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Stock Trading Strategy Creation Using GP on GPU

Dave McKenney

Presentation Outline

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- Stock Market and Technical Analysis Introduction
- Description of Genetic Programming Method
- Why/How to Perform GP on GPU
- Running Time Comparisons
- Profitability Comparisons
- Conclusions and Future Work

The Stock Market

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- Each share of stock represents a piece of a company
- The value of a stock is the current price at which people are willing to buy/sell shares
- These values increase/decrease based on supply and demand of the stock in question

Technical Analysis

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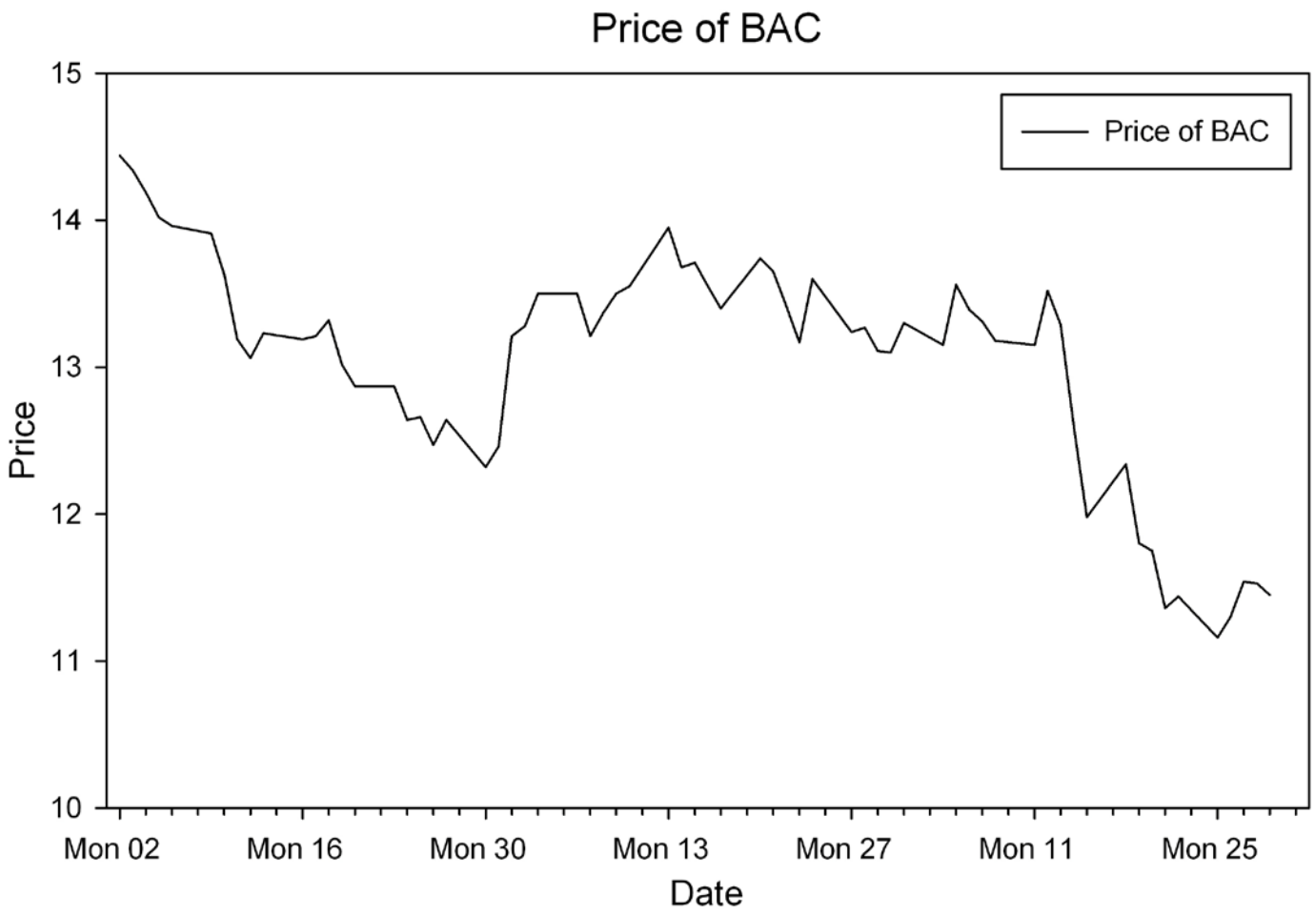
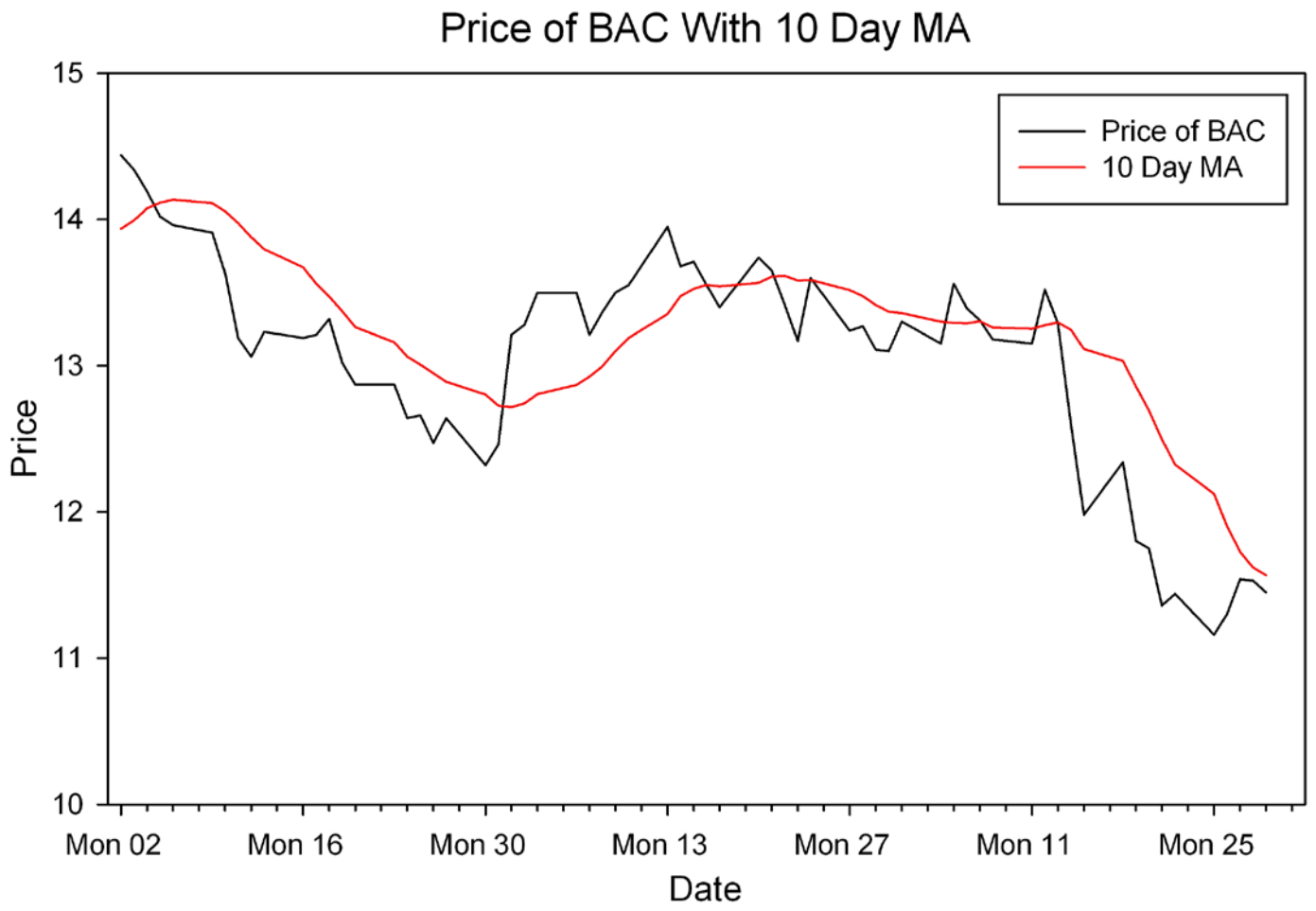
- Aims to identify mispriced stocks
- Decisions based on historical price/volume information
- Many indicators to consider
  - Moving Averages
  - Volume Indices
  - Ease of Movement

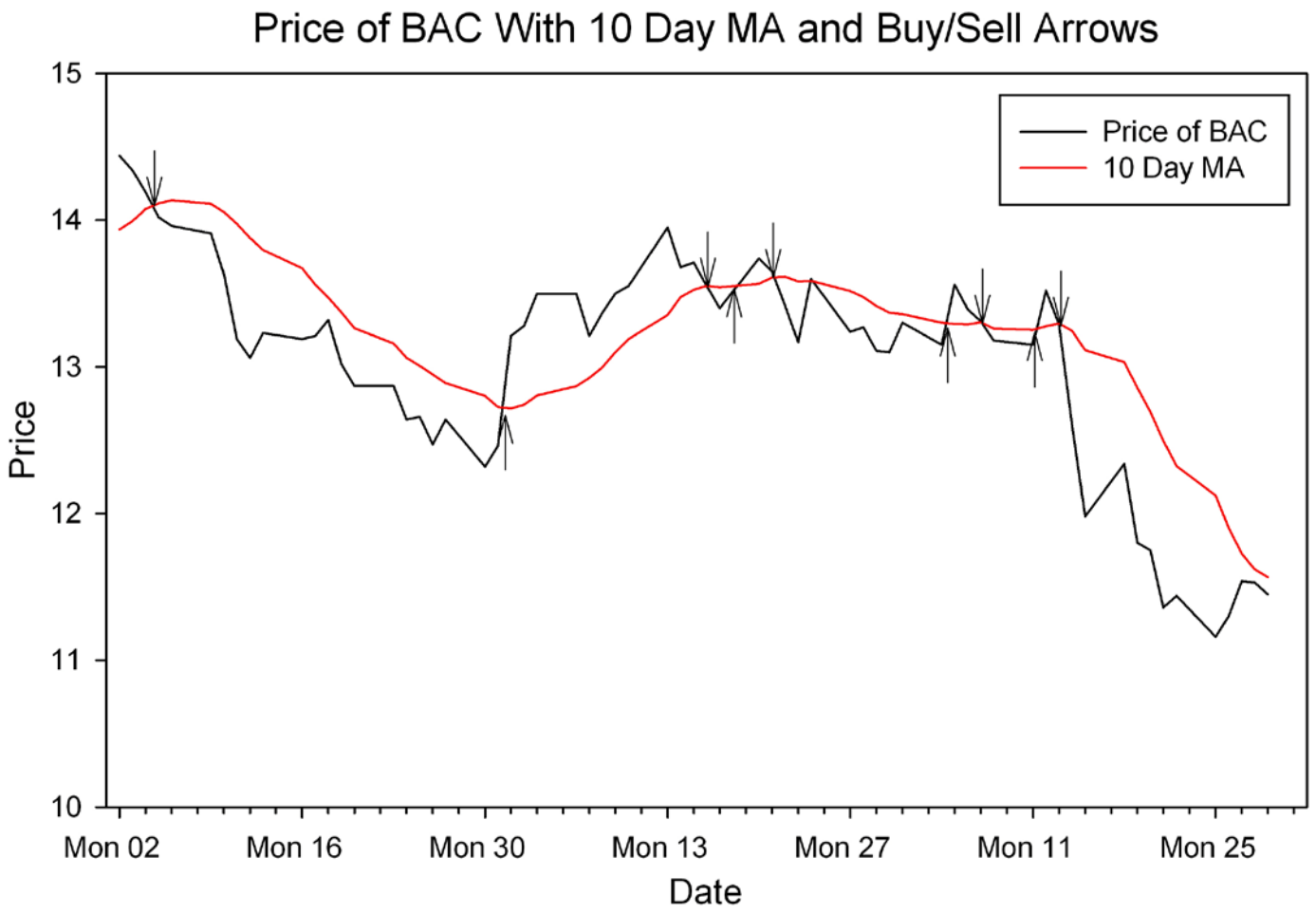
Technical Analysis



Technical Analysis



Technical Analysis



Genetic Programming

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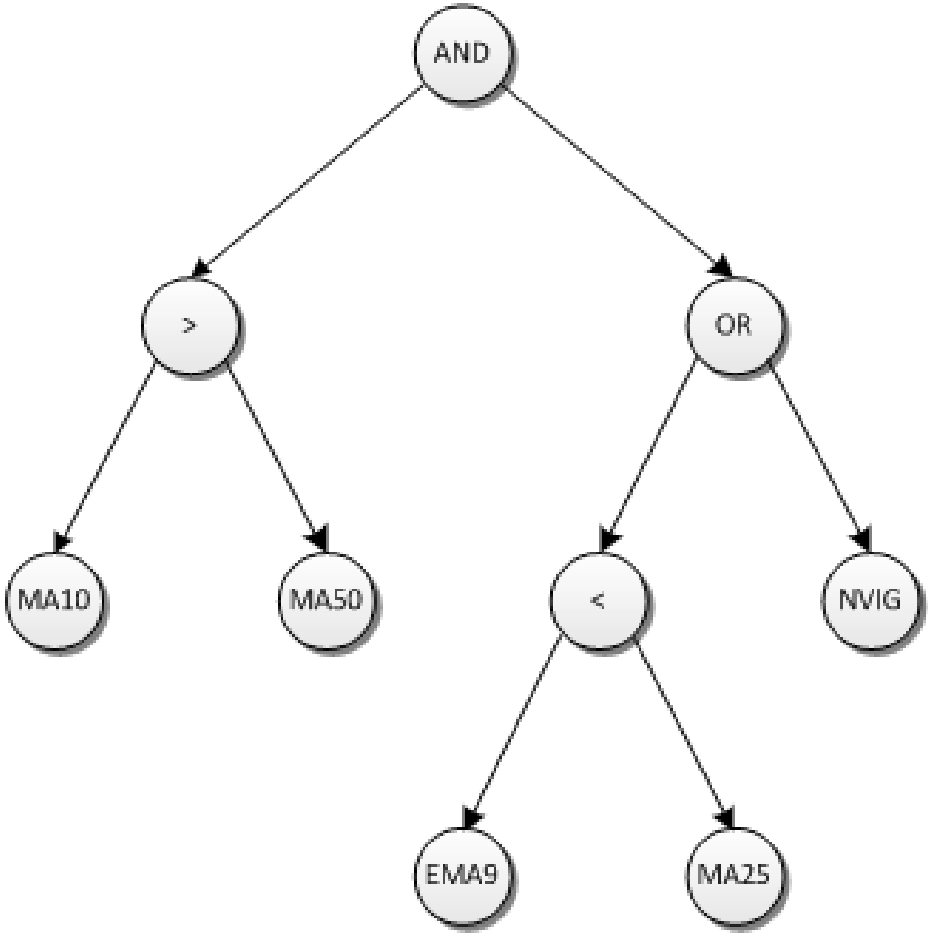
- An approach that aims to evolve programs which solve a problem effectively
- Programs are represented as trees, with inputs as leafs and functions as inner nodes
- Each individual is tested against training data which determines the individual's fitness

Example GP Tree



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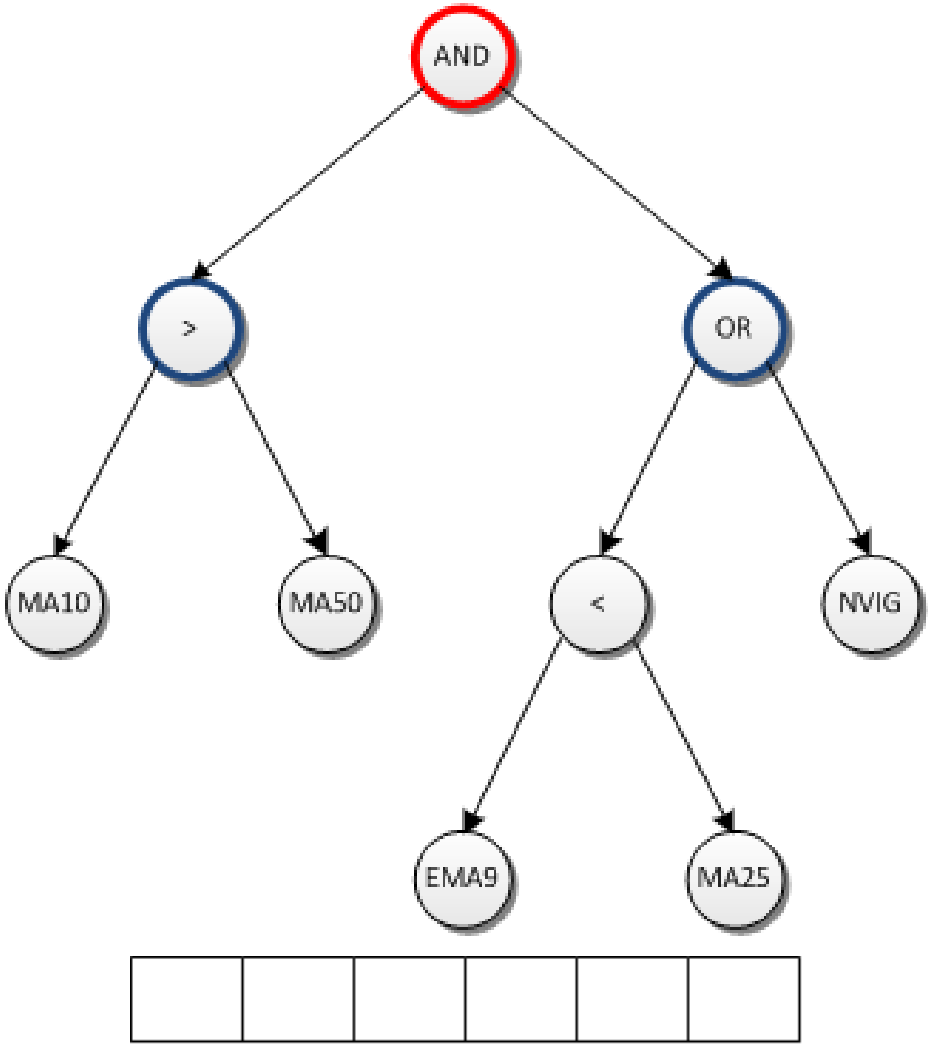

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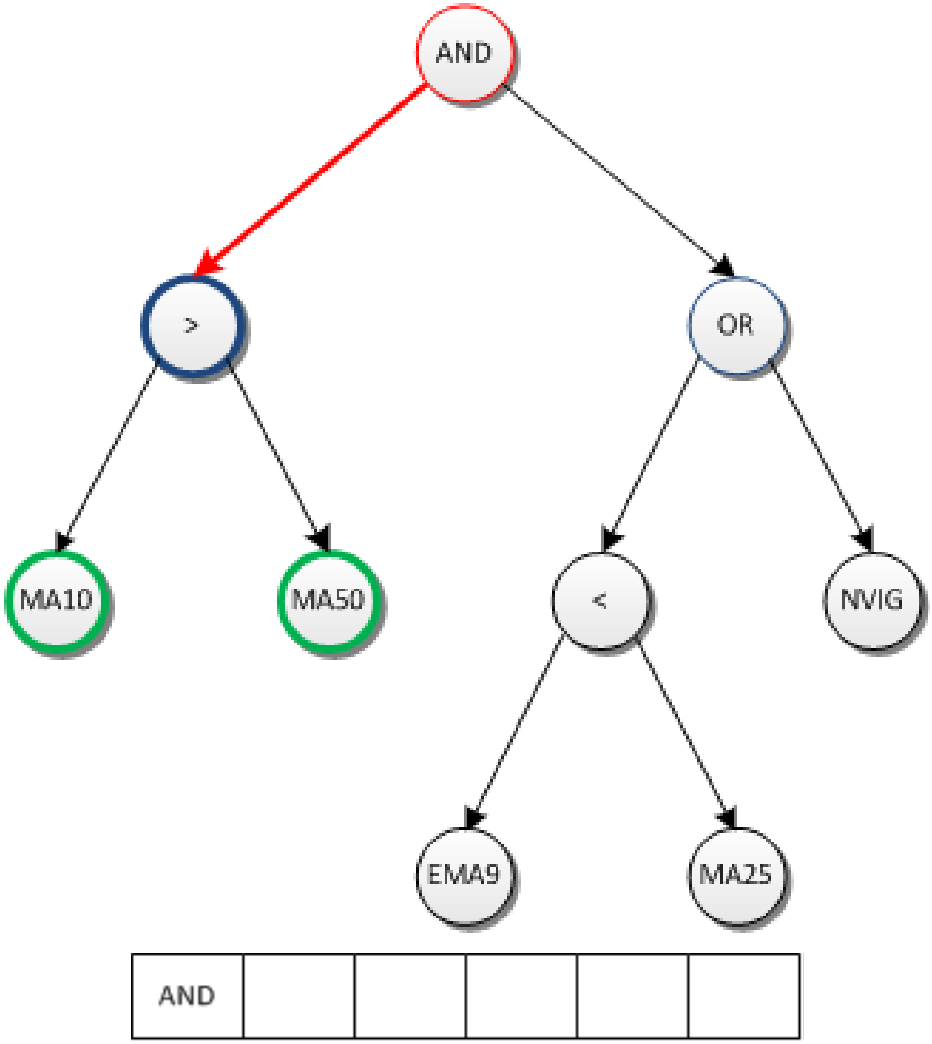

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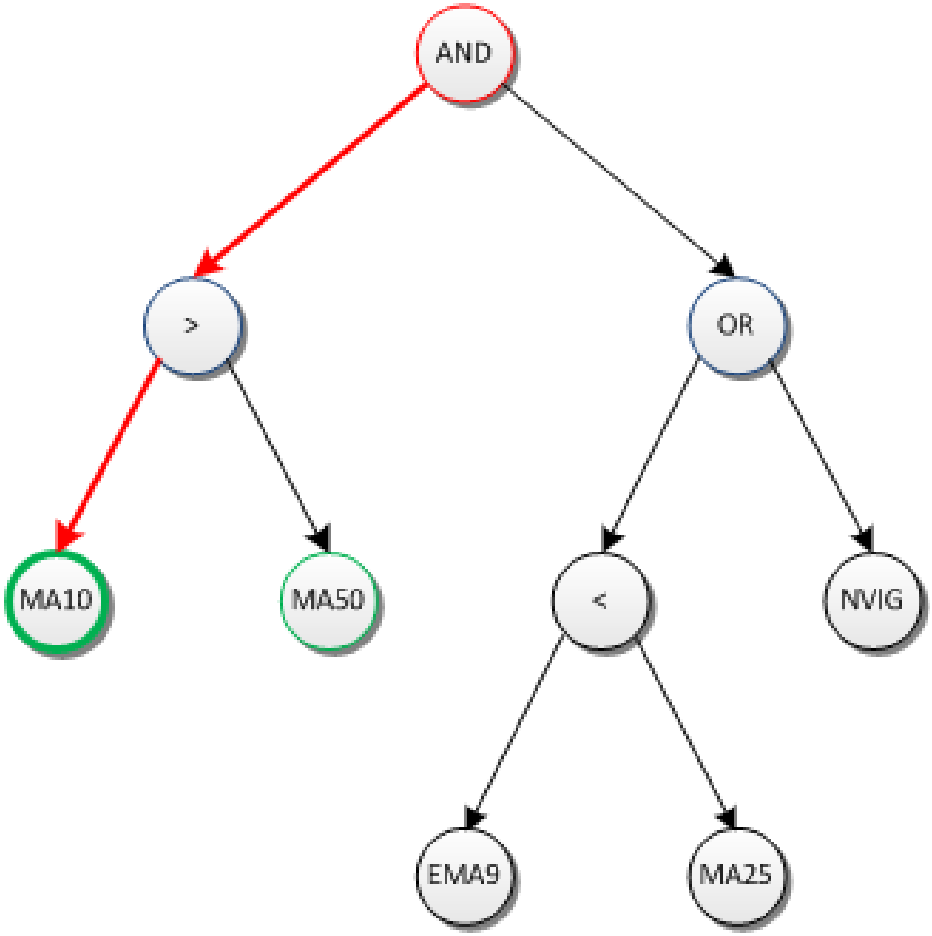

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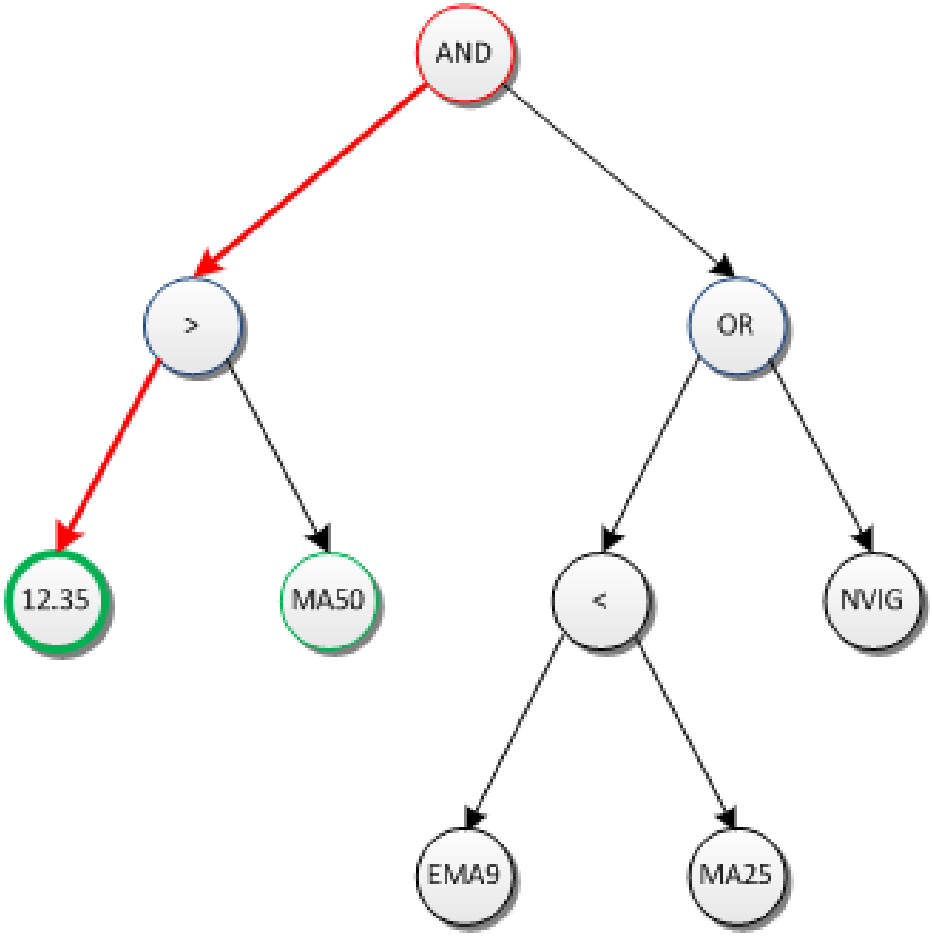
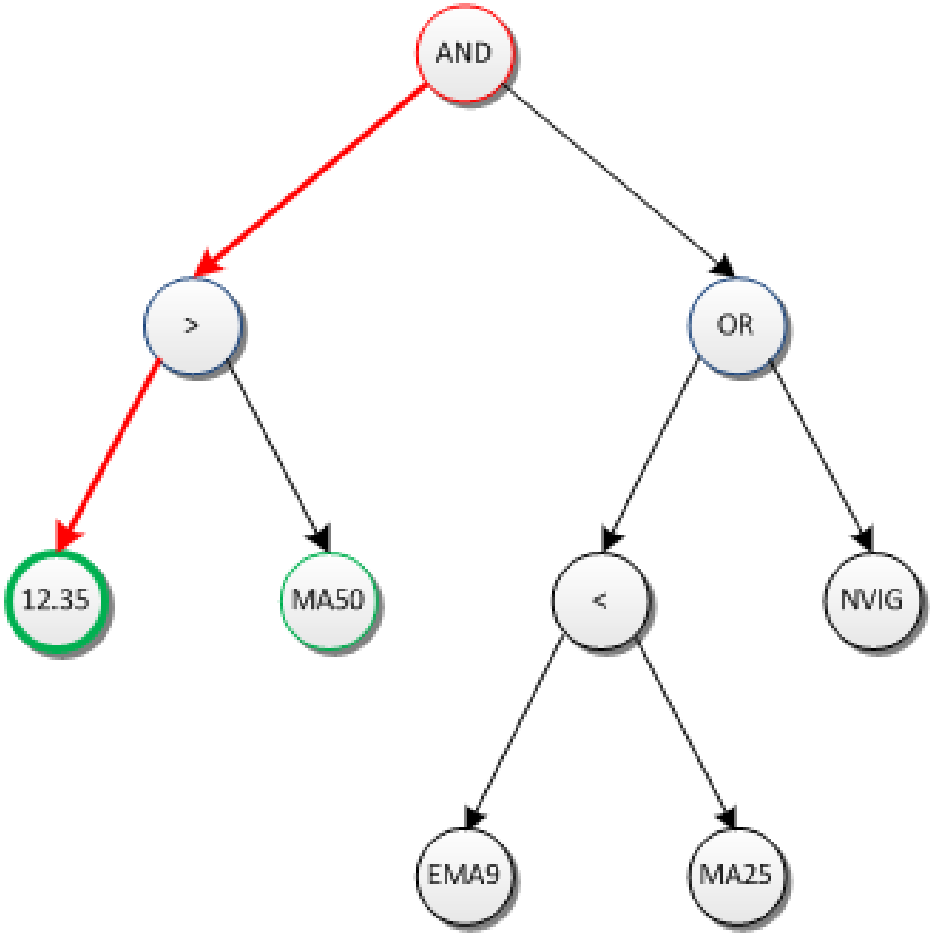
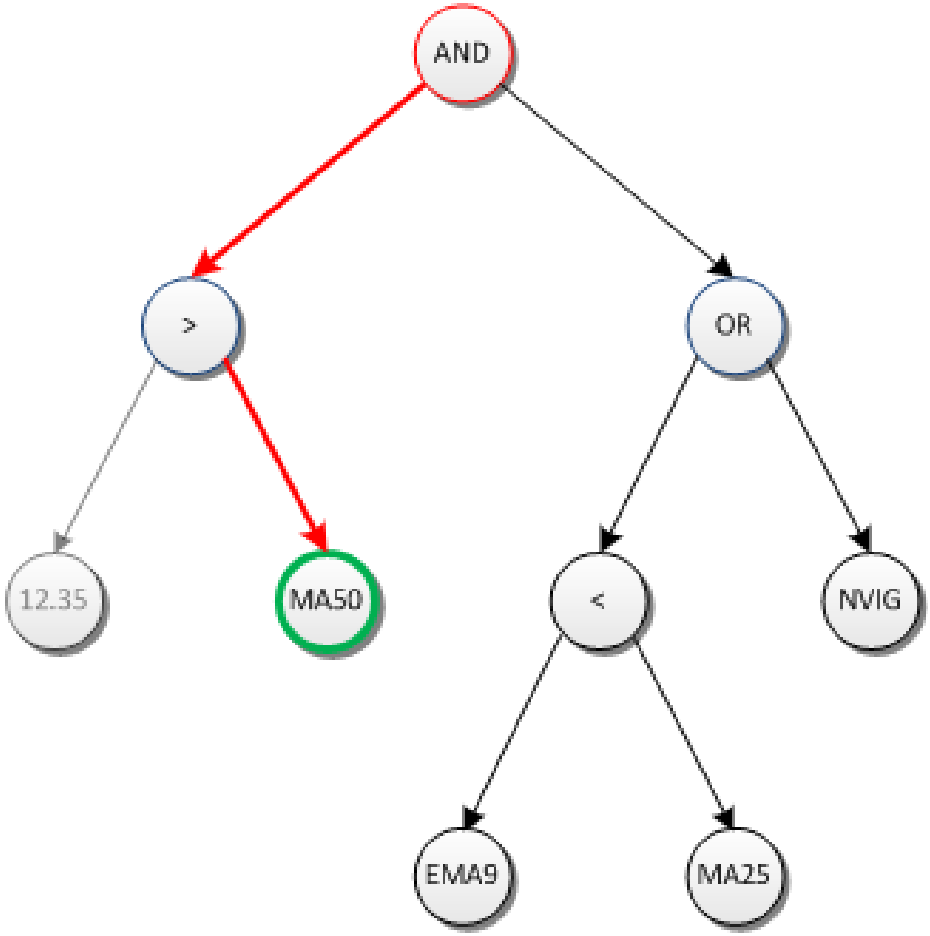


Example GP Tree



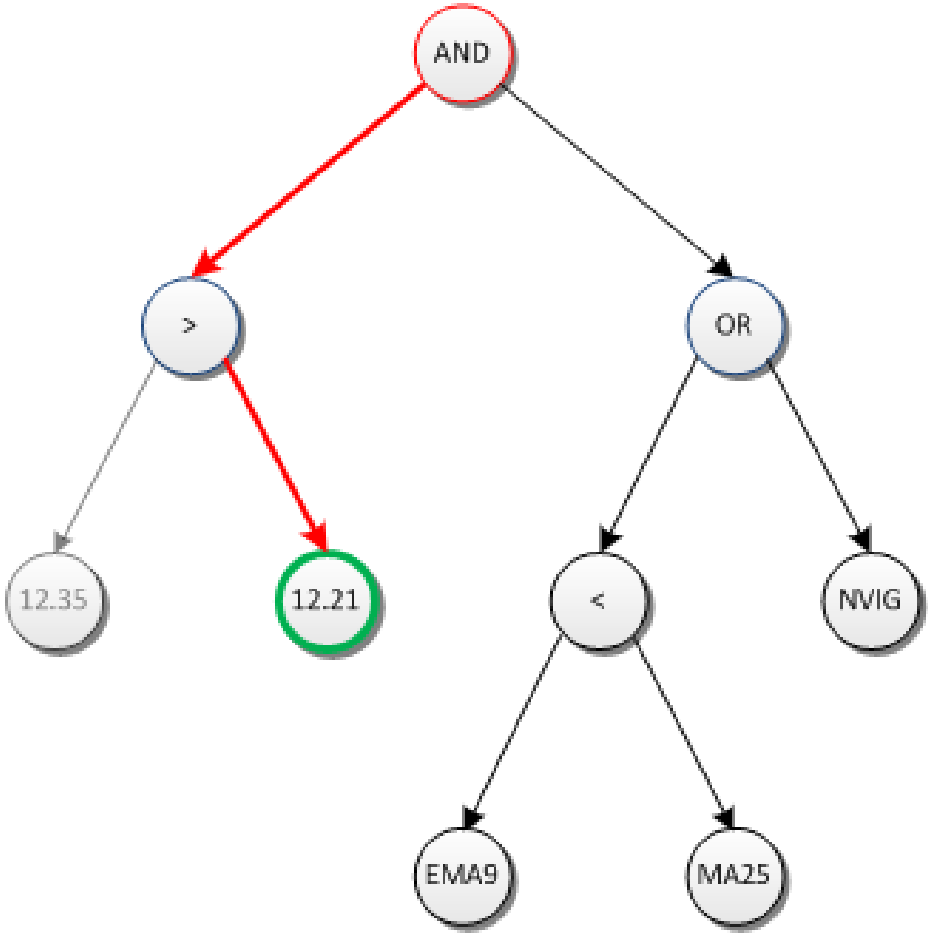
AND	>	12.35			

Example GP Tree



AND	>	12.35			

Example GP Tree



AND	>	12.35			

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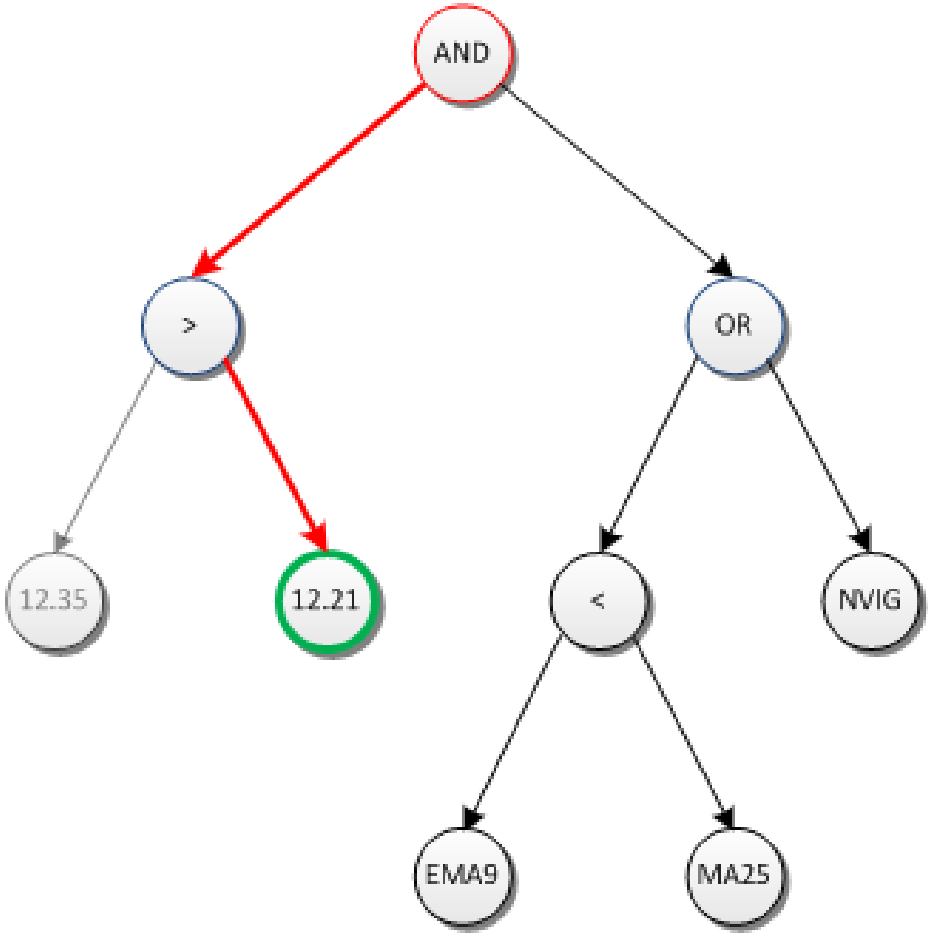
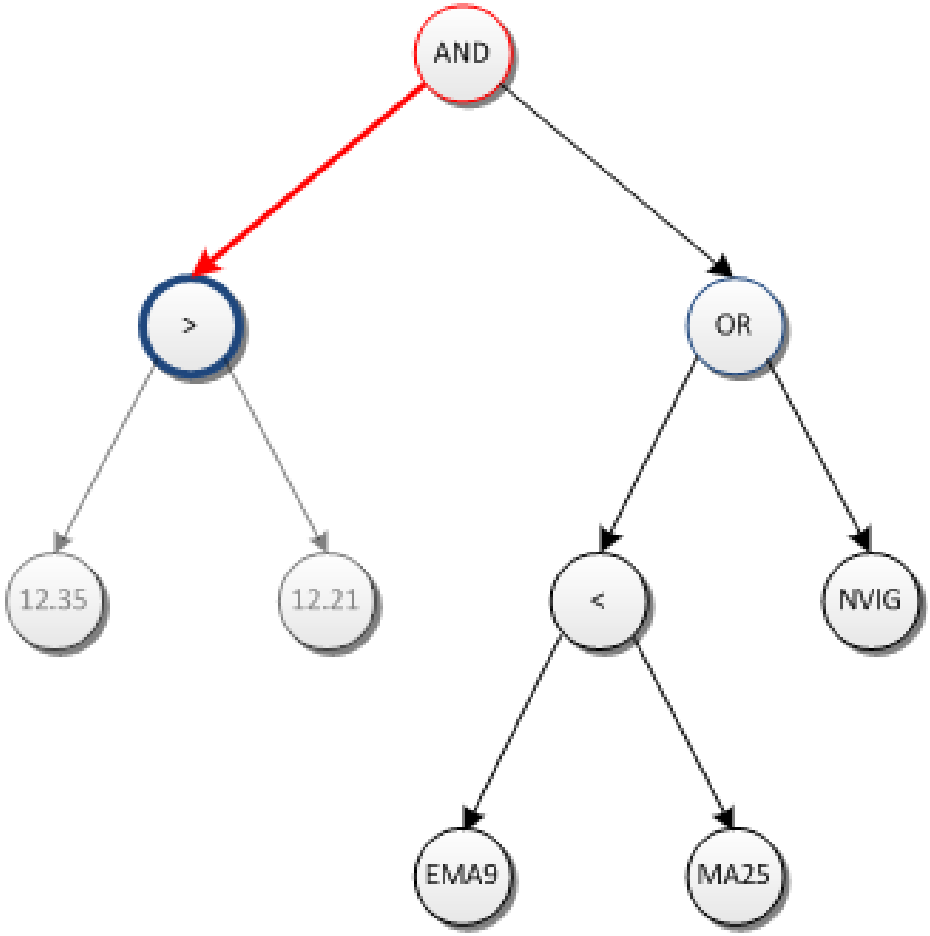


