An Evolutionary Approach for Forex Trading Based on Technical Indicators

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Outline

The idea of the work I

- Trading strategies based on charts have been used for identification of market trends
- They're developed from experts' previous experience and sometime sinthesized in heuristics for investing
- In general they're executed manually by humans and sometimes they're implement in a computer robot, which automates the decisions
- There are fully automatic and semi-automatic robots. Fully automatic supposes that the robot is very good and won't make mistakes. Therefore, most of them is semi-automatic and relatively simple to implement and setup
- More elaborated robots require large expertise, their implementation is relatively complex, computing time may be huge and the setup is complex in general (a large search space).

The idea of the work II

- This presentation shows a relatively complex strategy (based on the expertise of the trading team of IBILCE/UNESP, leadered by Geraldo Silva[1]) that was setup by an Evolutionary Algorithm in order to avoid mistakes and to improve profits obtained by the strategy.
- The results show the optimized strategy has avoided mistakes (mistakes due to naive setups), losses and mainly increased profits, returning a profit of 20% in the test performed.

[1] Silva, G.; Fiorucci, J.A. (PhD supervised by Louzada, F.); Popp, M.; Oliveira, V.H.C.

Outline

Definition of Technical Analysis for Trading

- Murphy (1999) defines Technical Analysis as "the study of market action, primarily through the use of charts, for the purpose of forecasting future price trends"
- Market action information sources (Murphy, 1999)
  - Price
  - Volume
  - Open interest
- Philosophy (Murphy, 1999)
  - Market action discounts everything
  - Prices move in trends
  - History repeats itself

Simple Moving Average – SMA

$$SMA(p, n) = \sum_{i=1}^{n} \frac{p_i}{n}$$

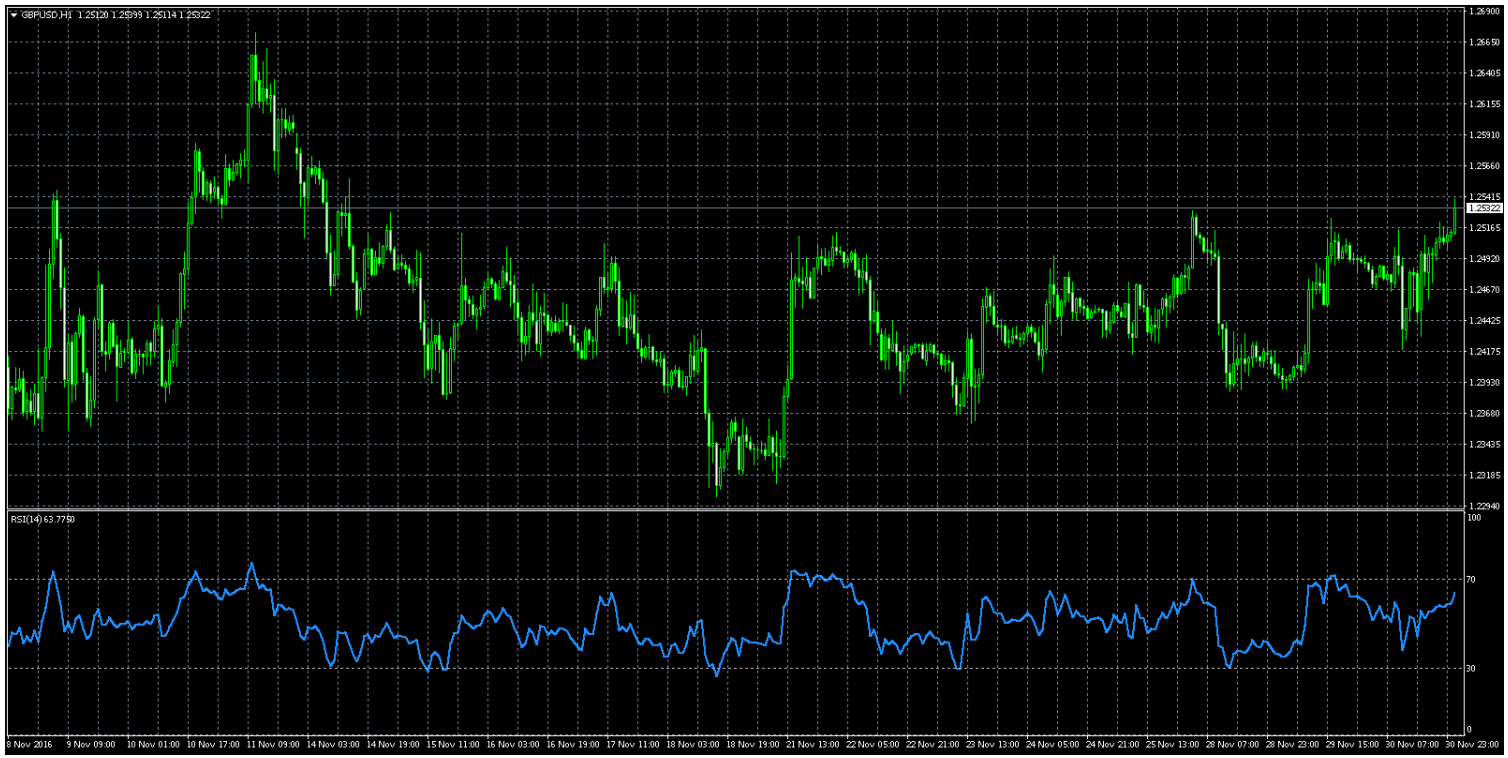
Examples of SMA[2] with 5, 30 and 80 periods

[2] http://www.fmlabs.com/reference/default.htm?url=SMA.htm

Relative Strength Index – RSI

$$\begin{aligned} RSI(p,n) &= 100 - \frac{100}{1-RS} \\ RS &= \frac{AvgUp}{AvgDn} \end{aligned}$$

