The Intelligent Hedge Fund

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Thesis:	Agents in the Market Place – An Exploratory Study on Using Intelligent Agents to Trade Financial Instruments
Field:	Artificial Intelligence
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- **Developing an "autonomous" hedge fund, where intelligent software agents make all the trading decisions.**

Hedge Fund – loosely regulated private investment firm that trades other people's money for a fee, and is allowed to buy and short sell a wide range of financial instruments.

Typically, it employs many human traders, each being responsible for negotiating a specific set of financial instruments, and for trying to obtain the best return possible.
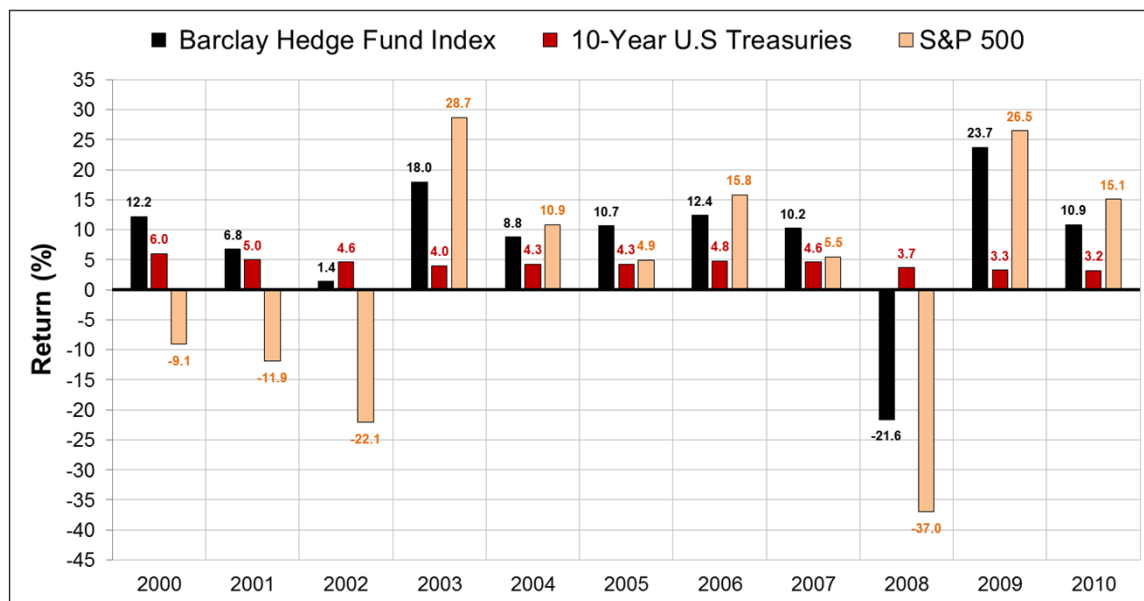
In our "intelligent" hedge fund, the intelligent agents replace the human traders.

Intelligent agents – autonomous, goal-driven entities.

Advantages of intelligent agents vs. human traders:

- *Cheaper* (no salary, no annual bonus)

- *Tireless* (can trade 24h/day, 7 days/week, with no breaks or vacation time)

- *Emotionless* (not affected by fear or greed)

- More *reliable* (no rough traders, no fraud)

- *Faster* (making decisions and opening trades)

The average hedge fund in existence today is not very efficient compared to safer passive investment strategies!

| Average Annual Return 2000-2010	
Barclay Hedge Fund Index	8.5%*
10-Year U.S. Treasuries	4.3%
S&P 500	2.5%

* Inflated due to survivorship bias, fraud, Taleb distribution investment strategies.

The industry needs better solutions!

Successful intelligent hedge funds could become an important part of the financial services industry.