AND	>	12.35	12.21		

Example GP Tree



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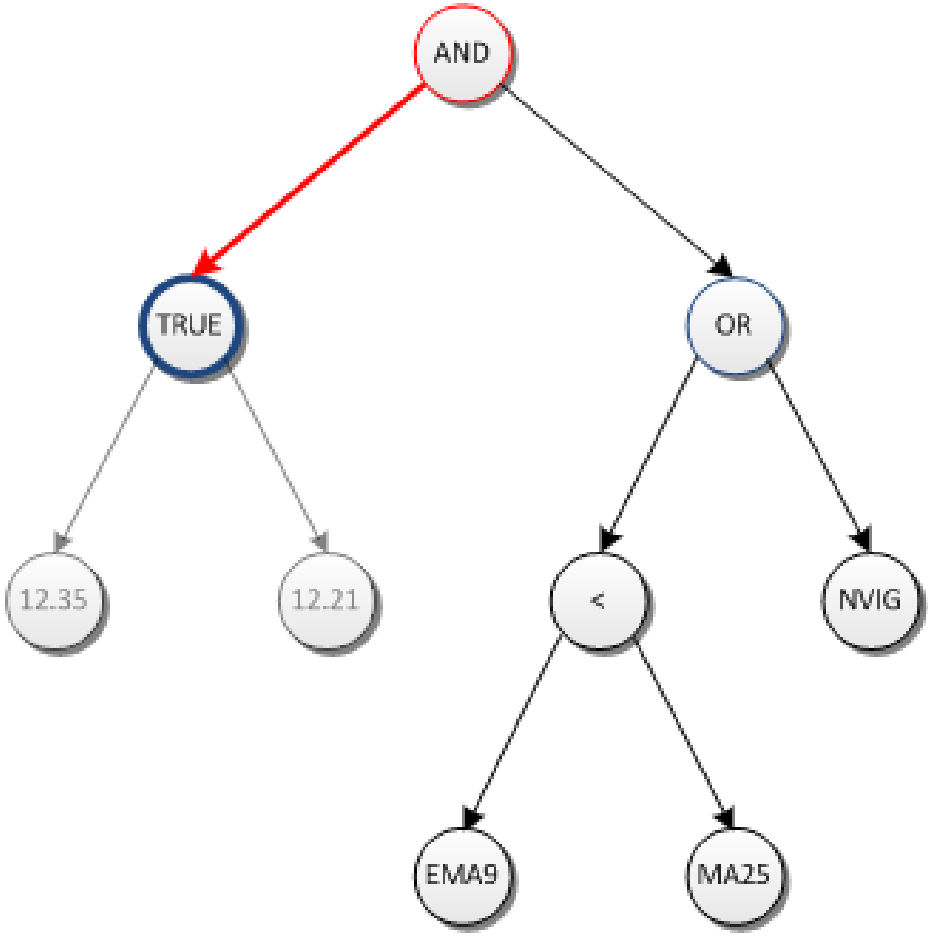

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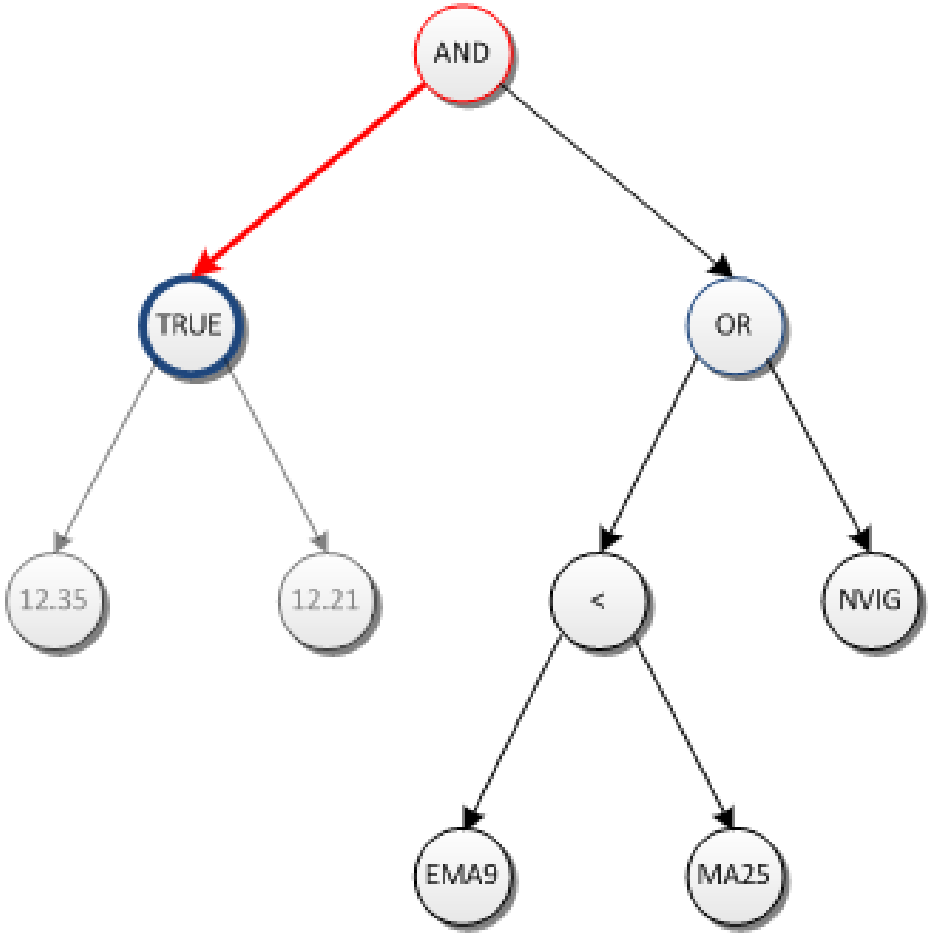

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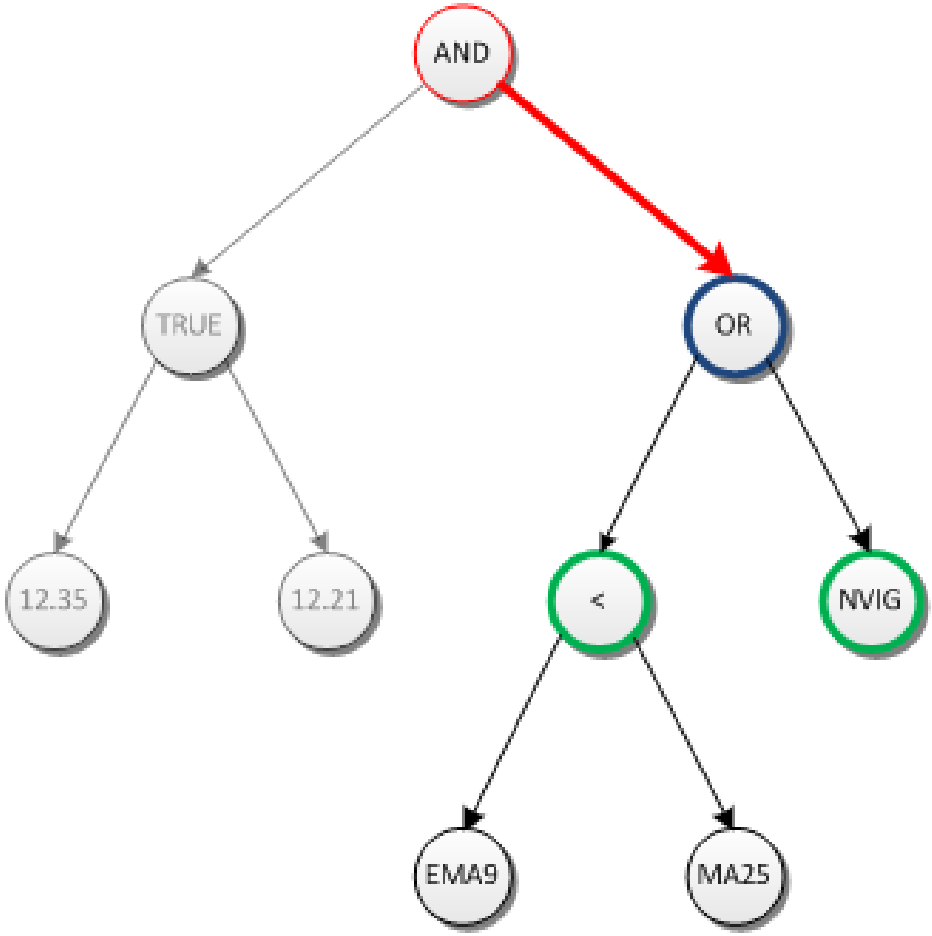
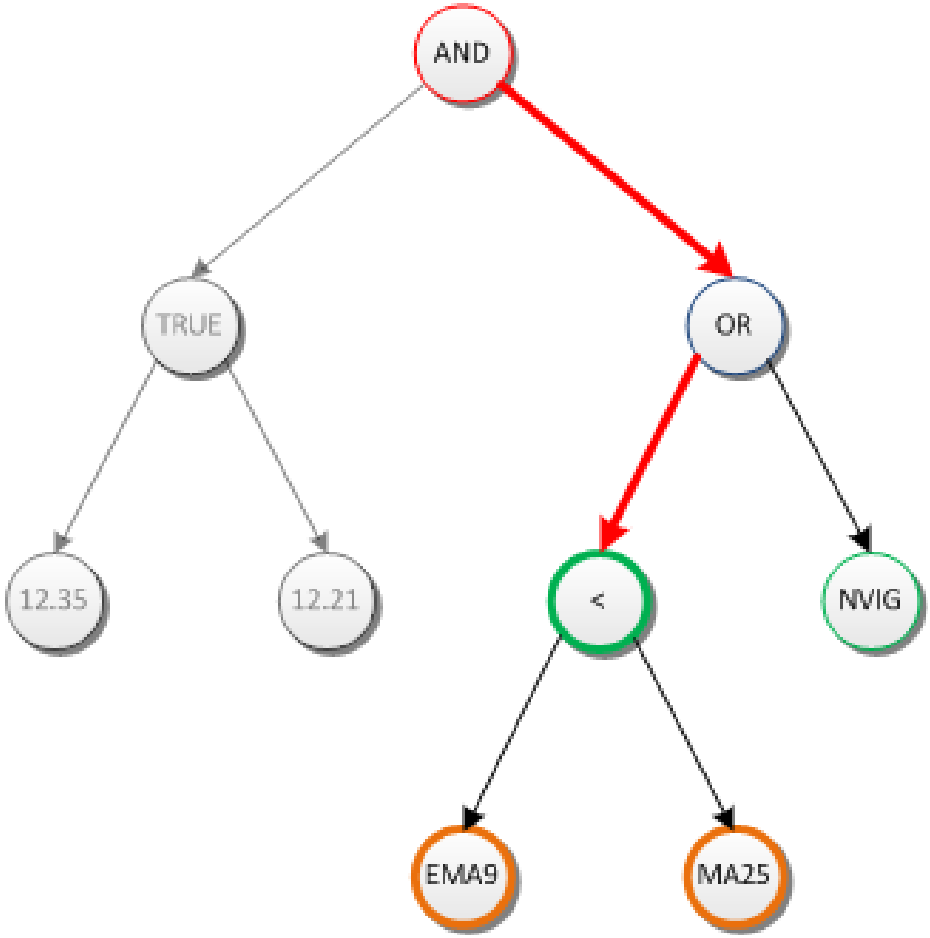
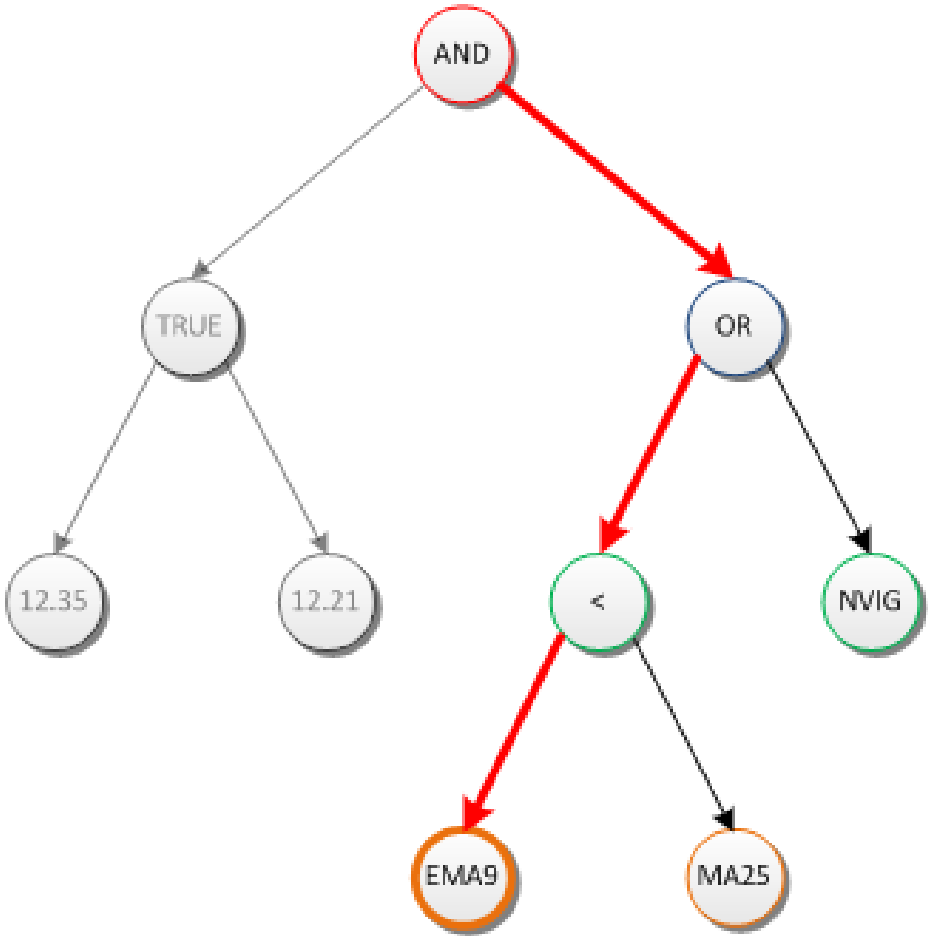


Example GP Tree



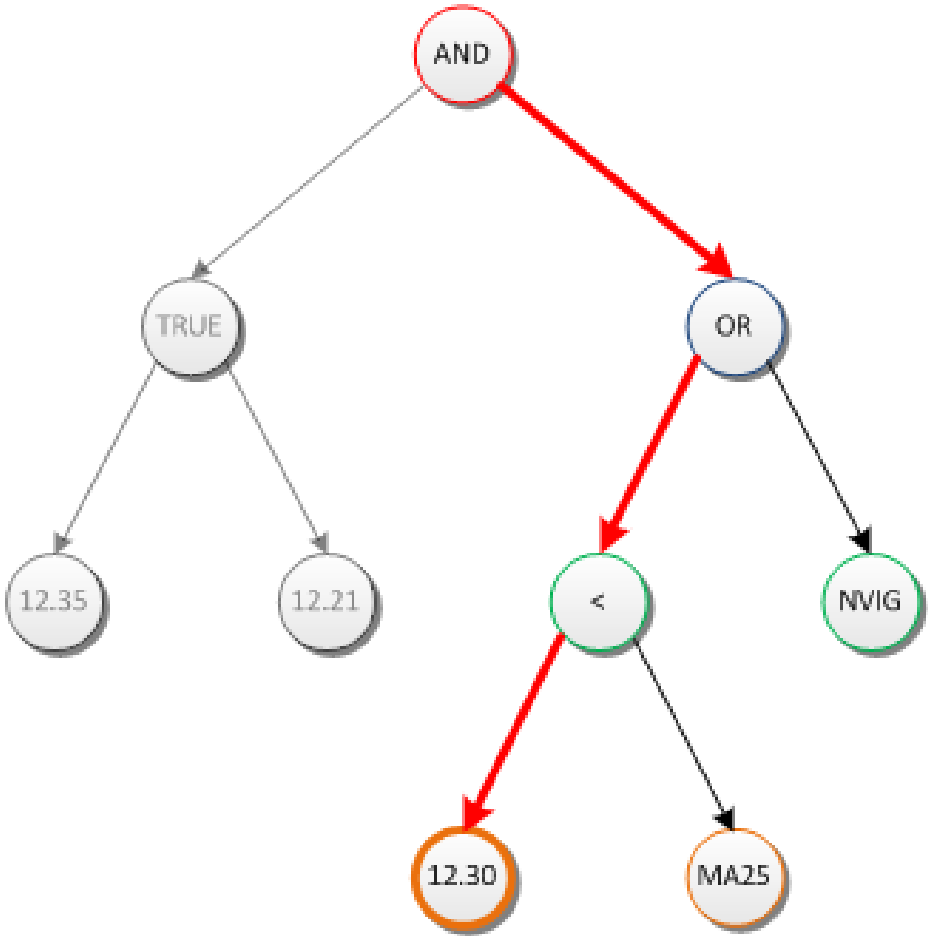
AND	TRUE	OR			

Example GP Tree



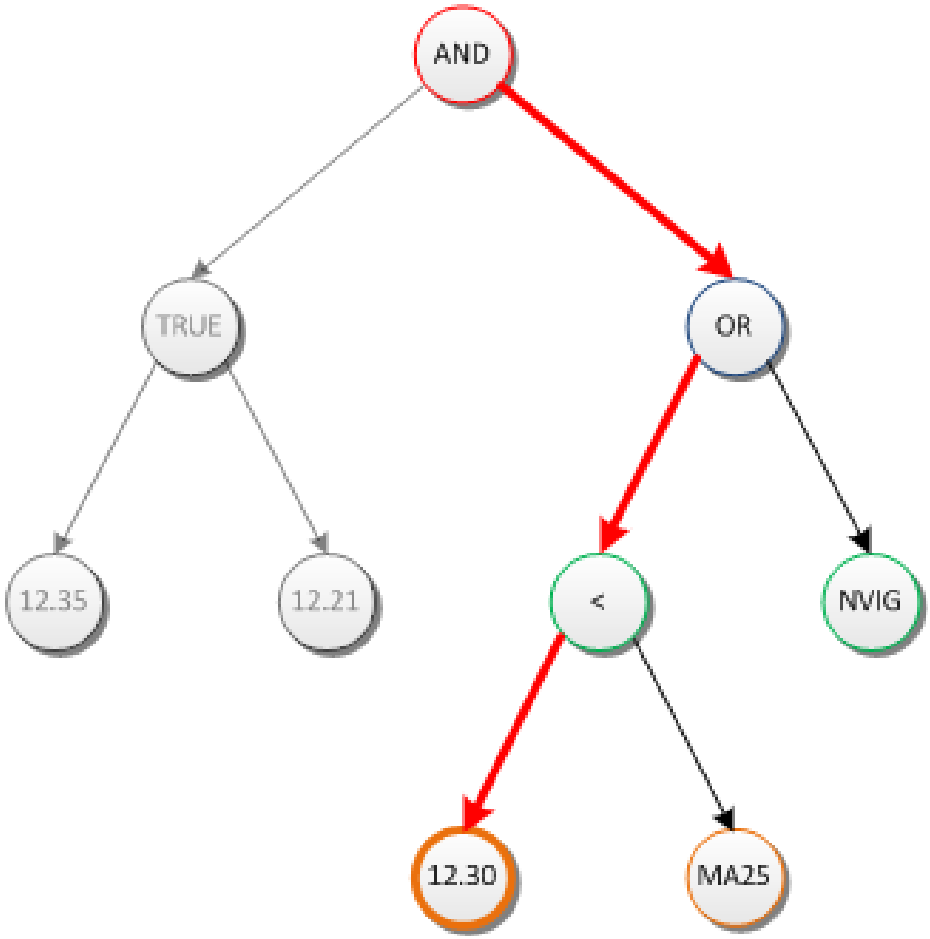
AND	TRUE	OR	<		

Example GP Tree



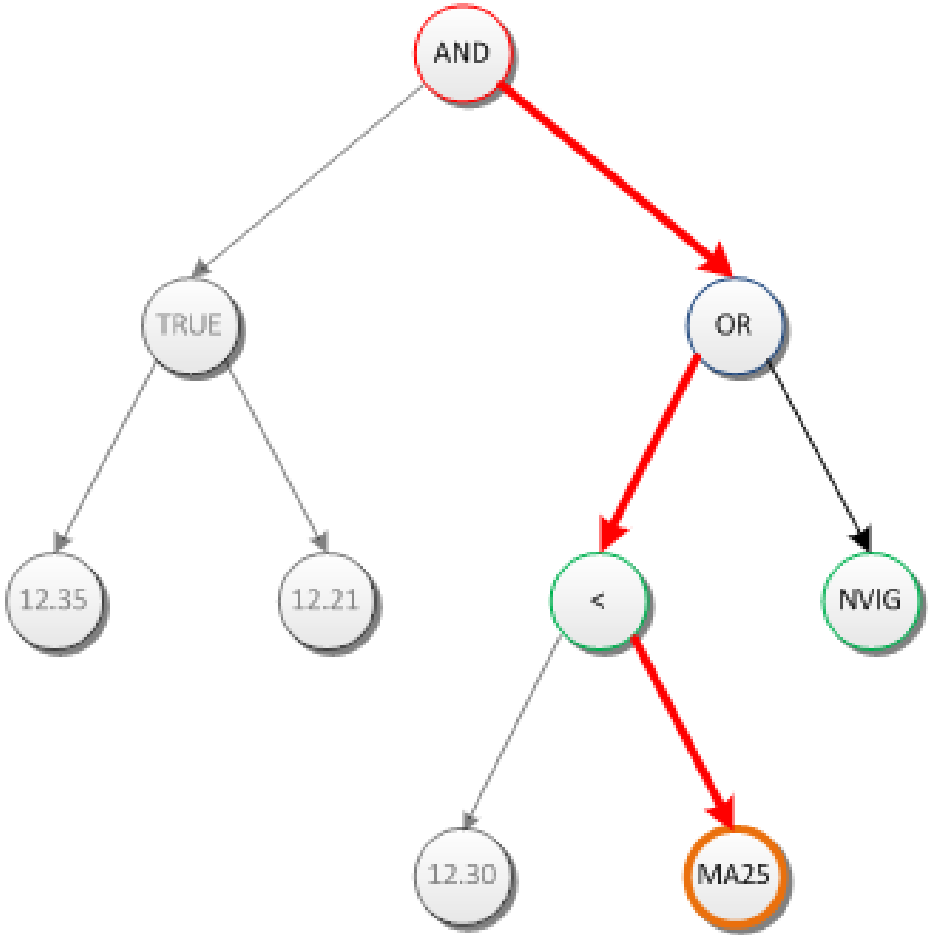
AND	TRUE	OR	<		

Example GP Tree



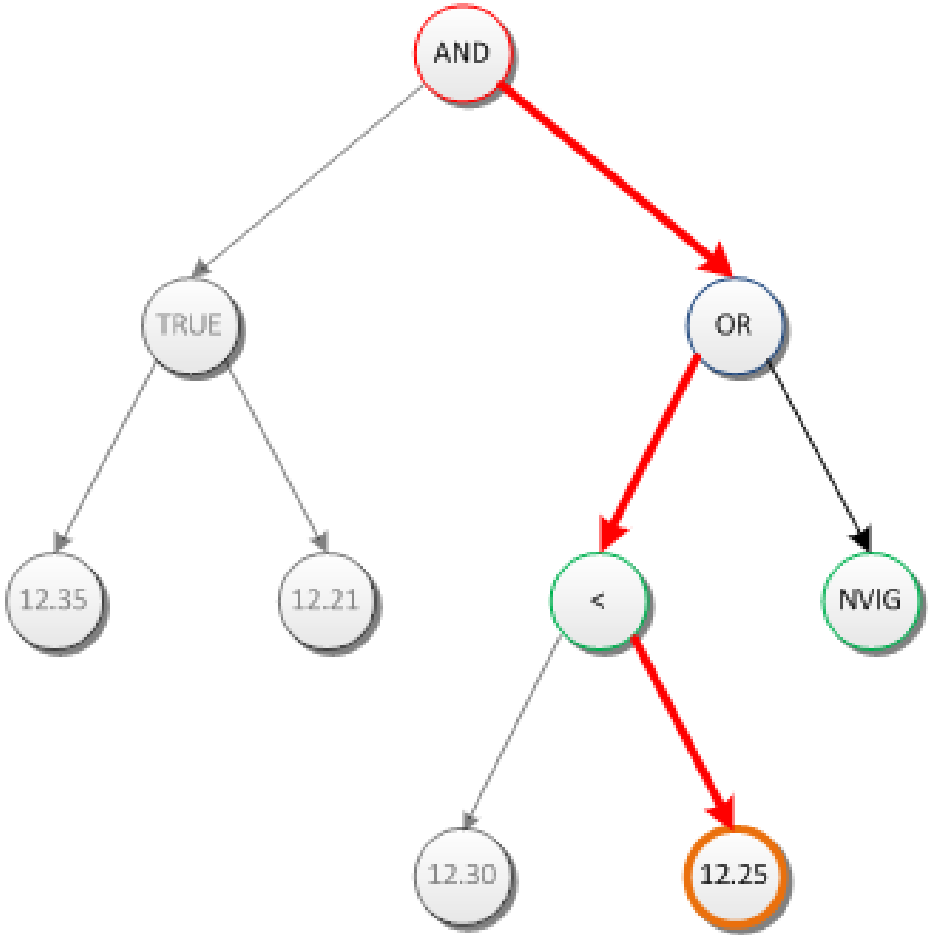
AND	TRUE	OR	<	12.30	

Example GP Tree



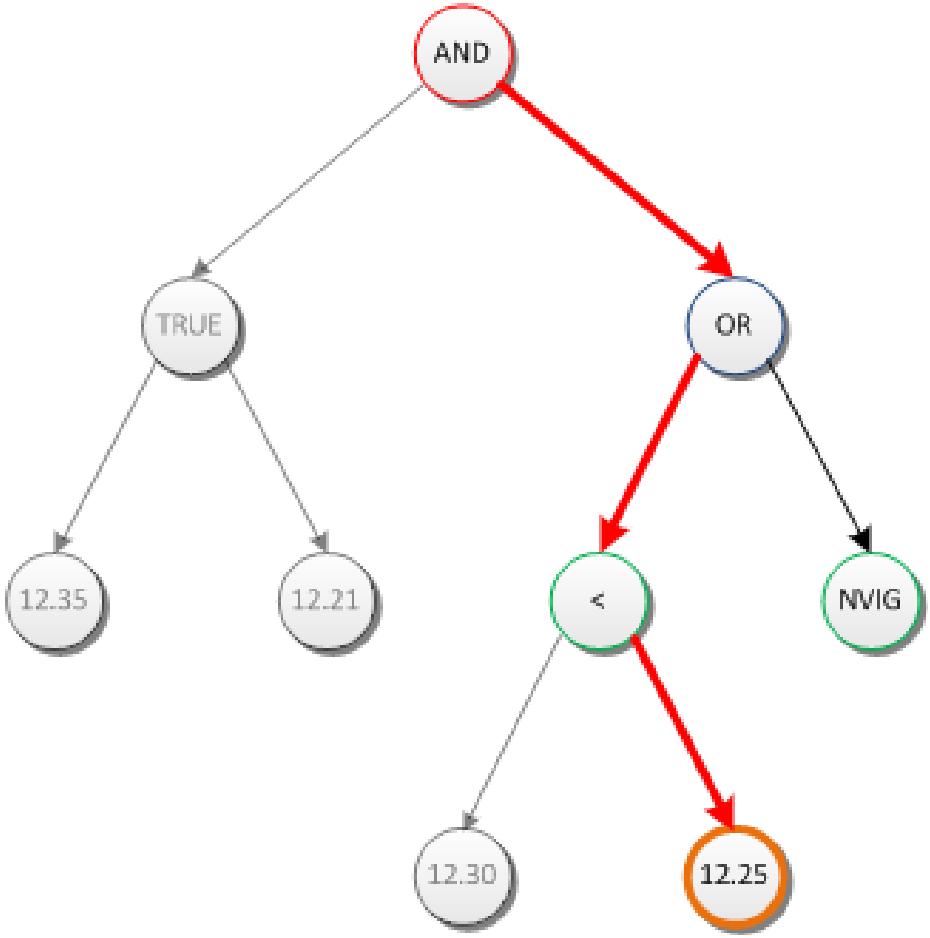
AND	TRUE	OR	<	12.30	

Example GP Tree



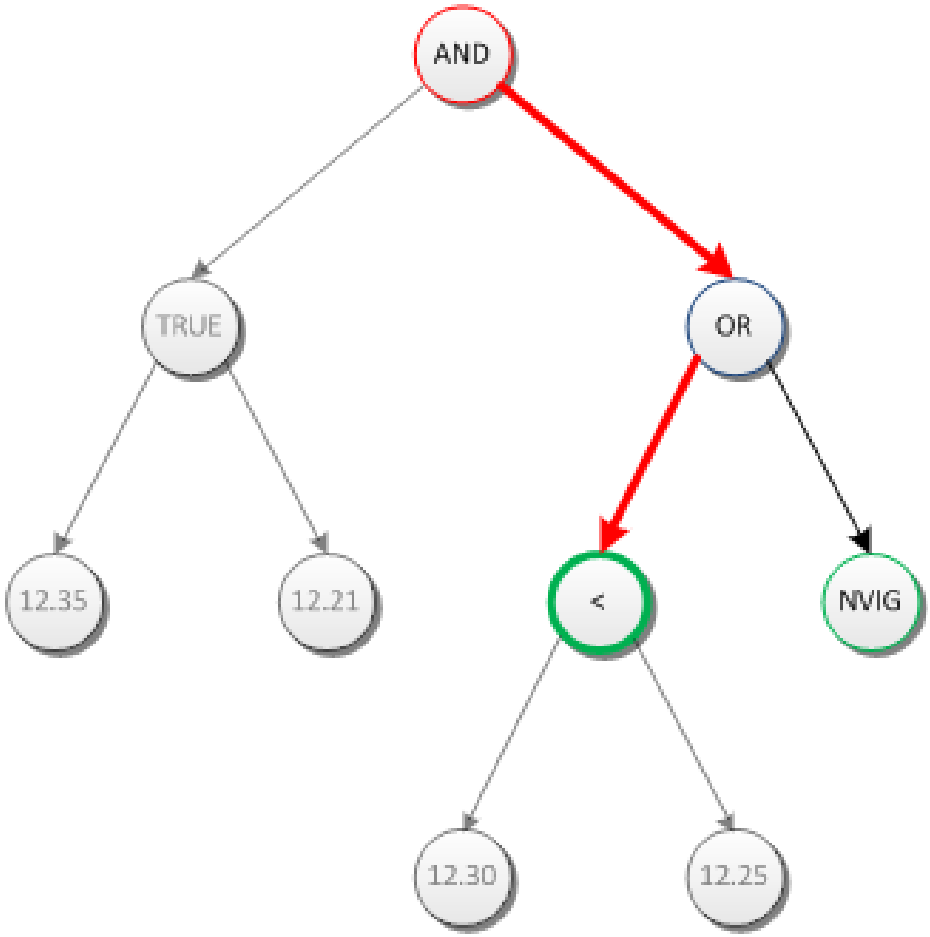
AND	TRUE	OR	<	12.30	

Example GP Tree



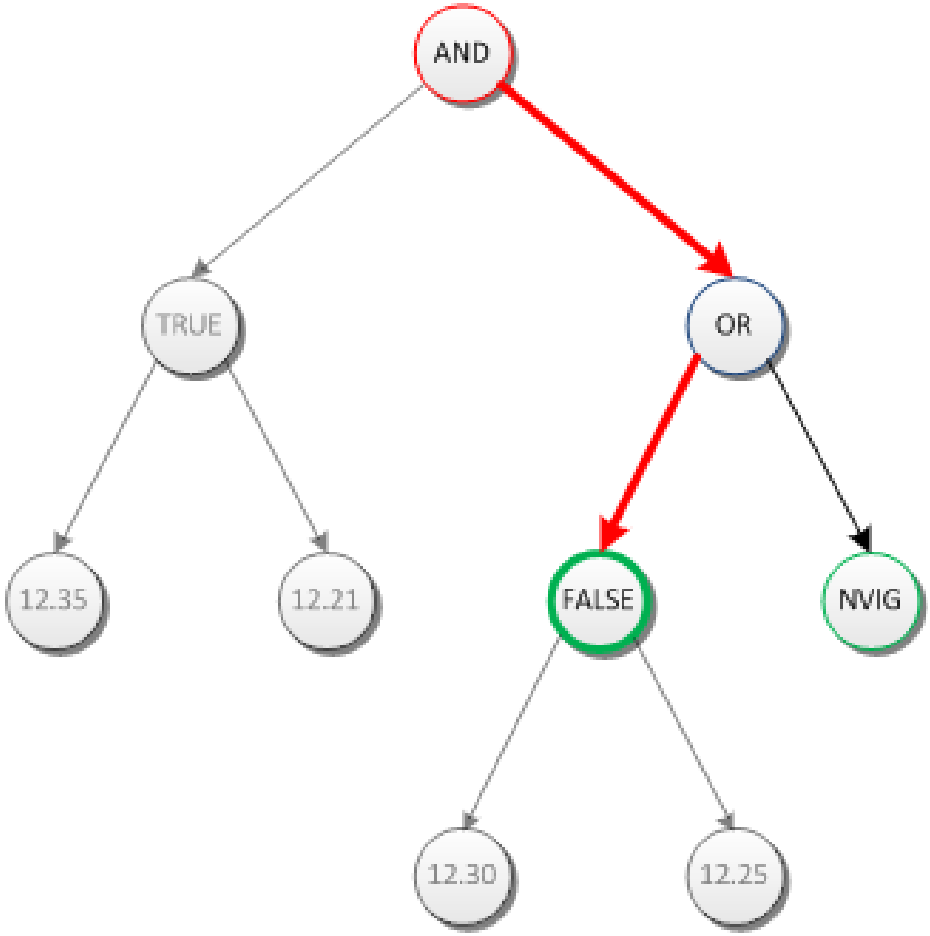
AND	TRUE	OR	<	12.30	12.25

Example GP Tree



AND	TRUE	OR	<	12.30	12.25

Example GP Tree



AND	TRUE	OR	FALSE		

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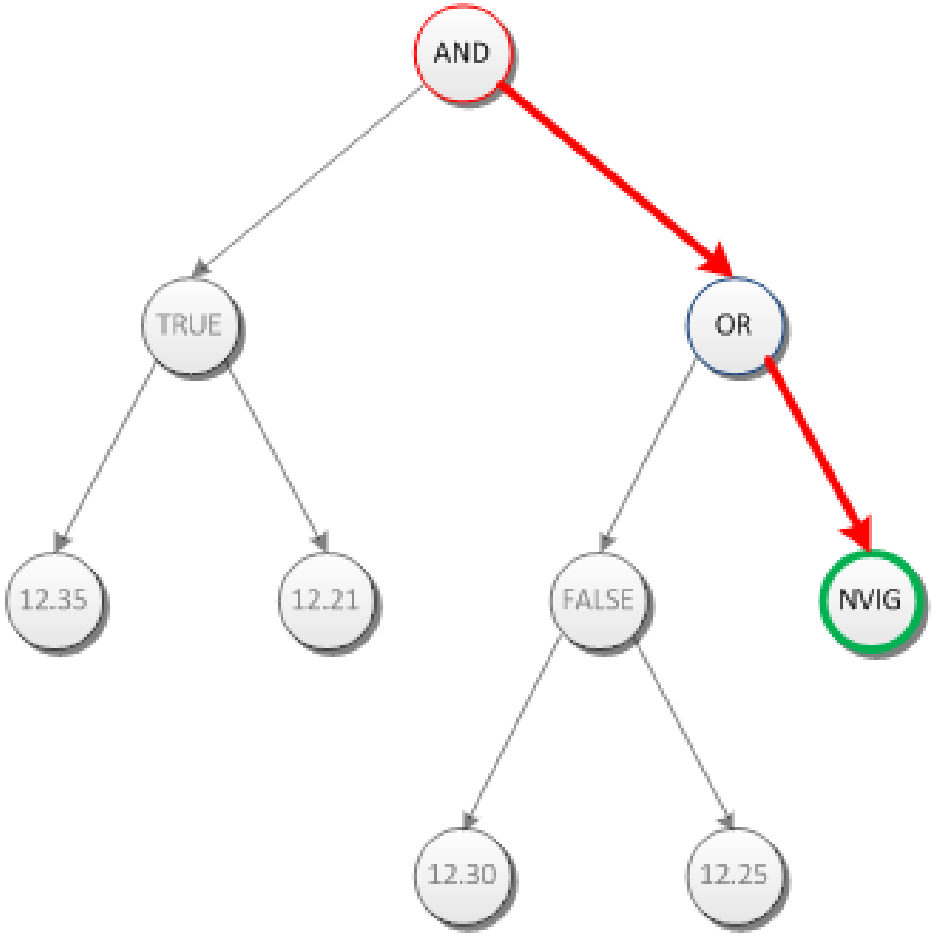

