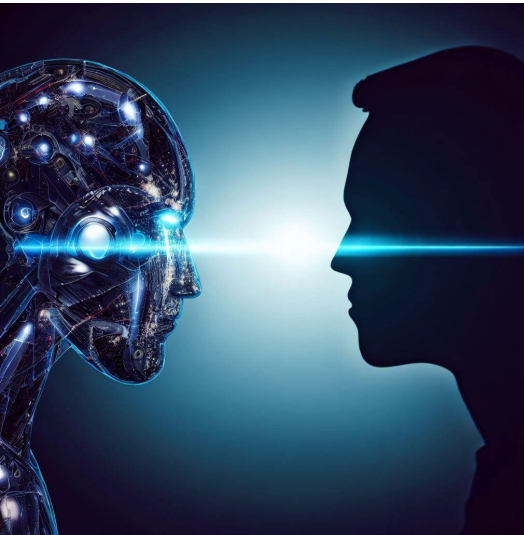


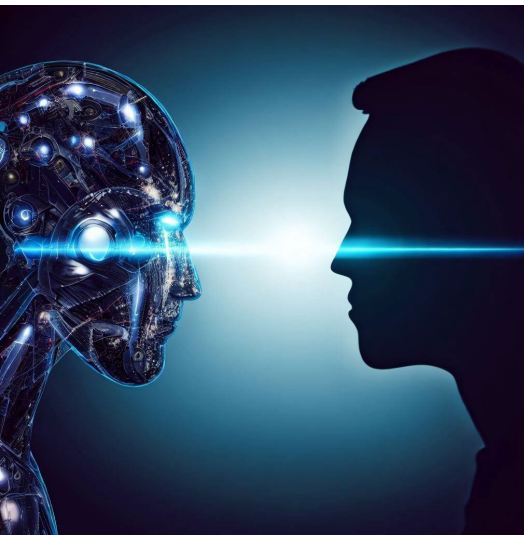
**TRANSITION FINANCE CONFERENCE –
“RAISING THE AMBITION”
5 NOVEMBER 2024, SINGAPORE**

**CAN AI HELP HUMAN DECISIONS:
A FINANCE PERSPECTIVE IN DIGITAL TRANSITION**



TWO QUESTIONS

- AI is widely used in the financial market:
 - Processing Financial Information: from traditional numerical data to text, images, and videos, AI handles more complex information.
 - Assisting in Financial Decisions: selecting stocks, choosing corporate directors, etc.
- 1. However, can we understand the **rationale** and **strategy** behind AI's success?
 - This understanding is essential for building **trust** in AI within the financial market.
- 2. Can AI illuminate the **limitations of human intelligence** and thus provide insights to **improve** human intelligence and welfare?
 - E.g., what AI considers the **most foolish human investment mistakes**? Avoiding them can significantly enhance welfare.

