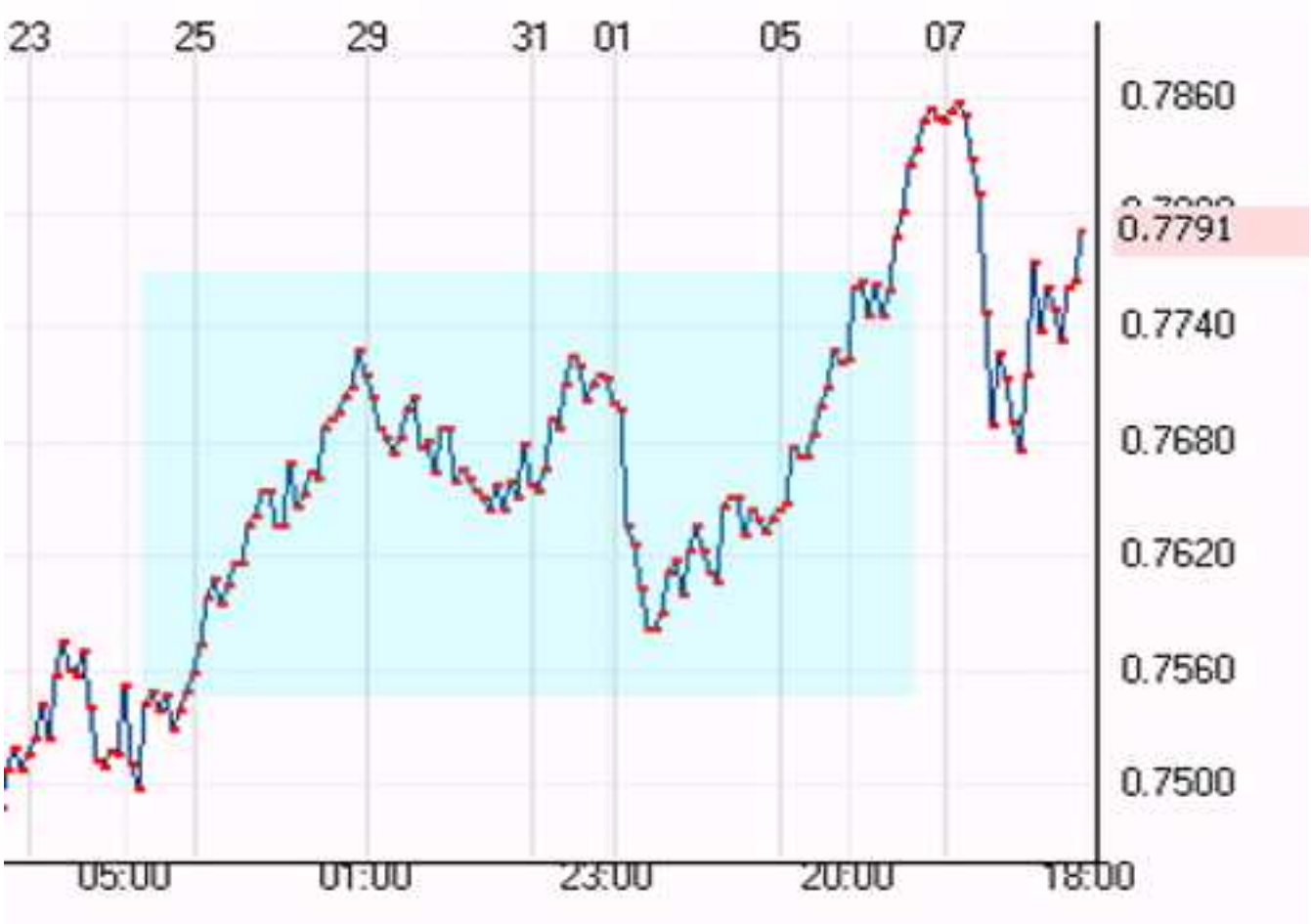
- Definition of trend based on heuristics loosely derived from the writings of Jesse Livermore (the "World's Greatest Stock Trader"),
  - Born July 26, 1877, began "bucket shop" trading at age 15, eventually reached sufficient notoriety due to his gains that the bucket shops collaboratively blacklisted him.
  - Gained $3M by shorting in the crash of 1907.
  - Lost most of that on one bad cotton future trade by repeatedly adding to a losing position.
  - Gained $100M shorting in the crash of 1929.
  - Managed to lose most of that by 1934.
  - Went bankrupt.
  - Committed suicide November 28, 1940.

Formulating "The Trend"

- Define an "upward trend"
  - a "peak" is detected,
  - retreated from,
  - then surpassed,

  all within a given time window.
- A "peak" is just a net downward change in price by a specified amount, within the time window.
- So, "upward trend" = a peak, a dip, and an overcompensating recovery.
- "Downward trend" is the complement.