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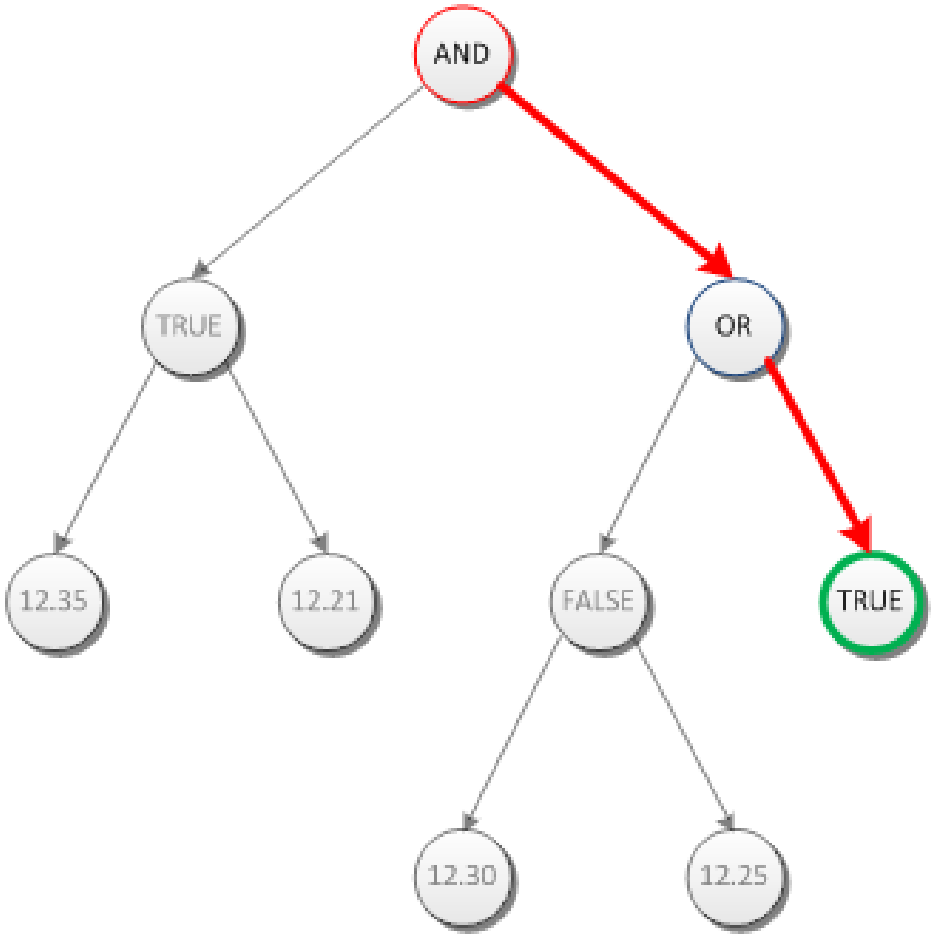
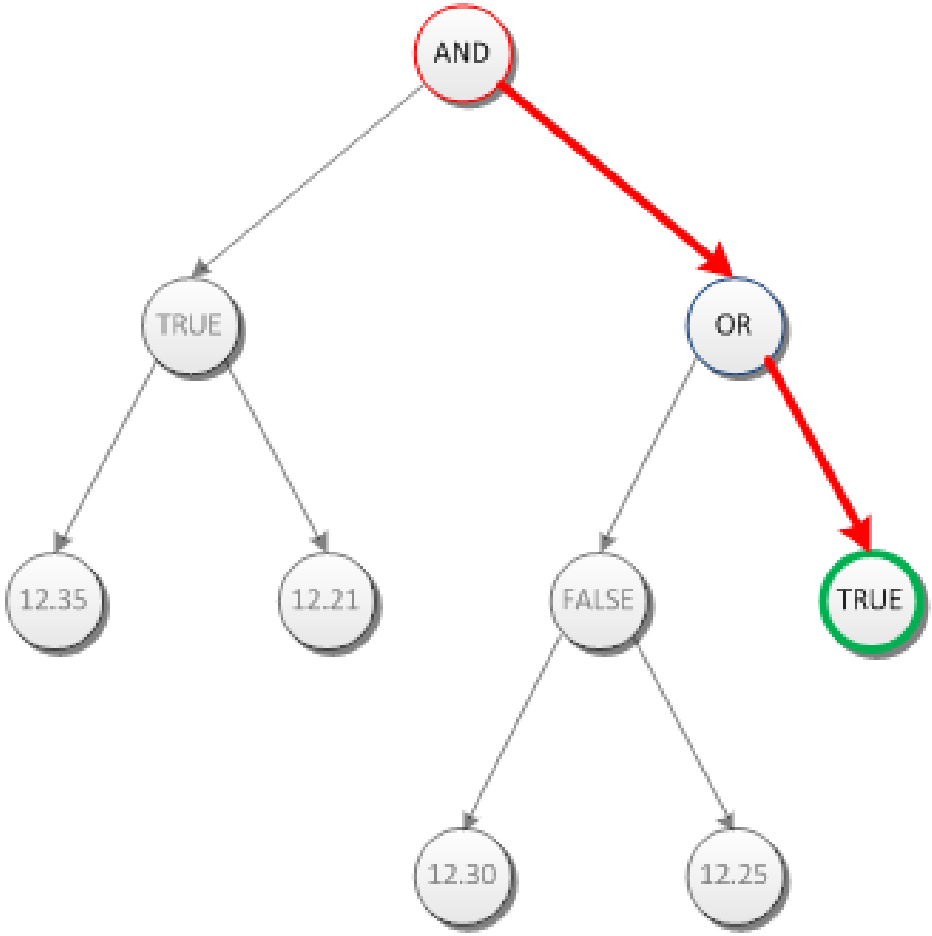


AND	TRUE	OR	FALSE		

Example GP Tree



AND	TRUE	OR	FALSE	TRUE	

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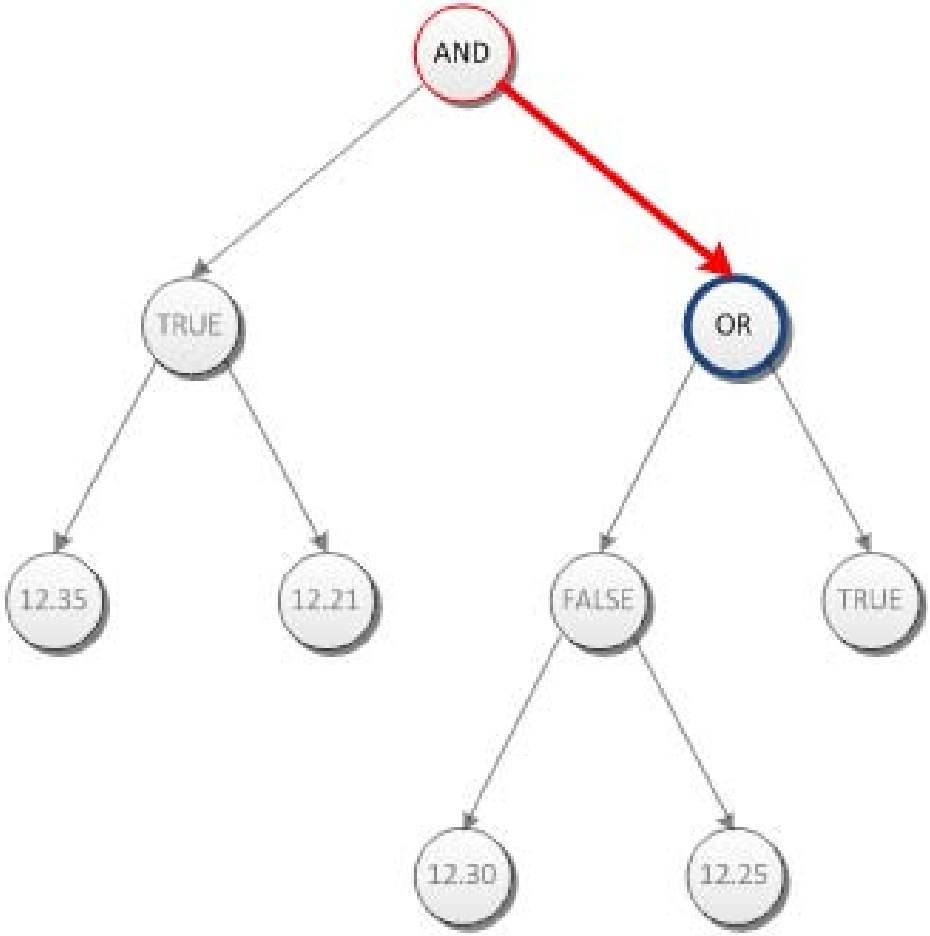
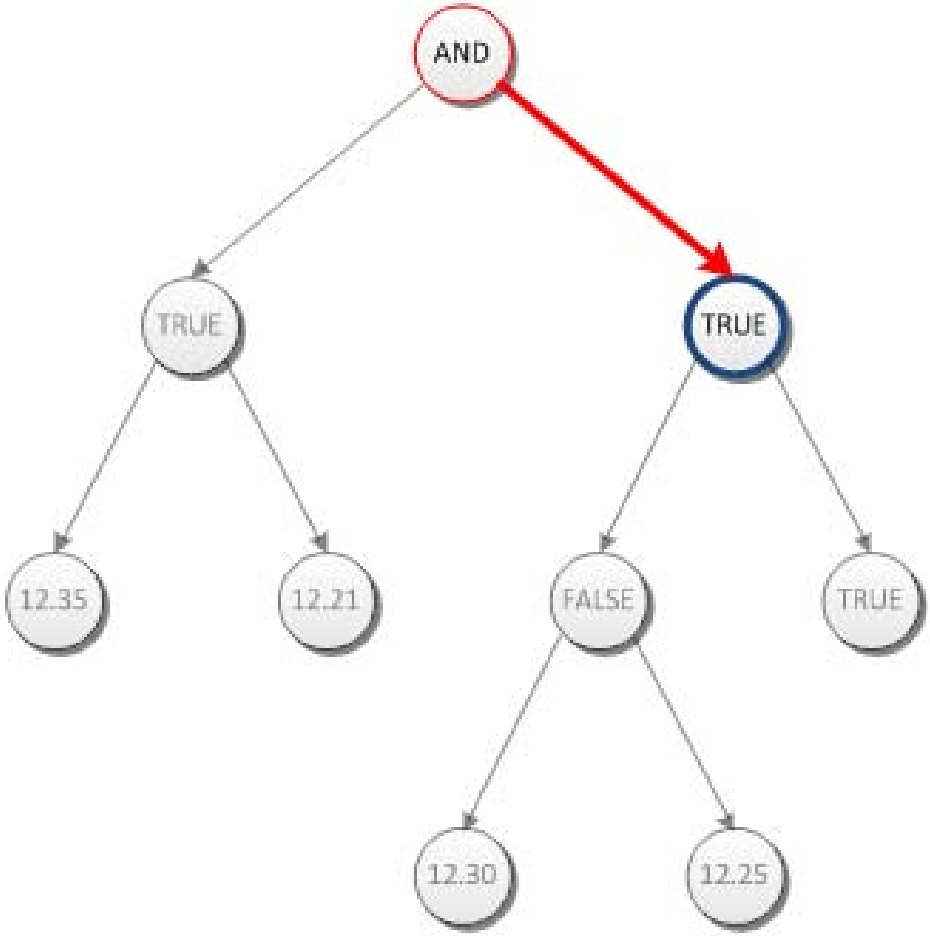


AND	TRUE	OR	FALSE	TRUE	

Example GP Tree



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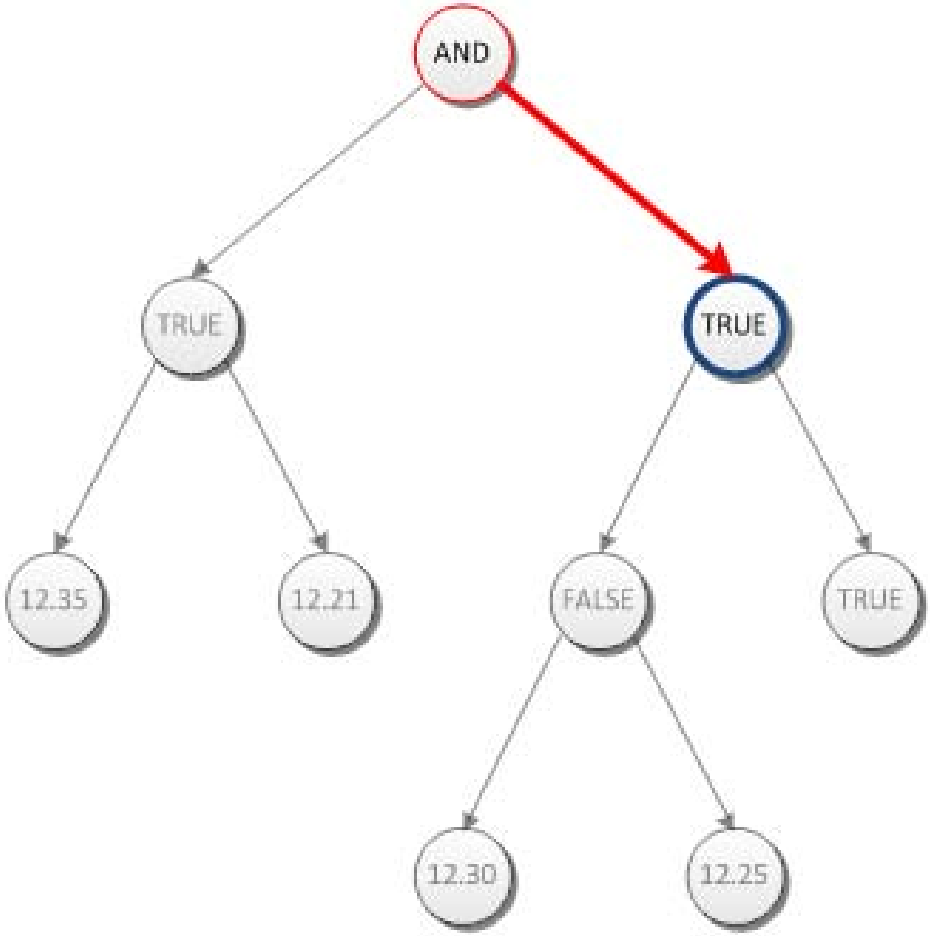
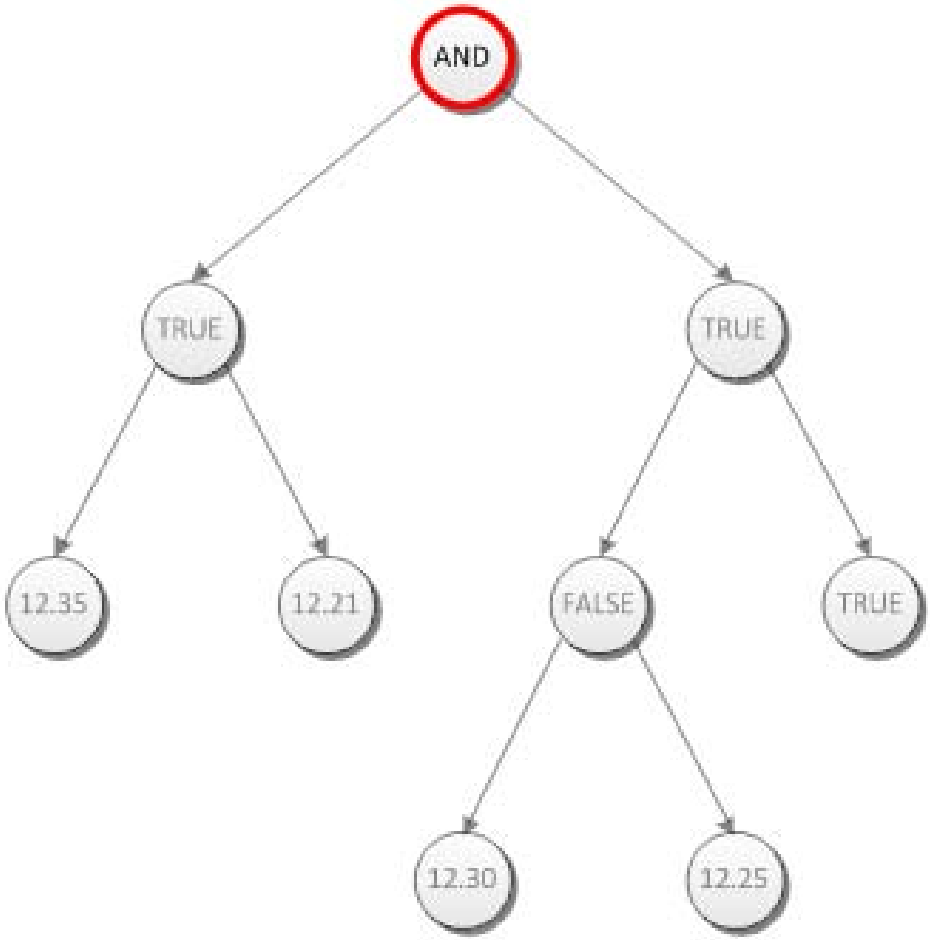


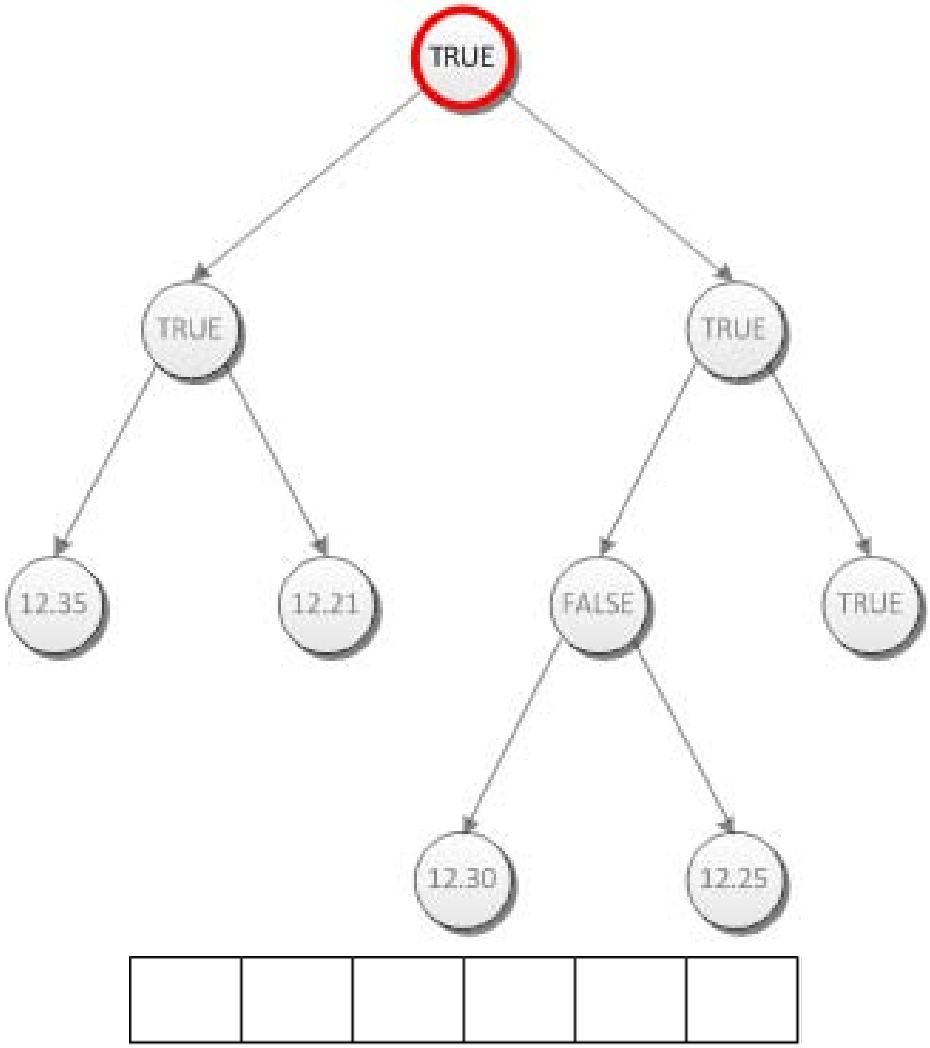
AND	TRUE	TRUE			

Example GP Tree



AND	TRUE	TRUE			

Example GP Tree



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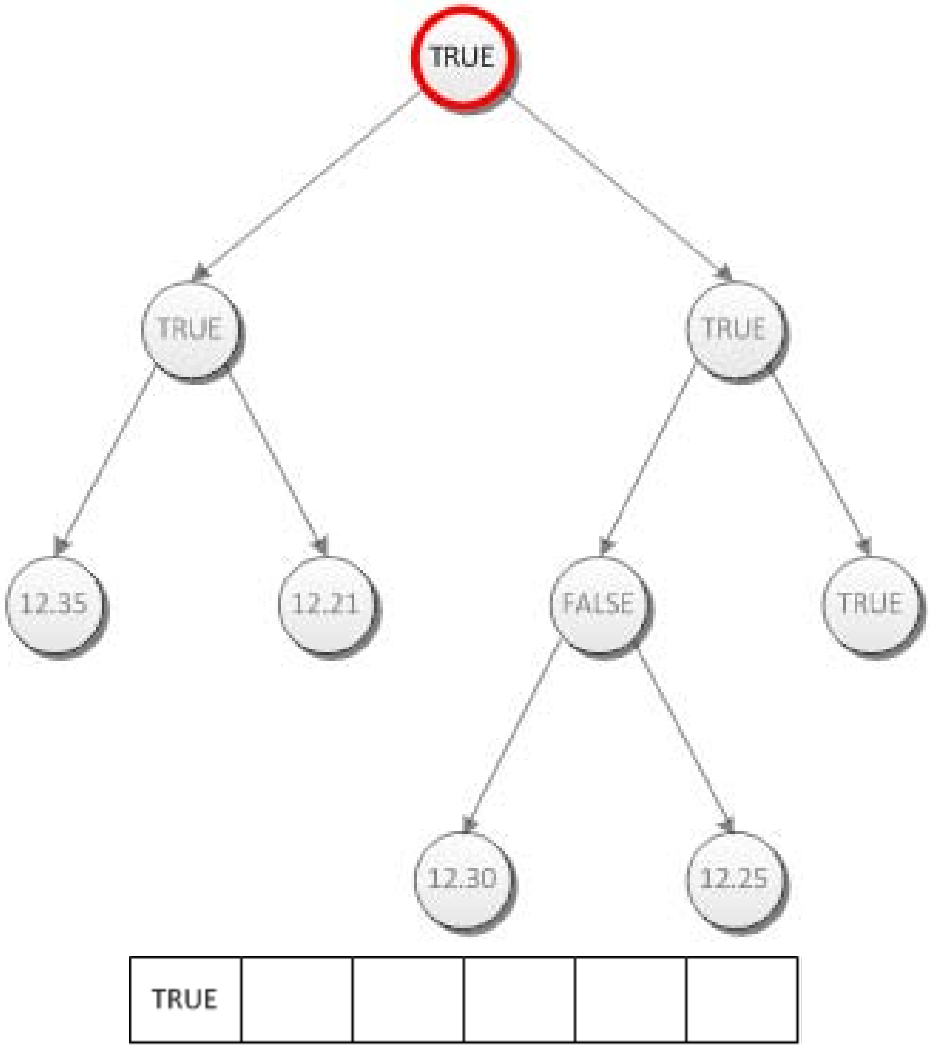
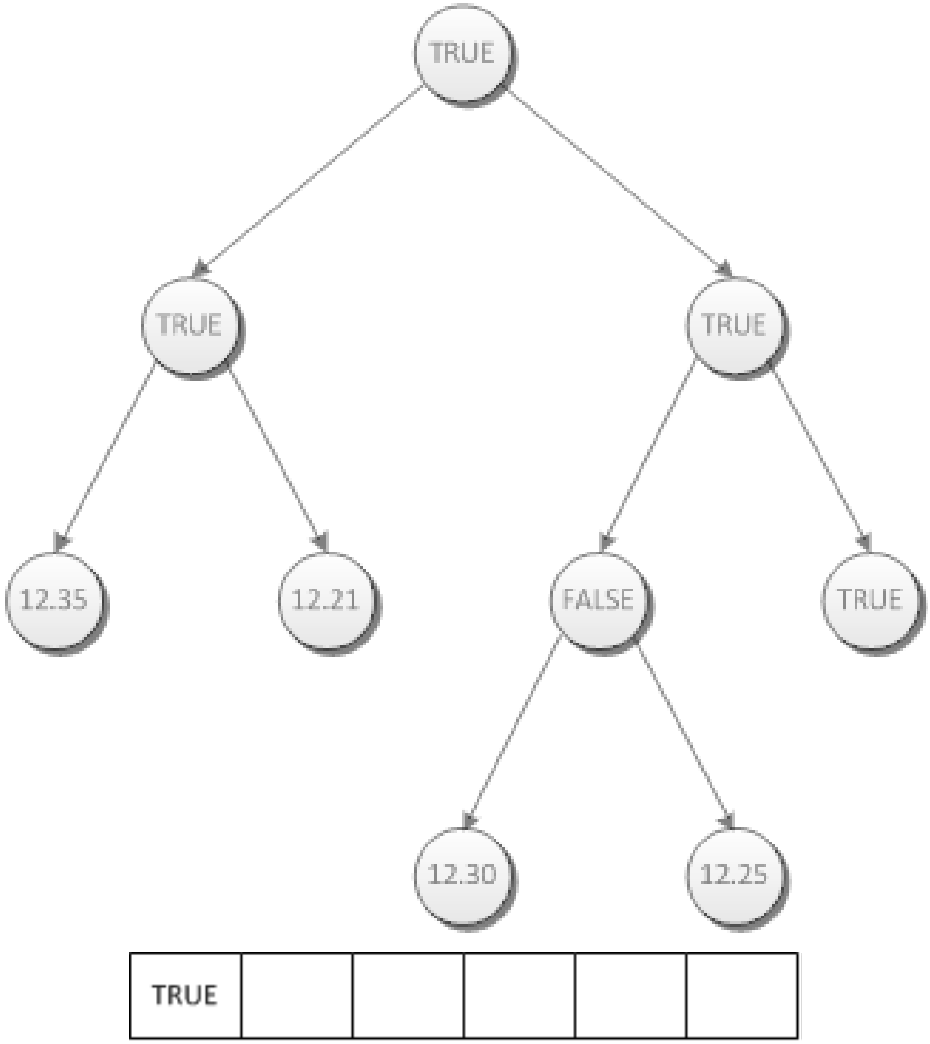


Example GP Tree



GP Details

- Five Boolean Functions:
  - AND, OR, NOT, >, <
- 17 Money Value Indicators:
  - MAs, EMAs, Closing/Typical Prices
- 14 Boolean Value Indicators:
  - Ease of movement, MACD, etc.

GP Details

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- Each individual consists of two trees
  - A buy signal and sell signal tree
- Tree values for a given day determine action
- A given amount of money is allocated for each stock
- The stocks are traded for a number of days
- Fitness is calculated based on ROI

GP Decision Matrix

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		Buy Tree	
		True	False
Sell Tree	True	No Action	Sell All Shares
	False	Buy Max. Shares	No Action

Why Use GPUs

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- Some typical parameters
  - 100 000 Individuals, 100 Stocks, 1000 Days
- Each individual's trees must be evaluated for each stock/day combination
  - 20 000 000 000 tree evaluations per generation
- With GPU these evaluations can be massively parallelized, resulting in extremely large speedups

GP On GPU Devices

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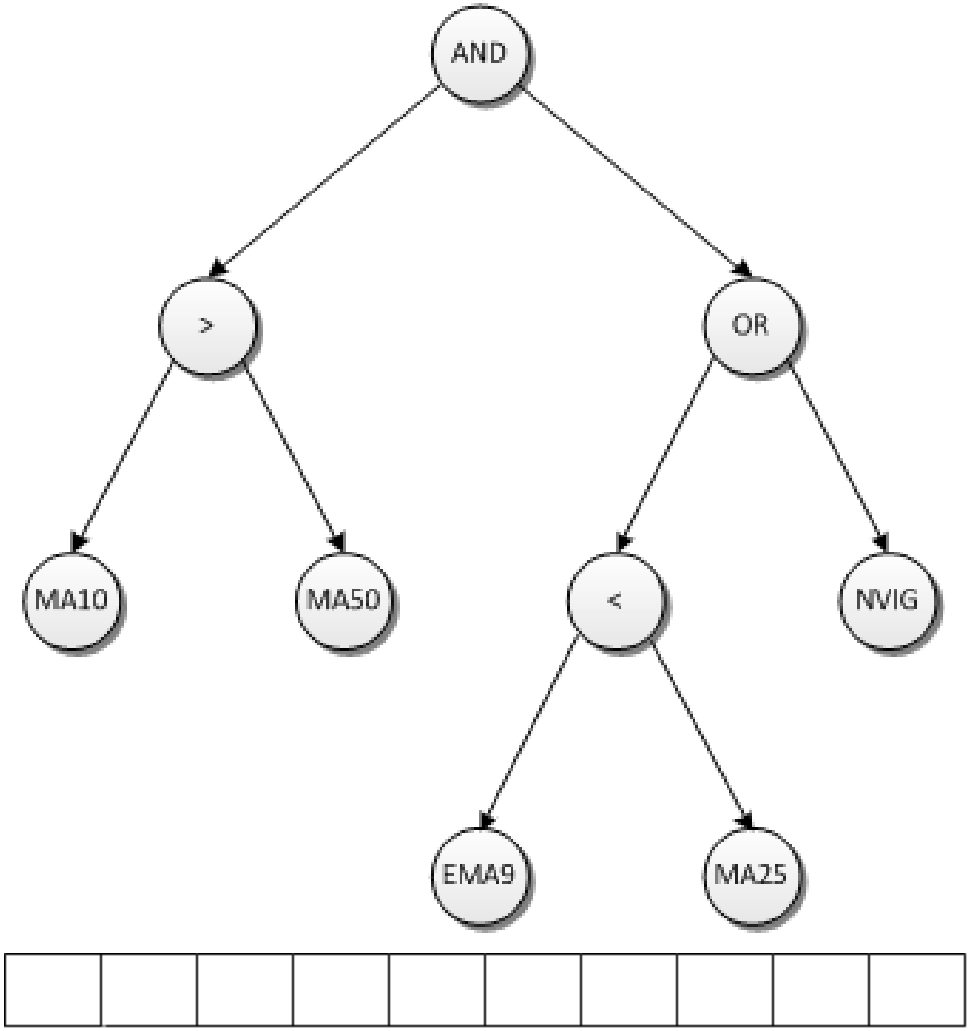
- Until recently, there was no recursion support within CUDA (no execution stack)
- Tree-based GP cannot run without a stack
- The solution:
  - Implement a stack on the GPU
  - Convert tree-based individuals into RPN
  - Parse these 'trees' using the stack interpreter program

Example Conversion



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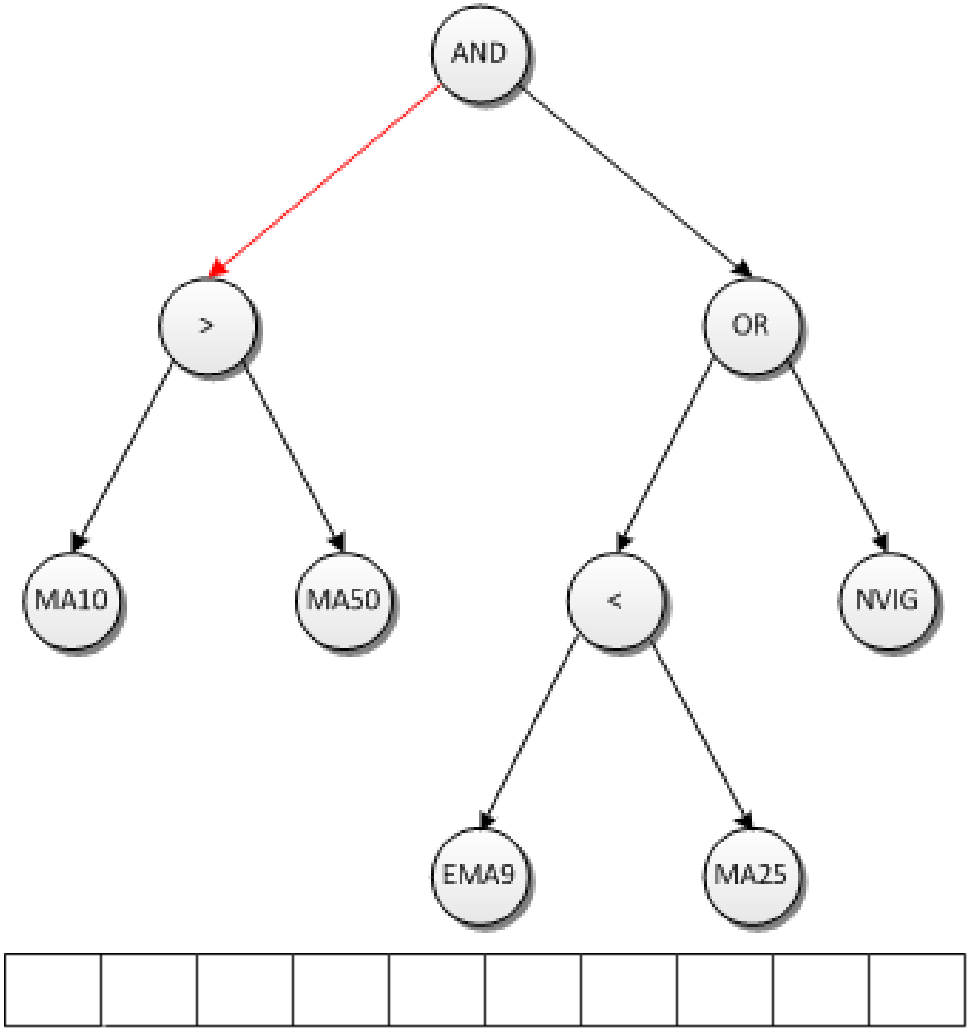

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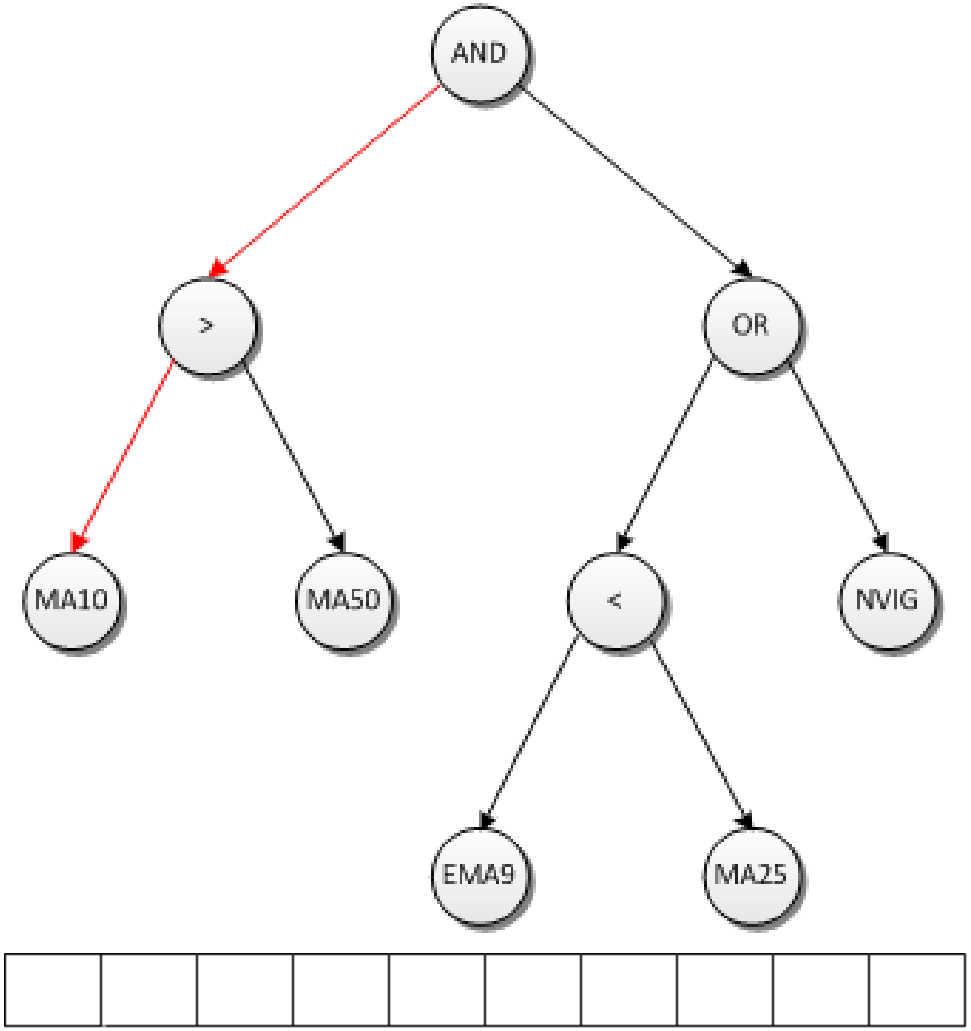