Example of RSI (Wilder Jr, 1978) with 14 periods



Stochastic Oscilator

$$\begin{aligned} \%K &= \frac{close - lowest(n_K)}{highest(n_K) - lowest(n_K)} \\ \%D &= MA(\%K, n_D) \end{aligned}$$

Example of Stochastic Oscilator (Lane and M.D., 1984) with $n_K = 14, n_D = 3$ periods

Stochastic RSI

Apply Lane's Stochastic Oscilator over Wilder's Relative Strength Index

Fibonacci Retracement Lines

Fibonacci Retracement Lines are placed according to some ratios present in the Fibonacci sequence[3]

$$F_{n+1} = F_n + F_{n-1}$$

$$\frac{F_n}{F_{n-1}} \approx 1.618$$

$$\frac{F_n}{F_{n+1}} \approx 0.618$$

$$\frac{F_n}{F_{n+2}} \approx 0.382$$

$$\frac{F_n}{F_{n+3}} \approx 0.236$$

[3] http://stockcharts.com/school/doku.php?id=chart_school:chart_analysis:fibonacci_retracemen

Fibonacci Retracement Lines

These lines are used as support and resistance levels

Outline

GT Strategy – Currencies

- The idea: finding the pairs with the largest movement unbalance
- Based on the strength of the following currencies and the 21 currency pairs resulting of their combination

Symbol	Name
AUD	Australian Dollar
CAD	Canadian Dollar
EUR	Euro
GBP	Pound Sterling
JPY	Japanese Yen
NZD	New Zealand Dollar
USD	United States Dollar

GT Strength – Strength Matrixes

- Matrix 1: if the current price is above $SMA(Close, n)$
  $\rightarrow m \in \{-1, 1\}$
- Matrix 2: if the current price has retracted to Fibonacci's 0.382 level (using $SMA(Close, n)$)
  $\rightarrow m \in \{-1, 0, 1\}$
- Matrix 3: $M1 + M2 \rightarrow m \in [-2, 2] \cap \mathbb{Z}$
- Vector 4: sum of columns for each line $\rightarrow v \in [-12, 12] \cap \mathbb{Z}$

$$v[i] = \sum_{j=1}^{7} x_{ij}, i = 1, 2, ..., 7$$

- Matrix 4: strength difference between currencies $\rightarrow m \in [-24, 24] \cap \mathbb{Z}$

$$m[i, j] = v[i] - v[j], i, j \in [1, 7]$$

GT Strength – Selecting Currencies

Loop in time, taking risk per order and maximum risk into account.

- Choose, based on $M4$, the group of pairs with the higher strength difference ($>= 6$)
- Do not choose pairs which currencies have absolute strength (vector 4) below 4
- Some definitions
  - Stop loss is placed 15 pips below the last bottom
  - Take profit is placed $3 * (current - SL)$ pips above current price (TP:SL = 3:1)
  - Stochastic RSI: $stoch(RSI(n = 14), fastK = 5, fastD = 5, slowD = 3)$, using $fastD$ ($\%D$)

GT Strength – Order Management

- Order is open following the strength given by Matrix 4. BUY order example:
  - Current price is above $SMA(High, n)$ by at least 5 pips
  - Stochastic RSI is below 20% or 70% but falling
  - Pair strength given by $M3$ is 2 (max)
  - Last bottom must be below current price
  - When the candle opens below last top price the SL is updated to 15 pips below the last bottom
- Lot size is calculated based on risk per order

Geraldo's Team Strategy

- This is the strategy where most of Geraldo's team's effort is being applied to
- Here we used an optimization method based on Evolutionary Computation in order to verify if the setup can significantly improve profit and find the best setup

Outline

Genetic Algorithms

- Developed by Holland (1975), Genetic Algorithms are probabilistic search methods inspired by natural selection and genetics (Cunha et al., 2012).
- Reproduction, competition, mutation and selection

Algorithm 1 Genetic Algorithm Structure (Cunha et al., 2012)

1: $t \leftarrow 0$
2: Generate initial population $P(t)$
3: Evaluate individuals from $P(t)$
4: **while** Stopping criteria is not reached **do**
5: Select parents $P'(t)$ from $P(t)$
6: Apply genetic operators to $P'(t)$ to obtain new population $P(t+1)$
7: Evaluate $P(t+1)$
8: $t \leftarrow t+1$
9: Retrieve optimization final result

Genetic Algorithm

Selection and operators used

- Selection – Resampling by tournament of 2
- Crossover (70%) – BLX-α
- Mutation (1%) – Apply mutation factor $m \sim U(-5, 5)$ over 10% of chromosome's genes