Formulating "The Trend"



"Agent"-based Approach

- Agents (software entities) watch for trend formations, and open and close positions accordingly using trailing stops.
- Dimensions of agent parameter space:
  - window size
  - peak size
  - trailing-stop size

Agent Parameter Space

- 3-dimensional parameter space:
  - Sliding window length: 0.7 to 25 days, logarithmically spaced, 16 values.
  - Peak size (minimum dip): 7 to 350 pips, logarithmically spaced, 16 values.
  - Trailing stop spread: 6 to 300 pips, logarithmically spaced, 16 values.
- Each agent's behavior is governed by one triple within the parameter space.
- The entire population of agents is 16 x 16 x 16 = 4096.

- Compensating for "drift": both the historically-based and randomized strategies have equal position bias.
  - Equivalently: all price-series data were *de-biased* by preprocessing.
- All comparison testing between the historical and randomized strategies was done out-of-sample.

- Experiment: Divide the historical data in half. Call the earlier half "in sample", and the later half "out of sample".
  - Allow all 4096 agents to perform "hypothetical" trades on the in-sample data.
  - For each agent, record
    - the highest net gain (gain relative to initial capital),
    - the lowest net gain, and
    - the final net gain.
- Each agent gets a score given by the sum of these three figures. (Why: this (very crudely) correlates with average net gain (from initial capital) of agent during trial.)
- The ten highest-scoring agents participate in out-of-sample test.

The Arbitor

- After in-sample run, choose the agents with the ten highest scores.
- Using the out-of-sample data, begin hypothetical trading with these ten agents.
- For each agent, the *arbitor* maintains a sliding average of that agent's net gain.
- At regular intervals, the arbitor chooses the agent with the highest sliding-average net-gain currently.
- The arbitor (actually) executes the (hypothetical) trades indicated by the chosen agent, for the duration of the current interval. The hypothetical trades of the other agents are computed but not used by the arbitor.

The Arbitor

- Selecting ten agents from the agent parameter-space amounts to choosing 30 parameters of a trading model.
- If in-sample price-change behavior contains no information about out-of-sample price-change behavior, then a choice of the 30 parameters based on inspection of the in-sample price data should, on average, perform as well as (i.e. not better than) 30 parameters chosen randomly from the parameter-space.
- In practice, we chose ten arbitrary agents and compared their performance with the ten highest-scoring agents from the in-sample run.

Agent Performance on Out-of-sample Data

Bse.	Ctr.	Best 10 Net Gain	Rand. 10 Net Gain			Bse.	Ctr.	Best 10 Net Gain	Rand. 10 Net Gain			Bse.	Ctr.	Best 10 Net Gain	Rand. 10 Net Gain		
AUD	JPY	568	-1822	x		2AU	JPY	-2486	-1936		x	2US	BEF	-16884	-98093	x	
AUD	USD	-1591	-1463		x	2AU	USD	-2081	-2367	x		2US	CAD	-618	-1679	x	
CAD	JPY	66	-11	x		2CH	JPY	-1132	-4266	x		2US	CHF	-2636	-2606		x
CHF	JPY	-1093	-1513	x		2DE	CHF	-577	-995	x		2US	DEM	-2705	-2834	x	
EUR	AUD	449	119	x		2DE	JPY	-1100	-4167	x		2US	DKK	-302	-519	x	
EUR	CAD	-14	-241	x		2EU	CHF	-576	-2272	x		2US	ESP	-3422	-35666	x	
EUR	CHF	-689	-513		x	2EU	GBP	-1245	-900		x	2US	FIM	-9183	-14966	x	
EUR	GBP	-910	-1371	x		2EU	JPY	-3427	-2839		x	2US	FRF	-12515	-7445		x
EUR	JPY	-733	-806	x		2EU	USD	-1852	-1885	x		2US	HUF	-9467	-32301	x	
EUR	USD	-90	-404	x		2GB	CHF	-6640	-15984	x		2US	ITL	-4540	-2185		x
GBP	CHF	-2437	-4534	x		2GB	DEM	-6057	-14504	x		2US	JPY	-961	-5185	x	
GBP	JPY	398	-1619	x		2GB	EUR	-2545	-6010	x		2US	NLG	-1757	254		x
GBP	USD	501	-1571	x		2GB	JPY	-711	-3134	x		2US	NOK	-1290	-56626	x	
USD	CAD	-366	-2011	x		2GB	USD	317	-5982	x		2US	SEK	-1790	-28980	x	
USD	CHF	-1498	-3106	x		2NZ	USD	-1007	-2022	x		2US	SGD	-2341	-872		x
USD	JPY	-1715	-1645		x	2US	ATS	-1451	-34846	x							

Performance of best ten agents and of random ten agents on out-of-sample historical data.