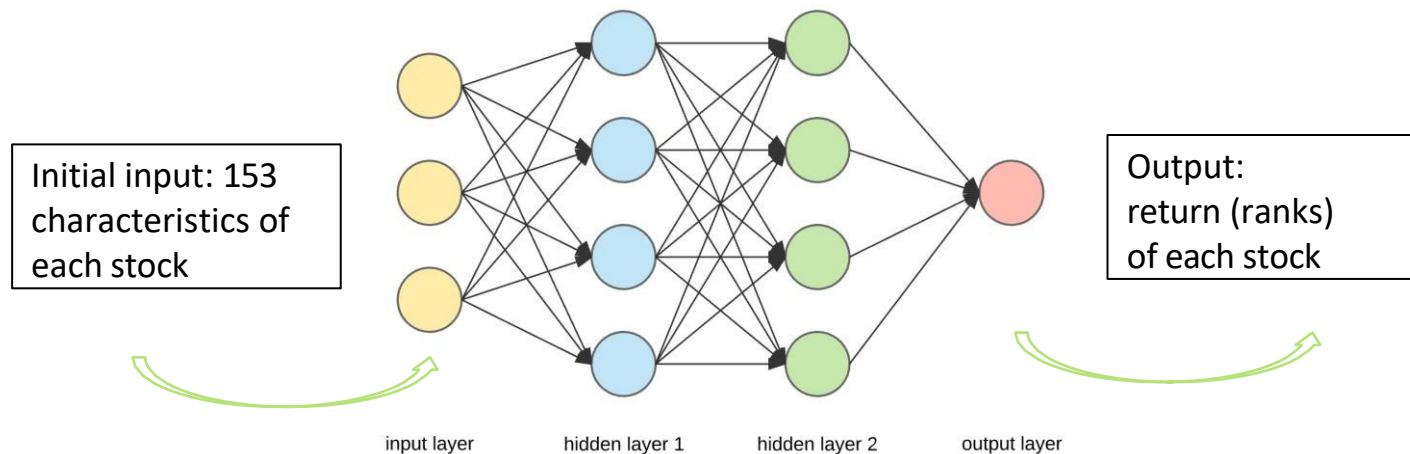


Q1: THE RATIONALE AND STRATEGY OF AI

- Ongoing SKBI research project (“Machine Learning as Arbitrage” by Lu, Spiegel, and Zhang 2024.)
- To explain the **rationale** and **strategy** of AI, we focus on one task that AI is good at: using firm characteristics to predict stock returns.
- We then compare AI to the best human strategy in finance (**Arbitrage**): **dynamic arbitrage portfolios (DAPs)**.

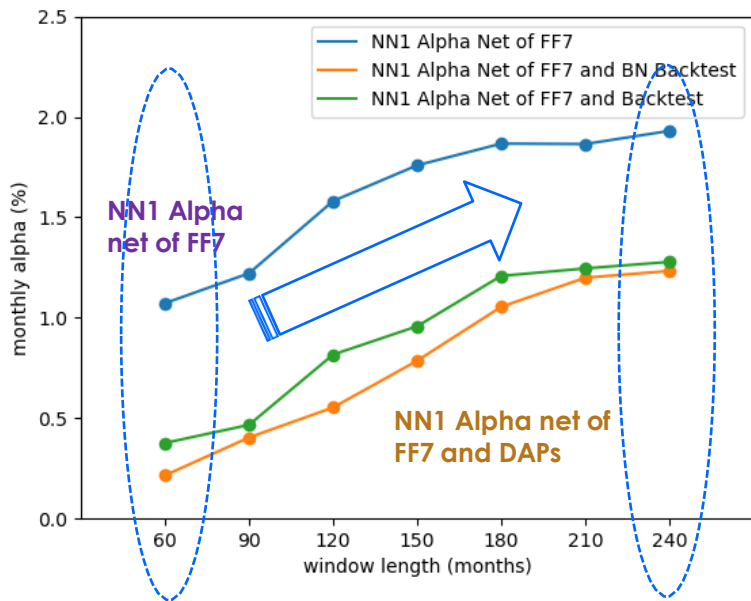
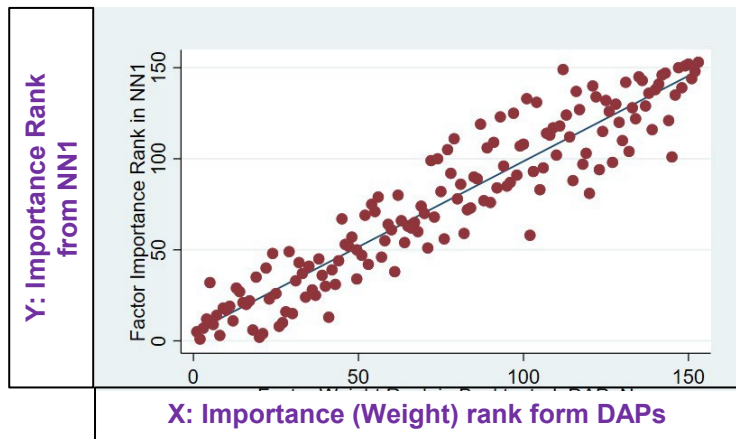
MACHINE LEARNING VS. ARBITRAGE