Cromosome structure

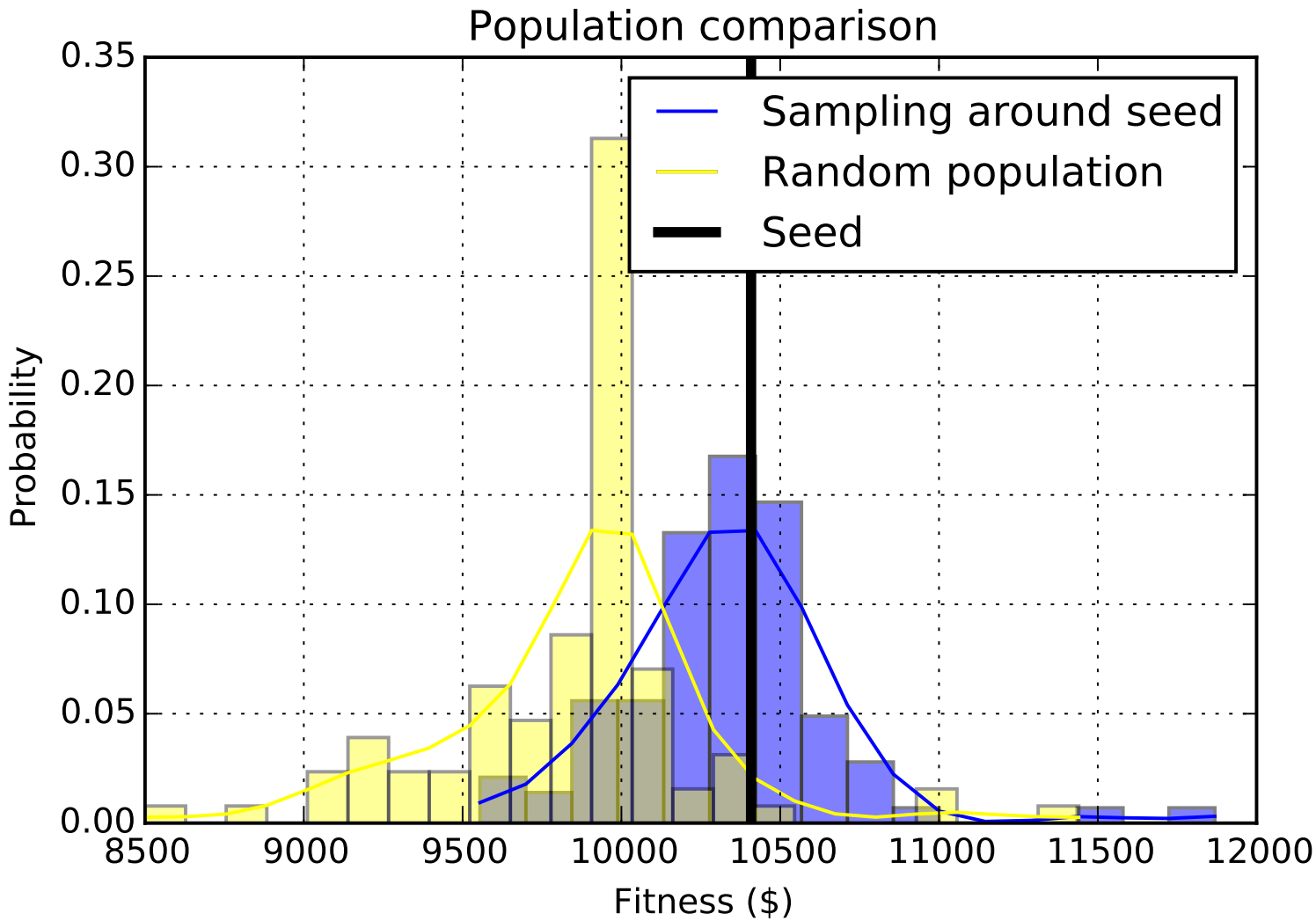
Vector with 240 integer values

- Risk per order and total risk (2)
- Update SL – pips until SL (21)
- Pair selection – SMA periods (21)
- Pair selection – Minimum pair strength difference given by M4 (21)
- Pair selection – Minimum currency strength given by V4 (7)
- Fibonacci – SMA periods (21)
- Pair selection – Minimum distance from SMA (21)
- Stochastic RSI – RSI periods (21)
- Stochastic RSI – Stochastic periods %K, %D and slowD (3*21)
- Order Management – Distance from last bottom to place Stop Loss (21)
- Order Management – Ratio TP:SL (21)