Agent Performance on Out-of-sample Data

- Sign Test (non-parametric statistic): performance of best 10 vs. performance of random 10.
- Null hypothesis: best-10 and random-10 are equally likely to have higher gain.
- Rejected at 99%+ confidence interval.
- p-value is 0.000222

Price-Chart Discriminator

- The computational machinery developed here can be used to construct a discriminator of historical FOREX price-charts versus random price-charts.
- Random price charts are generated by Wiener/Martingale processes having means and variances the same as those of the historical data.
- A total of 36 random price-charts were generated, de-biased, and tested (both normal and log-normal error term distributions were tried, with no observable difference).

Price-Chart Discriminator

		Mean	Std	Mean/ Std			Mean	Std	Mean/ Std
AUD	JPY	-67.40	100.31	-0.672	2GB	USD	-3.3557	6.0669	-0.553
AUD	USD	-0.3425	0.4733	-0.724	2NZ	USD	-1.7765	3.4507	-0.515
CAD	JPY	-2.3817	2.4979	-0.953	2US	CAD	-2.9311	4.8862	-0.600
CHF	JPY	-50.105	60.417	-0.829	2US	CHF	-6.1424	10.5563	-0.582
EUR	AUD	-2.1876	2.7625	-0.792	2US	JPY	-344.48	636.94	-0.541
EUR	CAD	-0.0421	0.0410	-1.027	2DE	CHF	-0.1670	0.2749	-0.608
EUR	CHF	-0.3288	0.4784	-0.687	2DE	JPY	-22.105	40.169	-0.550
EUR	GBP	-0.1705	0.2432	-0.701	2GB	DEM	-5.3227	6.8148	-0.781
EUR	JPY	-66.972	100.148	-0.669	2GB	EUR	-2.9077	3.9168	-0.742
EUR	USD	-0.6730	0.8392	-0.802	2US	ATS	-30.937	22.050	-1.403
GBP	CHF	-2.0467	2.6119	-0.784	2US	BEF	-530.87	293.28	-1.810
GBP	JPY	-176.29	255.08	-0.691	2US	CZK	-1470.78	735.90	-1.999
GBP	USD	-0.6957	1.1111	-0.626	2US	DEM	-1.7525	2.3737	-0.738
NZD	JPY	-6.9914	13.8979	-0.503	2US	DKK	-133.35	107.40	-1.242
NZD	USD	-0.1280	0.1791	-0.715	2US	ESP	-996.67	495.34	-2.012
USD	CAD	-0.6774	0.6561	-1.032	2US	FIM	-10.2551	9.3788	-1.093
USD	CHF	-0.7992	0.8876	-0.900	2US	FRF	-12.6381	12.9553	-0.976
USD	JPY	-51.370	74.065	-0.694	2US	HUF	-12016.45	5694.70	-2.110
2AU	JPY	-425.22	766.72	-0.555	2US	ITL	-21953.75	11412.82	-1.924
2AU	USD	-2.2583	4.5370	-0.498	2US	NLG	-2.5734	3.2189	-0.799
2CH	JPY	-340.15	566.86	-0.600	2US	NOK	-204.41	165.04	-1.238
2EU	CHF	-15.713	31.503	-0.499	2US	SEK	-420.31	280.00	-1.501
2EU	GBP	-2.5231	5.3610	-0.471	2US	SGD	-3.5250	4.9206	-0.716
2EU	JPY	-869.63	1536.03	-0.566	2US	ZAR	-520.28	255.83	-2.034
2EU	USD	-2.2370	4.1729	-0.536	2XG	USD	-357.67	181.08	-1.975
2GB	CHF	-44.095	57.827	-0.763	2XU	USD	-14162.18	6202.24	-2.283
2GB	JPY	-1563.87	2027.95	-0.771					

		Mean	Std	Mean/ Std			Mean	Std	Mean/ Std
NOI	ZAJ	-356.26	116.50	-3.058	NNO	IEU	-1.2006	0.7808	-1.538
NOI	ZAU	-0.5010	0.3777	-1.327	NNO	IGF	-1.9282	0.8896	-2.168
NOI	ZCJ	-12.75	3.9363	-3.238	NNO	IGJ	-271.56	104.79	-2.591
NOI	ZFJ	-221.48	77.67	-2.852	NNO	IGU	-2.3736	1.1193	-2.121
NOI	ZEA	-1.6304	0.7673	-2.125	NNO	INJ	-19.2289	11.423	-1.683
NOI	ZEC	-0.0620	0.0403	-1.540	NNO	INU	-0.2425	0.1449	-1.674
NOI	ZEF	-0.2893	0.3294	-0.878	NNO	IUC	-1.3708	0.8780	-1.561
NOI	ZEG	-0.1572	0.1744	-0.901	NNO	IUF	-1.2729	0.9275	-1.372
NOI	ZEJ	-366.82	106.71	-3.437	NNO	IUJ	-154.09	80.544	-1.913
NOI	ZEU	-0.5641	0.4172	-1.352					
NOI	ZGF	-1.8955	0.7282	-2.603					
NOI	ZGJ	-565.20	161.44	-3.501					
NOI	ZGU	-1.6875	0.9969	-1.693					
NOI	ZNJ	-43.43	14.388	-3.018					
NOI	ZNU	-0.2714	0.2124	-1.278					
NOI	ZUC	-1.1993	0.9314	-1.288					
NOI	ZUF	-2.3184	1.0971	-2.113					
NOI	ZUJ	-430.31	113.75	-3.783					
NNO	IAJ	-108.26	55.120	-1.964					
NNO	IAU	-0.8602	0.5187	-1.658					
NNO	ICJ	-12.75	3.9363	-3.238					
NNO	IFJ	-84.66	49.53	-1.709					
NNO	IEA	-2.2451	0.8603	-2.609					
NNO	IEC	-0.0172	0.0229	-0.753					
NNO	IEF	-0.3634	0.2737	-1.328					
NNO	IEG	-0.1944	0.2085	-0.932					
NNO	IEJ	-157.89	81.309	-1.942					