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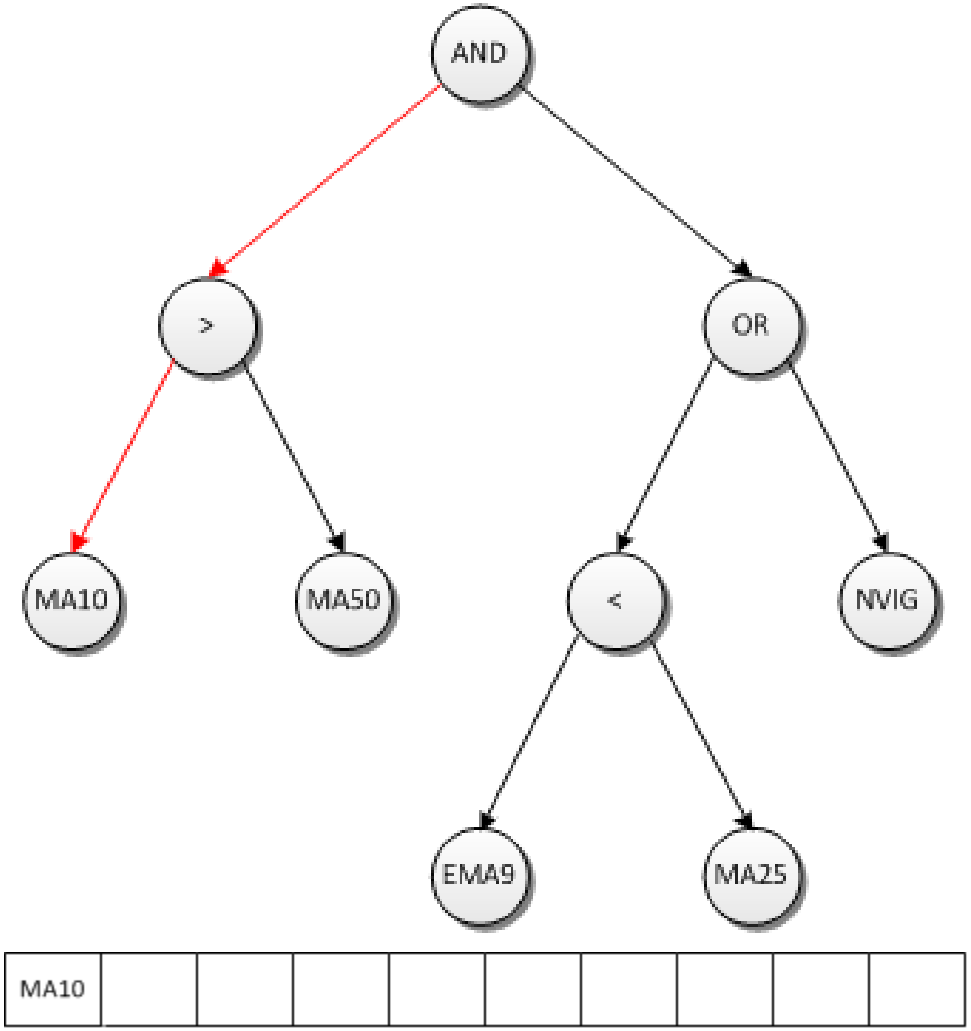

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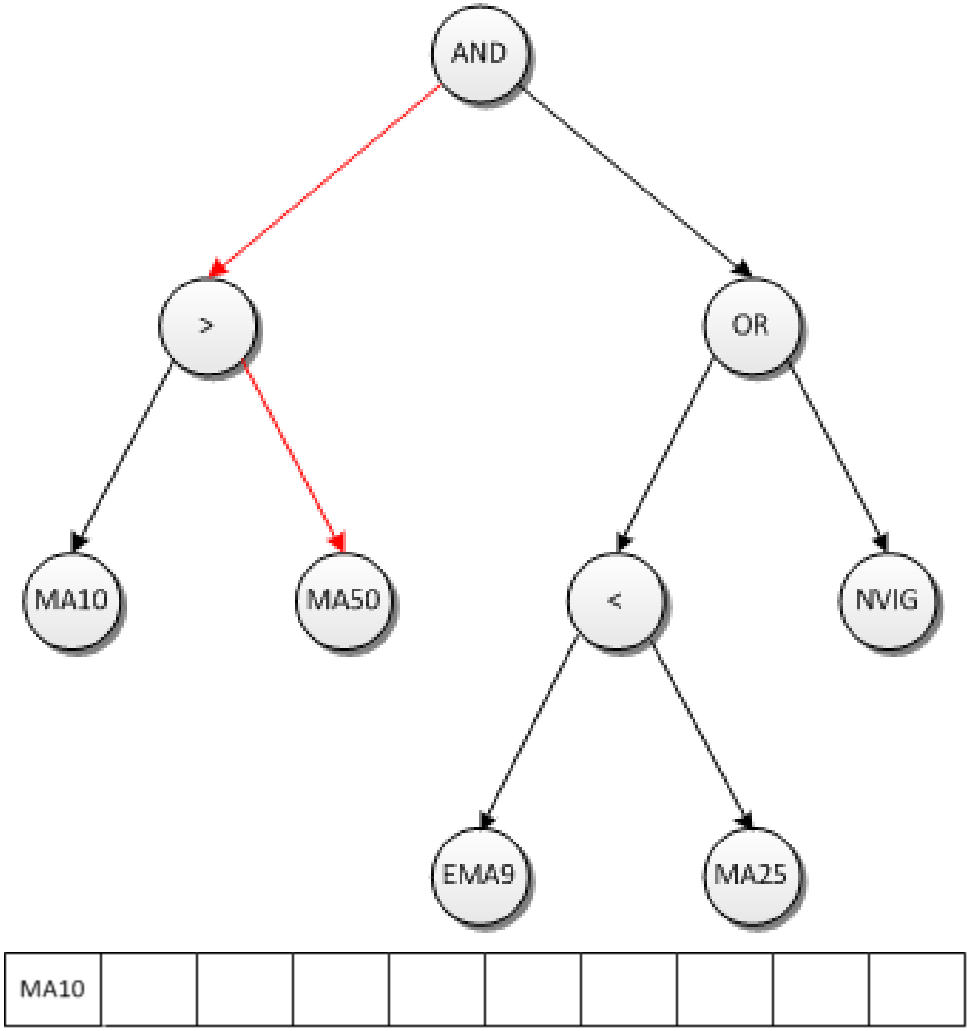

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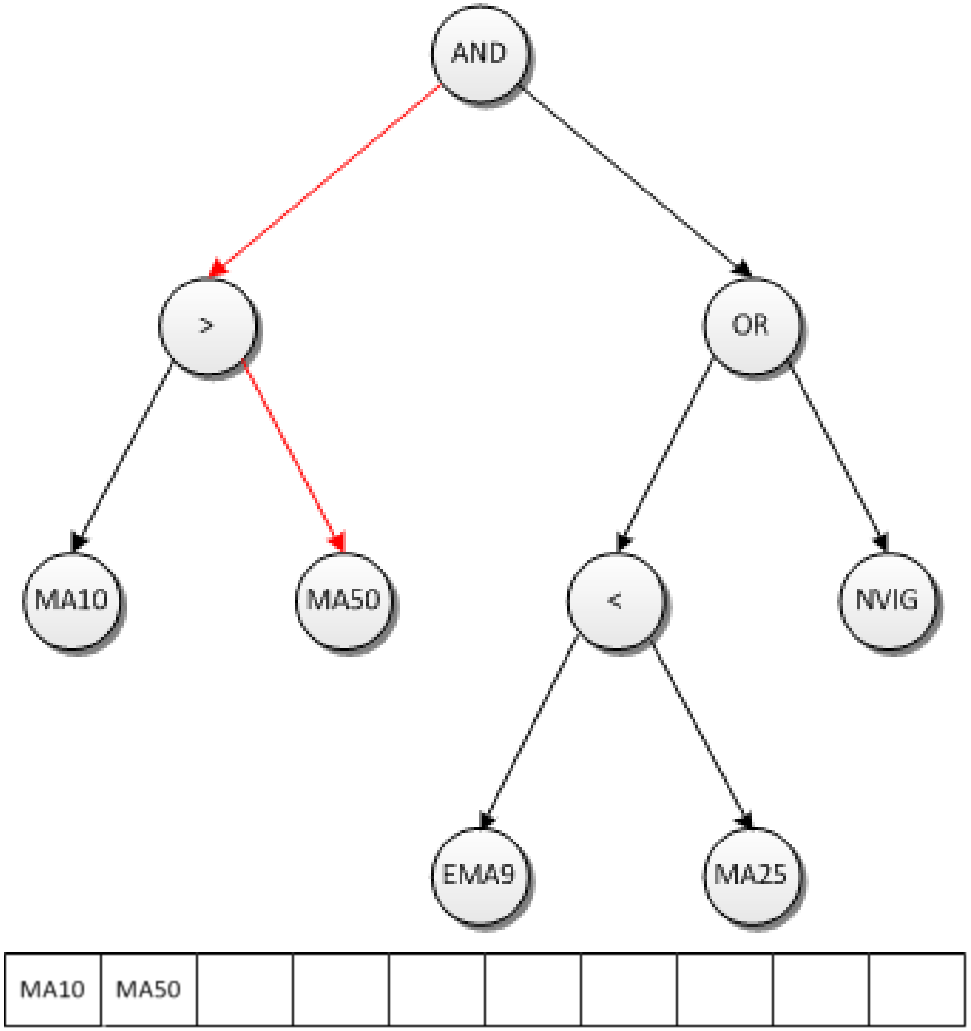

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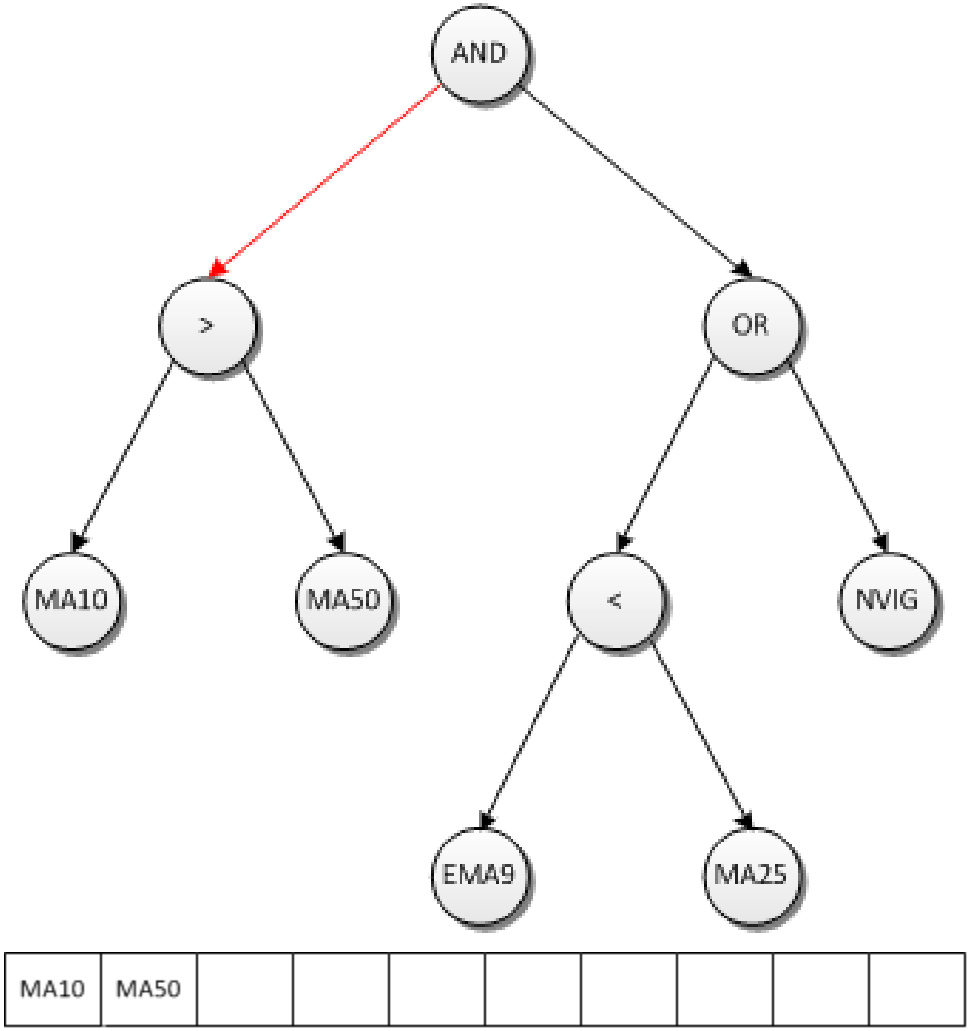

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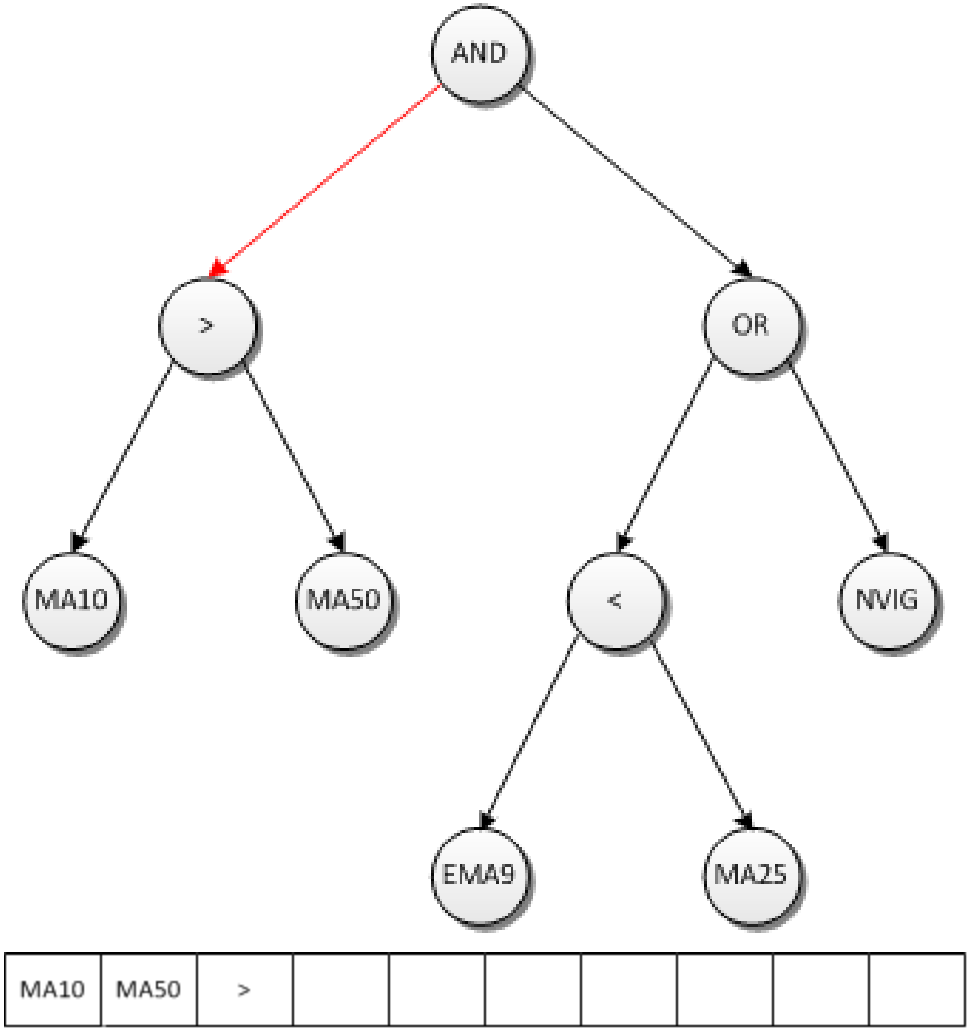

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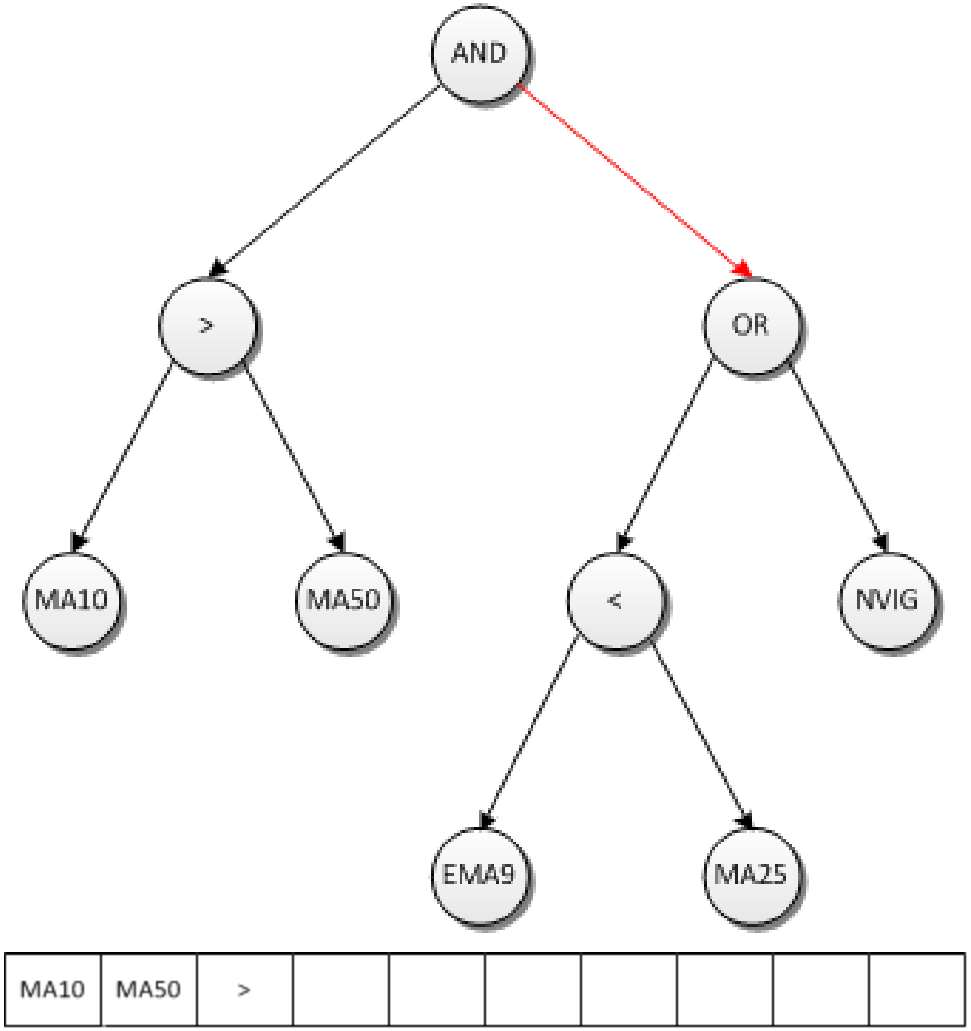

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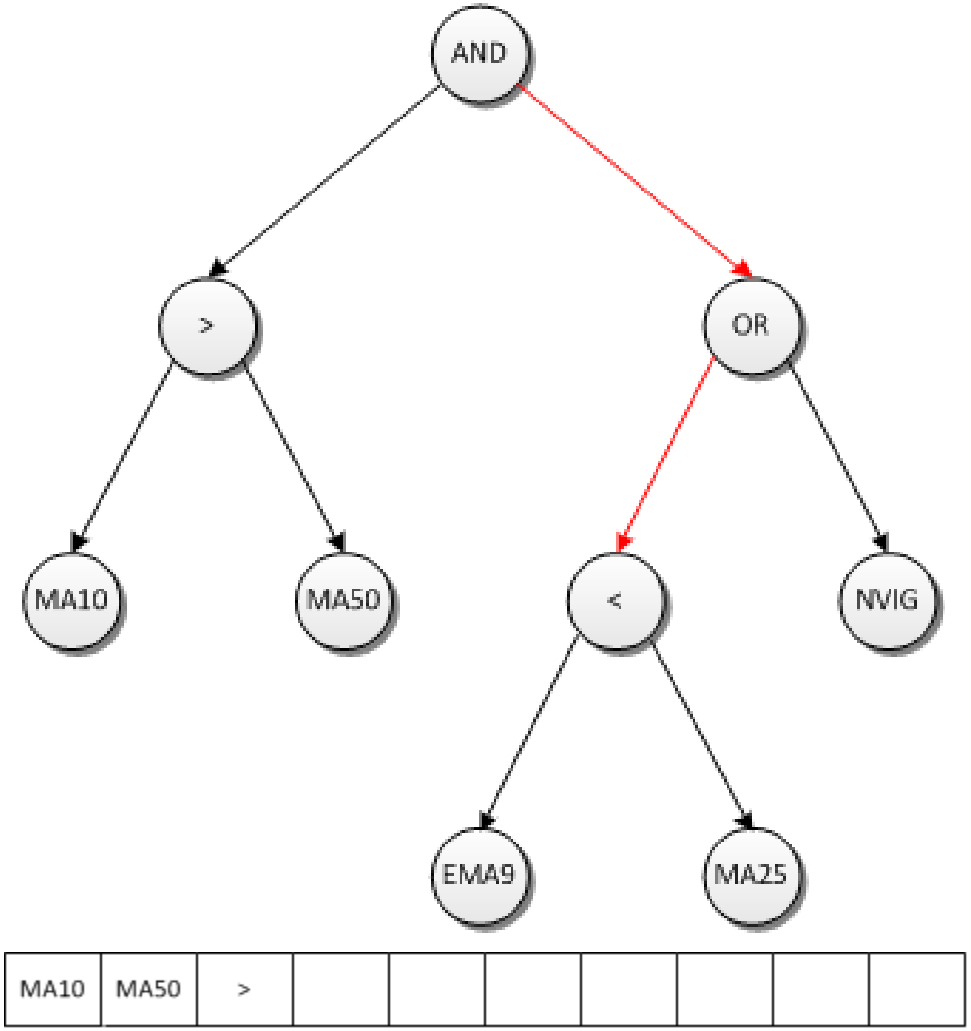

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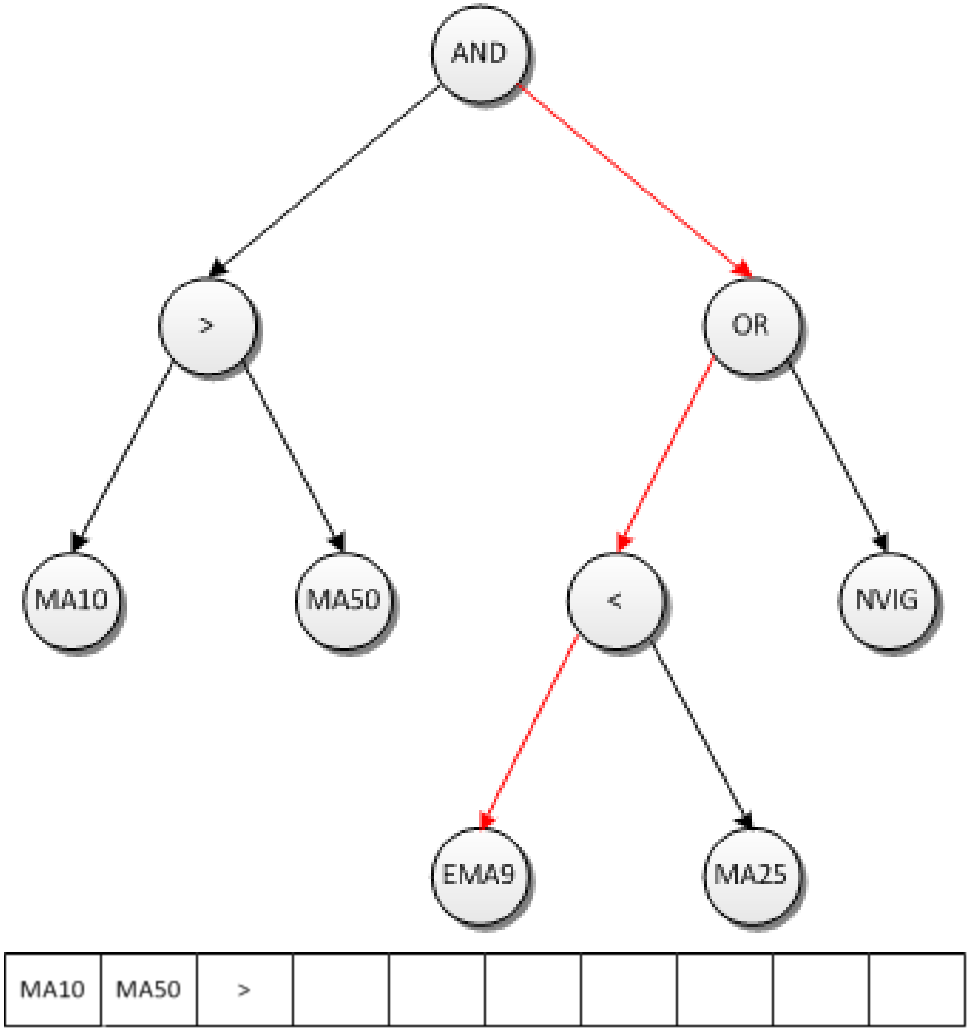
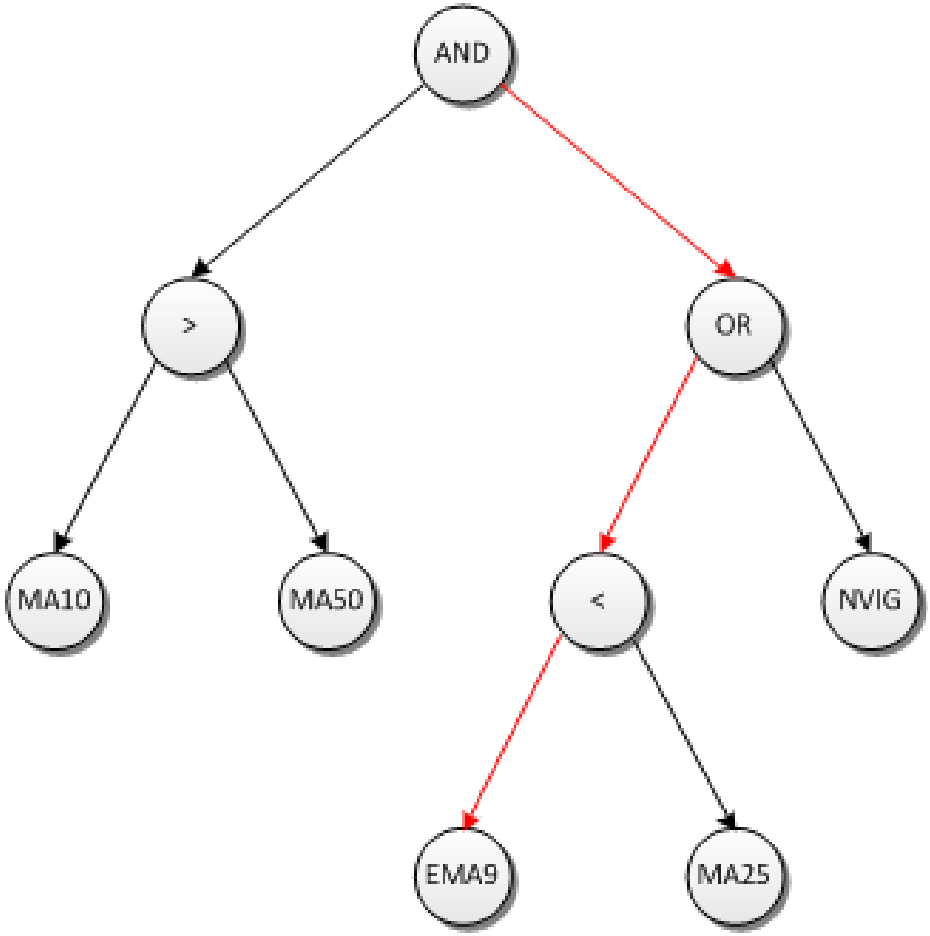


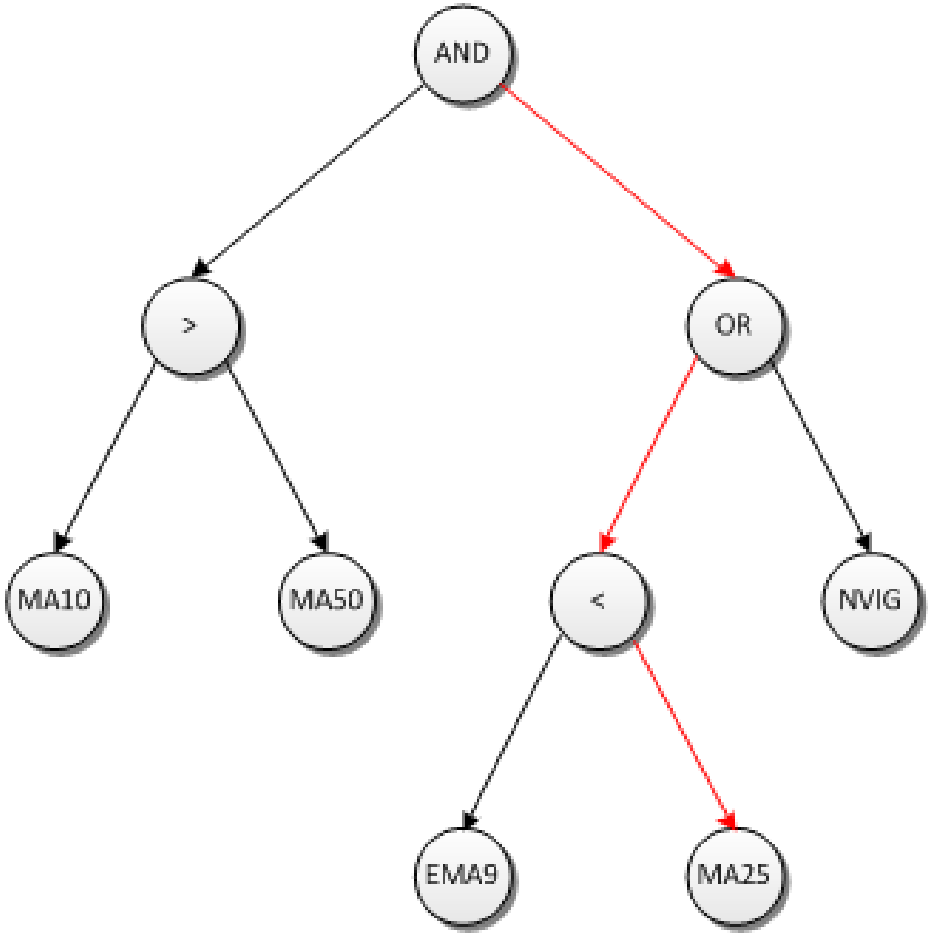
MA10	MA50	>							

Example Conversion



MA10	MA50	>	EMA9						

Example Conversion



MA10	MA50	>	EMA9						

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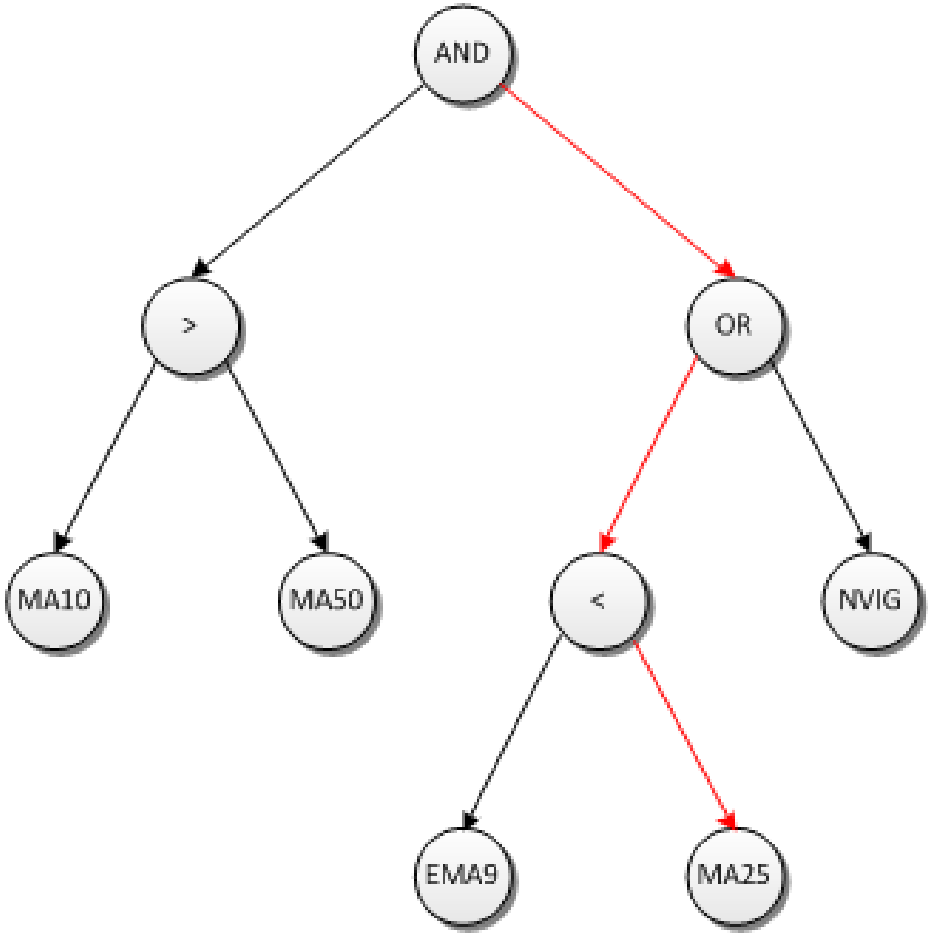

MA10	MA50	>	EMA9						

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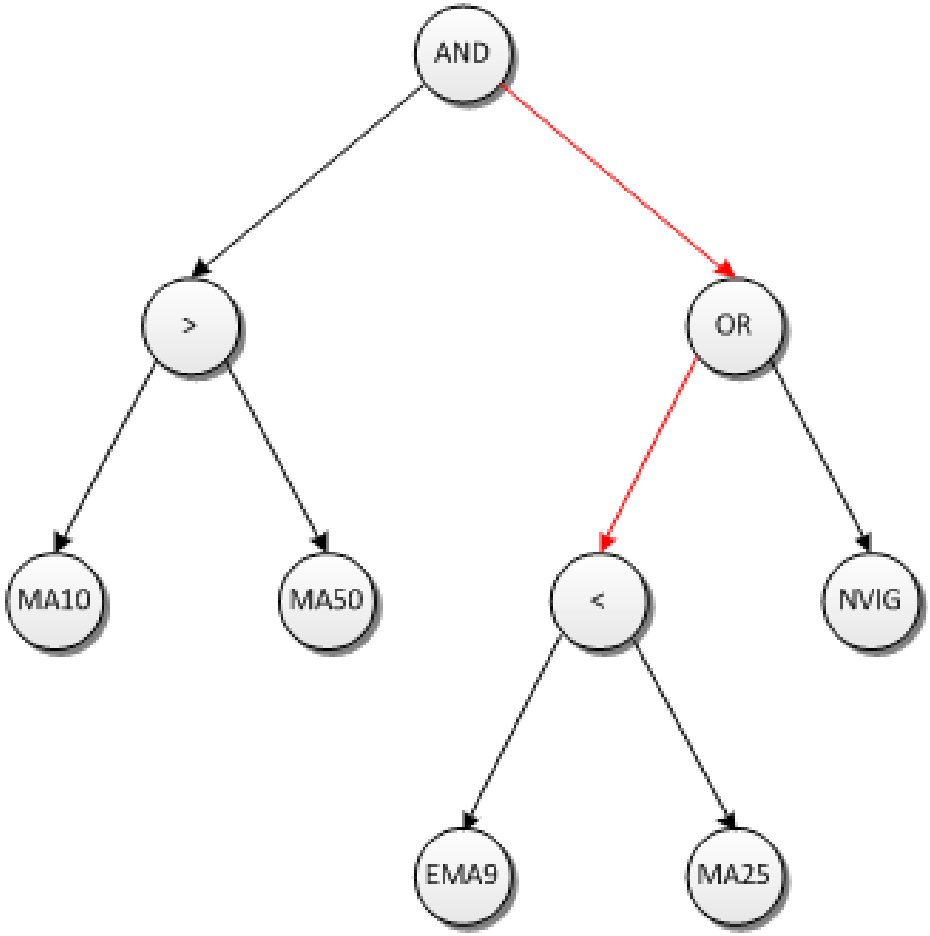

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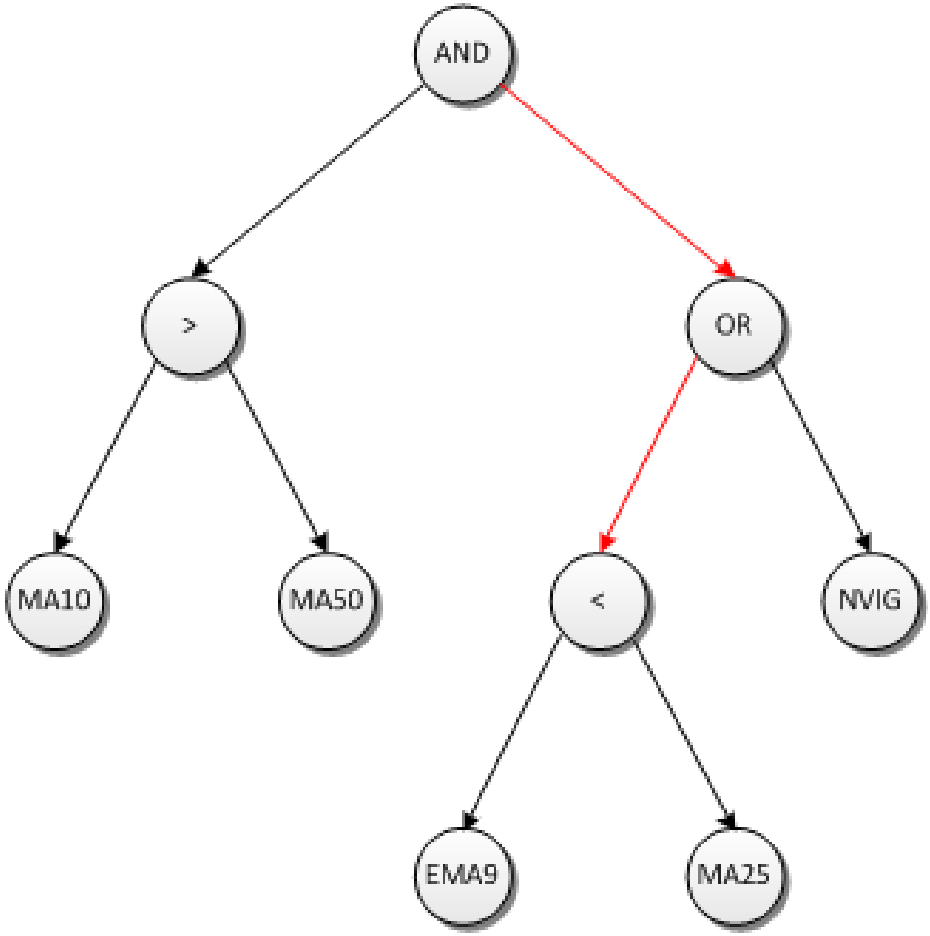