- **The Feedforward Neural Network**



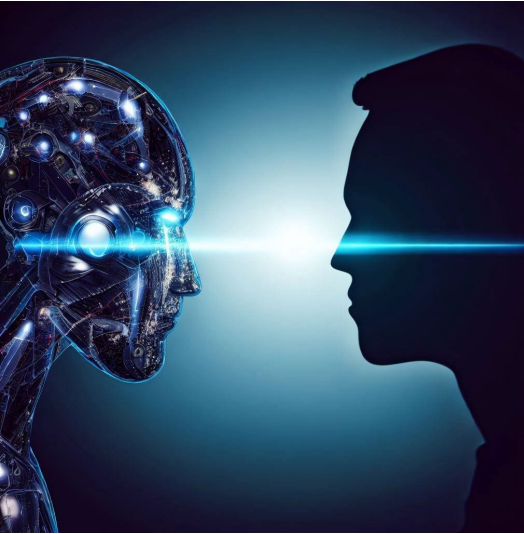
Our analysis:

1. In each month, we sort stocks into 10 deciles based on NN predicted returns. We then **long/short** the portfolios of stocks with the highest/lowest returns.
2. We compare the NN strategy to the best human strategy in finance (Arbitrage): **dynamic arbitrage portfolios (DAPs)**.



ML AS ARBITRAGE:

- **Top:** The importance of characteristics ranked by NN and DAPs.
 - ML select similar characteristics as DAPs.
- **Bottom:** the “Alpha” (the performance) of neural networks at different training horizons, as well as the part explained by arbitrage.
 - ML also delivers returns like DAPs.
- Yes, we can understand the **rationale** and **strategy** of AI in finance:
 - ML behaves as Arbitrage
 - ML can assist trading in line with the best human decisions.



Q2. CAN AI HELP **IMPROVE** HUMAN DECISIONS?

- Ongoing SKBI research project (“A Tale of Two Zoos”, by Ghosh, Lu, Zhang, and Zhang, 2024)
- Retail investors are known to make mistakes due to their cognitive limitations: the “**Bias Zoo**”
- What AI considers to be **the most significant investment mistakes**?
- A related question: which one is more damaging for investment:
 - Making behavioral **mistakes**, or
 - Missing the **opportunities** offered by certain types of stocks.



COMMON BEHAVIORAL BIASES

- **Under-Diversification:** holding too few stocks in the portfolio.
- **Overtrade:** trading stocks too frequently, leading to a very high **Portfolio Turnover**.
- **The Disposition Effect:** selling winners too soon & holding on to losers too long.
- **Local Bias:** investing too heavily in local stocks.
- **Lottery Preference:** betting on small-probability events
- **Salience/Rank Effect:** Paying attention to stocks with extreme events or price movement/ranks
- **Extrapolation:** Believing that recent trends in stock prices will last longer.
- All these seven types of “mistakes” are well documented to harm investment performance.

FIRM OPPORTUNITIES

- **Profitability:** e.g., ROA
- **Momentum:** e.g., past winner will deliver better performance
- **Investments:** e.g., physical (capital) expenditure and share repurchase.
- **Intangible and knowledge assets**
- **Value of firms:** e.g., Tobin's Q, PE, PB,
- **Trading frictions:** size, liquidity,

OUR ANALYSIS

- A **very big data** on retail investors: The National Stock Exchange of India(NSE), 2012-2020. Over **15.4 million** valid retail investor accounts
- We construct **13** proxies for behavioral biases and **23** holding-weighted stock characteristics for firm opportunities
- We employ a list of ML tools for our analysis
 - Traditional linear (OLS) model
 - LASSO, Ridge, and Random Forest
 - Two Neural Networks
 - *Feedforward NN*
 - *Residual Neural Network (ResNN)*
- We validate these tools by asking them to **predict** retail investors' performance. We will then use the most successful tool to answer the previous two questions.