Average agent performance on historical price-series (left) and on random-walk price-series (right).

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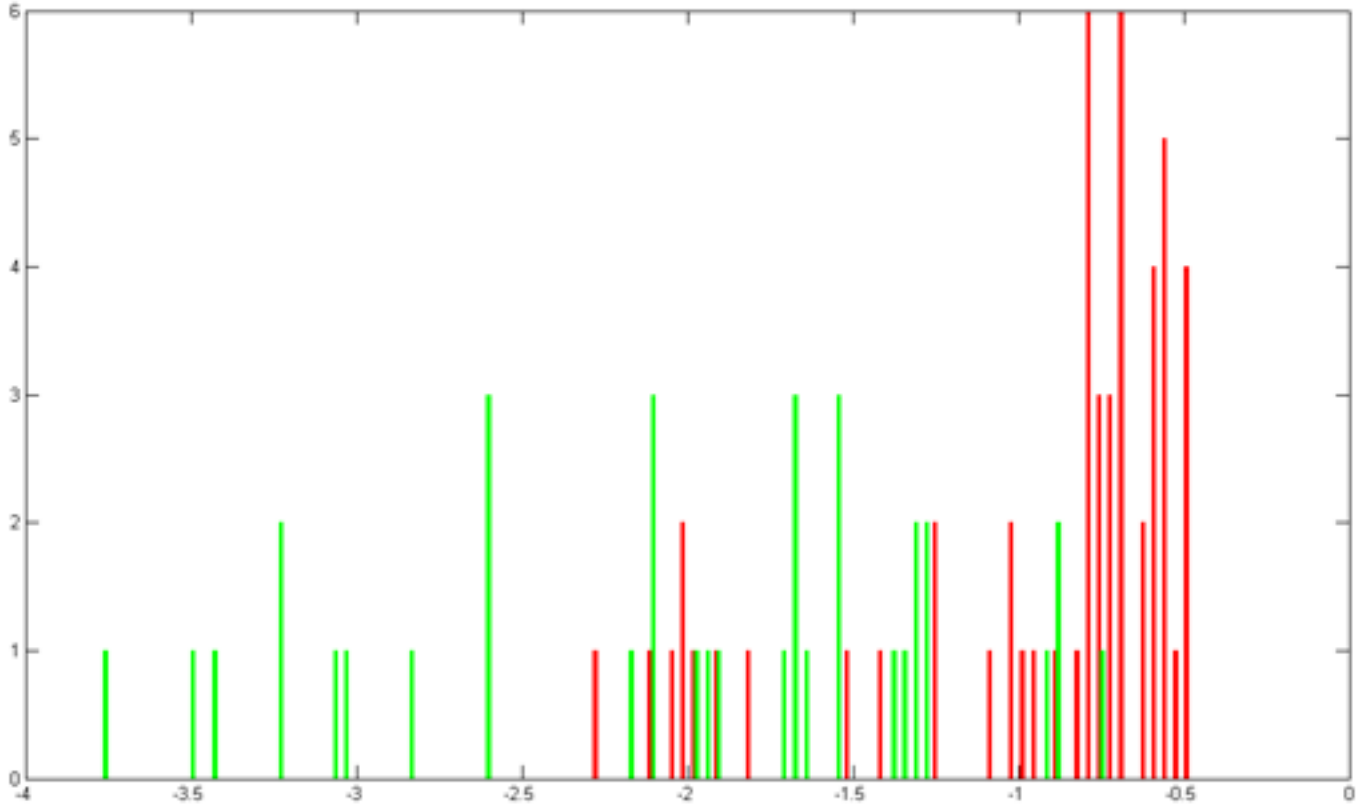
Price-Chart Discriminator

- Two populations
  - average agent gain/loss on historical price-series
  - average agent gain/loss on randomly generated price-series
- Null hypothesis: common mean for the two populations.
- Rejected at a 99%+ confidence interval.
- Two-sided un-pooled t-test
  - p-value is 0.000000006.

