Lab Program

Time (EST)	Content	Speaker
10:45 - 11:00	Welcome and introduction	Filip
11:00 - 11:20	Internet Memes: *Knowledge connects culture and creativity*	Filip
11:20 - 11:40	Financial transactions: *Detecting anomalies in trading*	Ke-Thia
11:40 - 12:00	PubGraphs: *What should I read next?*	Kian & Jay
12:00 - 12:20	Morality in events: *From news to timelines and graph maps*	Gleb
12:20 - 12:30	Discussion and Closing remarks	Jay

Financial Transaction Anomaly Detection

We are creating tools to detect and characterize many types of problems arising from data inconsistency in diverse markets.

Before introducing our methods in detail, consider an illustration of how we can use them to identify money laundering, a common and important problem.

(The exact same method can identify wash trades used in market manipulations.)

How to Launder Money through Financial Markets

- A donor sells a thinly traded security to the recipient at a low price.
- The donor then buys back the security from the recipient at a higher price.
- The recipient receives capital gains at the expense of the donor's capital losses.
- Sophisticated schemes may involve more than two accounts and many trades to obfuscate the activity.

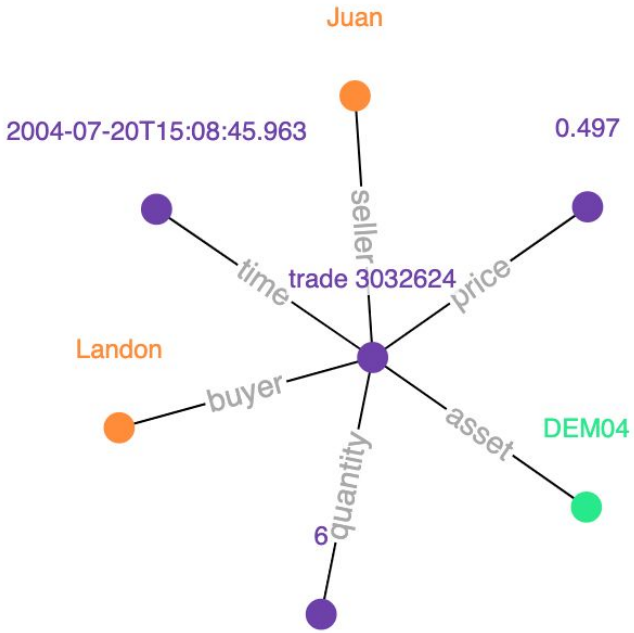
Defining Characteristics of Financial Market Money-Laundering

- A ring of confederate accounts trades primarily only with each other.
- Each node trades much volume with little net change in position.
- For each node, net position is highly mean-reverting.