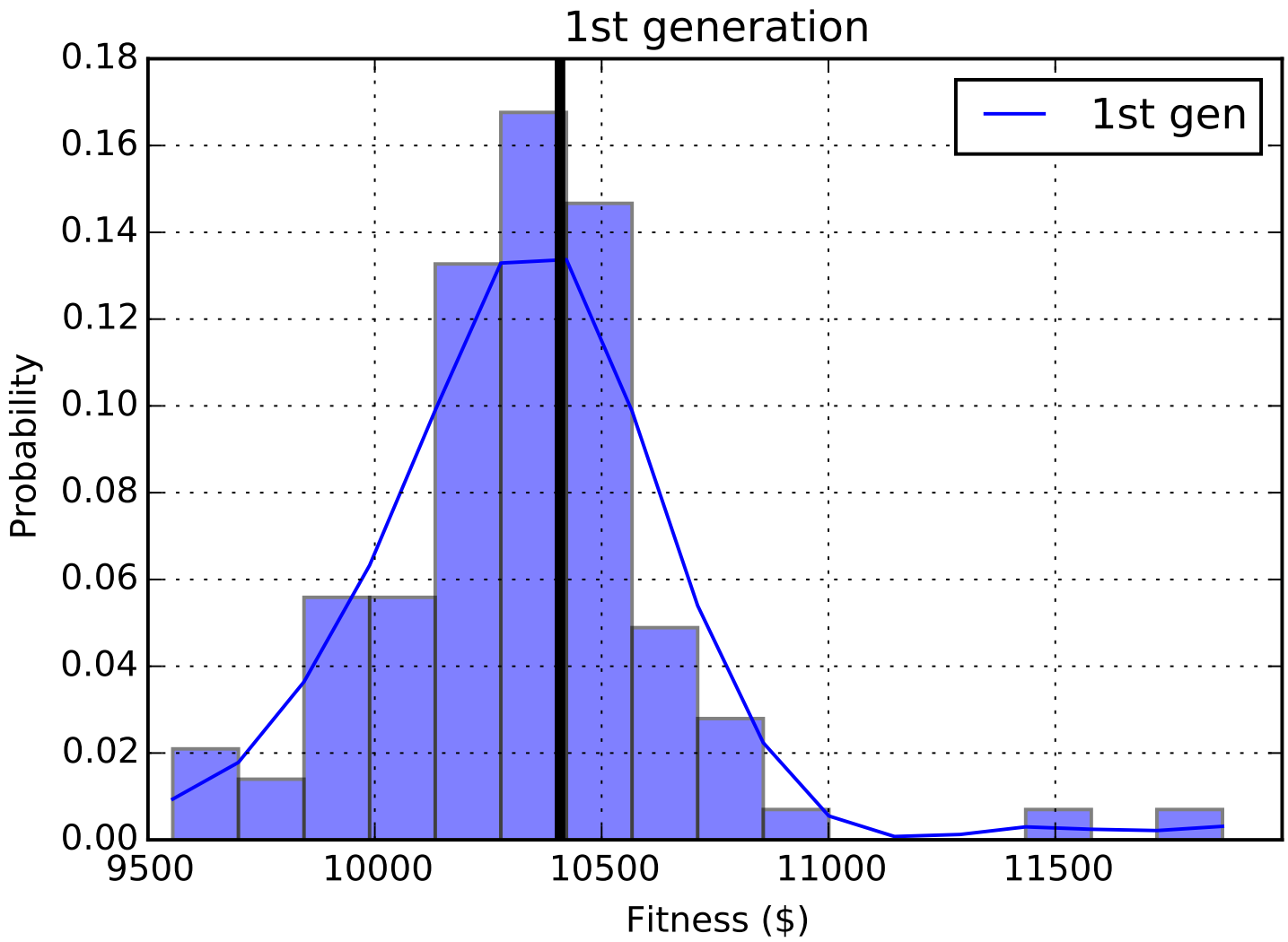
Outline

Results – Initial population with 100 chromosomes

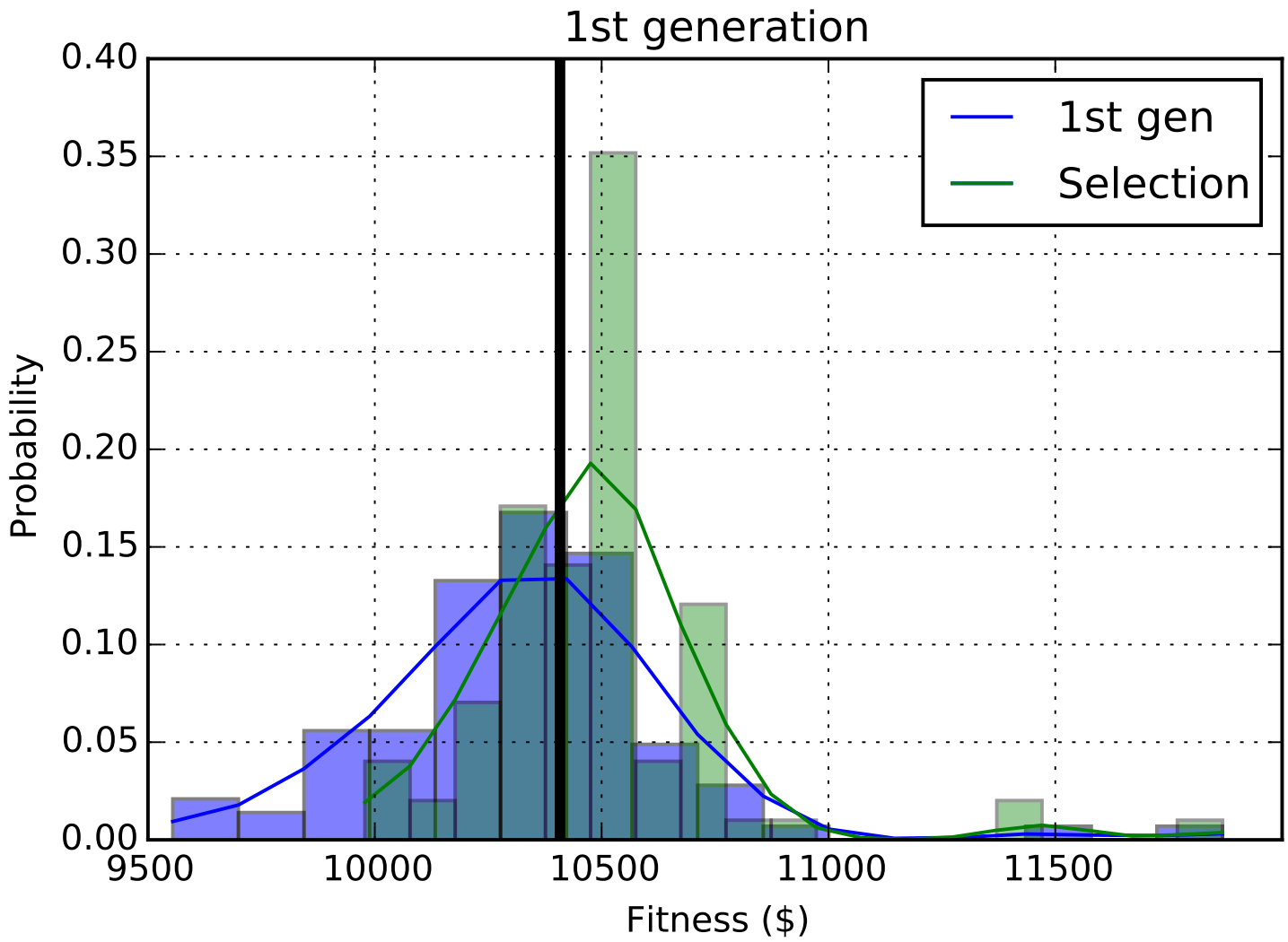
Chromosomes are generated around a setup seed (provided by Geraldo's team) with a final account balance of US$10408.29