Our research: a new hybrid cognitive architecture for implementing intelligent trading agents.
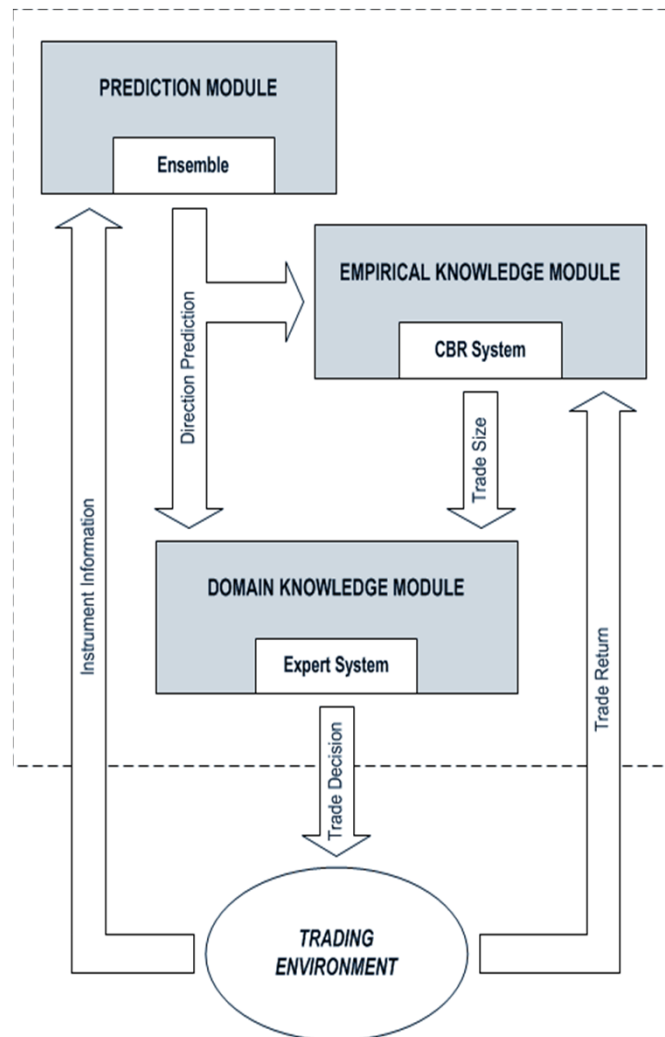
iQuant EURUSD 6h

Portfolio

1.4157   1.4158

Action	Price	Filled	Remaining	Status
SELL	1.4164	0	50000	Submitted

☑ AUTO ON

EUR/USD 6h

Start

Clean Log

Instrument	Quantity	Price	Pips	EUR	USD
eurusd	50000	1.4132	25.0	88.3	125.0

Prediction

[19:00:00 18/08/2009] -> [01:00:00 19/08/2009]

UP

Model	Long Acc	Short Acc	Long Ret	Short Ret	Corr	Vote	Weight
NaiveBayes	52.7	49.2	18.83	10.1	94.0	UP	0.0
LibSVM1	53.8	49.1	17.95	9.22	72.0	DOWN	-0.0
SimpleCart	53.1	49.7	20.75	12.02	70.0	UP	0.0
LibSVM2	52.3	46.8	13.12	4.39	74.0	DOWN	-0.1029
LeastMedSq	54.0	50.8	25.4	16.67	74.0	UP	0.0
KStar	53.4	48.5	21.96	13.23	74.0	UP	1.0462
RBFNetwork	52.3	47.9	5.21	-3.52	94.0	UP	0.0
ENSEMBLE	53.1	48.2	24.01	12.61	----	UP	0.9433

Empirical Knowledge

Accuracy: 50.0% [13 in 26]

Profit Factor: 0.7772 [4.5744 won, 2.574 lost]

0 models ignored.

Domain Knowledge

Normal investment. Trade multiplier is 1.

BUY $50000 @ 1.4131, 33 pips take profit (0.2379%).

Multi-agent

| Agent	Type before	Type after

Result:

Time:

```
23:07:45 18/08/2009 - Checking table...
23:07:45 18/08/2009 - ------------------------------------
23:07:45 18/08/2009 - Requested reconnect: First connect.
23:07:46 18/08/2009 - Client connected.
23:07:46 18/08/2009 - Starting agent thread...
23:07:46 18/08/2009 - Requesting historical data...
23:07:47 18/08/2009 - Request completed.
23:07:47 18/08/2009 - Data tables updated (0 rows inserted).
23:07:51 18/08/2009 - 6896: 0.9433.
23:07:51 18/08/2009 - Ensemble tables updated.
23:07:54 18/08/2009 - Agent thread running.
23:07:54 18/08/2009 - ------------------------------------
23:08:14 18/08/2009 - Inserted 1 new rows in eurusd_6h after 1 tries.
23:08:17 18/08/2009 - 6896: 0.9433.
23:08:20 18/08/2009 - Current status: sold 100000 @ 1.413, New status: buy 50000, Trade: buy 150000 @ 1.4131
23:08:20 18/08/2009 - Invert trade.
```