MA10	MA50	>	EMA9	MA25	<				

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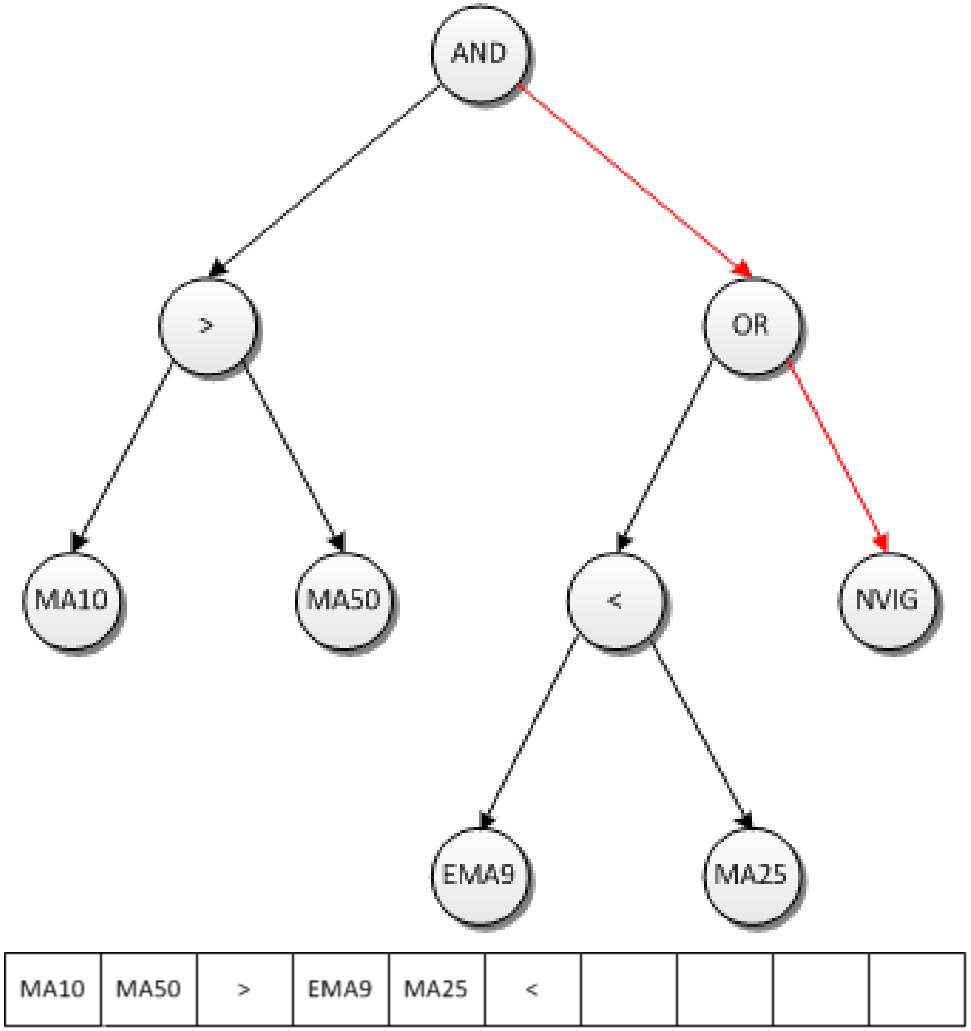

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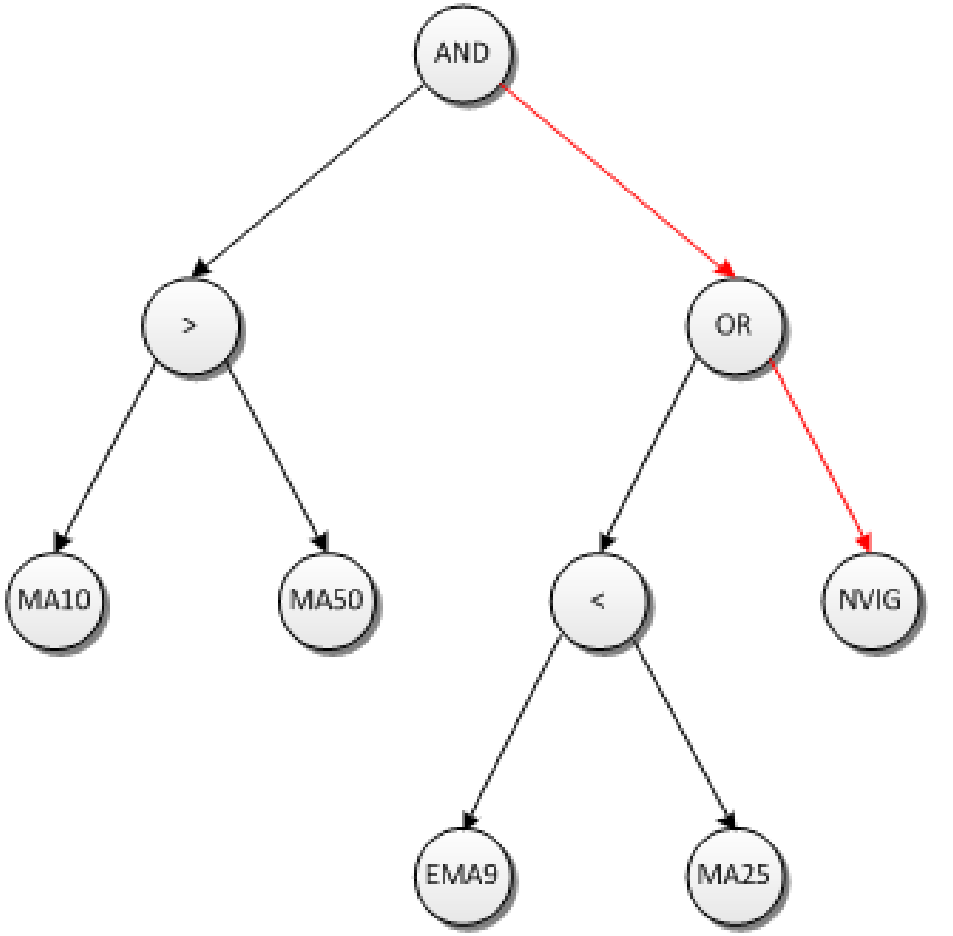
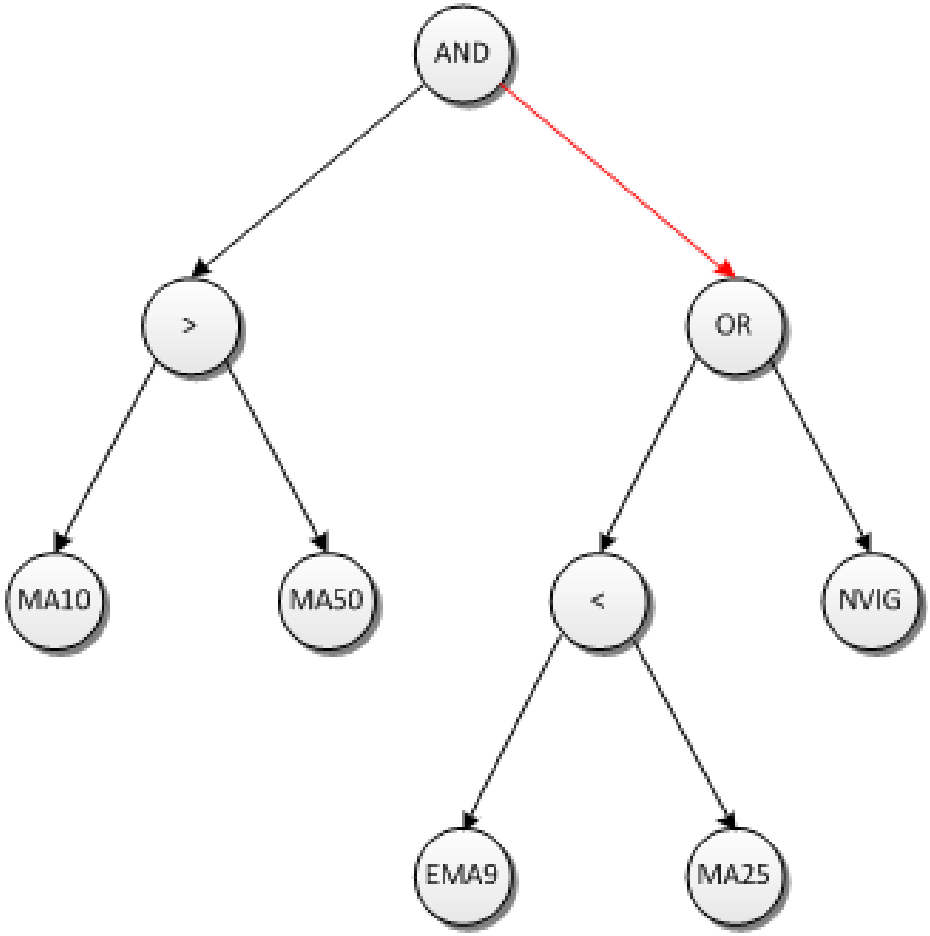


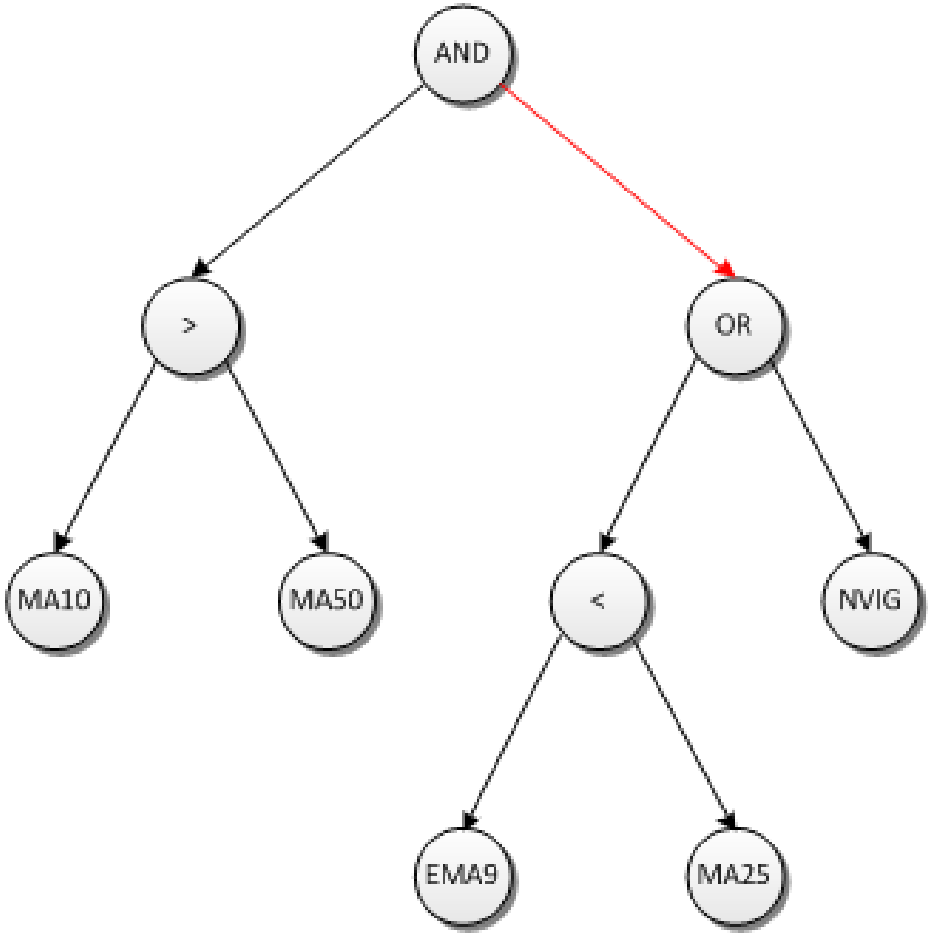
MA10	MA50	>	EMA9	MA25	<	NVIG			

Example Conversion



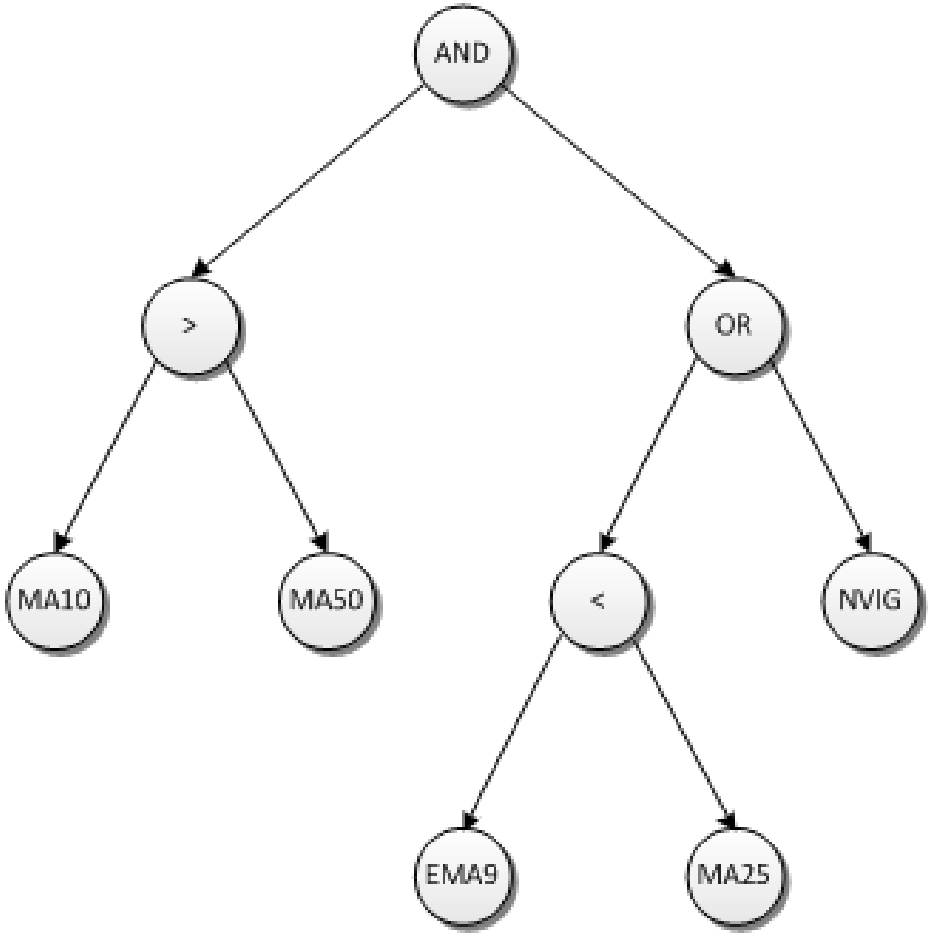
MA10	MA50	>	EMA9	MA25	<	NVIG			

Example Conversion



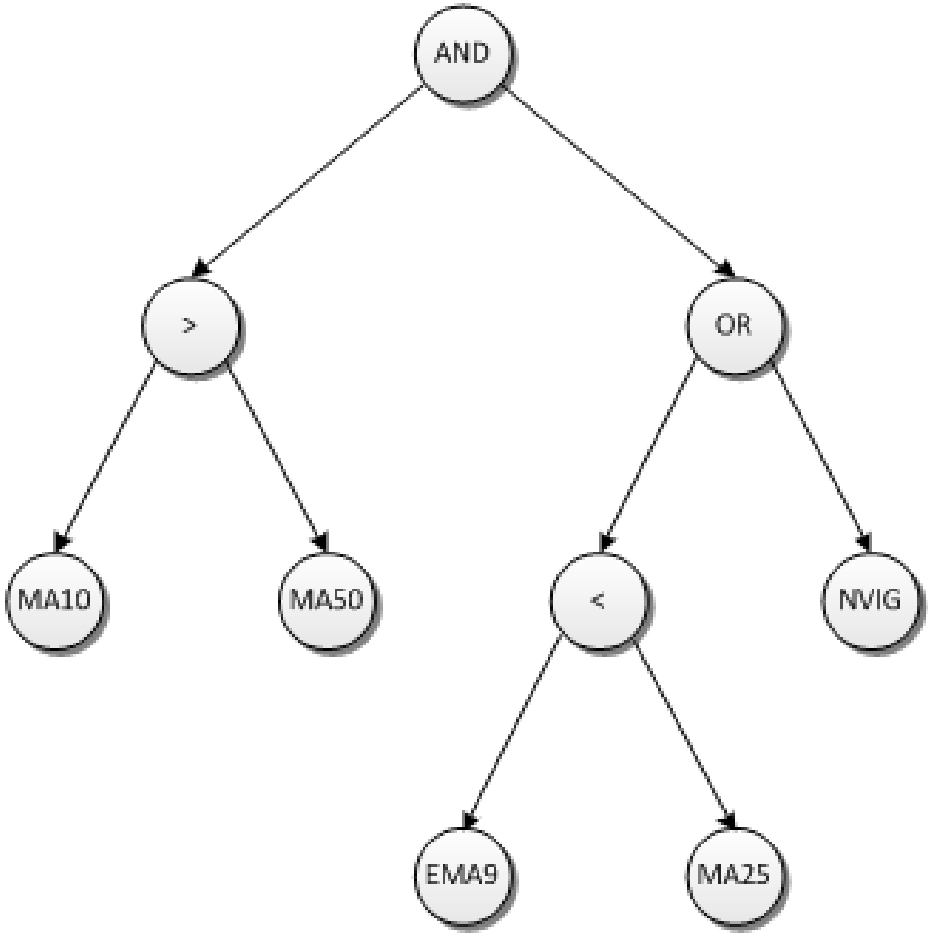
MA10	MA50	>	EMA9	MA25	<	NVIG	OR		

Example Conversion



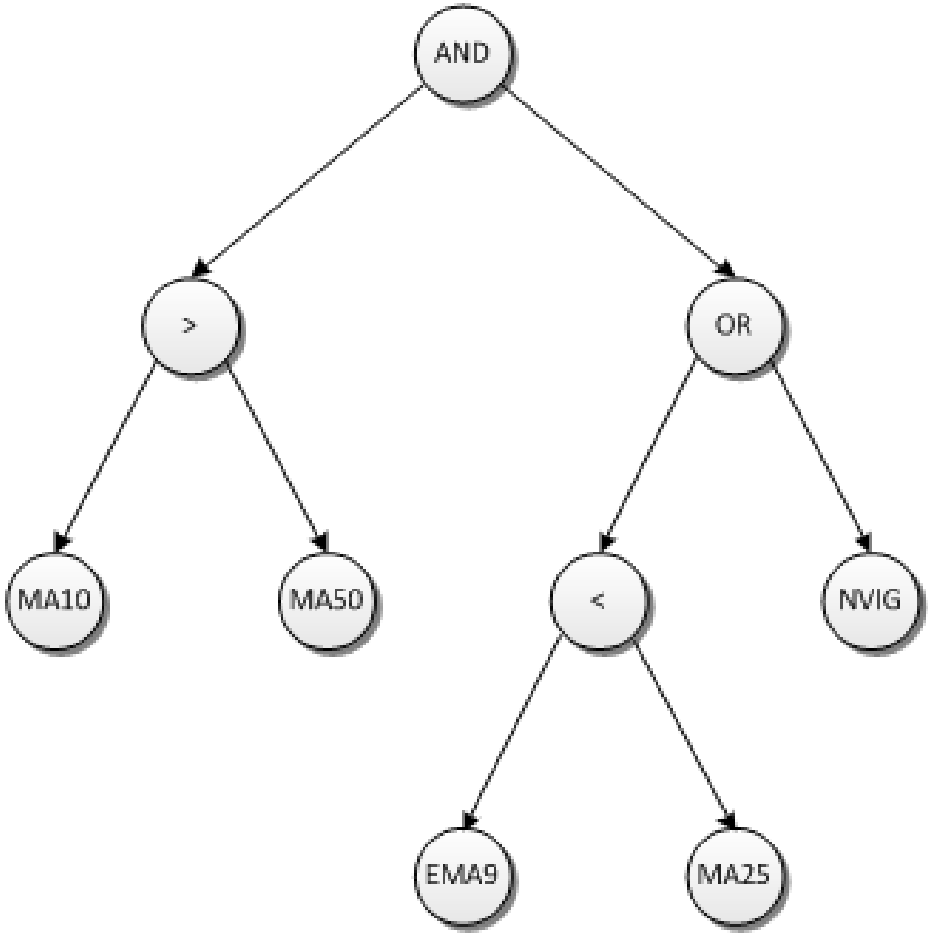
MA10	MA50	>	EMA9	MA25	<	NVIG	OR		

Example Conversion



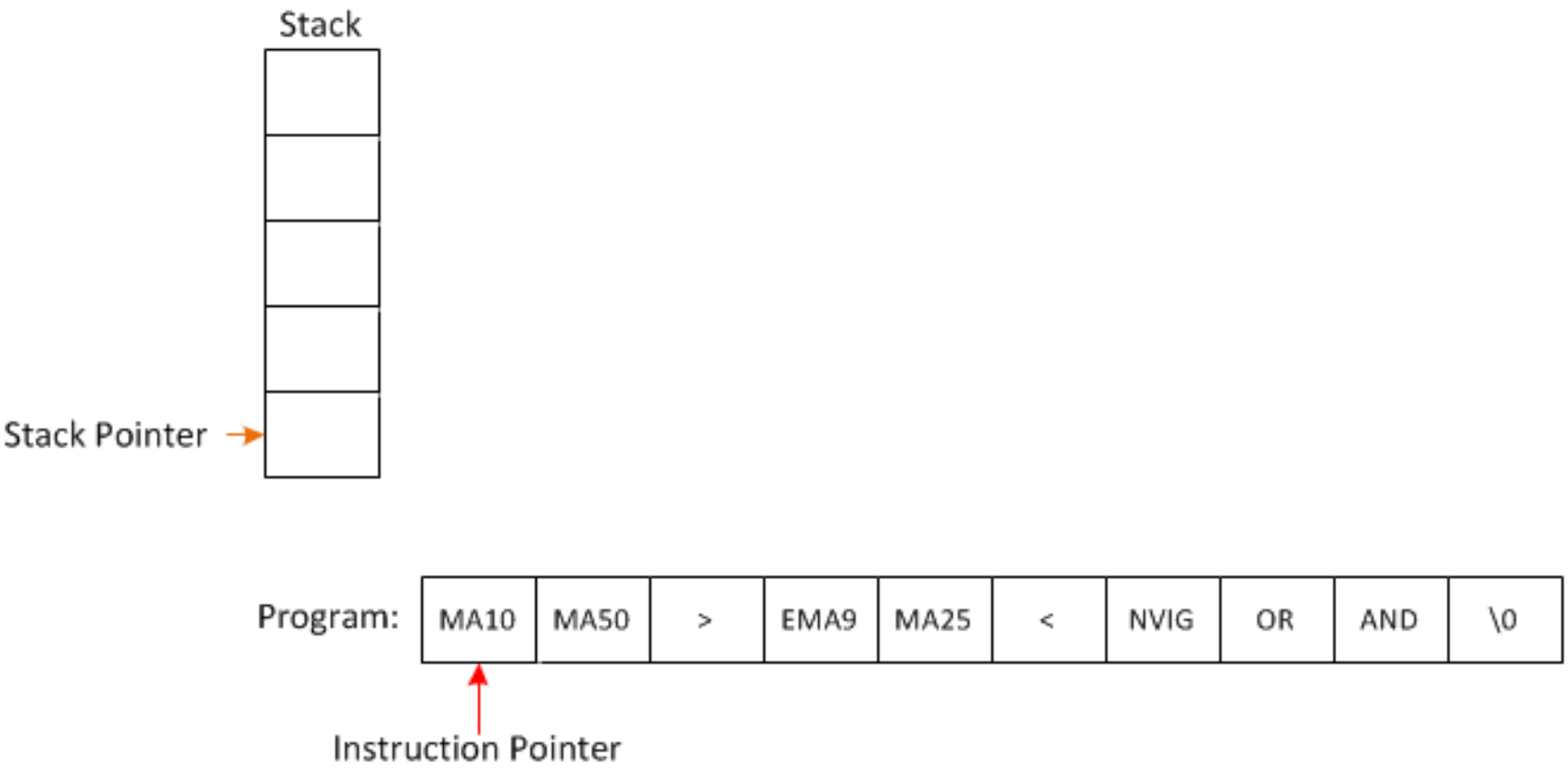
MA10	MA50	>	EMA9	MA25	<	NVIG	OR	AND	

Example Conversion



MA10	MA50	>	EMA9	MA25	<	NVIG	OR	AND	\0

Stack-based Interpreter



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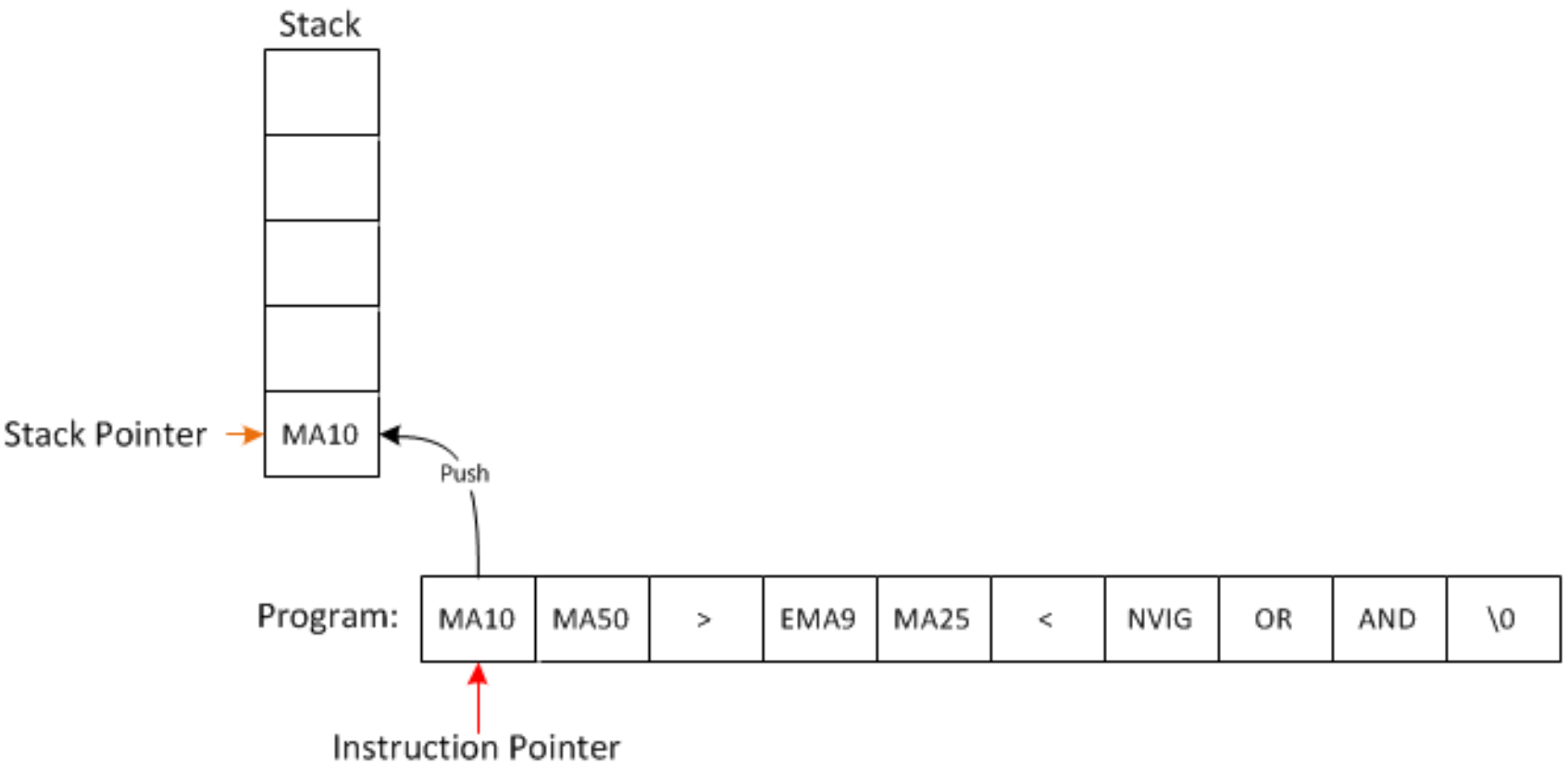

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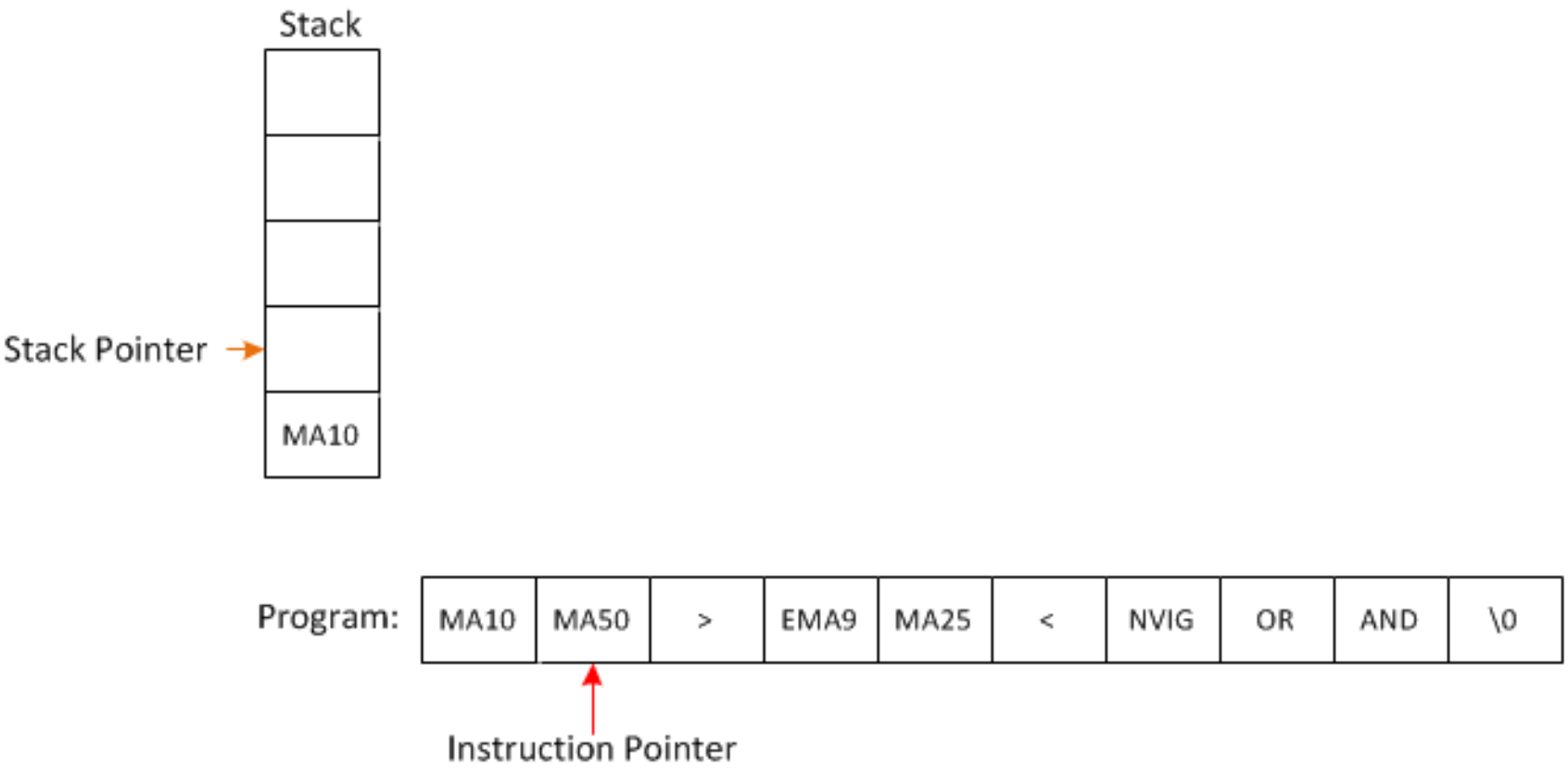

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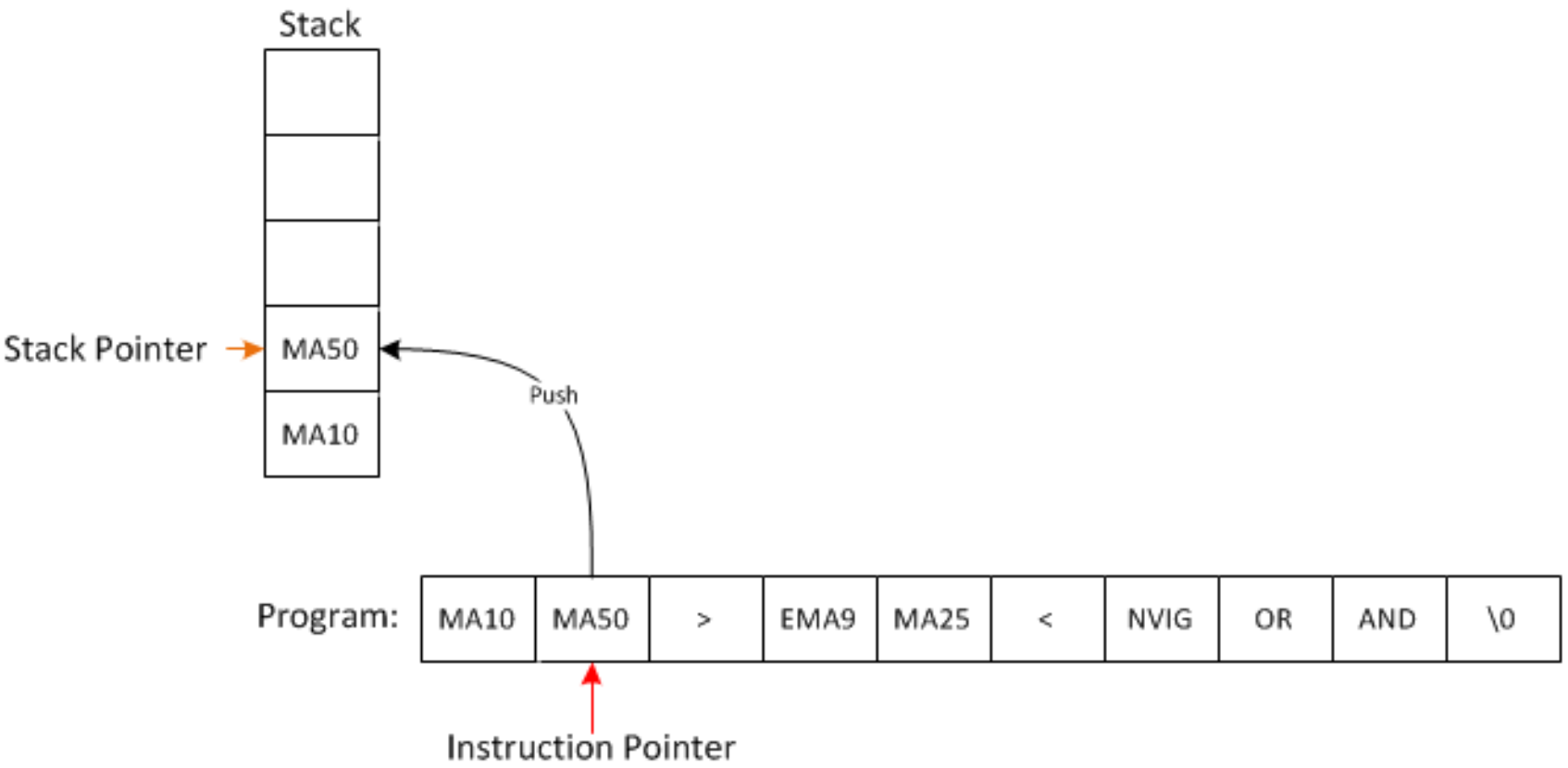

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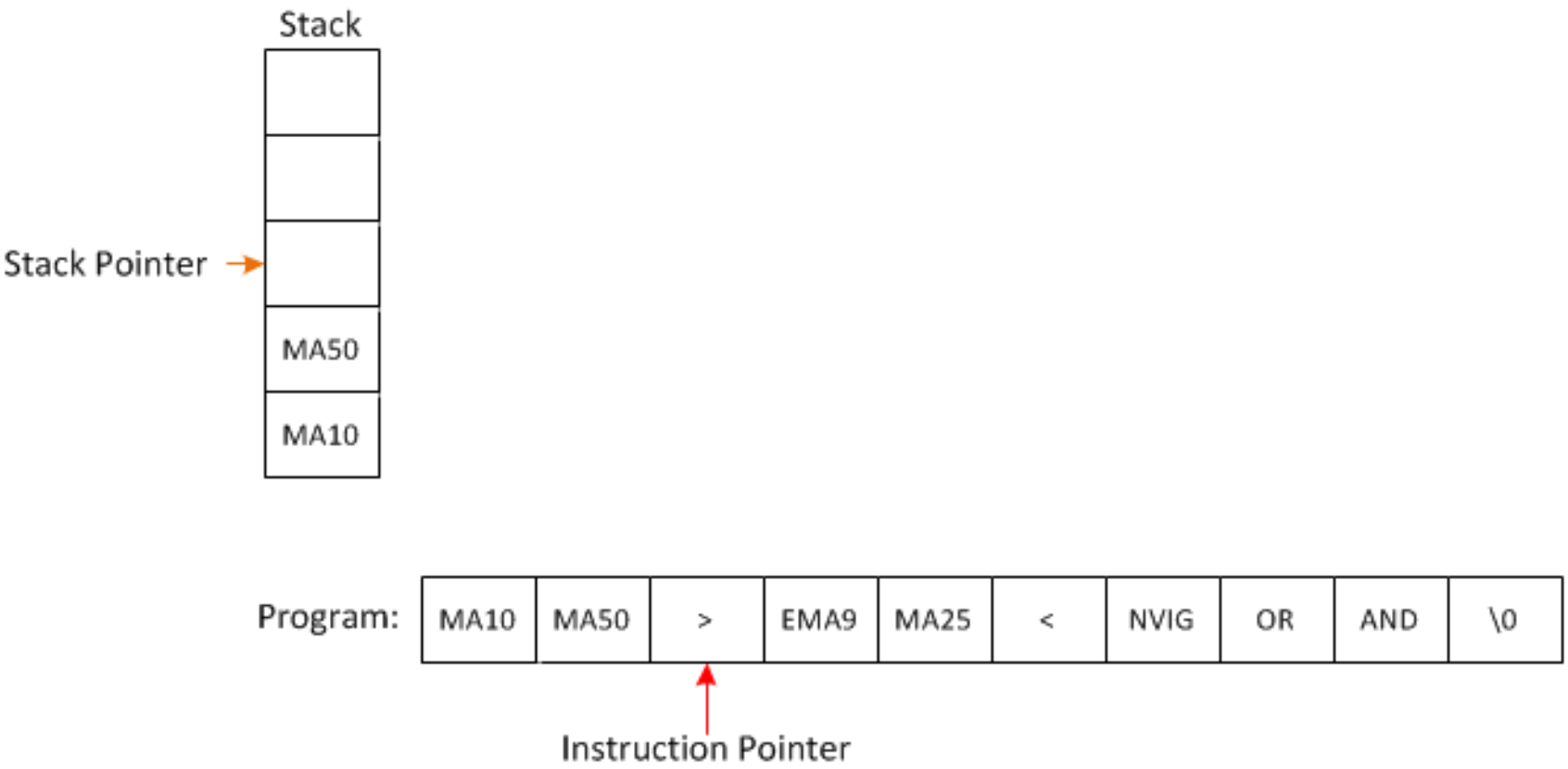