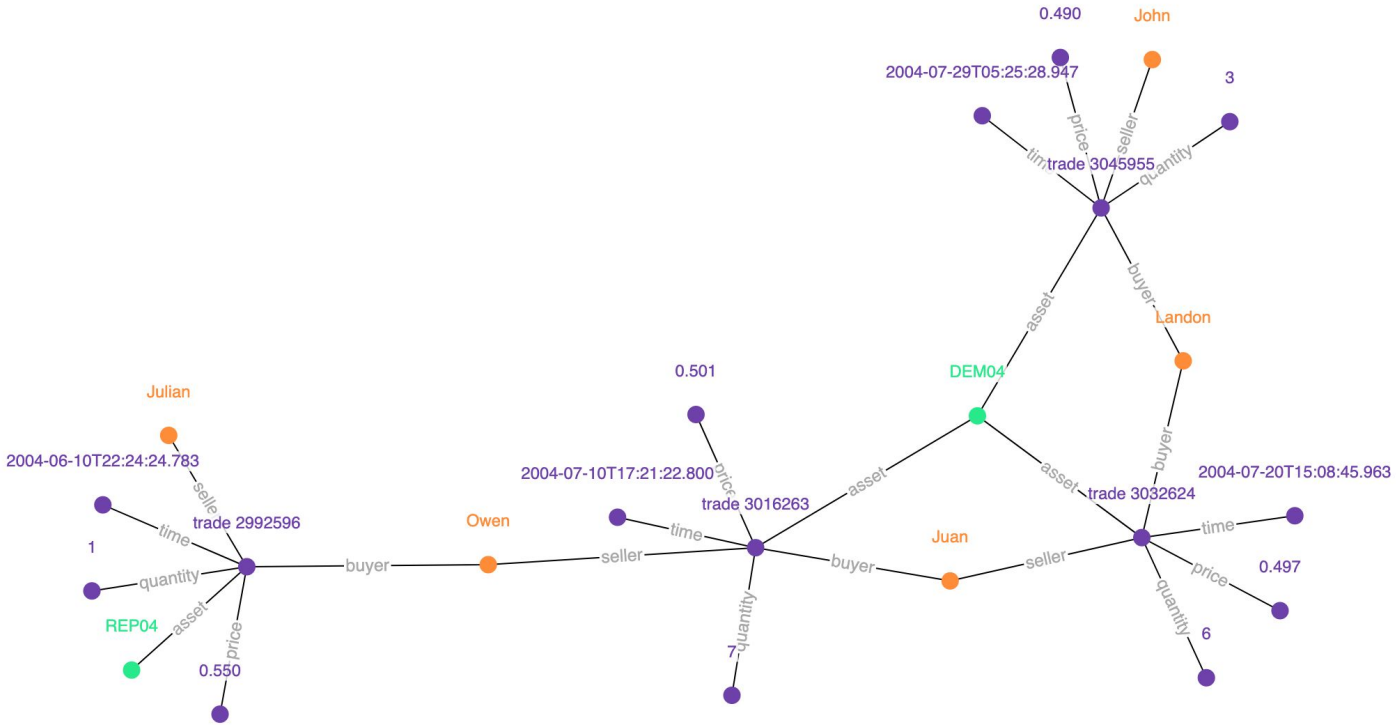
KGTK Capability Demonstration

- Financial transaction KG creation from external data sources
- KGTK analytic pipelines to transform, filter and visualize KG
  - Import anonymized IEM data and create force-directed graph visualization
  - Transform transaction KG into trader-interaction KG to detect potential money-laundering traders
  - Transform transaction KG into weekly transaction graphs to detect temporal patterns
  - Transform transaction KG into Tableau for data visualization and exploration