Price-Chart Discriminator



Green: average agent performance on random price-charts.
Red: average agent performance on historical price-charts.

Price-Chart Discriminator

- These results could be construed as evidence against the Random Walk Hypothesis.
- What the is physical/sociological/scientific justification for the Random Walk Hypothesis?
- Why should the distribution of changes in a stock price, bond return, commodity price, or FOREX rate be normally distributed and have zero hysteresis?

Price-Chart Discriminator

- Brownian motion is derivable from properties of molecular activity (Einstein).
- How is Brownian motion derived for price-series?
- Without derivation from first principles, strong claim (normal distribution and zero hysteresis) requires strong evidence.
- Lack of well-known means for exploiting price hysteresis does not constitute evidence.
  - Absence of evidence, not evidence of absence.

Relating Gain/Loss to Algorithmic Entropy

- Interesting (and serendipitous!) observed relation between:
  - average agent performance on a price-series, and
  - the 'amount of information' (roughly, the algorithmic entropy) in that series.
- Heuristically measuring information content: compression algorithms.
  - Perfectly compressed information is indistinguishable from noise.
  - Noise does not compress; likewise, less compressibility corresponds to more information.
  - Heuristic: use compressibility as measure of "information content".

Relating Gain/Loss to Algorithmic Entropy

Bse.	Ctr.	un-comp. (KB)	bz2 (KB)	gz (KB)	de-flate (KB)	log unc/ bz2	log unc/ gz	log unc/ de-flate	Mean/ Std Gain	Bse.	Ctr.	un-comp. (KB)	bz2 (KB)	gz (KB)	de-flate (KB)	log unc/ bz2	log unc/ gz	log unc/ de-flate	Mean/ Std Gain
AUD	JPY	8431.4	704.5	1248.0	2884.0	1.078	0.830	0.466	-0.672	2GB	CHF	12590.5	2111.9	3633.2	7084.0	0.775	0.540	0.250	-0.763
AUD	USD	7293.7	606.3	1044.7	2468.0	1.080	0.844	0.471	-0.724	2GB	DEM	11051.3	1824.5	3222.4	6224.0	0.782	0.535	0.249	-0.781
CAD	JPY	251.4	27.5	50.8	112.0	0.961	0.694	0.351	-0.953	2GB	EUR	10794.8	1397.5	2488.6	5312.0	0.888	0.637	0.308	-0.742
CHF	JPY	8500.5	681.8	1202.7	2832.0	1.096	0.849	0.477	-0.829	2GB	JPY	12443.5	1915.7	3685.7	6816.0	0.813	0.528	0.261	-0.771
EUR	AUD	8669.8	934.3	1606.5	3464.0	0.968	0.732	0.398	-0.792	2GB	USD	12345.2	1640.0	2950.5	6168.0	0.877	0.622	0.301	-0.553
EUR	CAD	249.2	30.3	51.9	116.0	0.915	0.681	0.332	-1.027	2NZ	USD	9959.6	1182.2	2061.6	4568.0	0.926	0.684	0.339	-0.515