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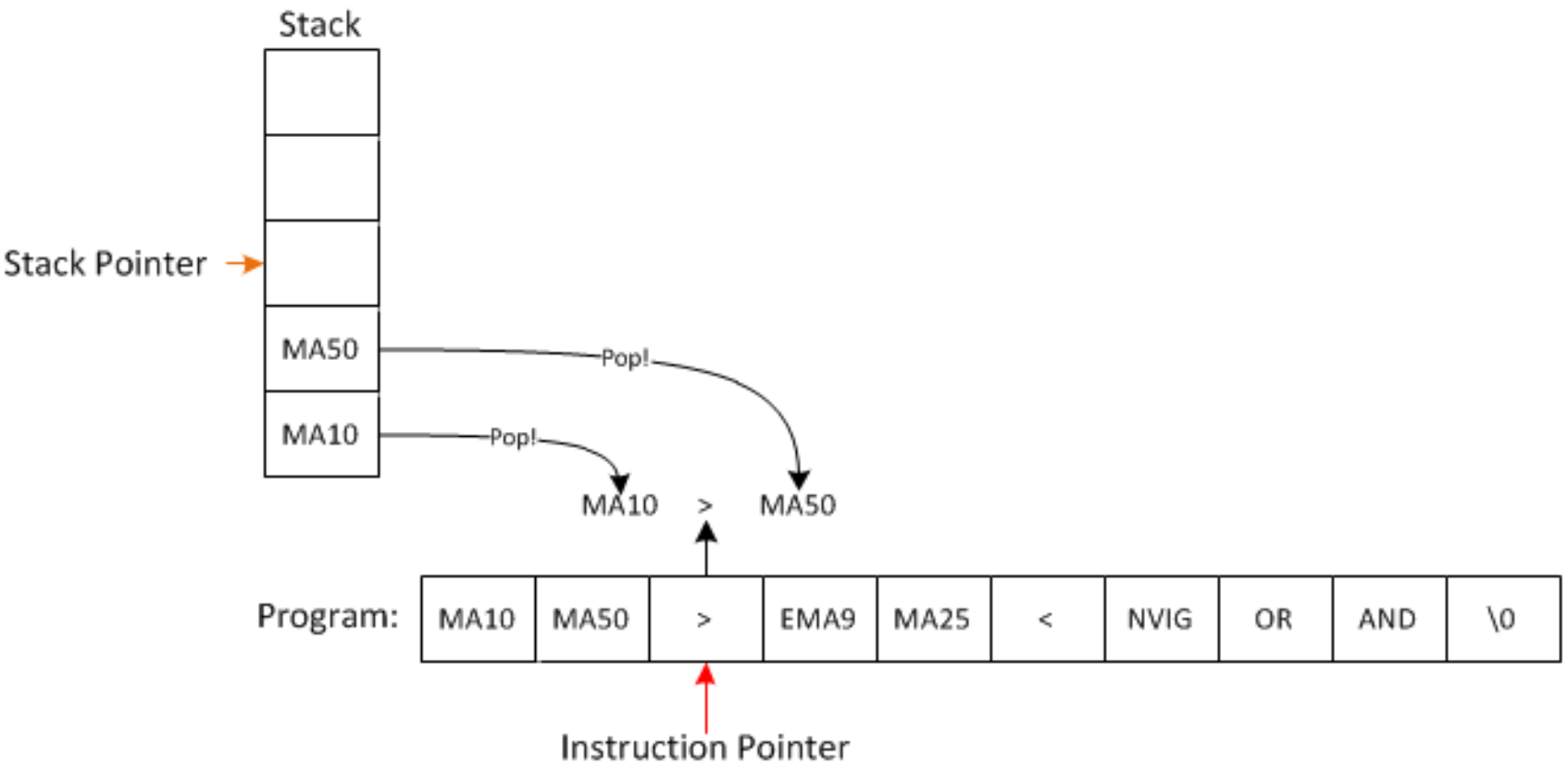

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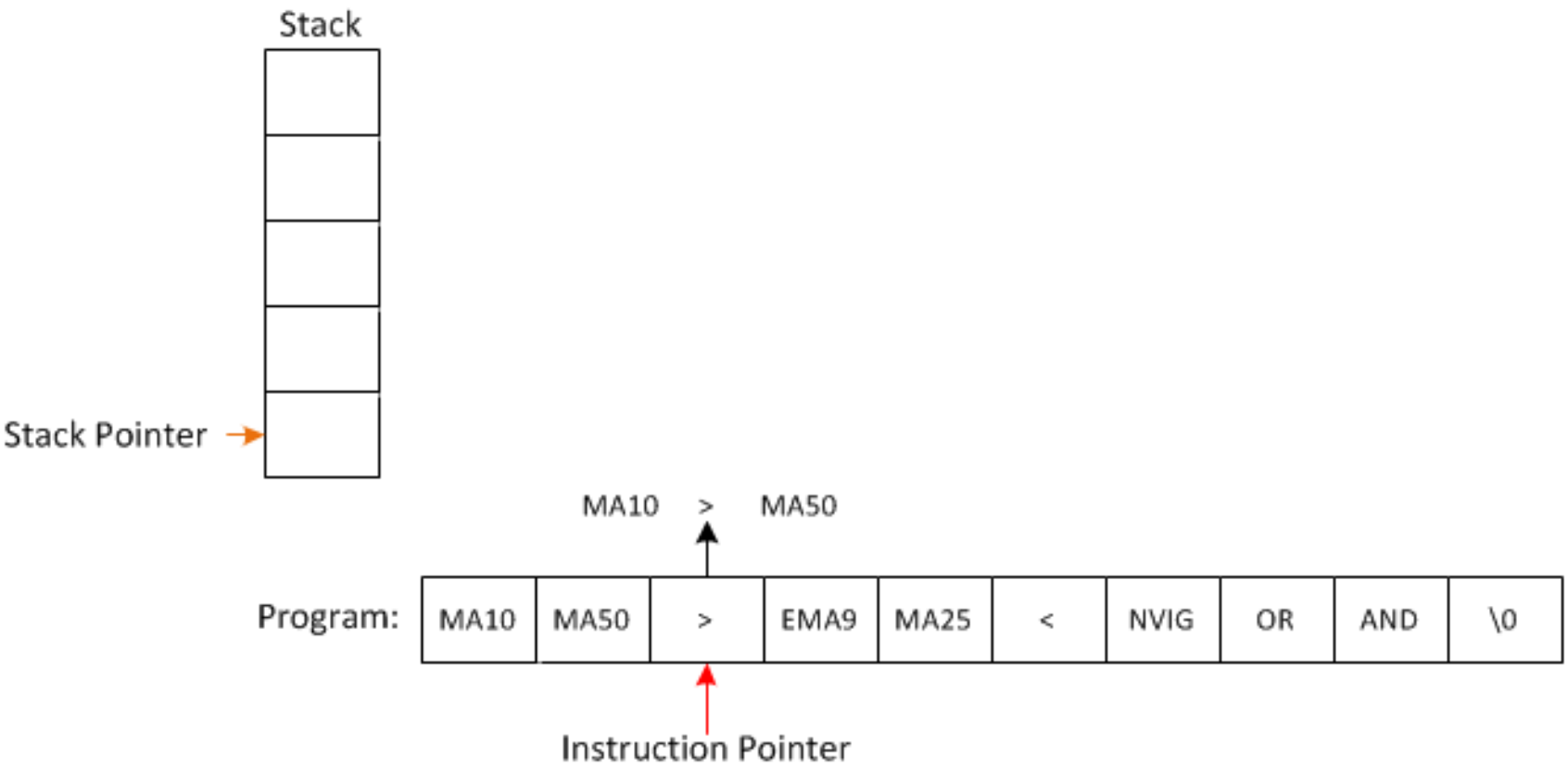

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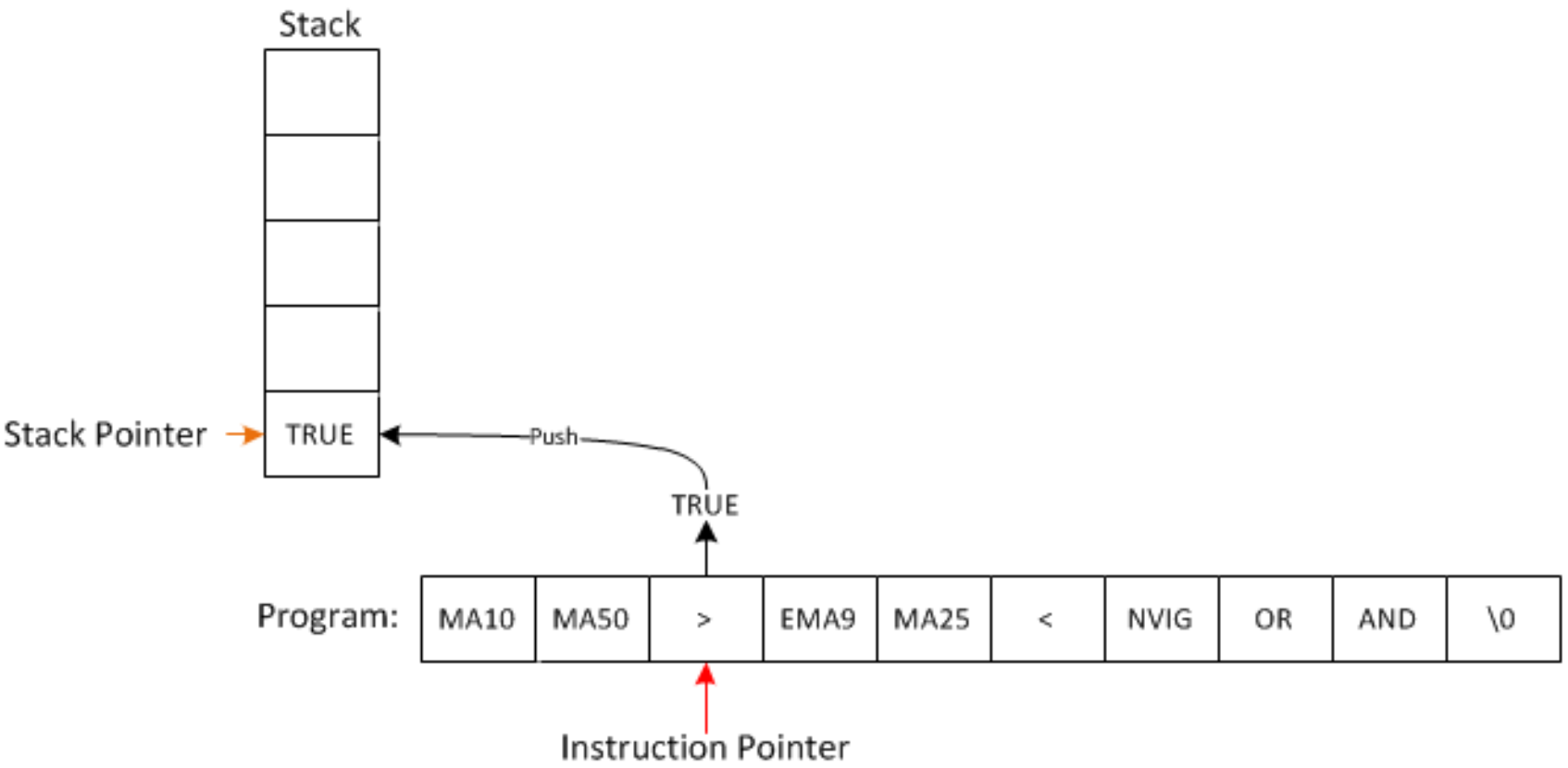

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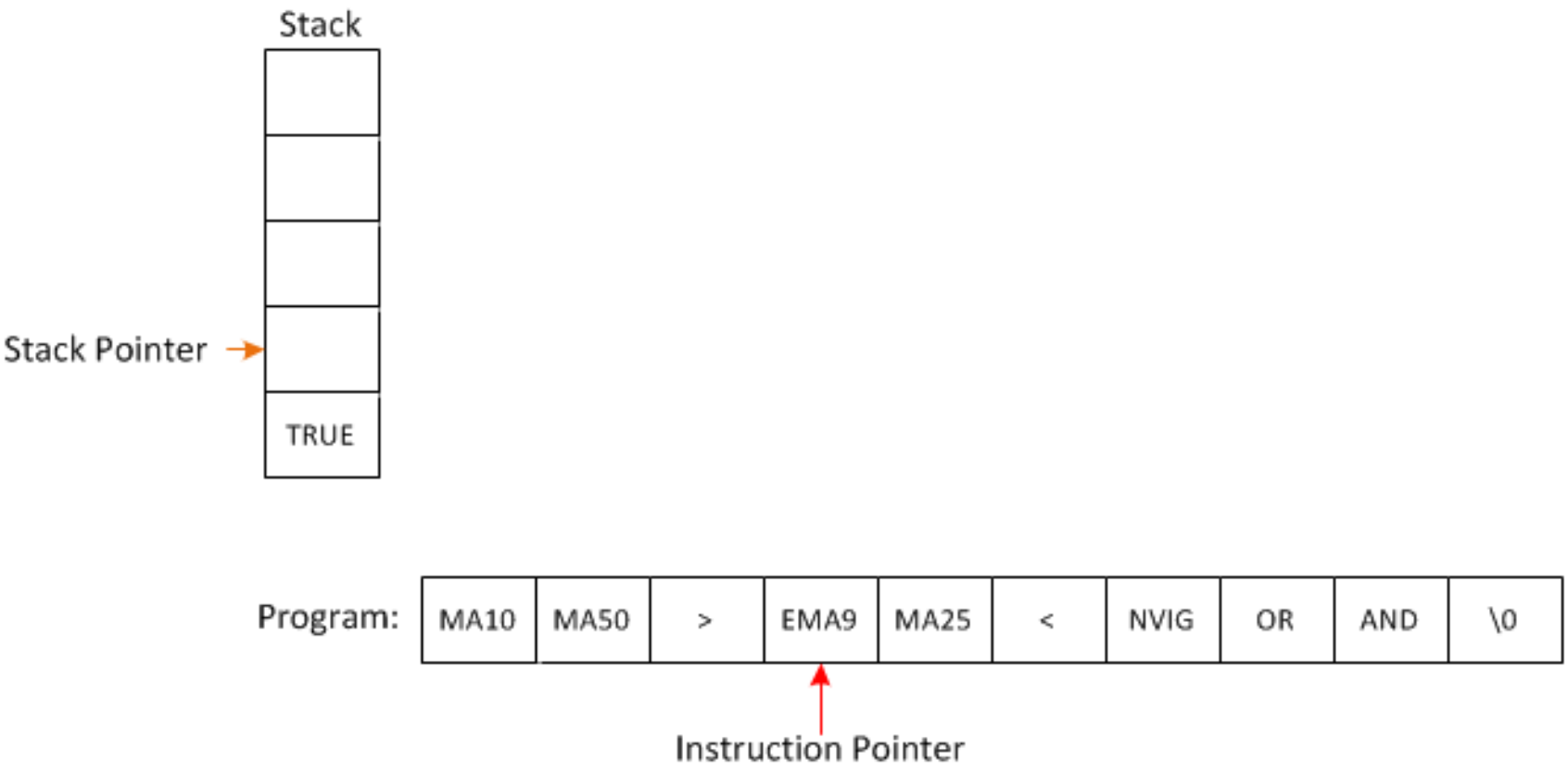

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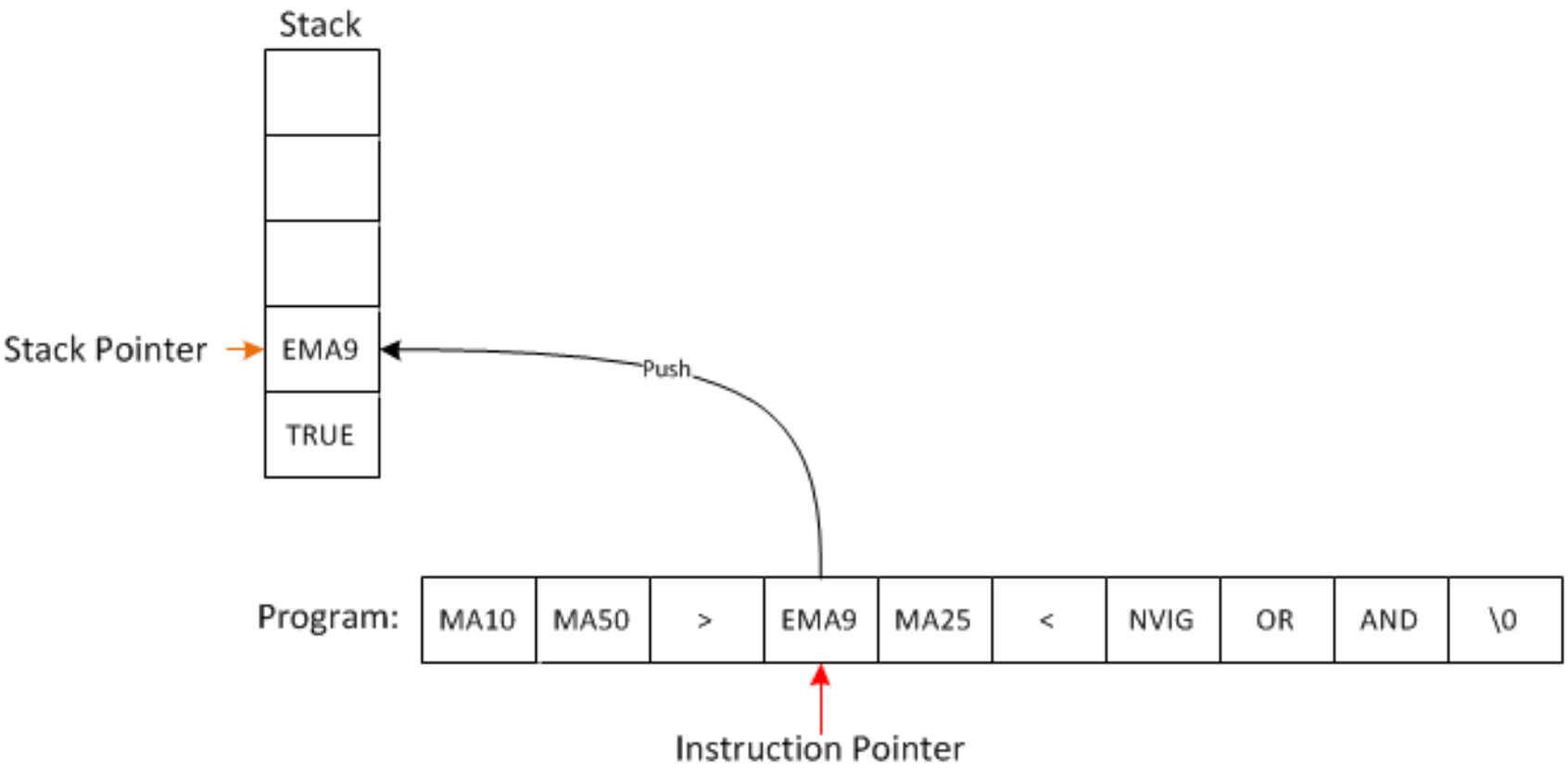

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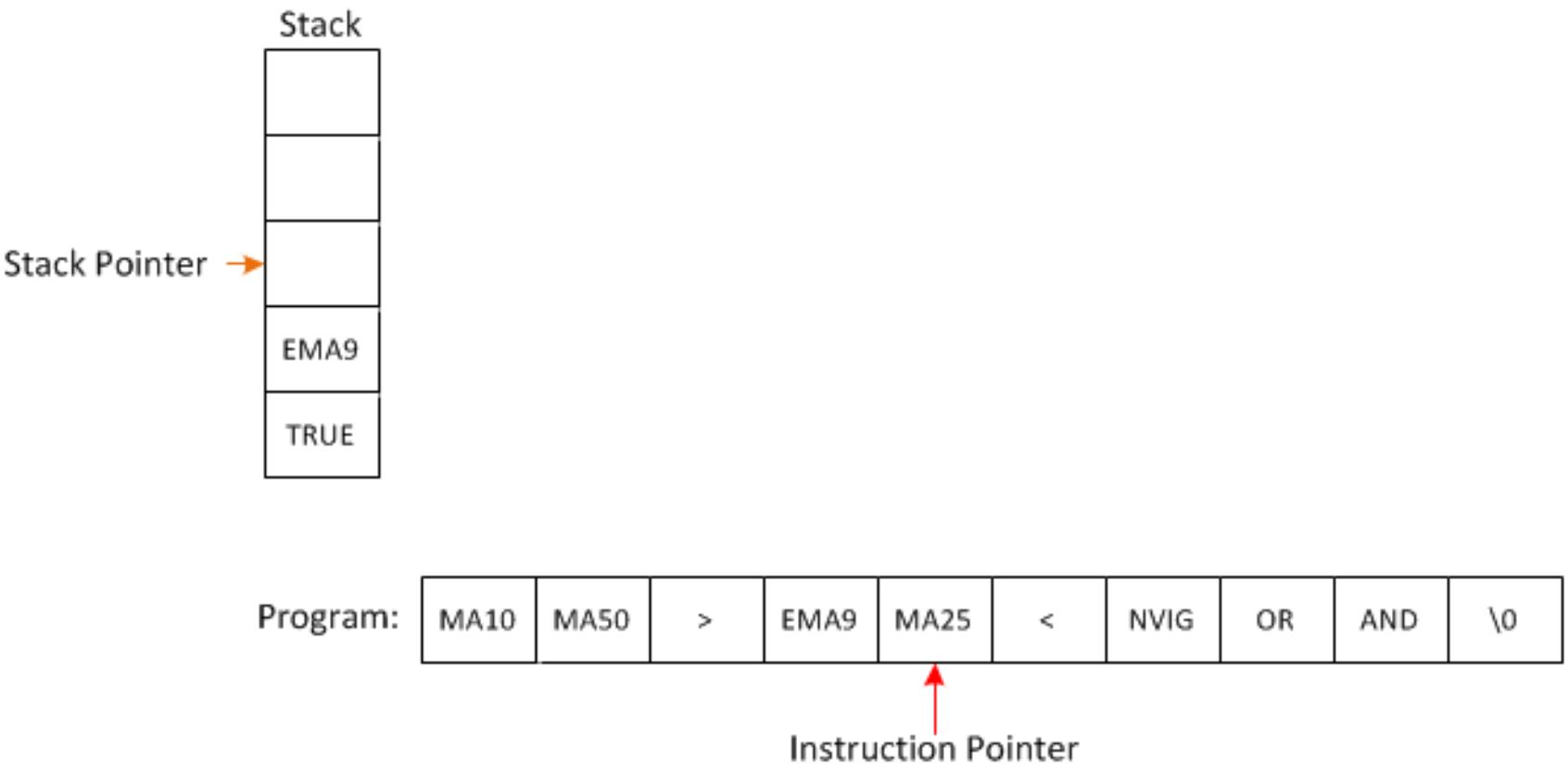

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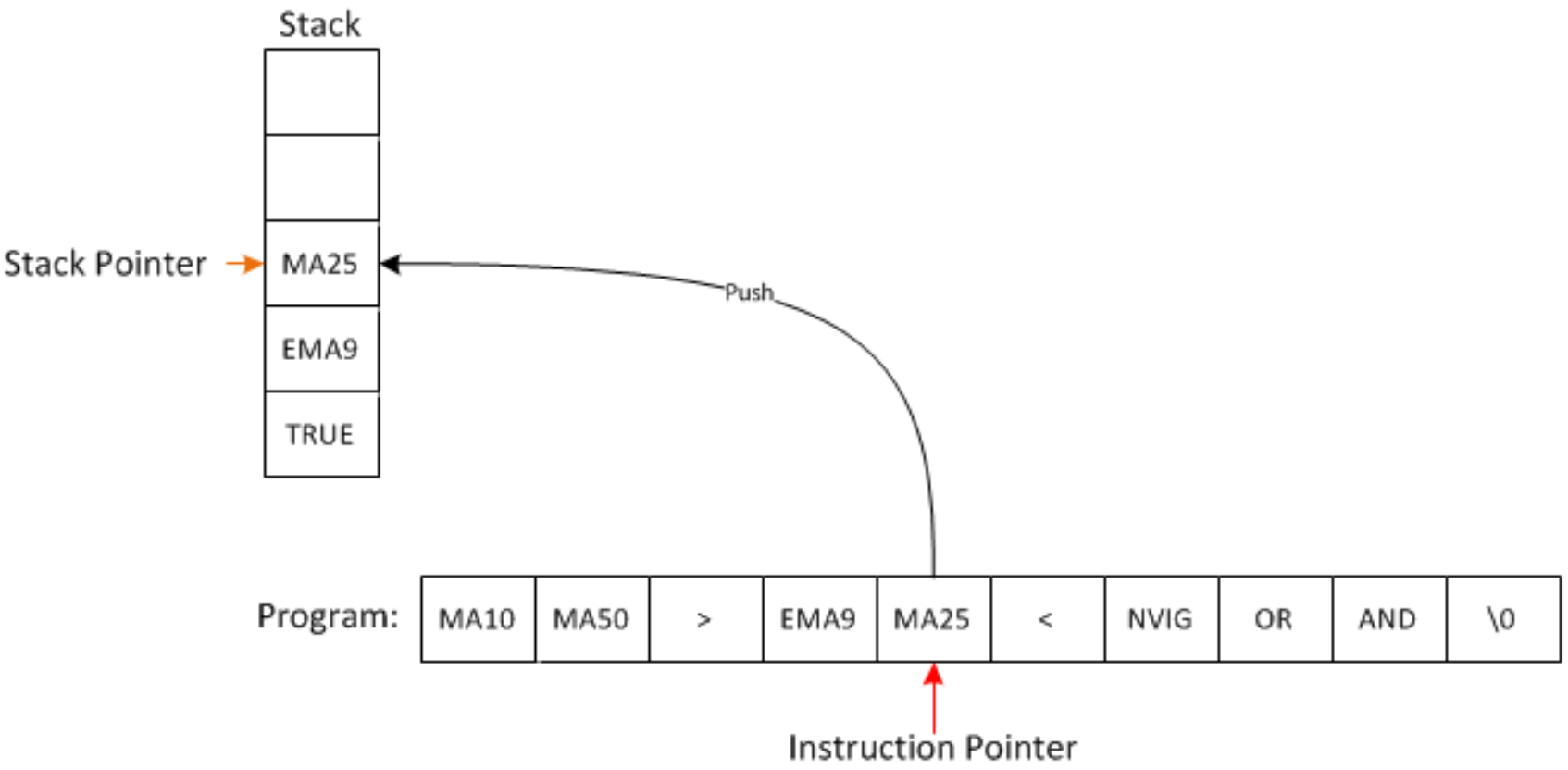

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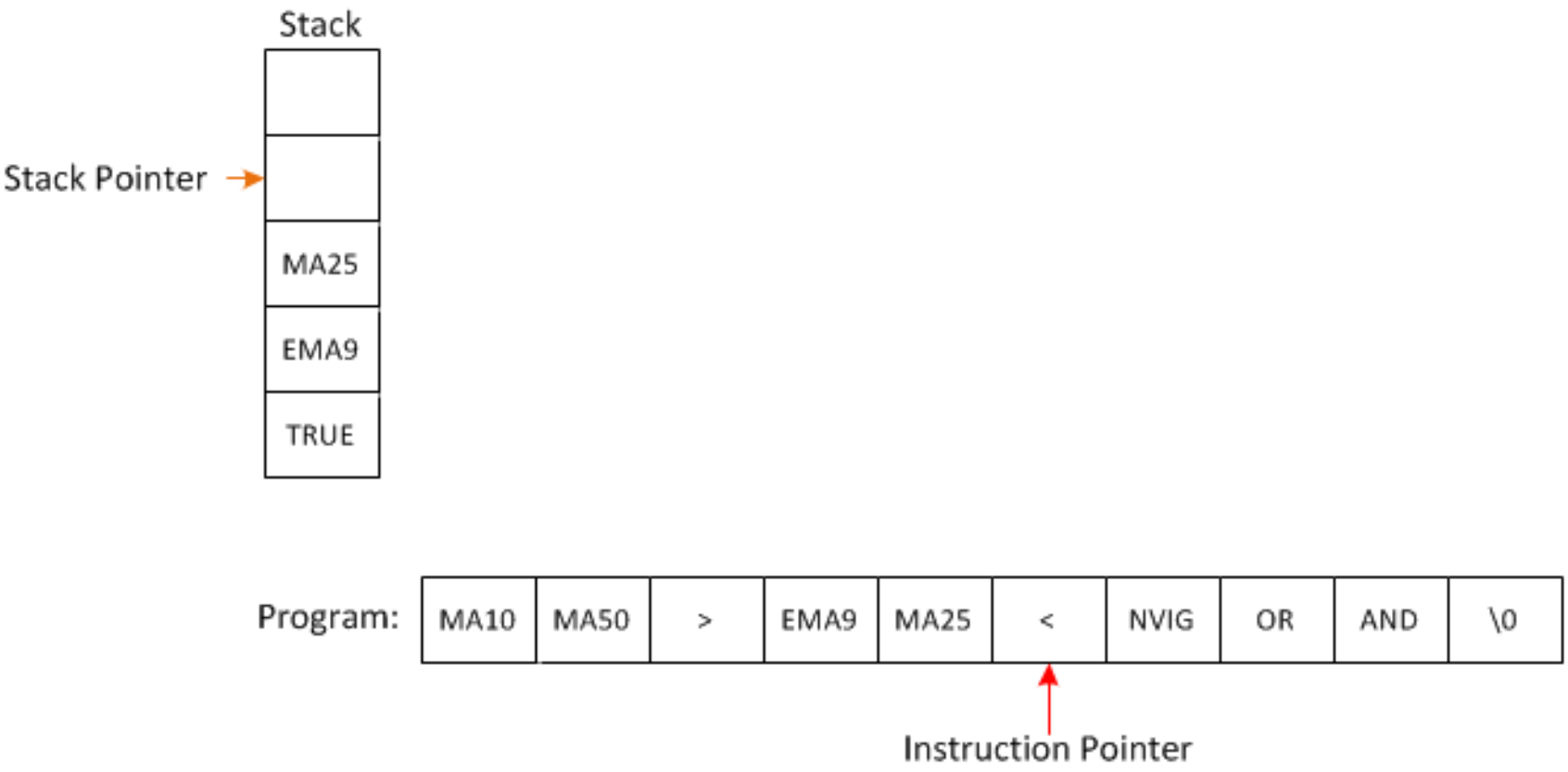

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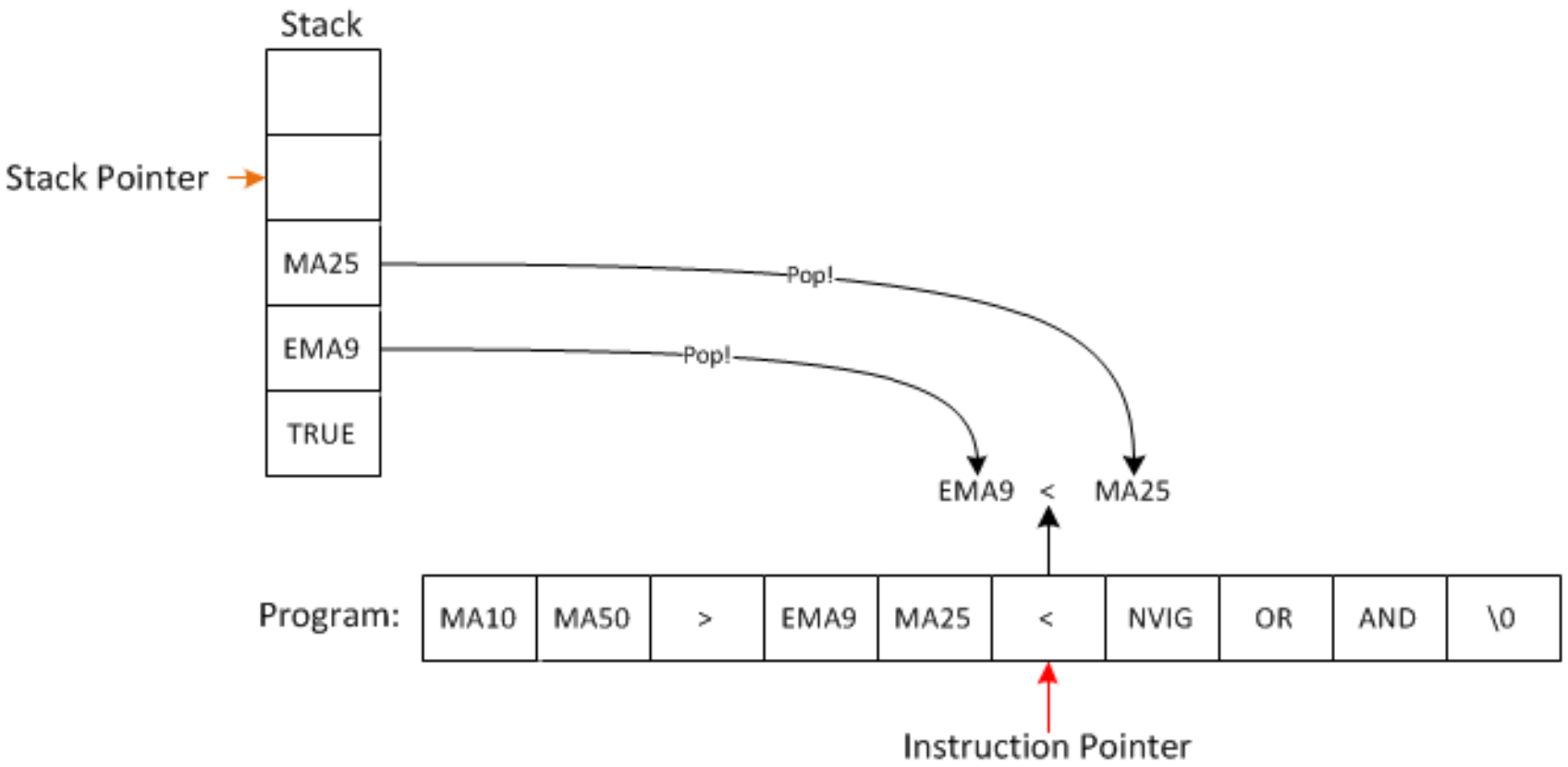

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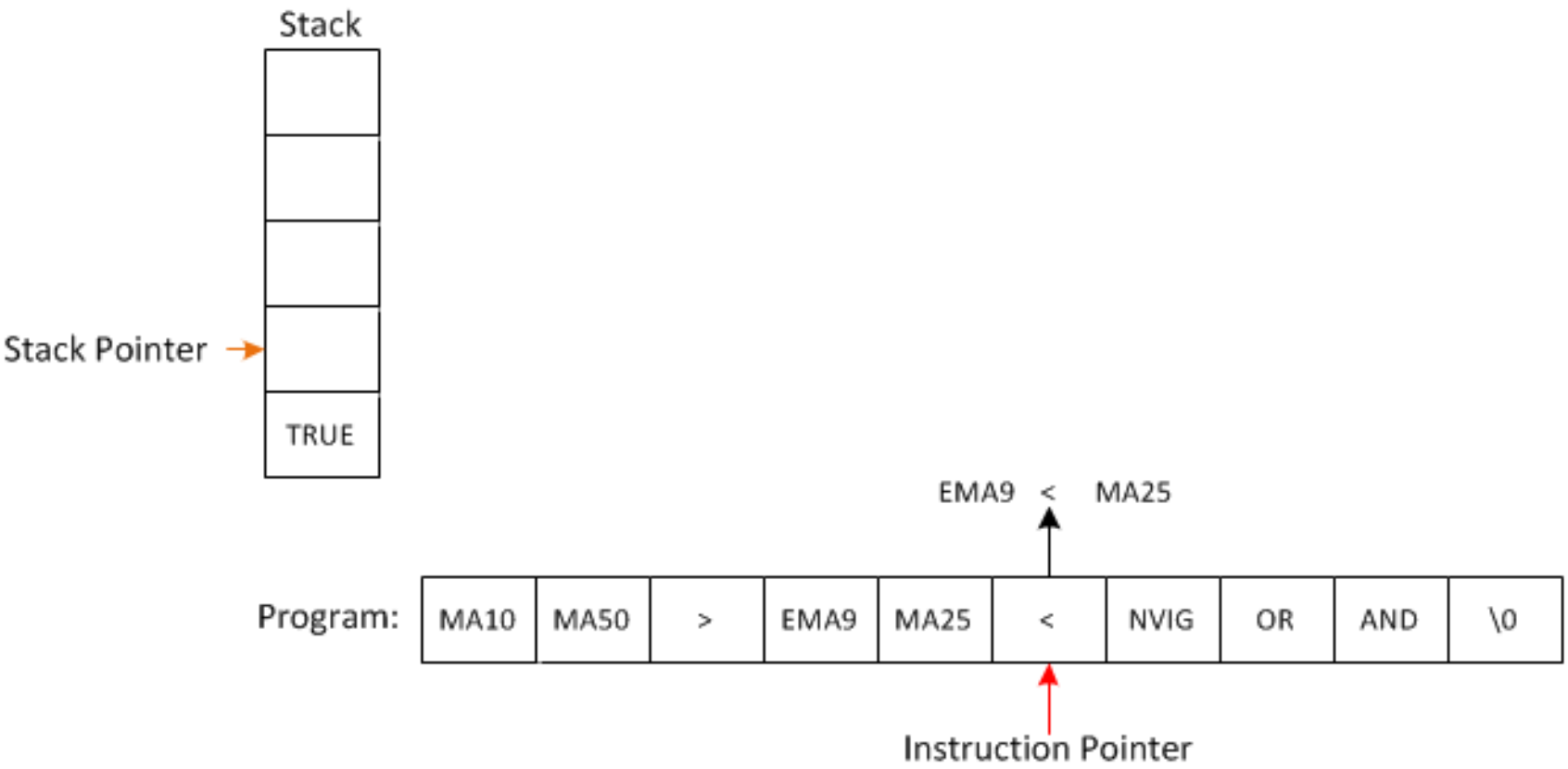