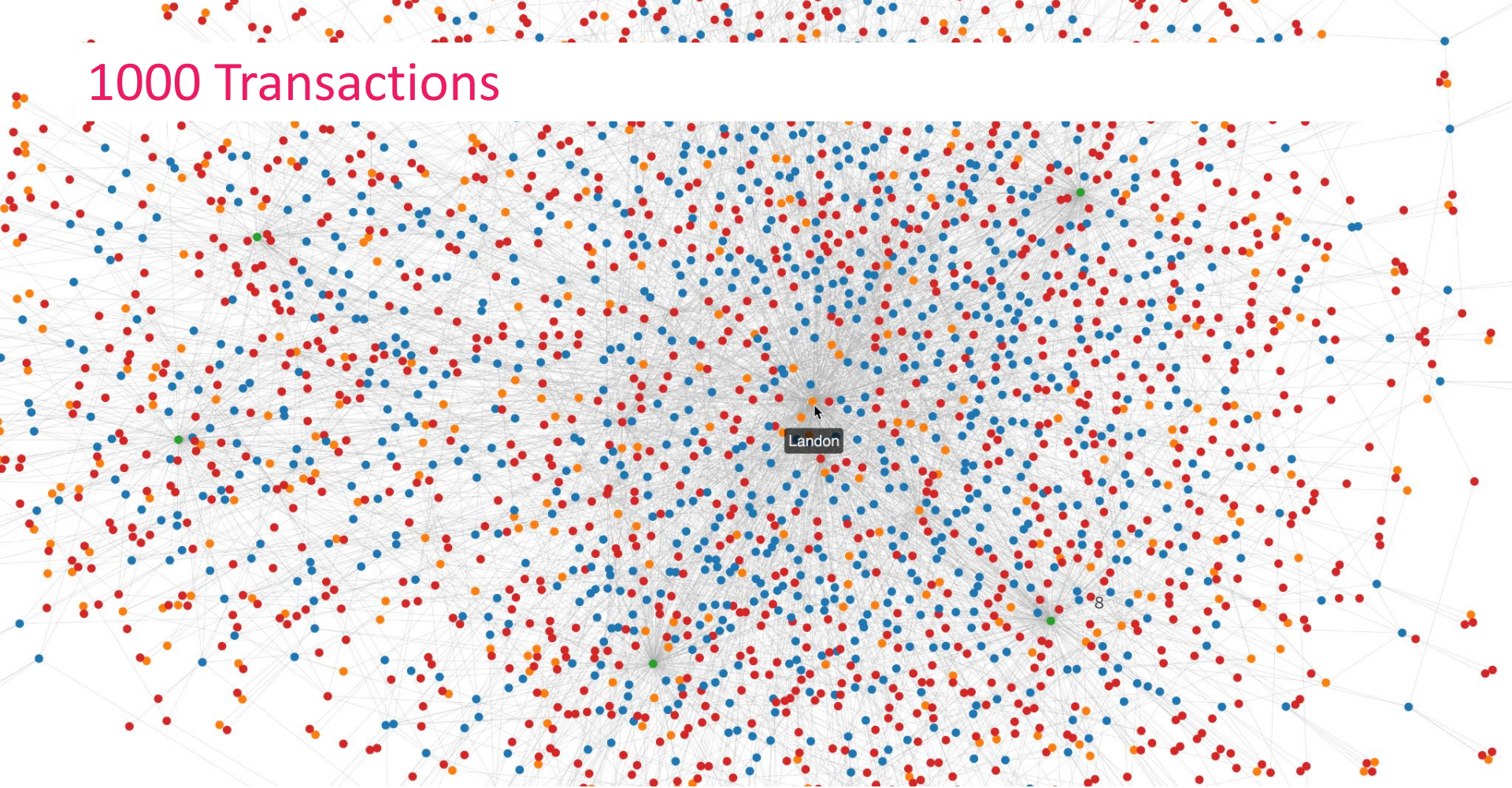
Representing Transactions in Knowledge Graphs



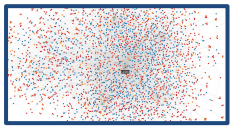
Four Transactions



1000 Transactions



KG Analytic Tools Transform KG into Insights:
Eden and Kyla are suspicious traders