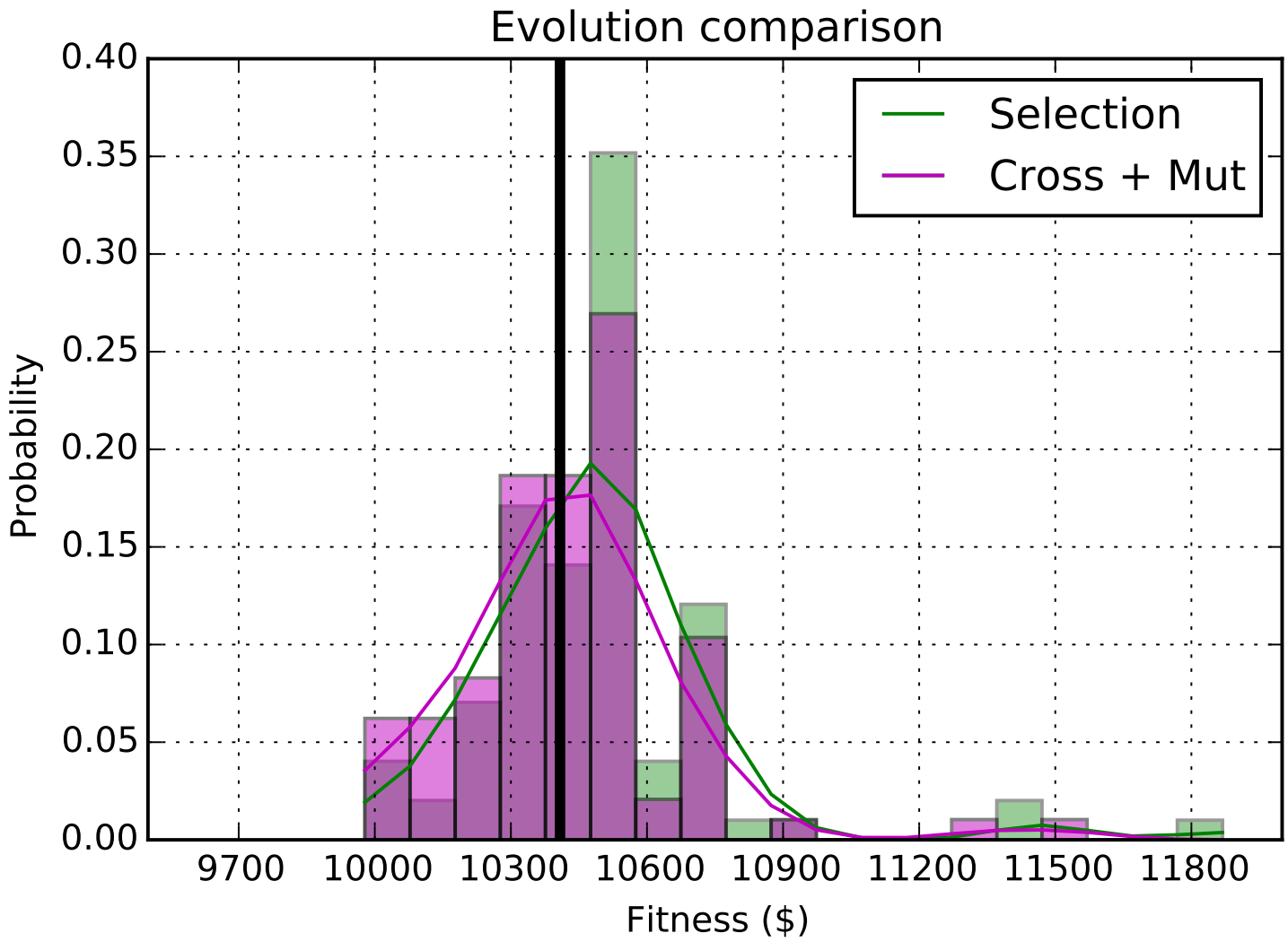
Results – Population around seed



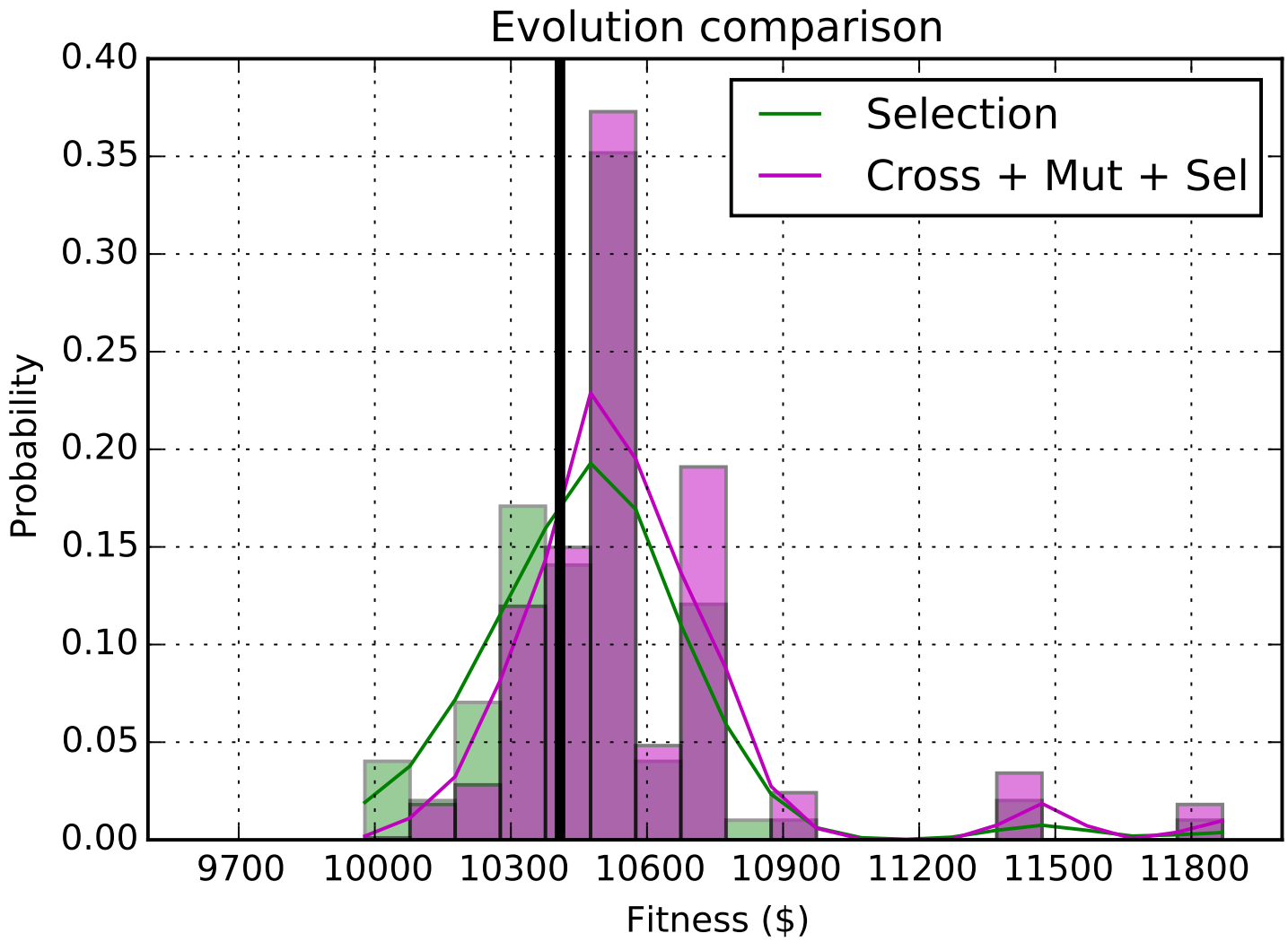