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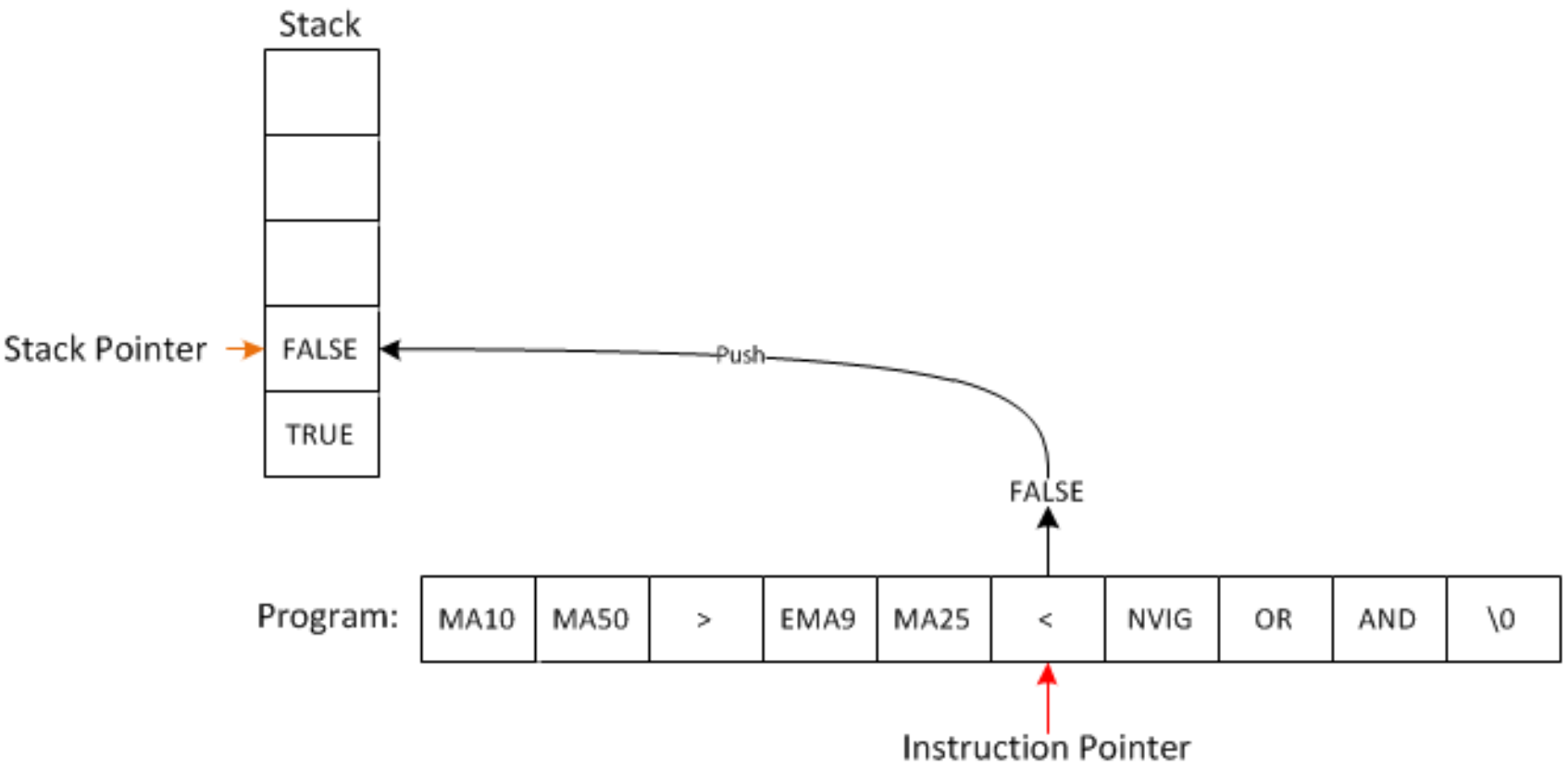

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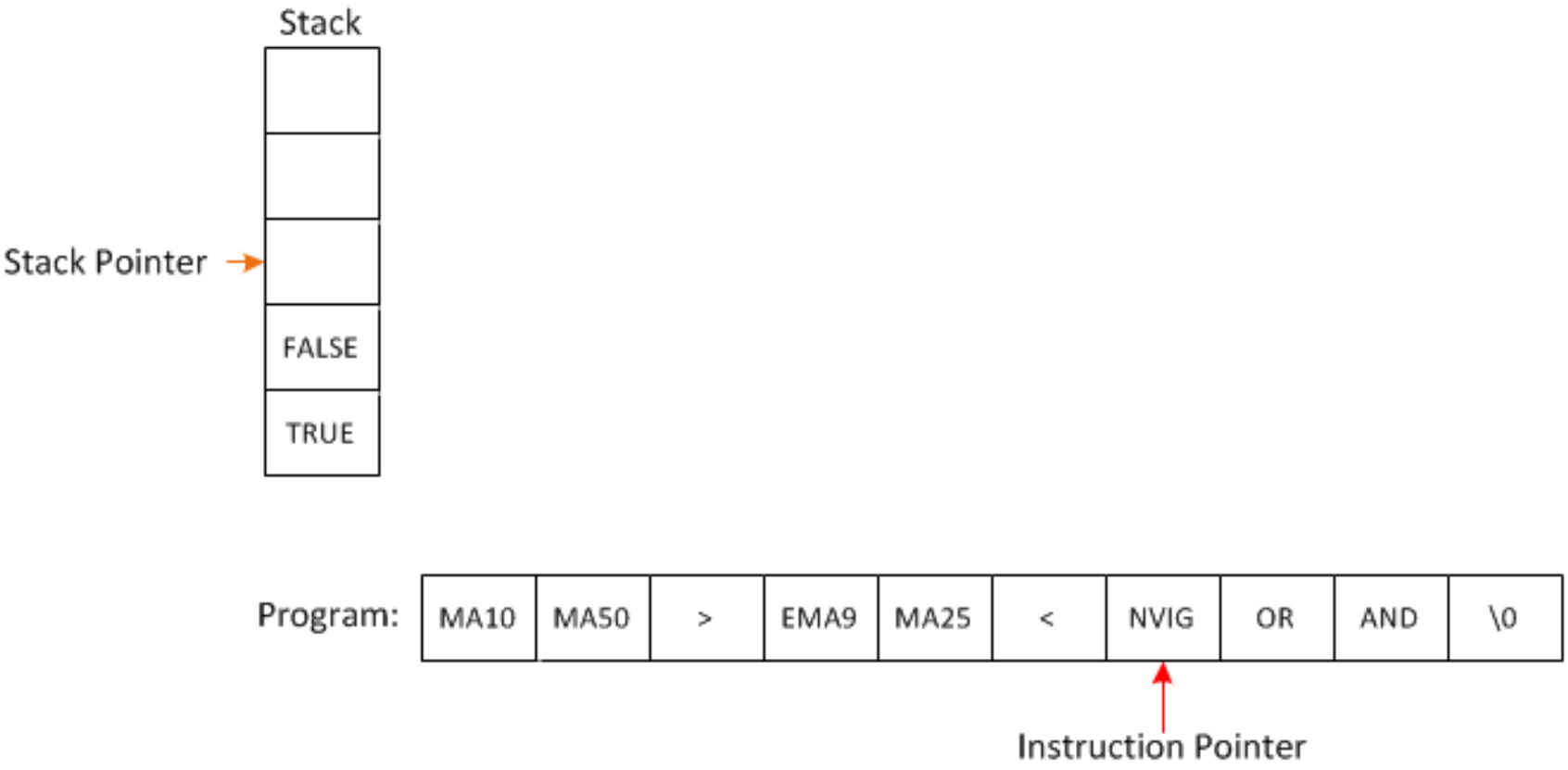

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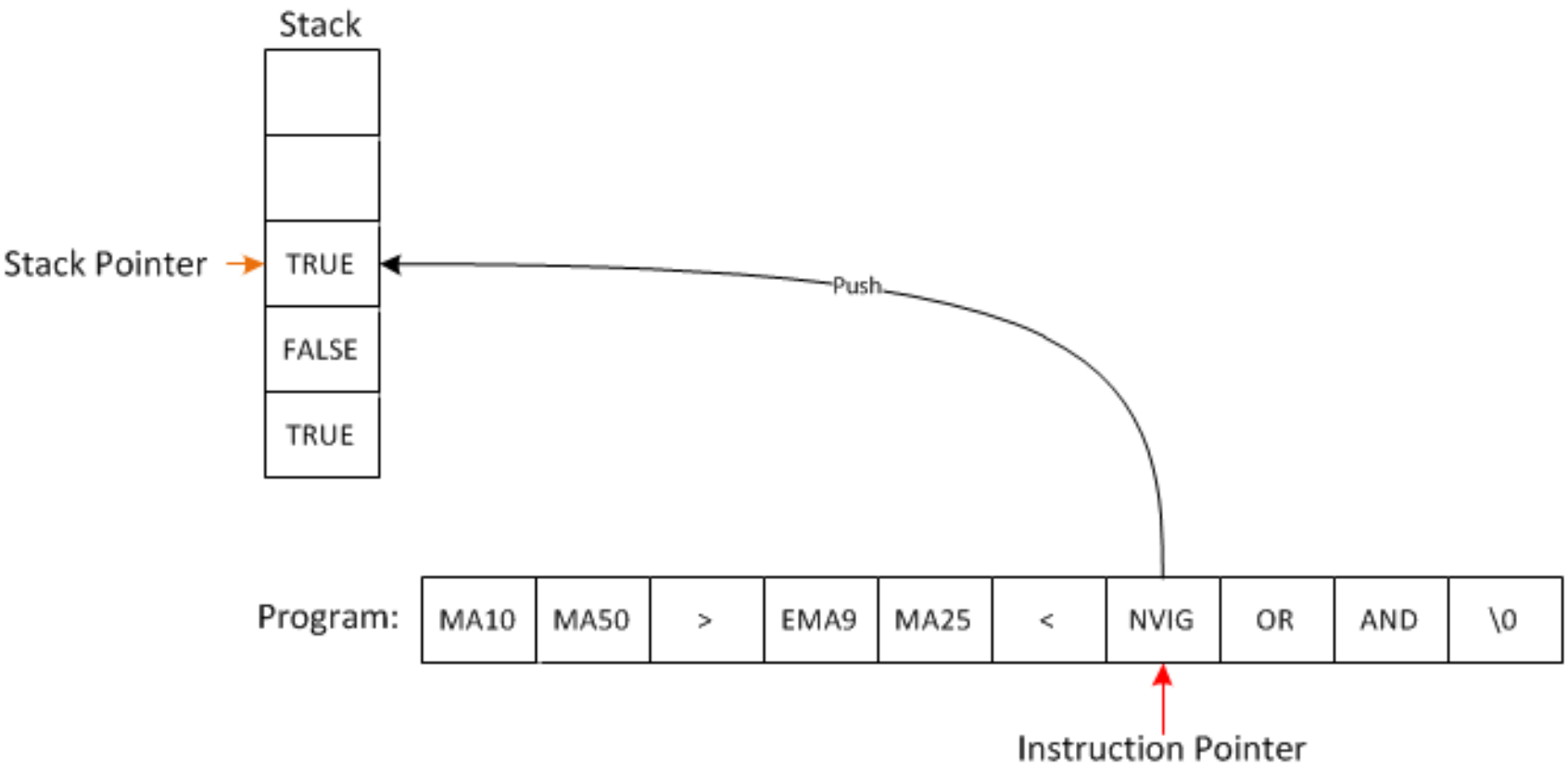

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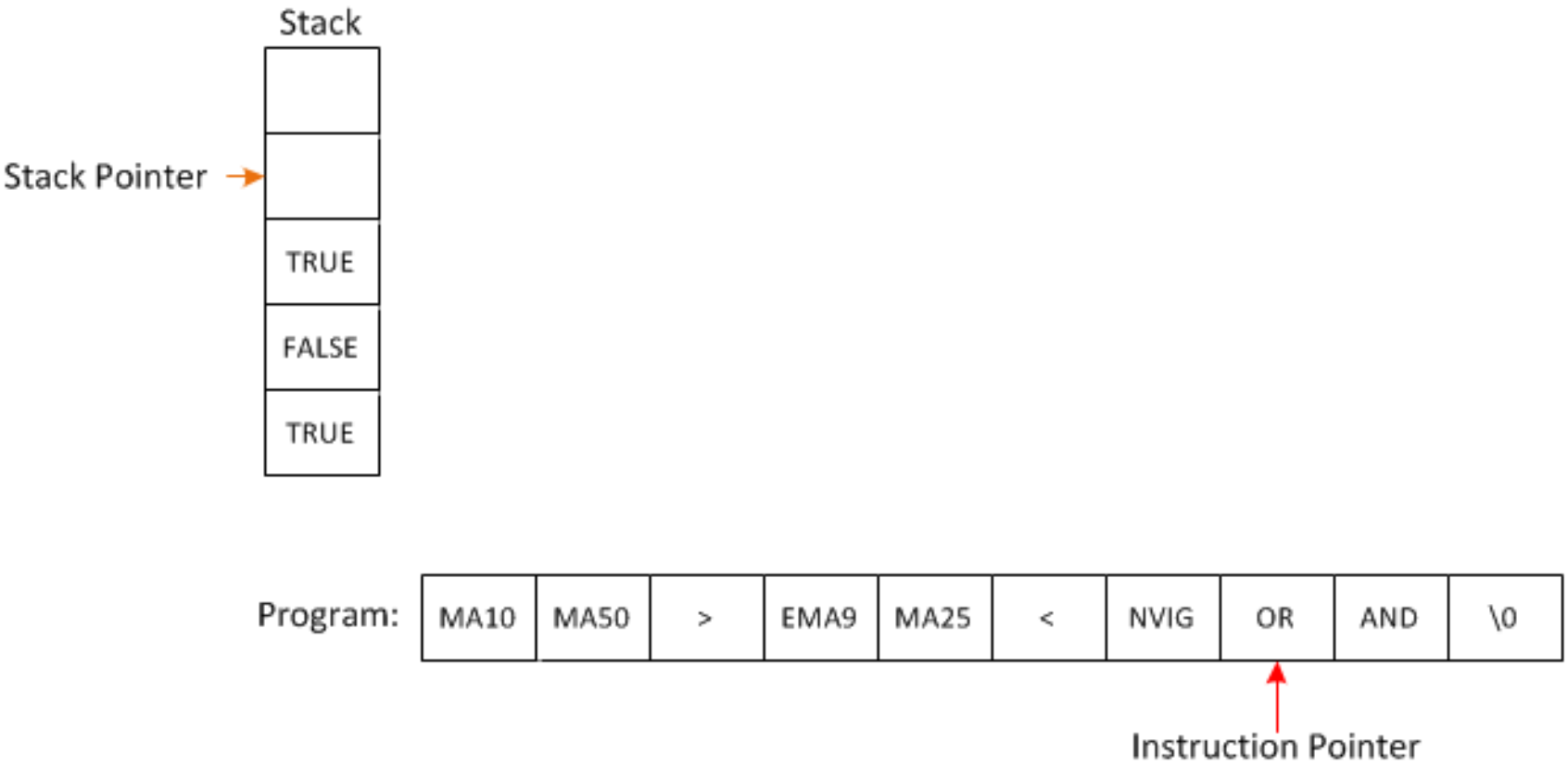

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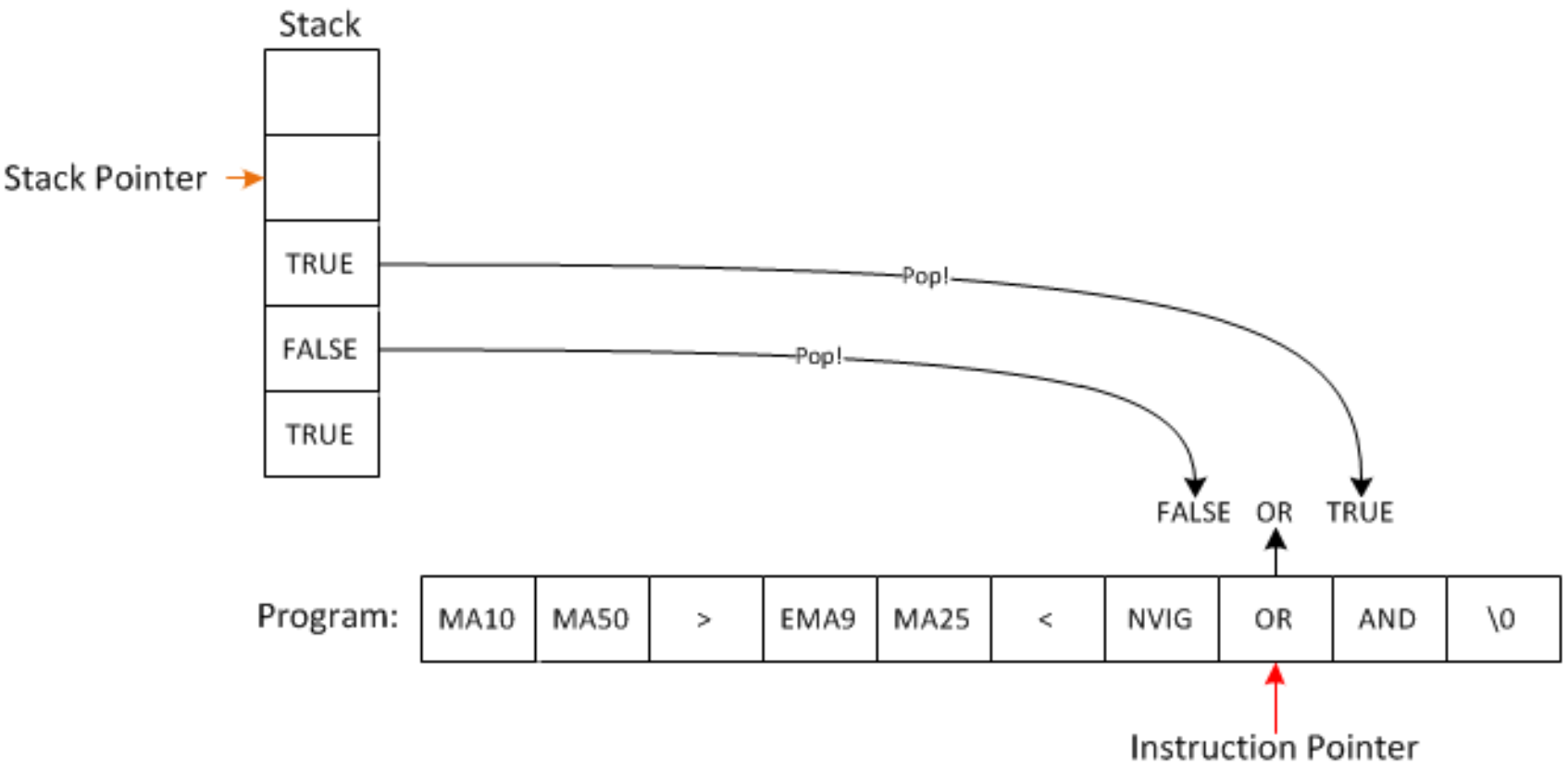

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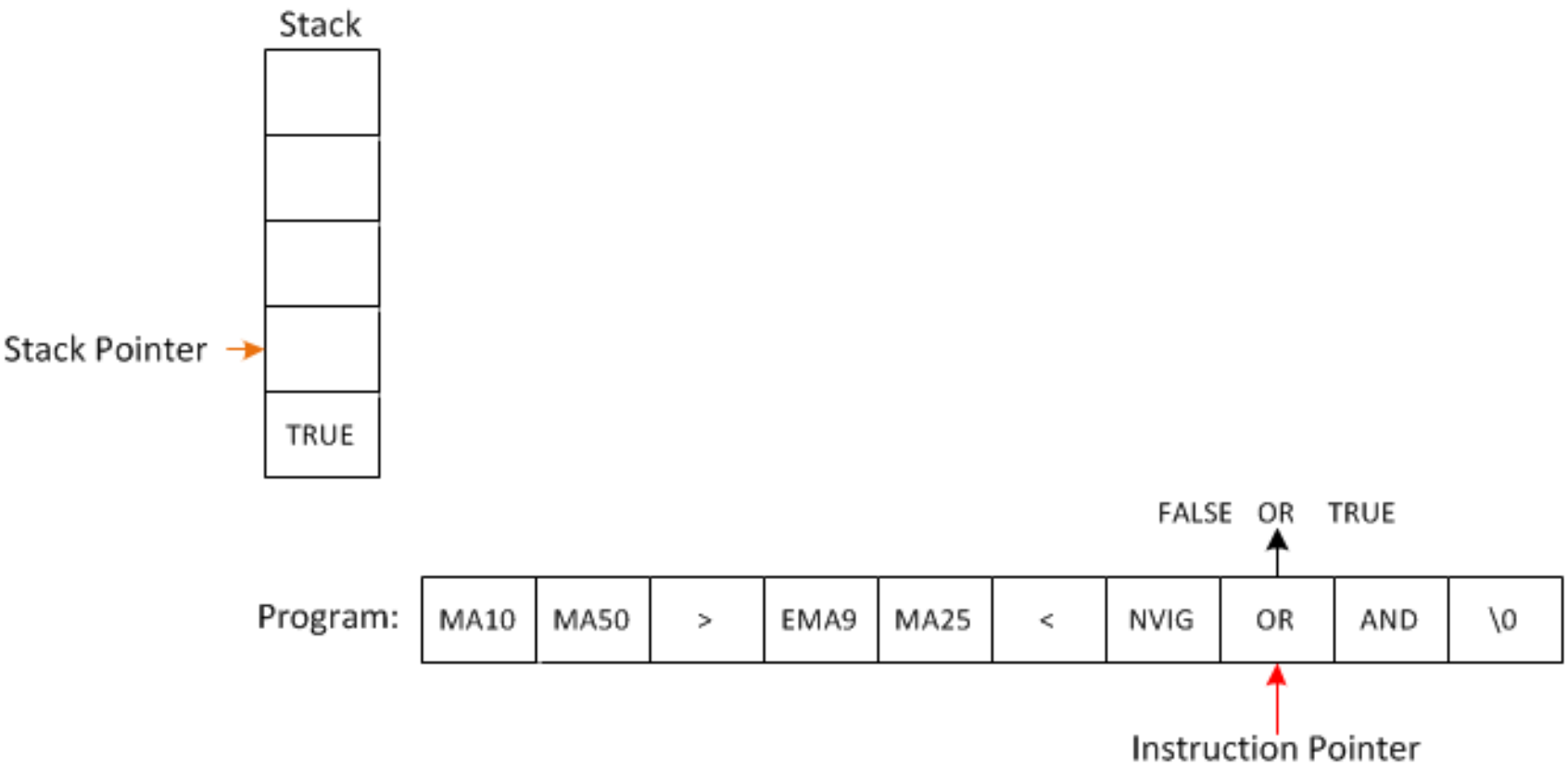

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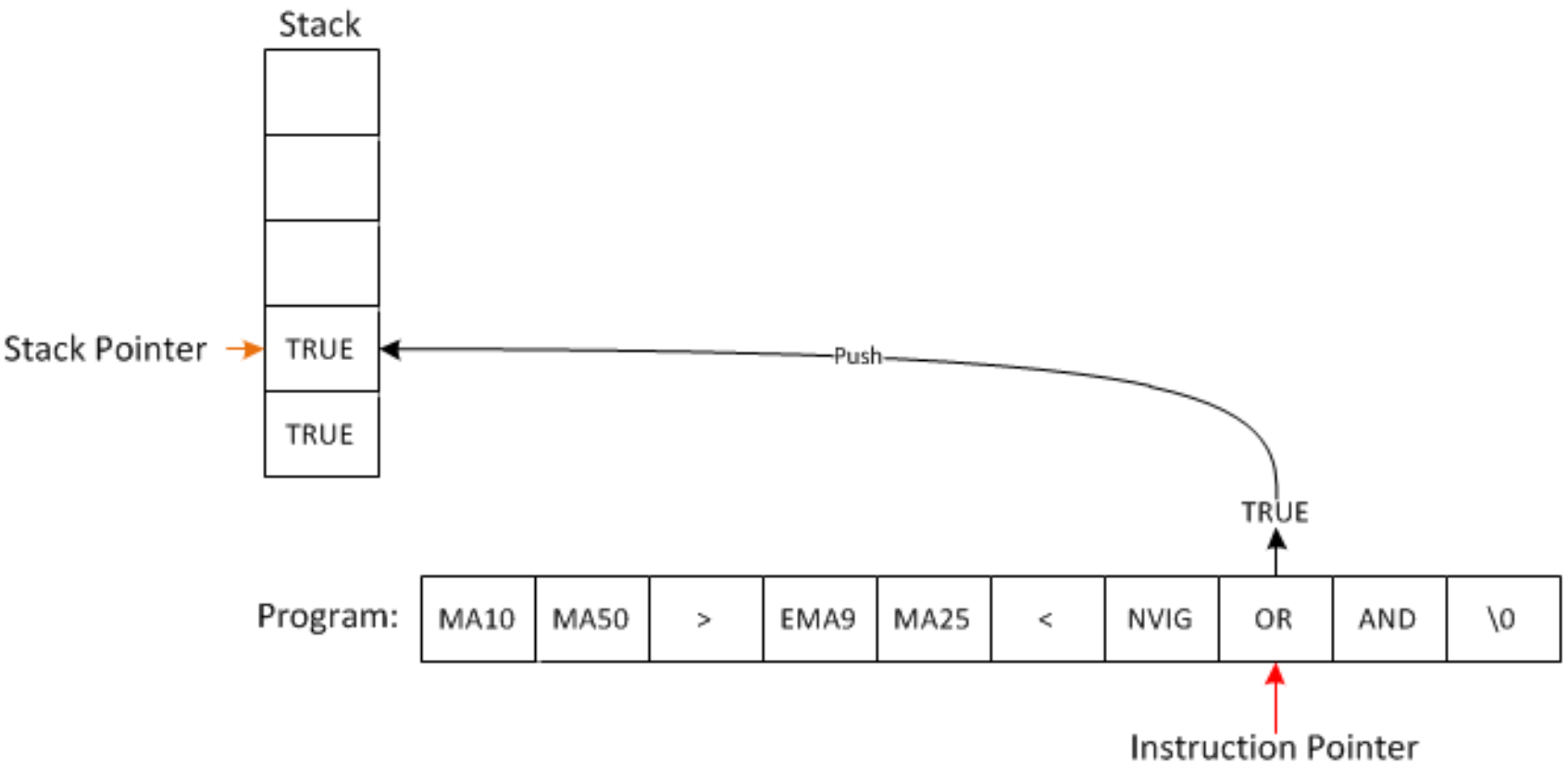

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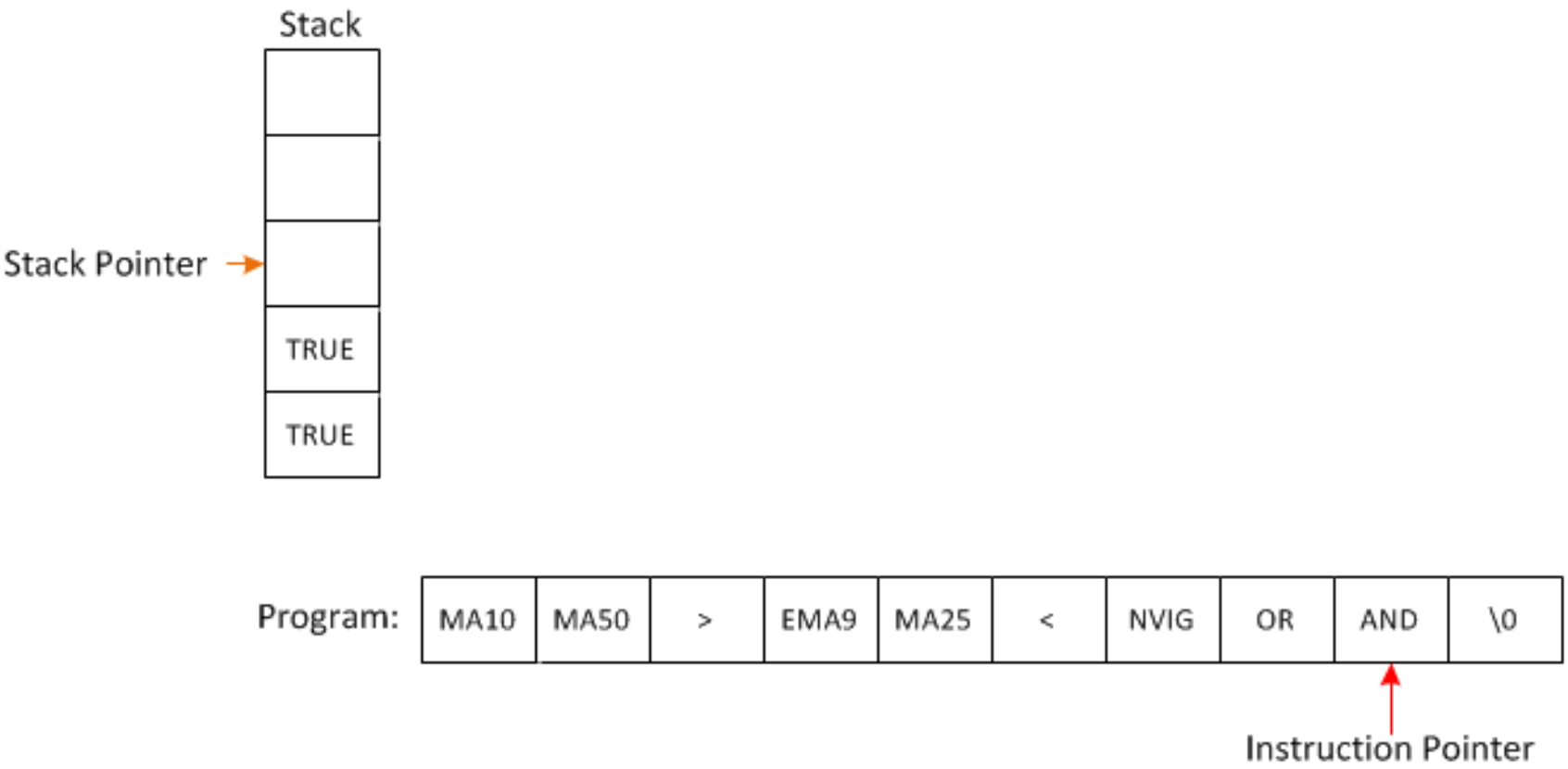

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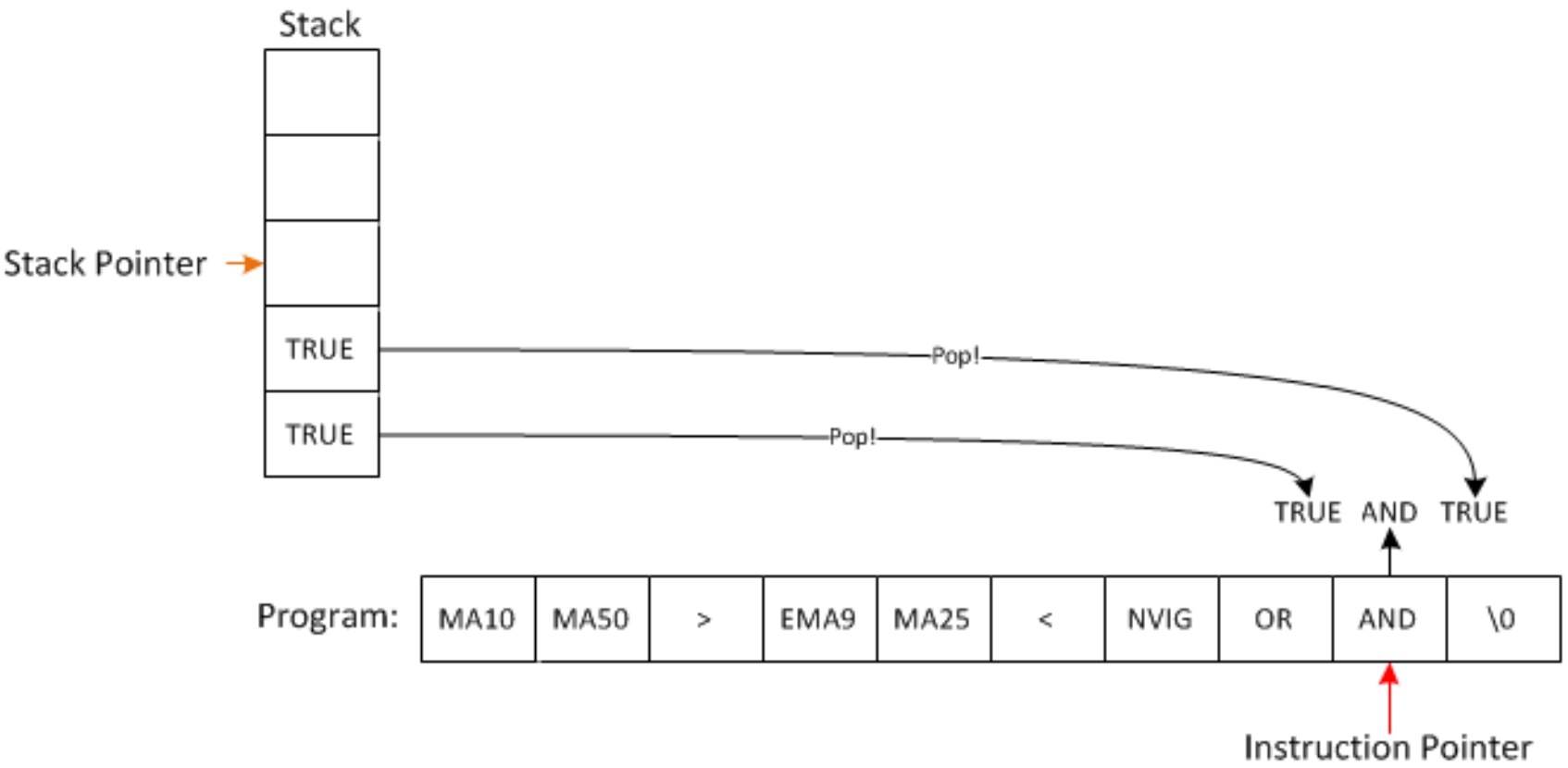

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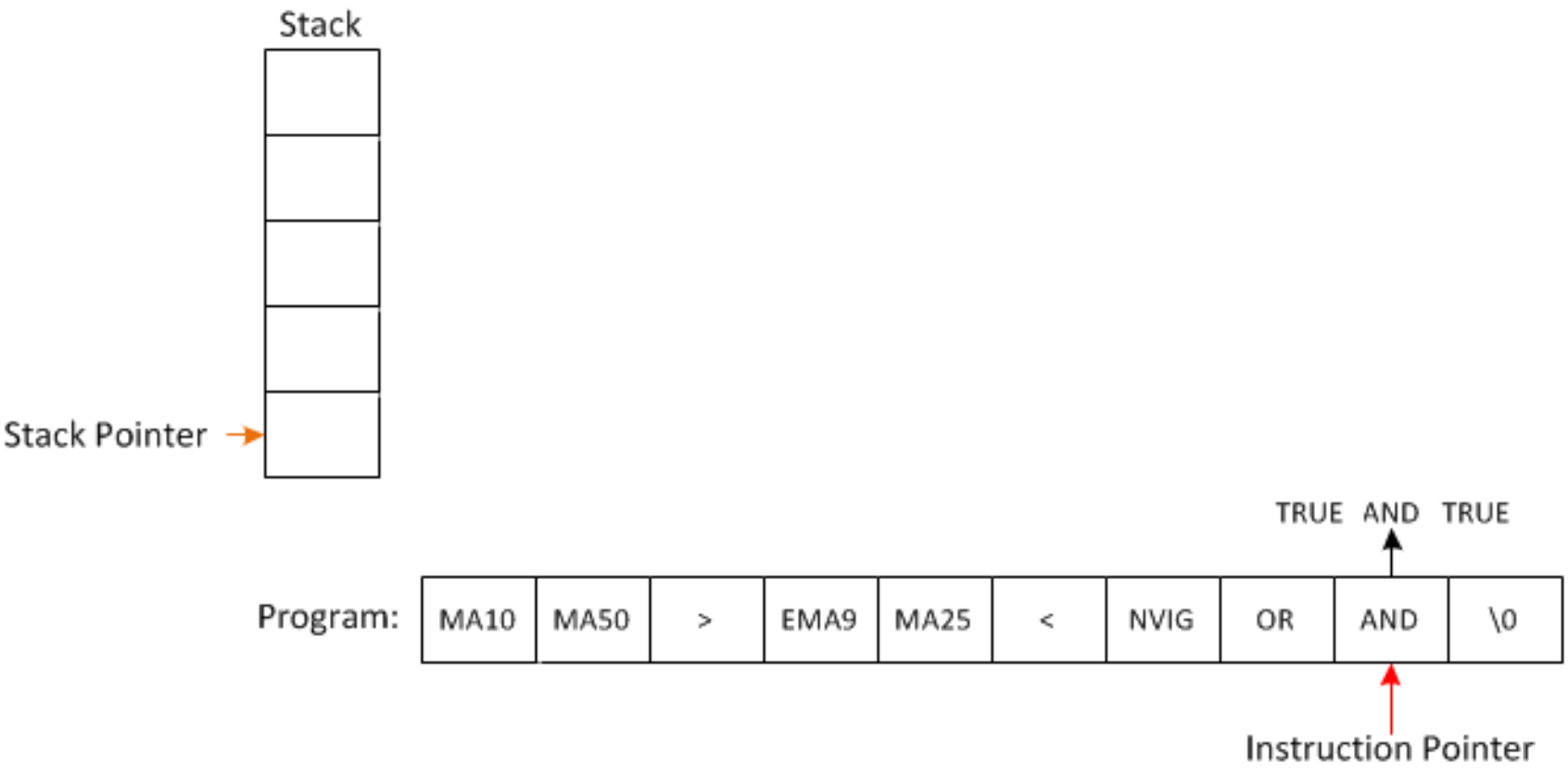