EUR	CHF	6975.2	518.3	865.5	2168.0	1.129	0.906	0.507	-0.687	2US	ATS	10210.7	2167.3	3126.0	5664.0	0.673	0.514	0.256	-1.403
EUR	GBP	7473.8	479.6	807.6	2132.0	1.193	0.966	0.545	-0.701	2US	BEF	7896.3	2057.5	2061.2	3876.0	0.584	0.583	0.309	-1.810
EUR	JPY	9220.3	855.9	1545.4	3332.0	1.032	0.776	0.442	-0.669	2US	CAD	10648.7	1321.3	2316.2	5072.0	0.906	0.663	0.322	-0.600
EUR	USD	9653.0	909.6	1586.9	3572.0	1.026	0.784	0.432	-0.802	2US	CHF	12365.8	1707.9	3057.4	6332.0	0.860	0.607	0.291	-0.582
GBP	CHF	8629.9	949.2	1623.3	3496.0	0.959	0.726	0.392	-0.784	2US	CZK	7826.6	2637.6	3769.6	5924.0	0.472	0.317	0.121	-1.999
GBP	JPY	8507.4	962.1	1742.1	3460.0	0.947	0.689	0.391	-0.691	2US	DEM	10904.7	1583.1	2820.7	5640.0	0.838	0.587	0.286	-0.738
GBP	USD	8676.4	939.1	1661.6	3584.0	0.966	0.718	0.384	-0.626	2US	DKK	11568.5	2599.6	4587.8	7616.0	0.648	0.402	0.182	-1.242
NZD	JPY	918.1	98.8	187.7	412.0	0.968	0.689	0.348	-0.503	2US	ESP	10307.0	4742.6	5144.7	7744.0	0.337	0.302	0.124	-2.012
NZD	USD	1769.1	178.0	315.4	728.0	0.997	0.749	0.386	-0.715	2US	FIM	10626.6	2118.5	3482.8	6124.0	0.700	0.484	0.239	-1.093
USD	CAD	6263.1	644.6	1115.1	2464.0	0.988	0.749	0.405	-1.032	2US	FRF	10576.3	2156.5	3493.8	6184.0	0.691	0.481	0.233	-0.976
USD	CHF	9167.7	975.0	1735.3	3748.0	0.973	0.723	0.388	-0.900	2US	HUF	7964.4	4229.3	4699.6	6640.0	0.275	0.229	0.079	-2.110
USD	JPY	9209.3	868.6	1580.1	3444.0	1.025	0.766	0.427	-0.694	2US	ITL	8732.5	5486.6	5283.9	7332.0	0.202	0.218	0.076	-1.924
2AU	JPY	10260.6	1294.7	2391.4	4972.0	0.899	0.633	0.315	-0.555	2US	JPY	12801.4	1576.4	2940.4	6104.0	0.910	0.639	0.322	-0.541
2AU	USD	11207.0	1276.6	2224.2	5008.0	0.943	0.702	0.350	-0.498	2US	NLG	10425.8	1576.9	2777.4	5480.0	0.820	0.574	0.279	-0.799
2CH	JPY	10210.6	1237.2	2291.1	4820.0	0.917	0.649	0.326	-0.600	2US	NOK	11685.0	2855.2	4916.2	8004.0	0.612	0.376	0.164	-1.238
2DE	CHF	4875.6	482.5	815.8	1992.0	1.005	0.776	0.389	-0.608	2US	SEK	11710.7	2967.5	5065.8	8104.0	0.596	0.364	0.160	-1.501
2DE	JPY	7109.3	787.6	1490.8	3176.0	0.956	0.678	0.350	-0.550	2US	SGD	6104.1	831.6	1399.8	2968.0	0.866	0.640	0.313	-0.716
2EU	CHF	11893.2	1561.6	2500.9	5664.0	0.882	0.677	0.322	-0.499	2US	ZAR	5724.5	1693.6	2597.6	4084.0	0.529	0.343	0.147	-2.034
2EU	GBP	11932.8	1246.3	2115.2	5036.0	0.981	0.751	0.375	-0.471	2XG	USD	3499.8	987.7	1361.9	2216.0	0.549	0.410	0.198	-1.975
2EU	JPY	12156.7	1625.1	3054.2	6136.0	0.874	0.600	0.297	-0.566	2XU	USD	5757.2	3706.3	4054.7	5460.0	0.191	0.152	0.023	-2.283
2EU	USD	12548.1	1511.0	2692.7	5940.0	0.919	0.668	0.325	-0.536										