PREDICTING MODELS

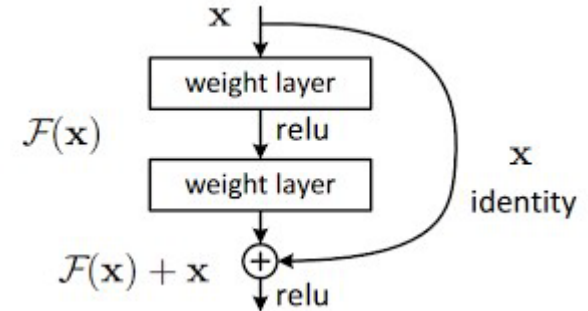
- Residual Neural Network (He et al., 2015):
- Output for a layer = Residual + Input

$$X^l = F W^l T X^{l-1} + b^l + X^{l-1} + b^l$$

Output of the layer

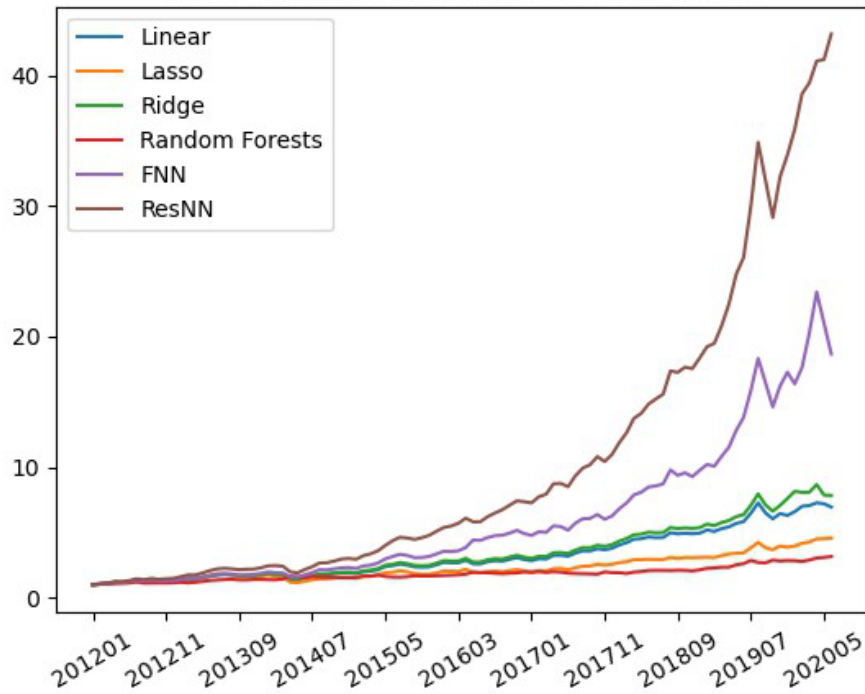
“Residual”:
 $F(\cdot) = g(\cdot) - X^{(l-1)}$