Results – Selection



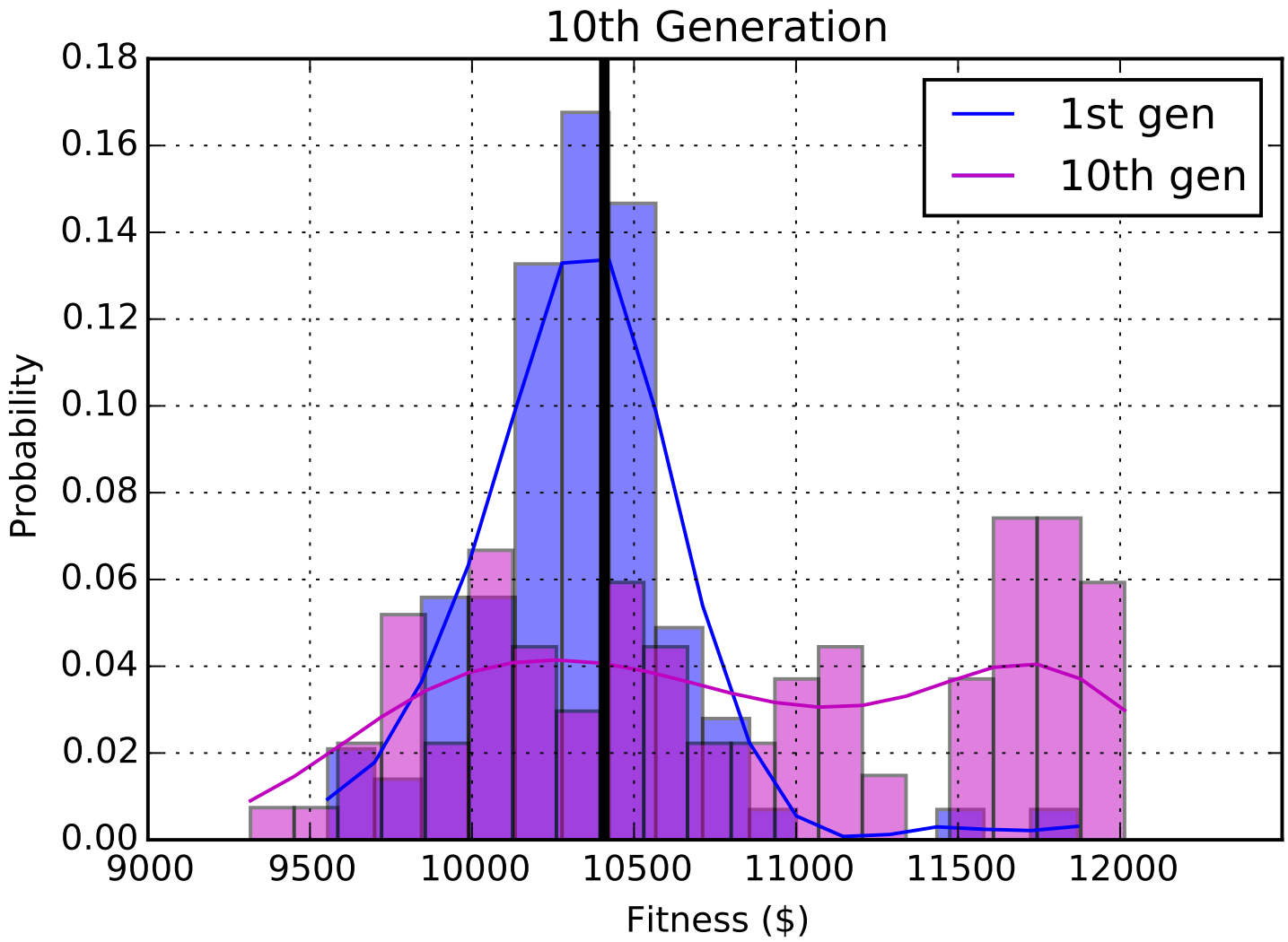
Results – Selection, crossover and mutation