Historical price-series: compressibility under various compression algorithms, and average agent gain/loss.

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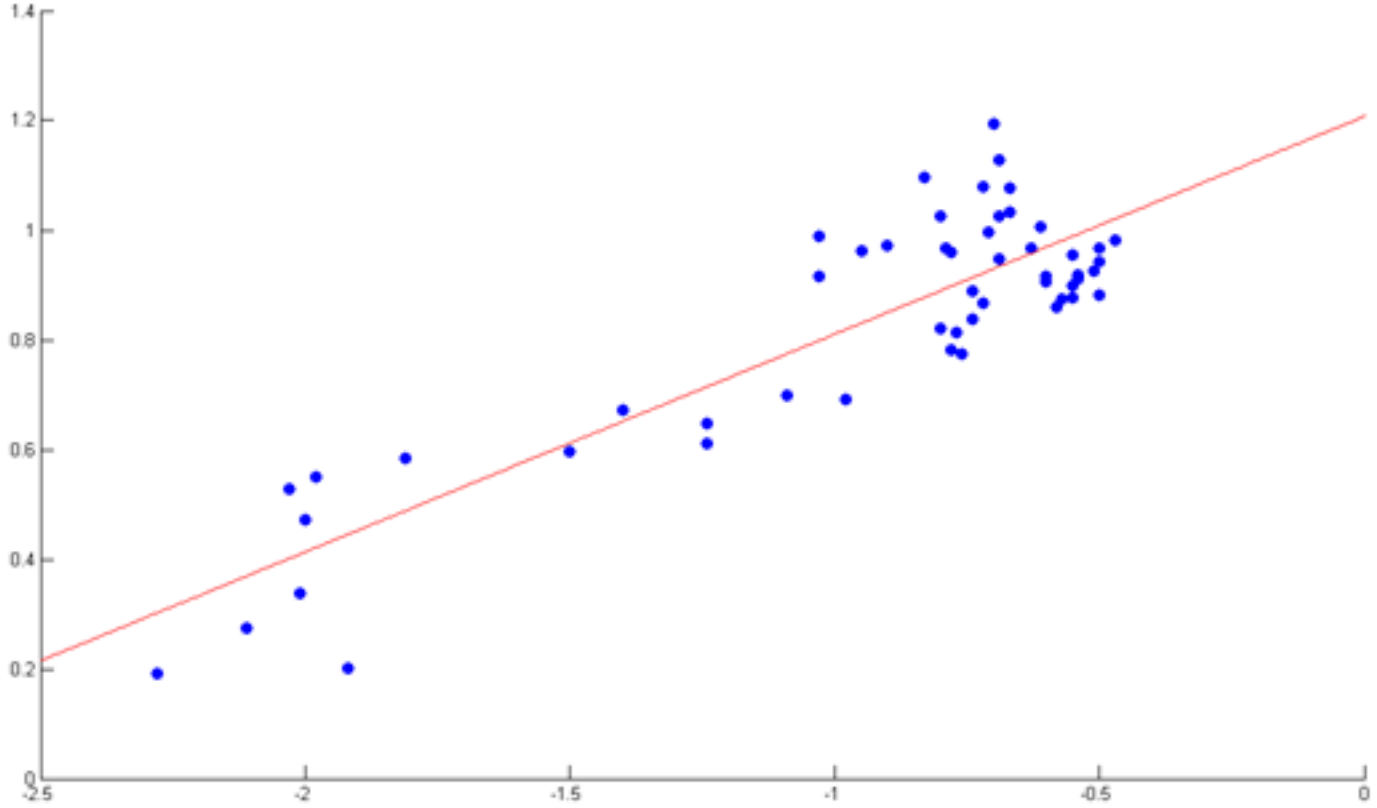
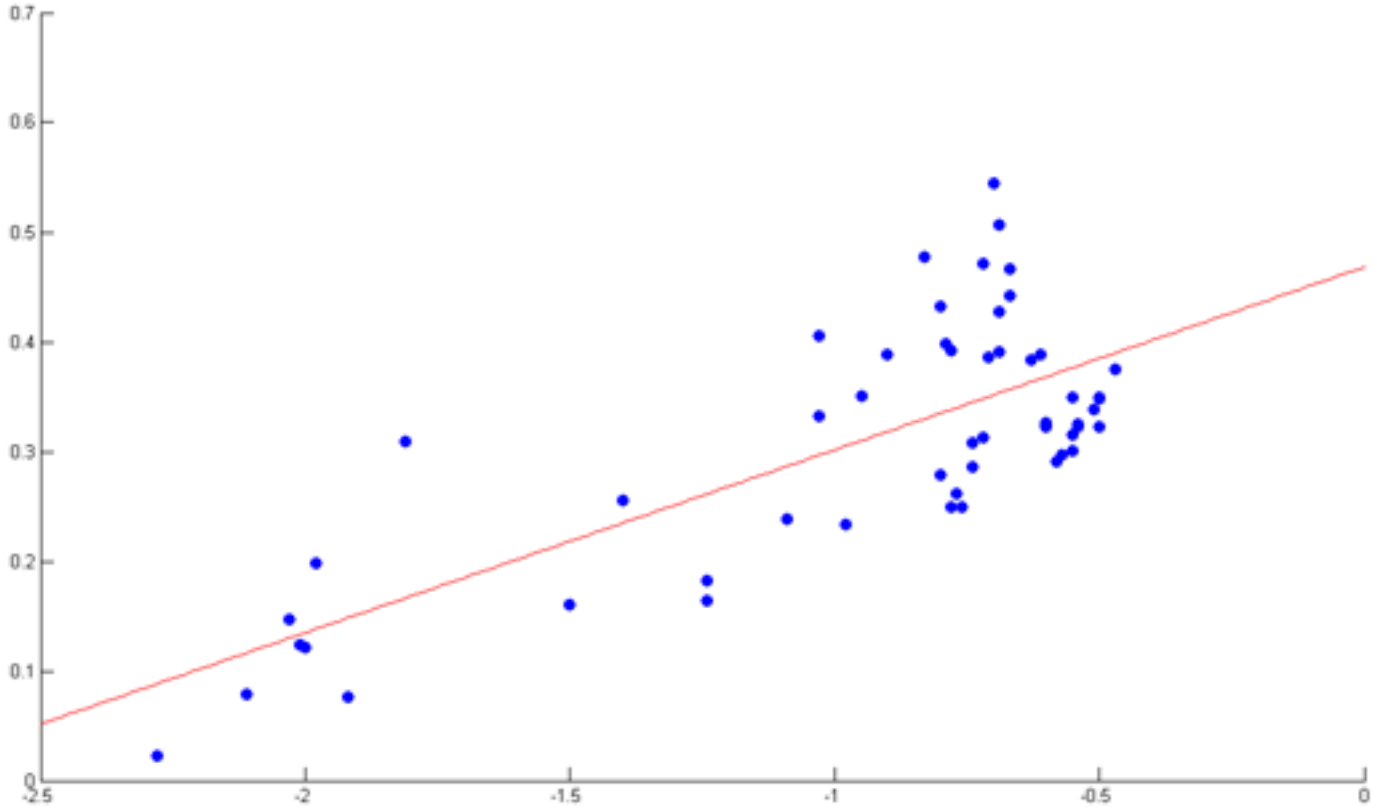
Relating Gain/Loss to Algorithmic Entropy



Log Compression vs. Gain/Loss, Burrows-Wheeler $\rho = 0.875$.