input to the layer



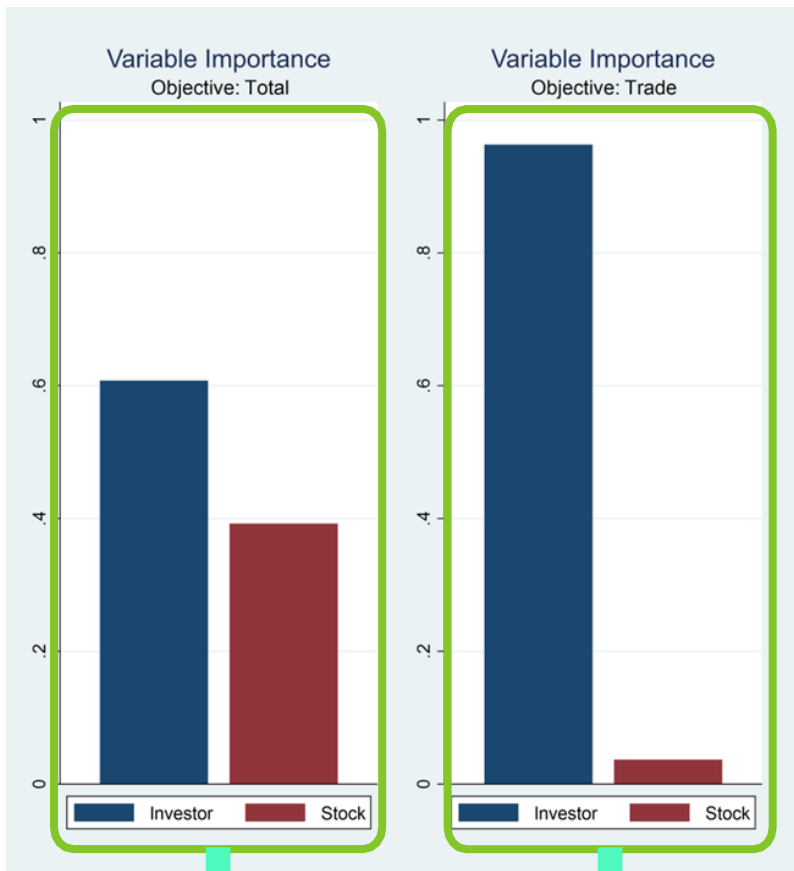
- Beneficial Features:
 - Each block tries to learn **some “new information” (i.e., residuals)** to **augment the data**, a simpler task to achieve with better information to learn from.
 - Each block has a **shorter gradient path**.
 - Modularity** allows for deeper learning.
 - These features help address issues like **overfitting** and **vanishing gradients**.
 - Allows the algorithm to pay more attention to **economically important inputs** (e.g., biases)

Model Comparison: High Minus Low Portfolio



MAIN FINDINGS (1)

- Validation of Models:
 1. We use ML to predict retail investors' returns.
 2. We then buy (sell) the portfolios of the best (worst) predicted investors.
 3. The figure plots the performance of these strategies.
 4. The two neural network tools can most successfully predict retail performance