- 25 intelligent trading agents

- Each agent trades a stock in the NASDAQ or NYSE markets (tickers: AA, AAPL, ADBE, BAC, CAL, CSCO, DELL, DIS, GE, GOOG, HD, IBM, INTC, JNJ, KFT, KO, MCD, MRK, MSFT, NVDA, PFE, T, VZ, WMT and XOM).

- After each trading session, the agent tries to predict what will happen to the stock's price during the following day, from open to close.

- If it predicts the price will increase (*UP*), it buys the stock when the market opens (13:30 GMT), and sells it during the day or when the market closes (20:00 GMT); if it predicts the price will decrease (*DOWN*), it short sells the stock at the open and covers during the day or when the market closes.

- All the agents were configured with the same settings, except for the set of models in their Prediction Modules (which was decided by an automatic process, to avoid biasing the results).

Out-of-sample simulated trading results from February 2006 till September 2011:
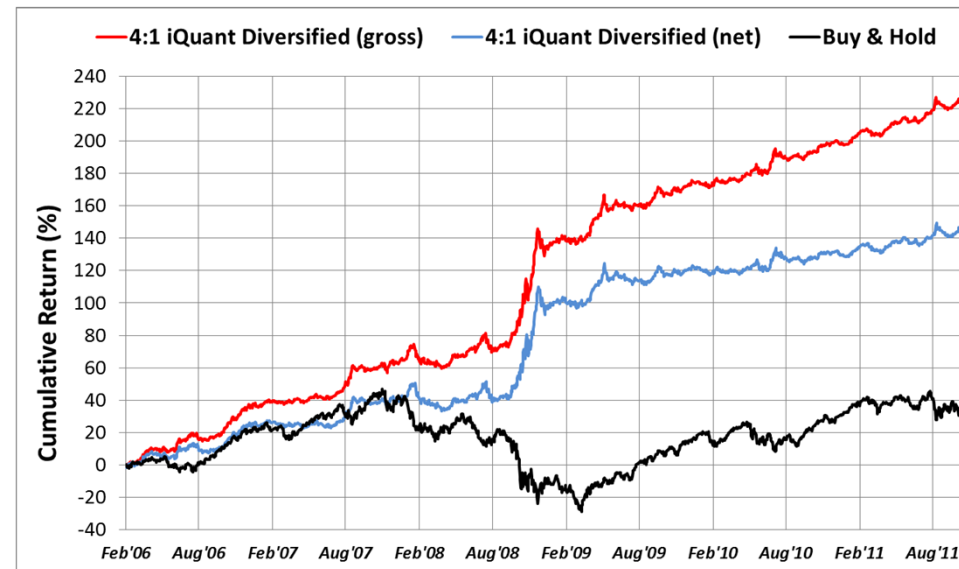
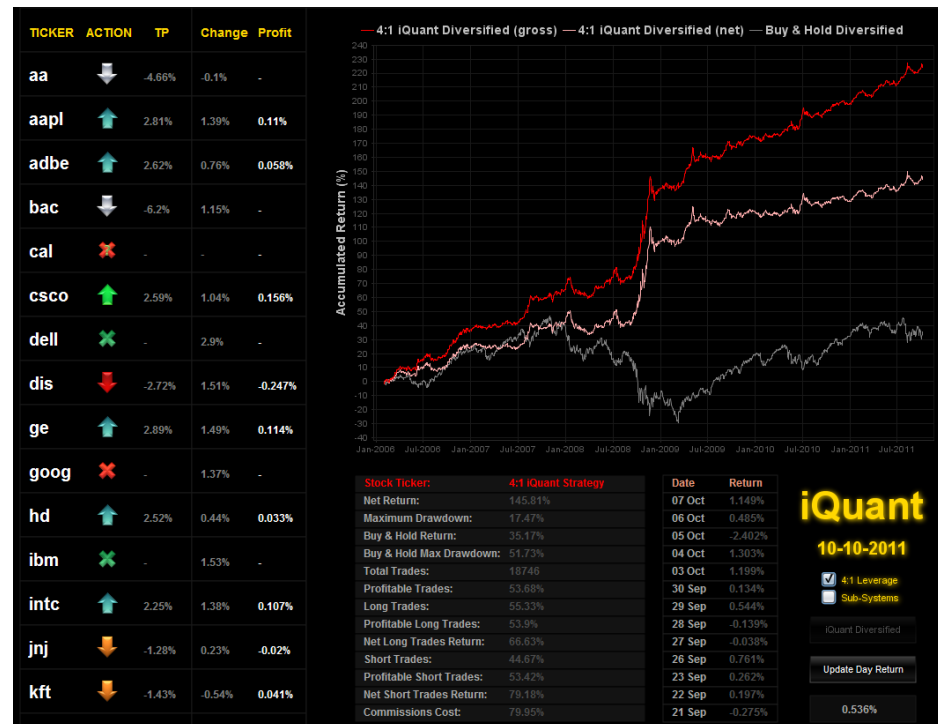| Strategy	Return	Maximum Drawdown
iQuant (Net)	145.8%	17.5%
Buy & Hold	35.2%	51.7%