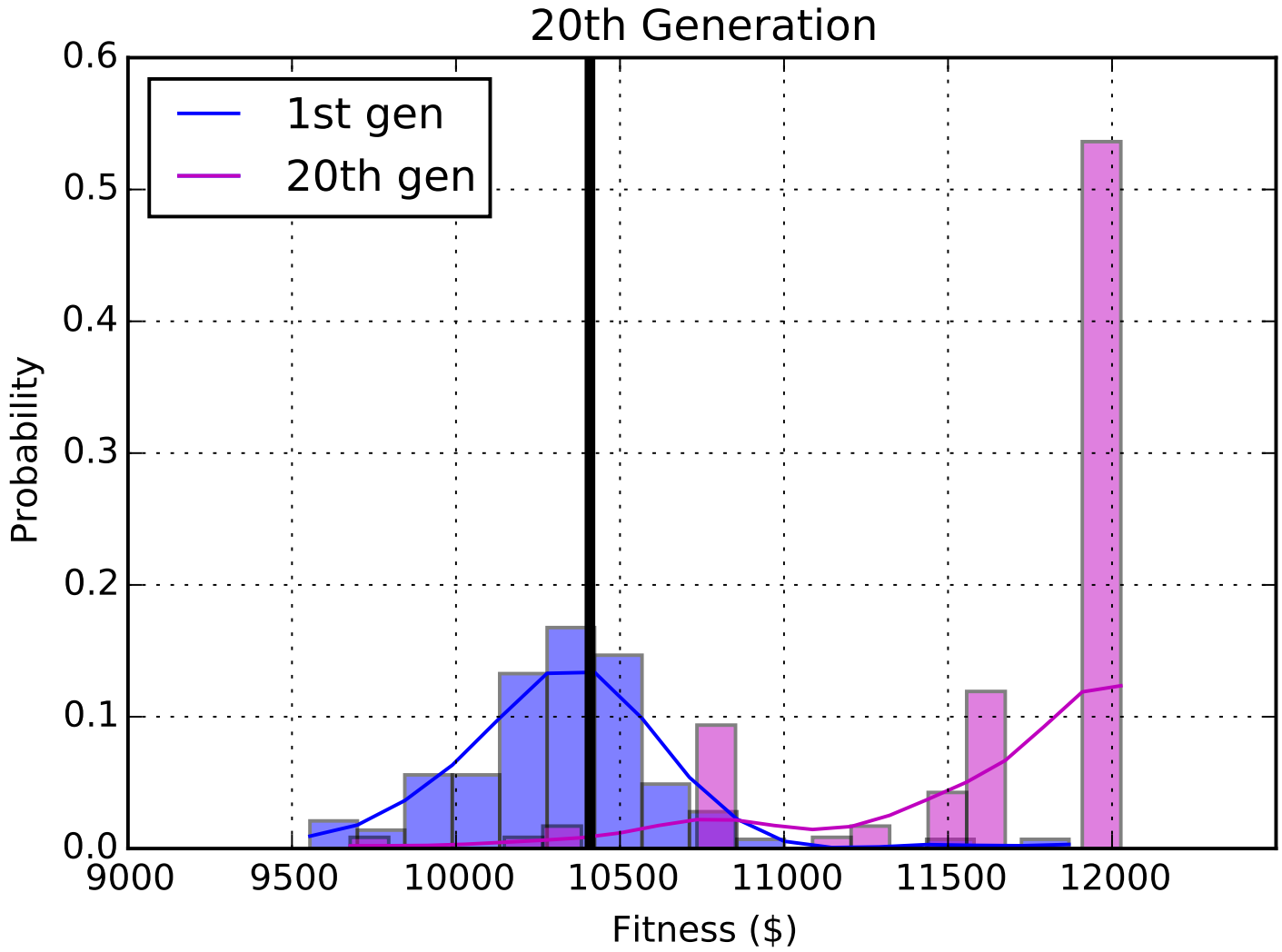
Results – Crossover, mutation and selection