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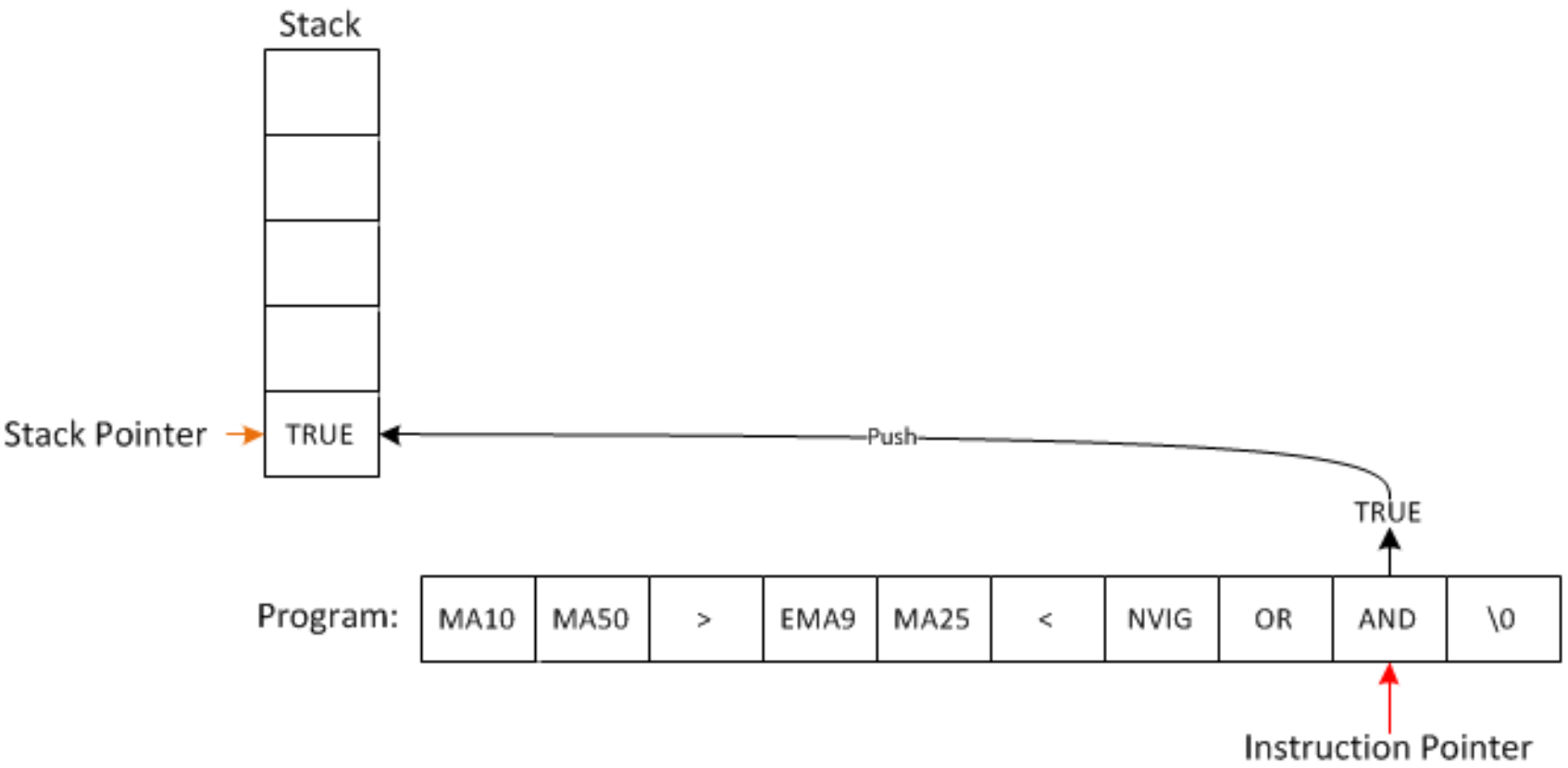

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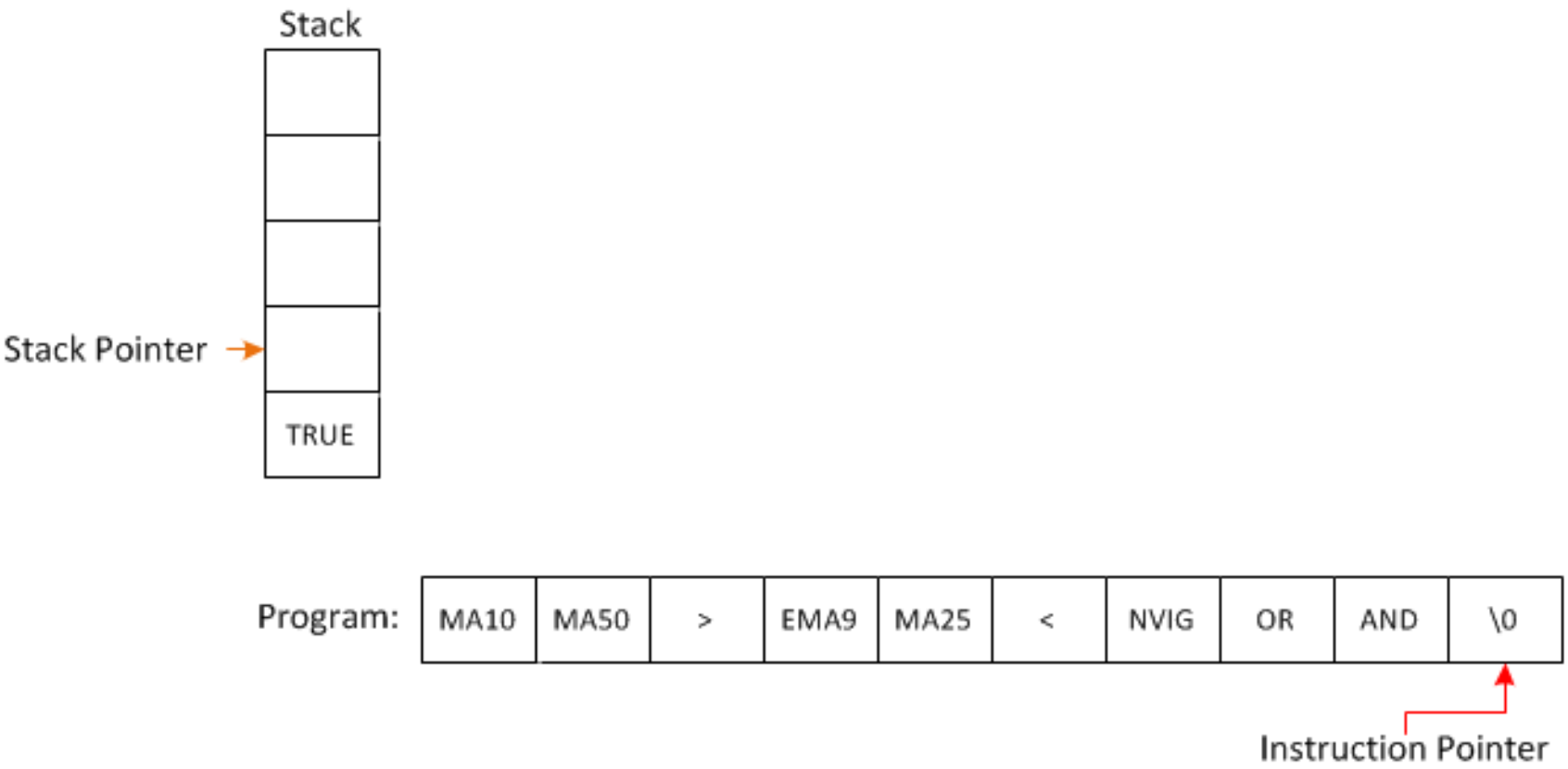

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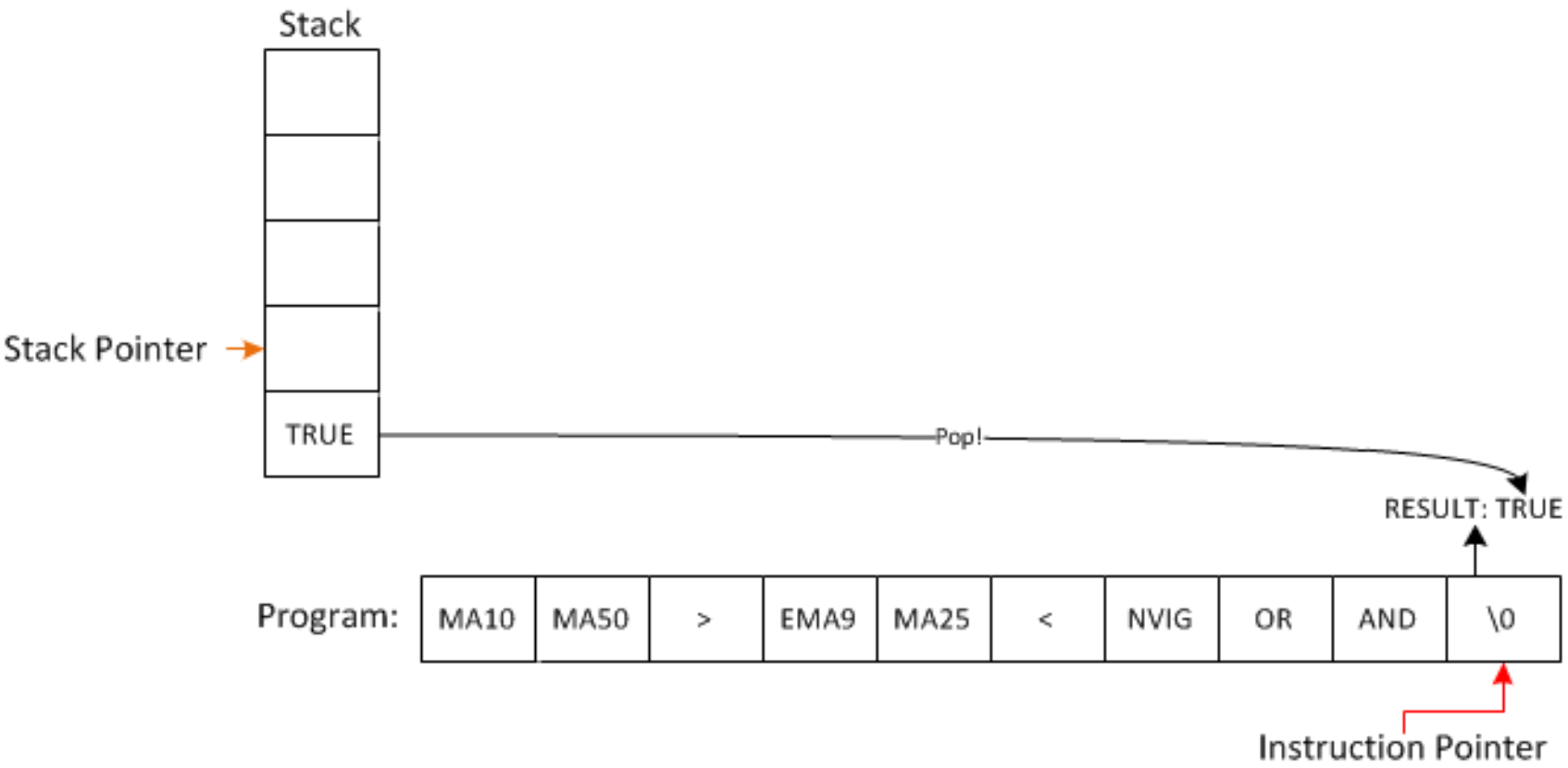
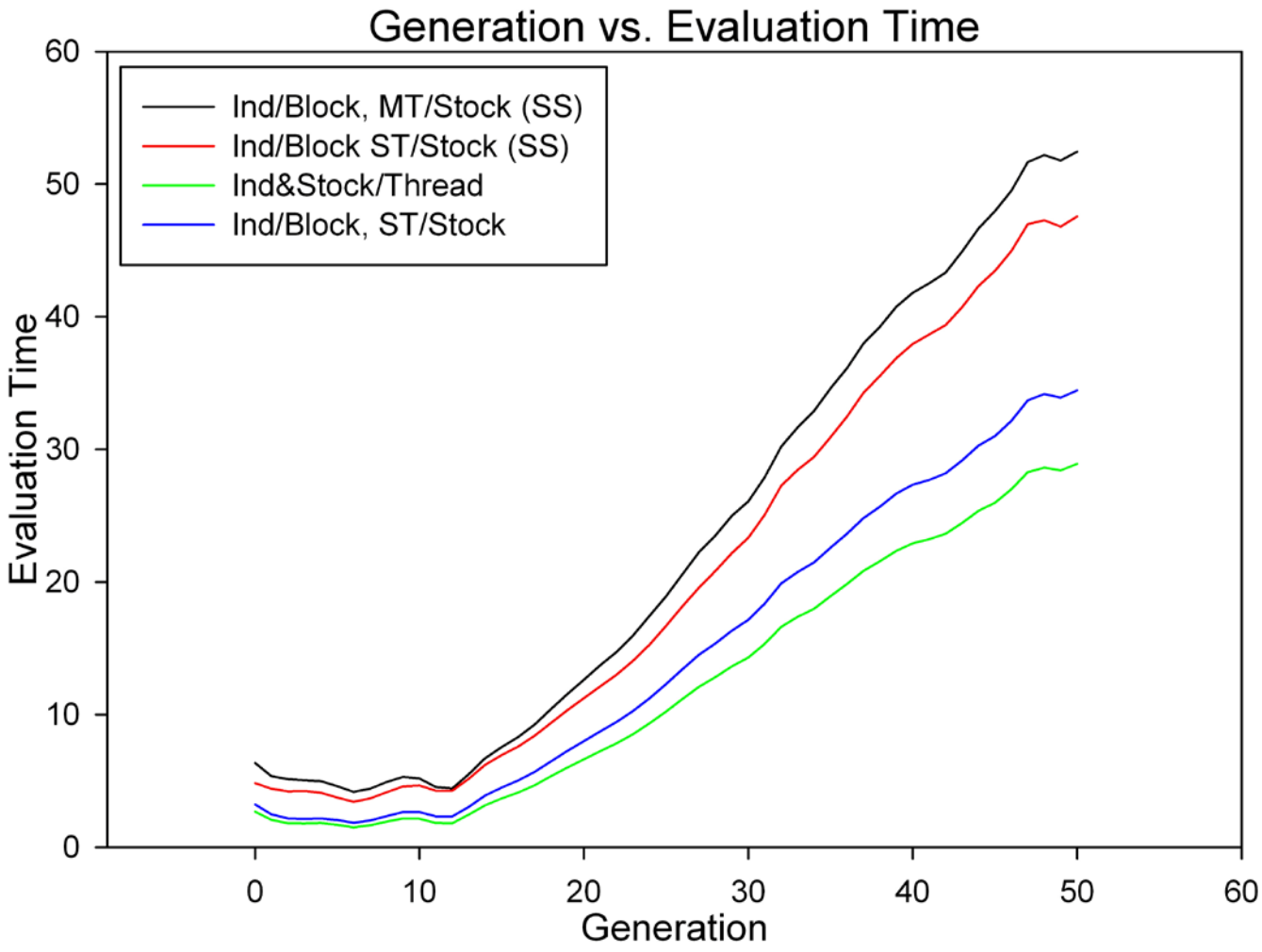
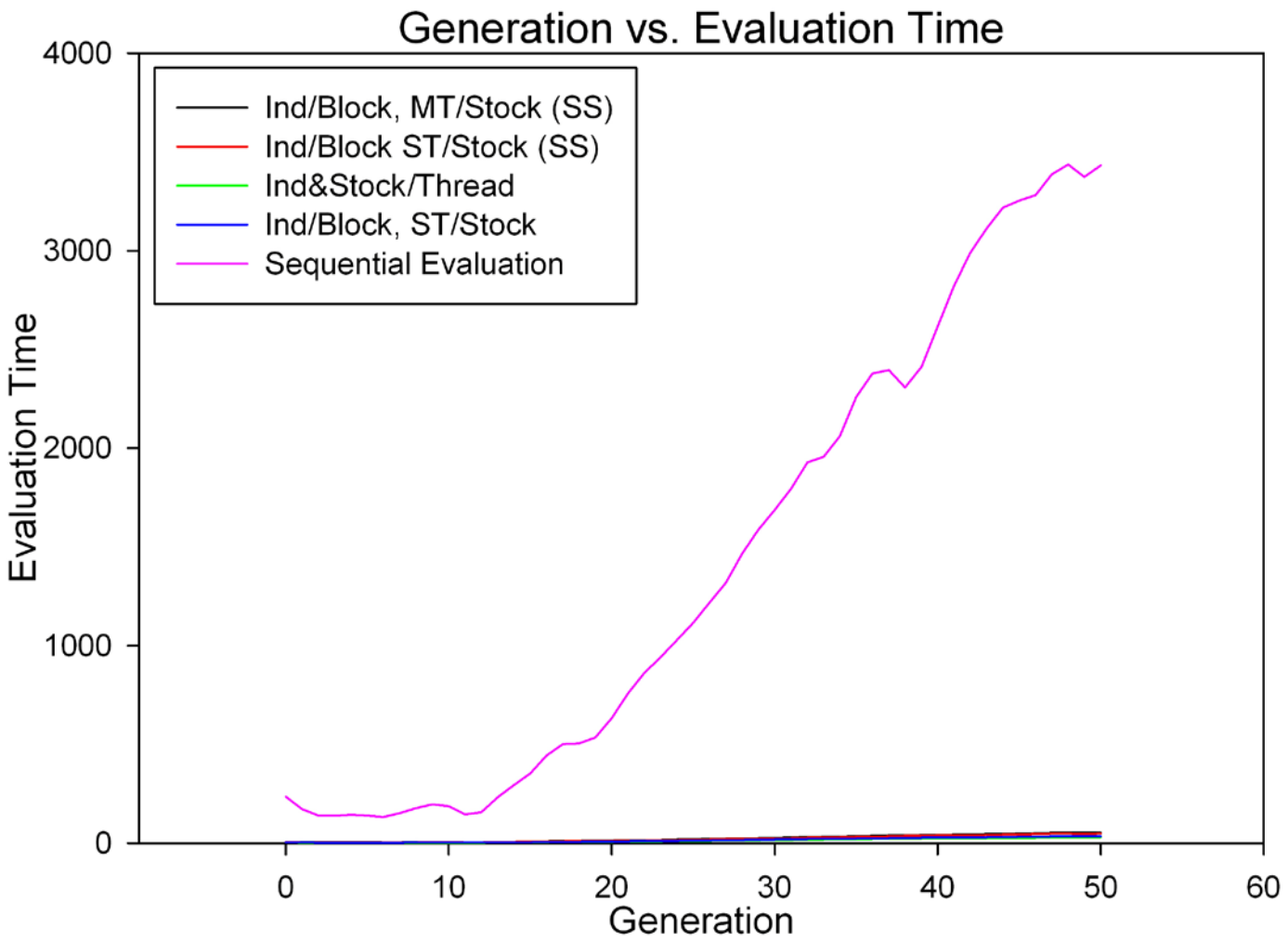


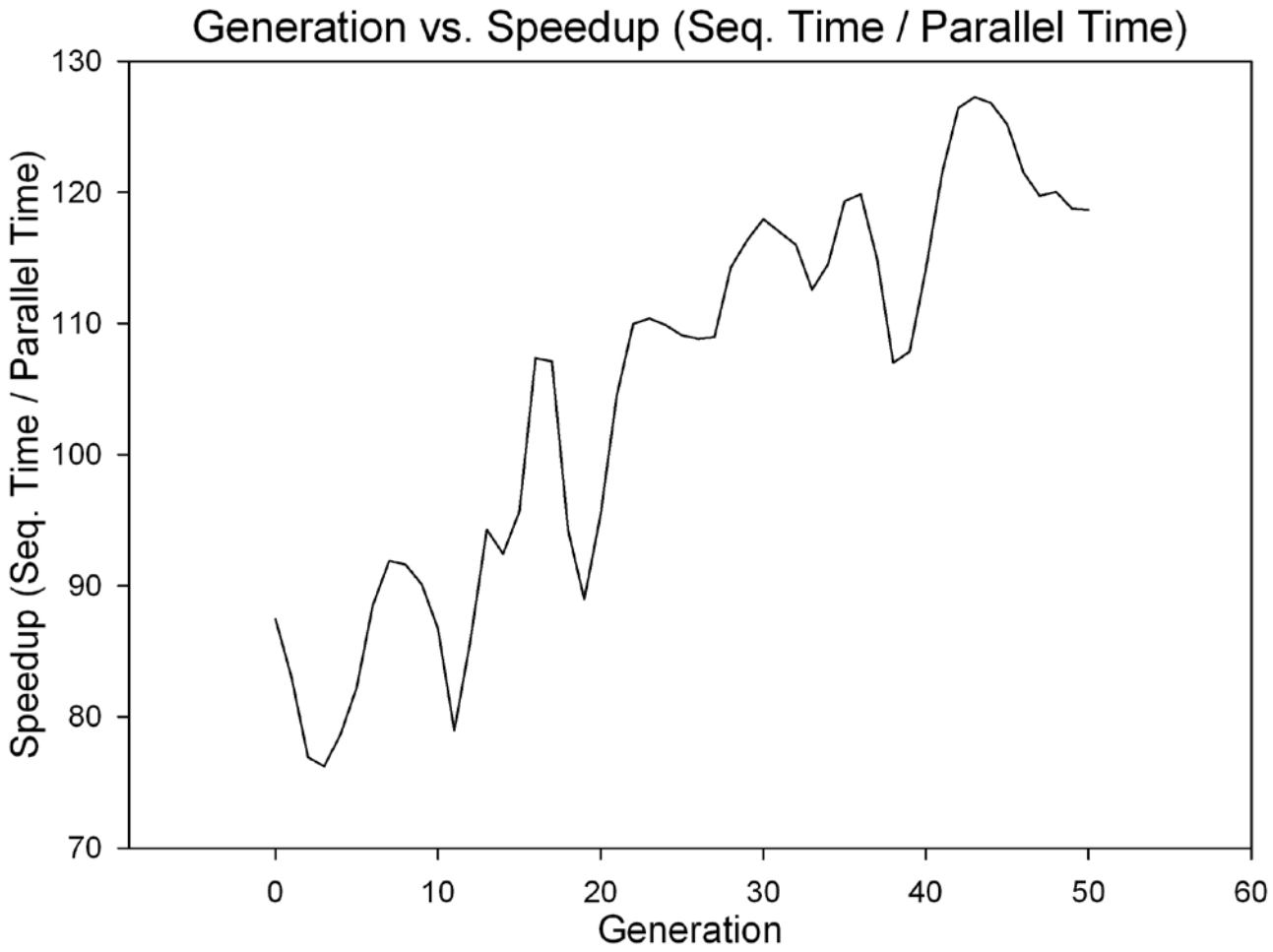
Initial Evaluation Times



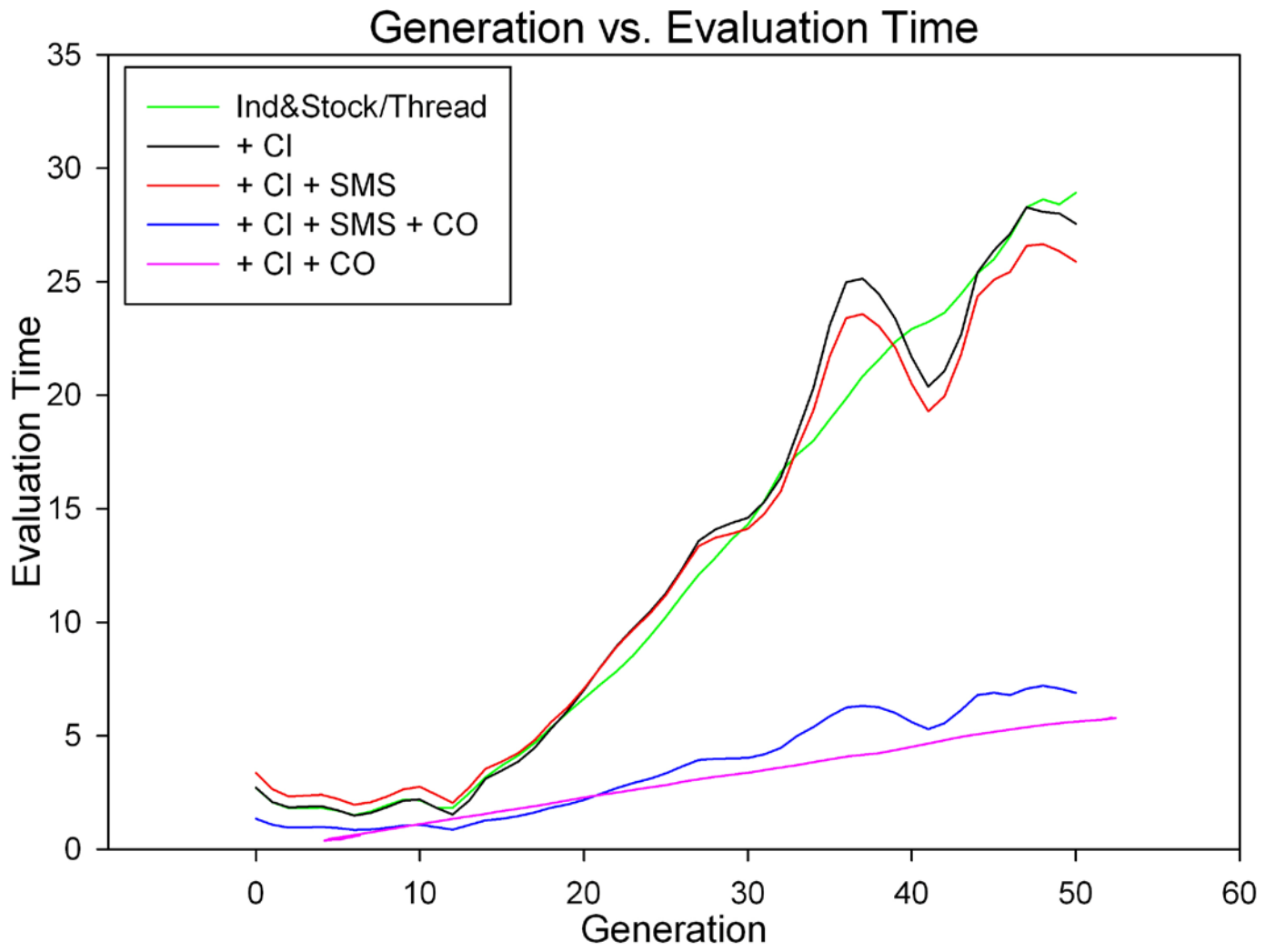
Initial Evaluation Times



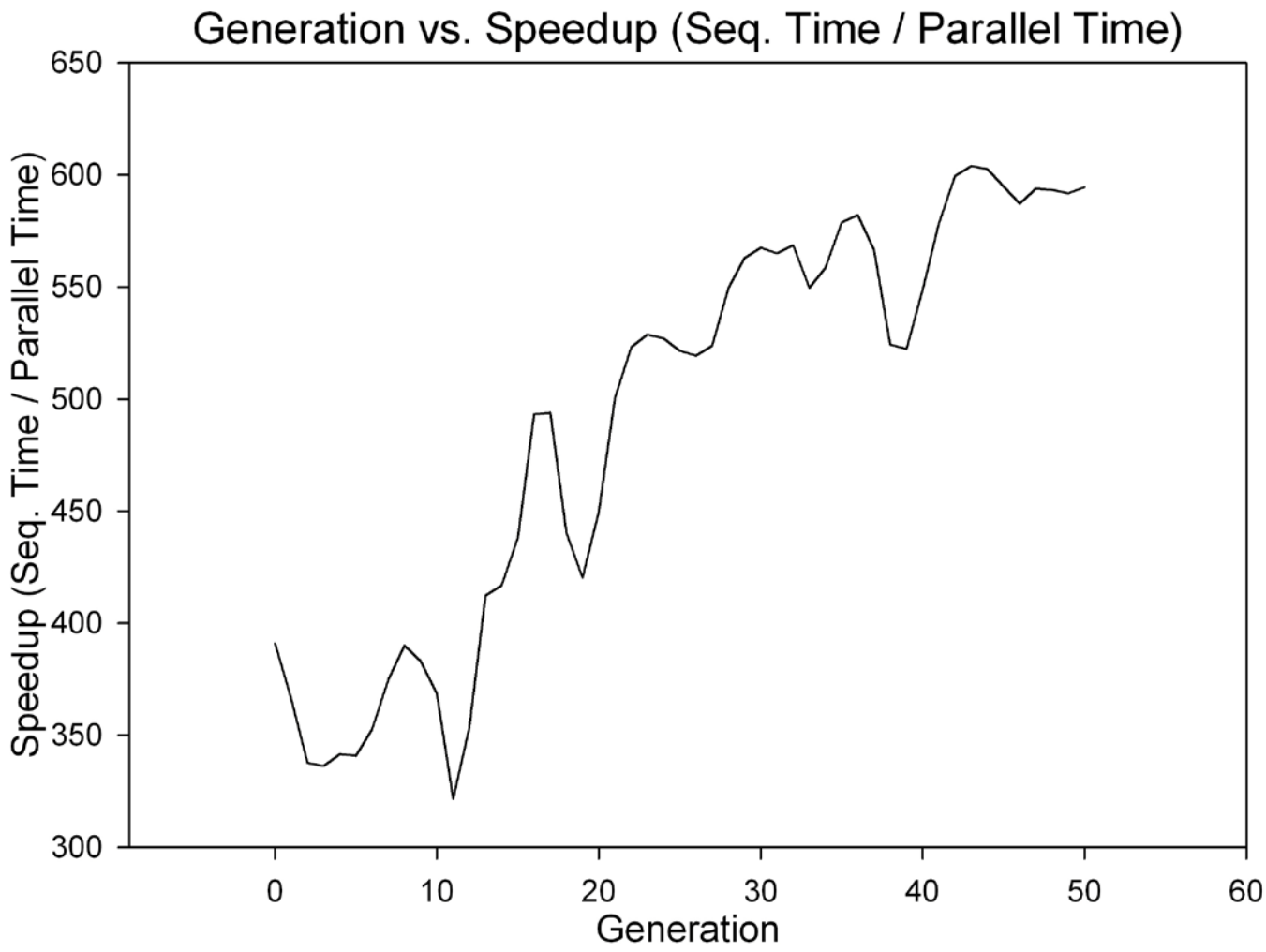
Speedup Comparison



Evaluation Times



Speedup Results



ROI Comparisons

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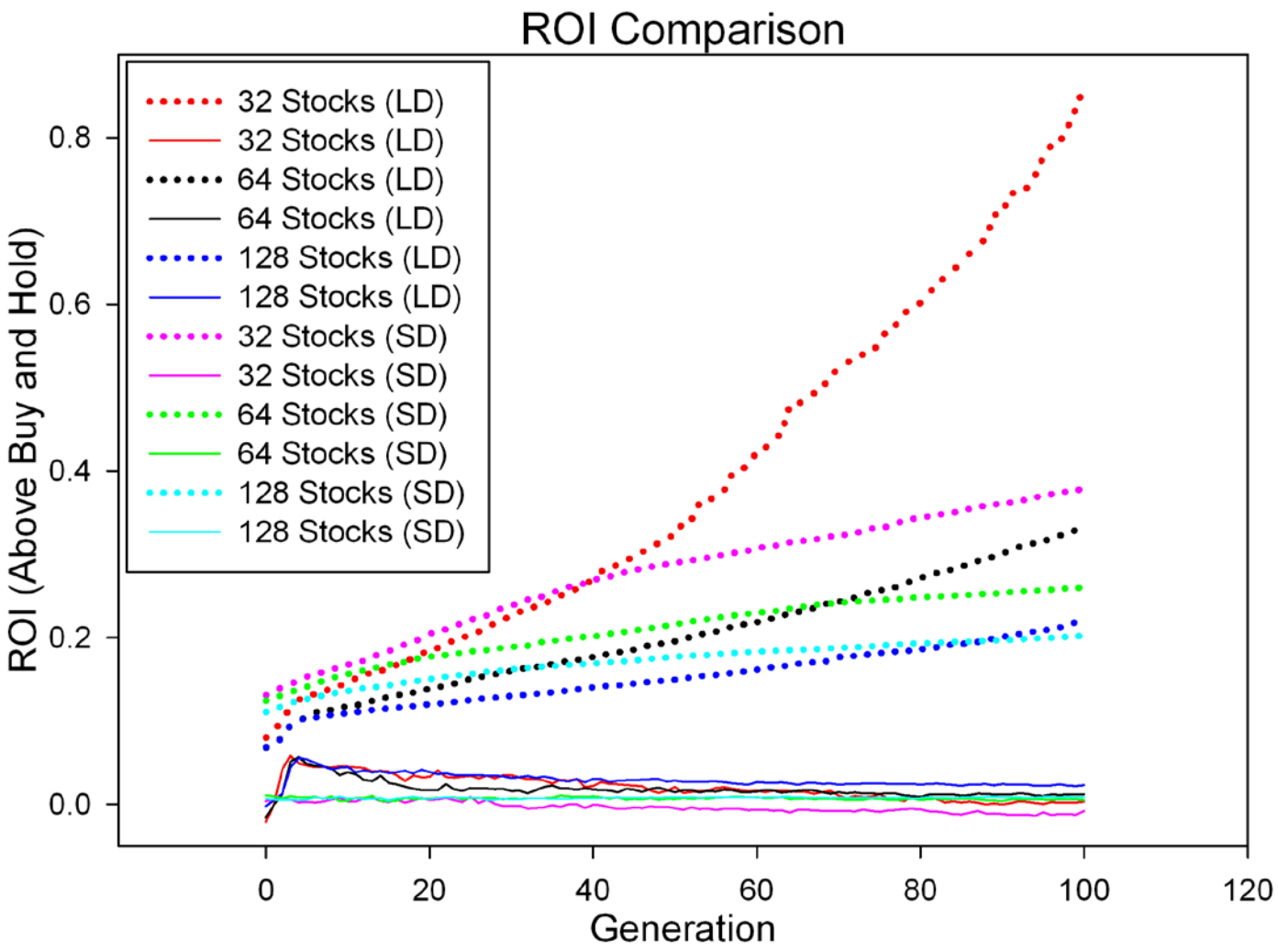

ROI Comparisons

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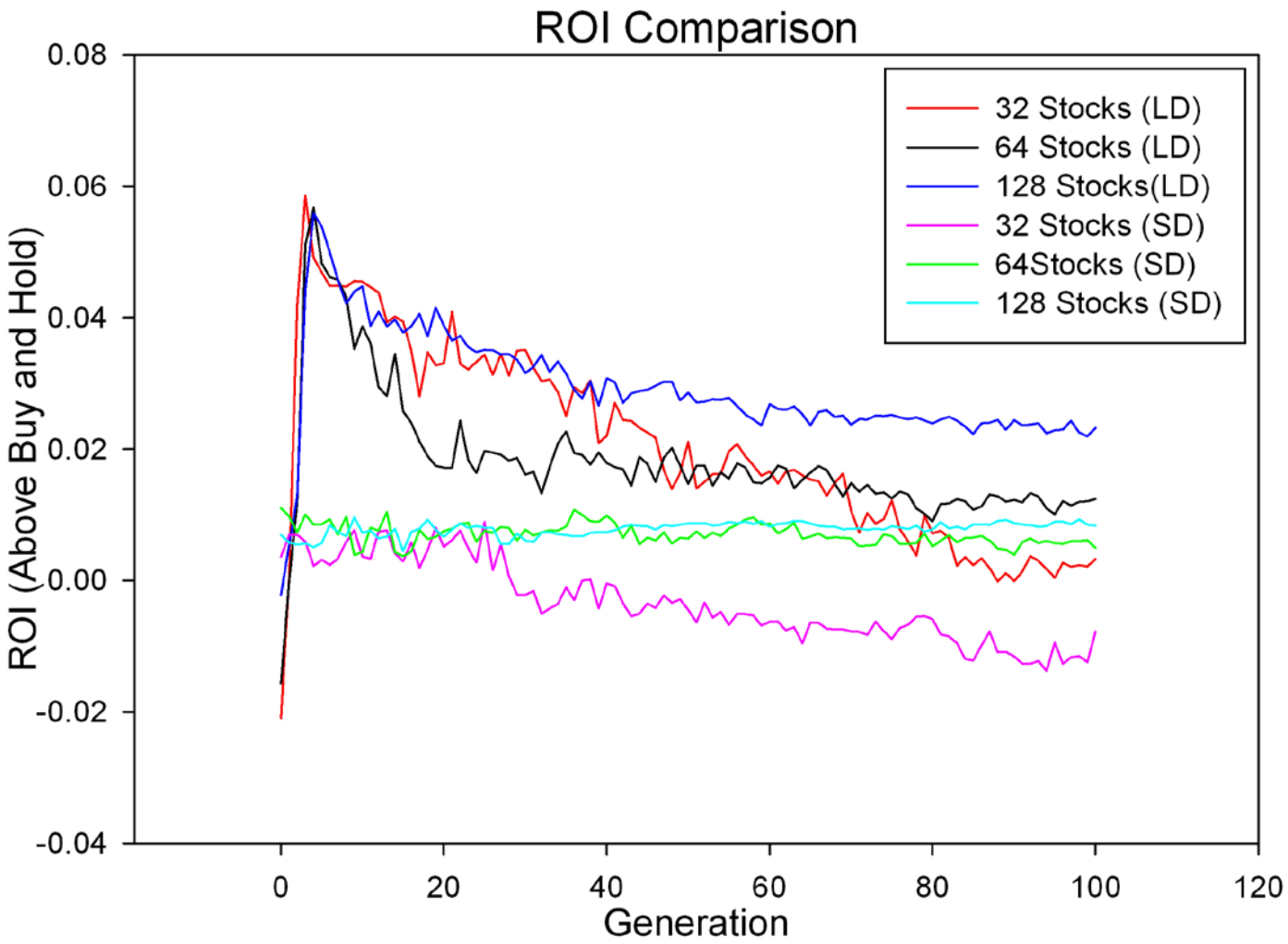

Conclusions

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- Evaluation on GPU can greatly increase evaluation speed
- Evaluating more training cases may result in better test case results
- Still a lot of room for improvement

Future Work

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- Stock Trading Specific
  - More advanced indicators
  - Improving GP parameters
  - Improve the stock trading model
- GP on GPU Specific
  - Move entire GP to the GPU
  - Look for more memory optimizations
  - Find other methods of speedup

Thank you!

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dmckenne@connect.carleton.ca

Question Sheet

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- What does the biggest problem with using GP to generate stock trading strategies seem to be?
- Why is proper/effective memory layout important when performing GP on GPU devices?
- Name one way to decrease premature convergence when using GP.