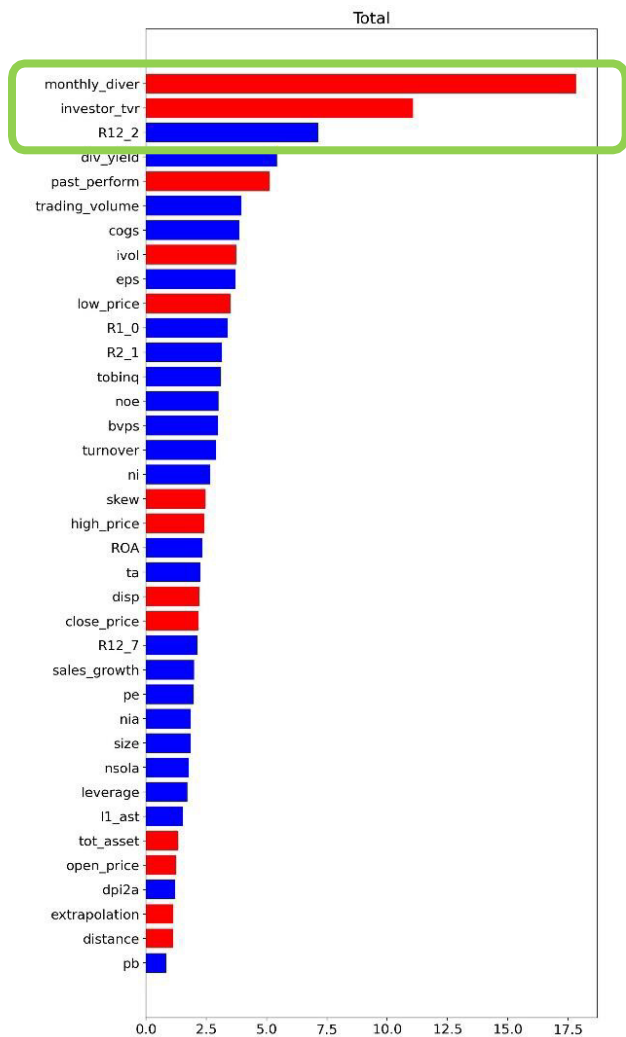


Training Goal:
Total returns

Training Goal: **Returns
of New Trades**

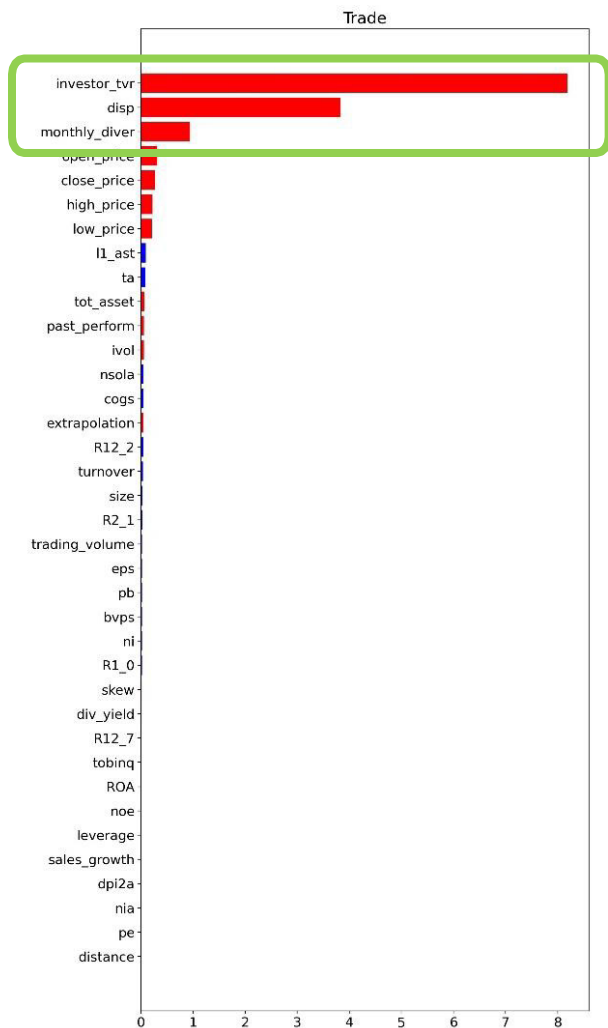
MAIN FINDINGS (2)

- The Figure plots the relative importance of bias (blue bar) vs. firm Opportunities (Red bar)
- Behavioral biases jointly affect 60% of portfolio's returns. Firm opportunities explain 40%.
- Behavioral bias plays a particularly important role for the returns of newly initiated trading (within one month).



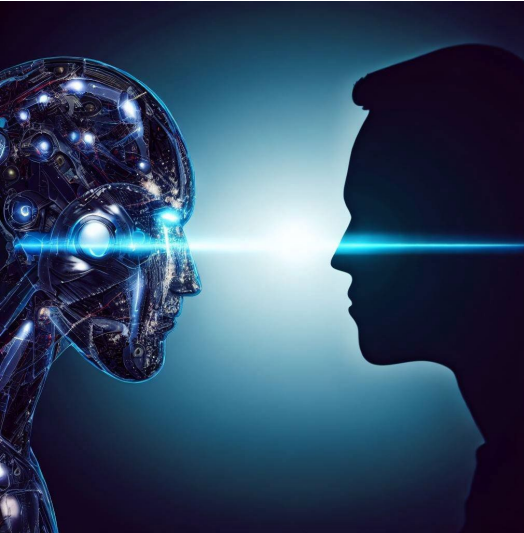
TOP FACTORS

- We use different colors to highlight behavioral (red) vs. firm opportunities (blue).
- The Top 3 factors (mistakes) are:
 - (Under)diversification
 - Portfolio turnover
 - Momentum



TOP FACTORS FOR NEW TRADES

- Behavioral factors dominate the contributions to trading returns.
- The Top 3 factors (mistakes) are:
 - Portfolio turnover
 - The Disposition Effect
 - (Under)diversification
- All these factors contribute to bad total performance



CONCLUSION

- Yes, the **rationale** and **strategy** of current AI are still within our understanding. Hence, we can trust AI in assisting human decisions.
- One potential important help of AI is to act as a tool to detect human mistakes. AI can **improve** human decisions.

THANK YOU!