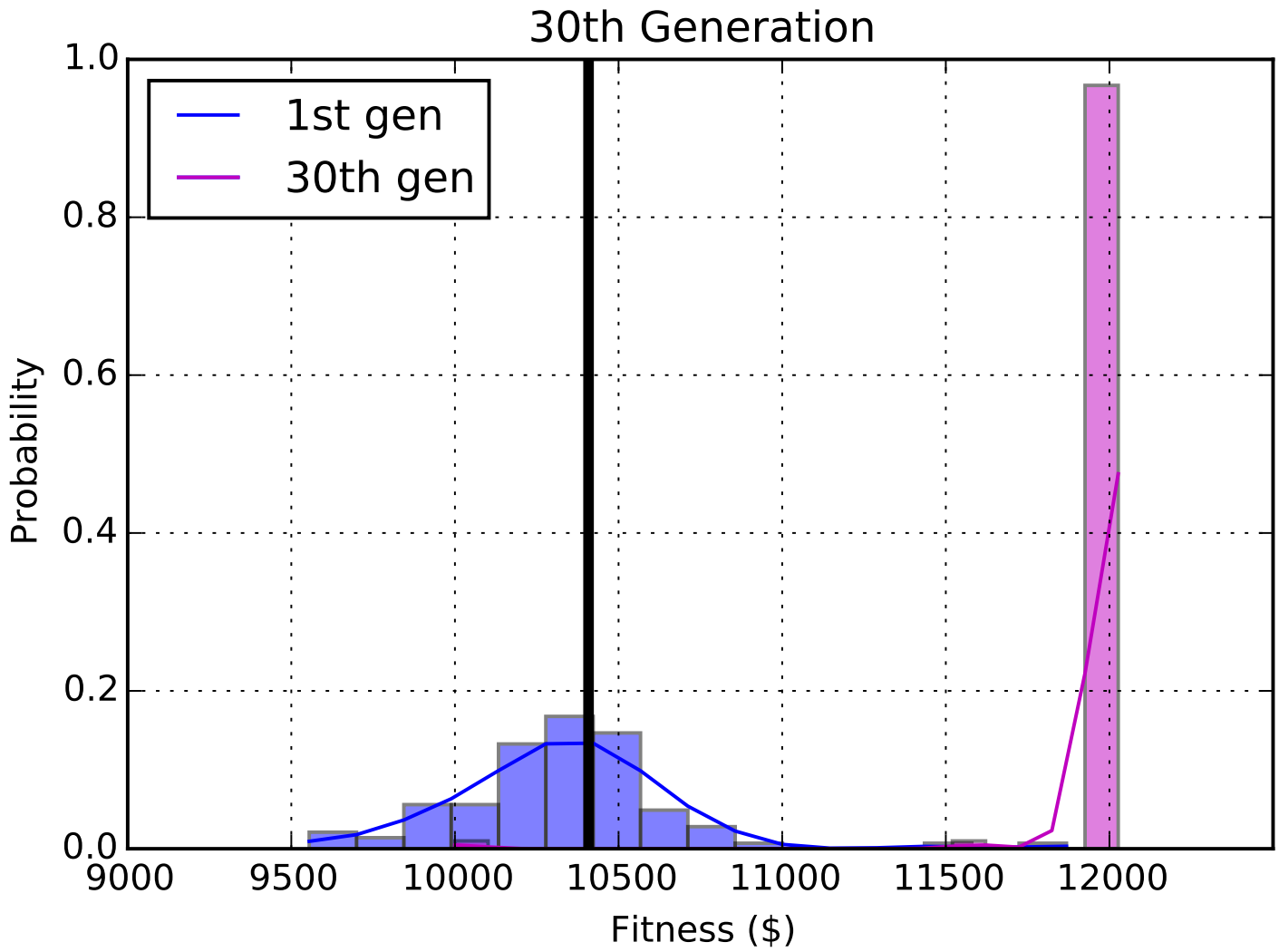
Results – 10th generation



Results – 20th generation



Results – 30th generation



Outline

Conclusions

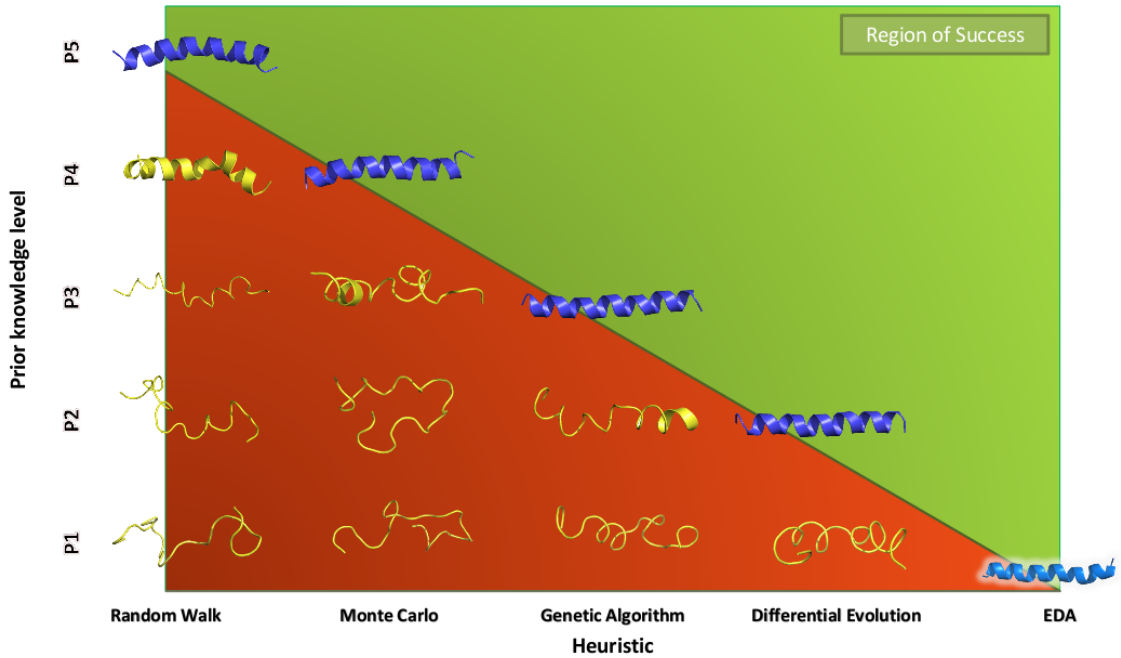
- The setup of a trading strategy by a GA can significantly improve final account balance
- 20% of augment in relation to a strategy developed by experts was achieved by the proposed GA

Future works I

- Test with larger periods and peform live trading (in real time)
- Test risk level controling (related to the account balance)
- Use risk and variance of return as objectives to minimize
  - Use them combined with final account balance, composing a three-objective problem
  - Then we can develop a multi-objective evolutionary algorithm for this problem
- Generate distribution of return according to the account balance and the period used for test

Future works II

- Evaluate other metaheuristics (Rodrigo and Bonetti, 2014)
  - Random Walk
  - Monte Carlo Metropolis
  - Differential Evolution
  - Estimation of Distribution Algorithms
  - They may require different levels of previous knowledge of the trader to succeed



Acknowledgments

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- PPG-CCMC from ICMC-USP

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