- No follow-up (updated results) on most studies on this subject!

- Our solution: a public website in which the agents post their predictions before market open.

- The 25 predictions are posted daily, at around 11:00 GMT (several hours before trading begins).

http://ruibarbosa.eu/iquant
(available since January 2009)

Due to several self-imposed restrictions, results can be much improved:

- Individual fine-tuning of each agent
- Instrument-specific training attributes
- The worst agents should be fired, and replaced with new ones

Next step: a bigger, better diversified multi-agent system, with hundreds of intelligent agents trading different financial instruments on different timeframes (to improve the investment diversification).

More Information

➢ Barbosa, R., & Belo, O. (2008). An Intelligent USD/JPY Trading Agent. Proceedings of the Adaptive and Learning Agents and Multi-Agent Systems Workshop at AAMAS'08, pp. 1-7.

➢ Barbosa, R., & Belo, O. (2008). Autonomous Forex Trading Agents. Advances in Data Mining: Medical Applications, E-Commerce, Marketing, and Theoretical Aspects, Springer Berlin / Heidelberg, pp. 389-403.

➢ Barbosa, R., & Belo, O. (2008). Algorithmic Trading Using Intelligent Agents. Proceedings of the 2008 International Conference on Artificial Intelligence, CSREA Press, pp. 136-142.

➢ Barbosa, R., & Belo, O. (2009). A Step-By-Step Implementation of a Hybrid USD/JPY Trading Agent. International Journal of Agent Technologies and Systems, IGI Publishing, Vol. 1, No. 2, pp. 19-35.

➢ Barbosa, R., & Belo, O. (2009). A Diversified Investment Strategy Using Autonomous Agents. Advances in Data Analysis, Data Handling and Business Intelligence. Springer Berlin / Heidelberg, pp. 339-350.

➢ Barbosa, R., & Belo, O. (2009). Lazy Classification Using an Optimized Instance-Based Learner. Intelligent Data Engineering and Automated Learning. Springer Berlin / Heidelberg, pp. 66-73.

➢ Barbosa, R., & Belo, O. (2010). Multi-Agent Forex Trading System. Agent and Multi-Agent Technology for Internet and Enterprise Systems, Springer Berlin / Heidelberg, pp. 91-118.

➢ Barbosa, R., & Belo, O. (2010). The Agent-Based Hedge Fund. Proceedings of the 2010 IEEE/WIC/ ACM International Conference on Web Intelligence and Intelligent Agent Technology, IEEE Computer Society Press, Vol. 2, pp. 449-452.

➢ Barbosa, R., & Belo, O. (2010). A Step-By-Step Implementation of a Multi-Agent Currency Trading System. Developments in Intelligent Agent Technologies and Multi-Agent Systems: Concepts and Applications, IGI Publishing, pp. 213-253.

➢ Barbosa, R., & Belo, O. (2011). An Agent Task Force for Stock Trading. Advances on Practical Applications of Agents and Multiagent Systems, Springer Berlin / Heidelberg, pp. 287-297.

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