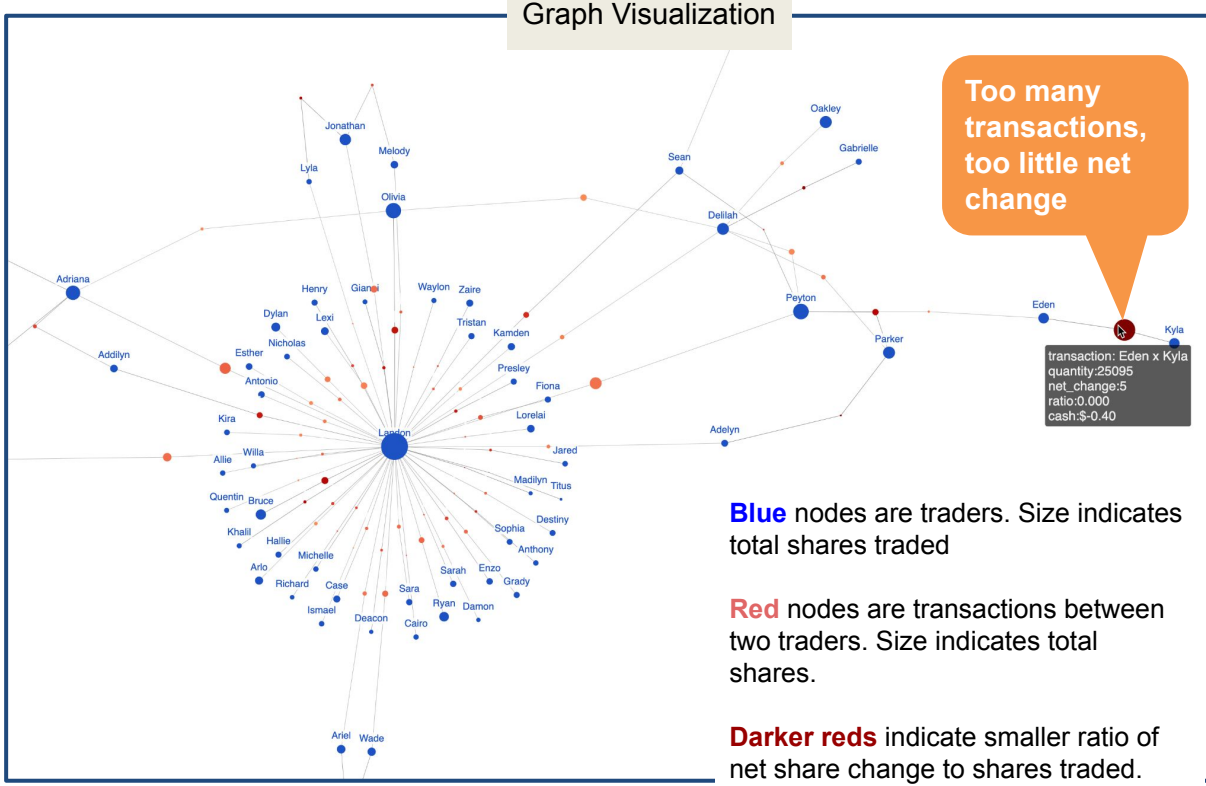


transaction KG

KG analytic pipeline

- analytic: trade/net
- filter: ratio < 0.5
- visualize

Graph Visualization



Blue nodes are traders. Size indicates total shares traded

Red nodes are transactions between two traders. Size indicates total shares.

Darker reds indicate smaller ratio of net share change to shares traded.

Analyzing Market Trading Trends using PageRank

- Partition IEM knowledge graph into multiple weekly knowledge graphs
- Perform PageRank

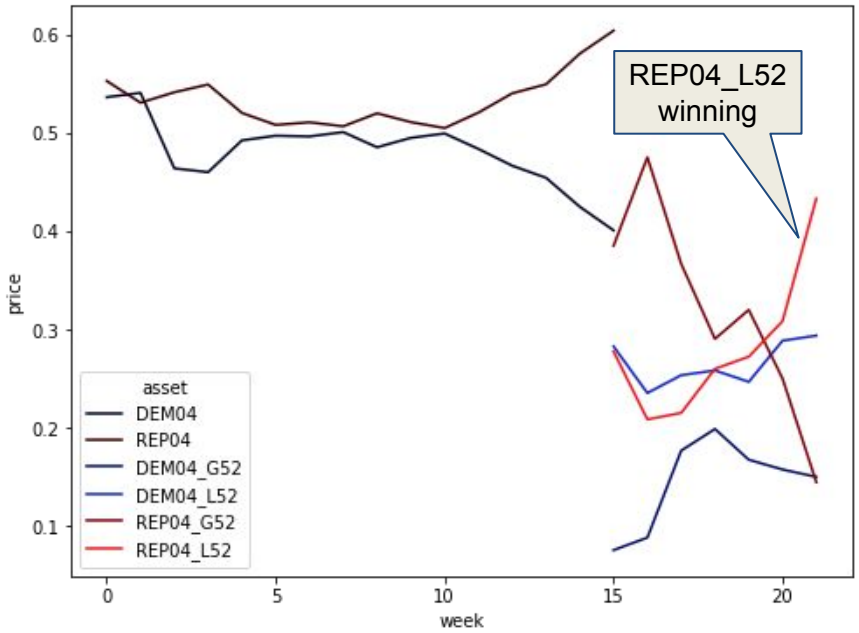
  to assign importance to asset nodes and to trader nodes