Relating Gain/Loss to Algorithmic Entropy



Log Compression vs. Gain/Loss, Lempel-Ziv77, $\rho = 0.746$.

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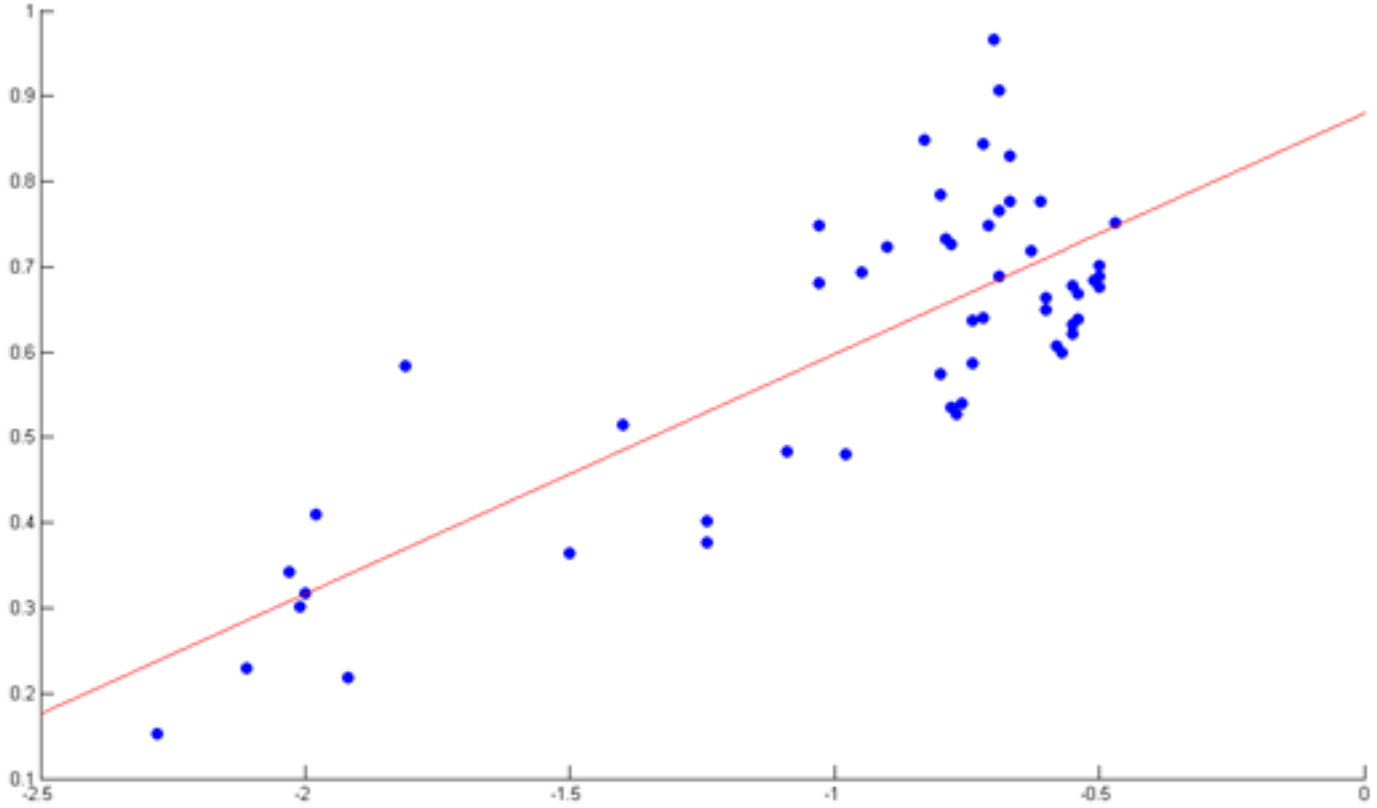

Log Compression vs. Gain/Loss, DEFLATE, $\rho = 0.797$.

Relating Gain/Loss to Algorithmic Entropy

- Why? Perhaps because:
  - Compression algorithms operate by finding (various sorts of) recurring patterns in the data and exploiting them.
  - A price signal with no recurring patterns would probably not be profitable, and also would not compress well!