  to assess market concentration

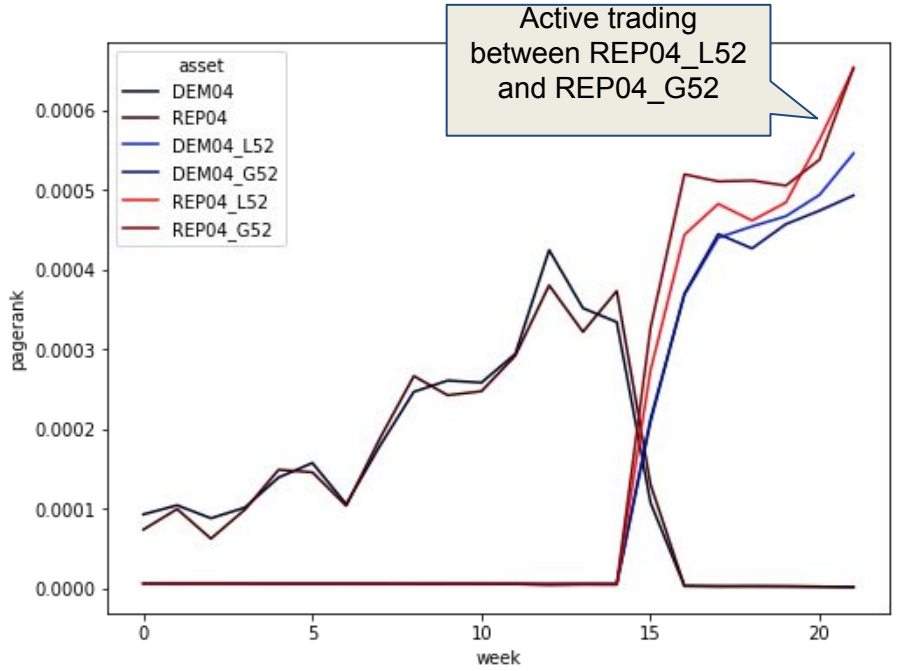
PageRank of IEM Assets

- PageRank highlights differ aspect of market behavior compared with price
- Price shows one asset winning towards the end
- PageRank shows active interest in all assets, but especially between REP04_L52 and REP04_G52

IEM asset price by week

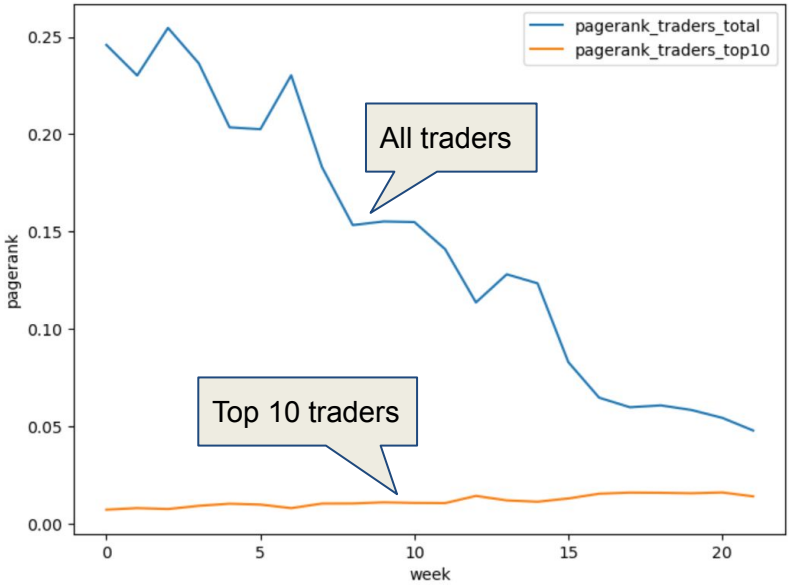


IEM asset PageRank by week

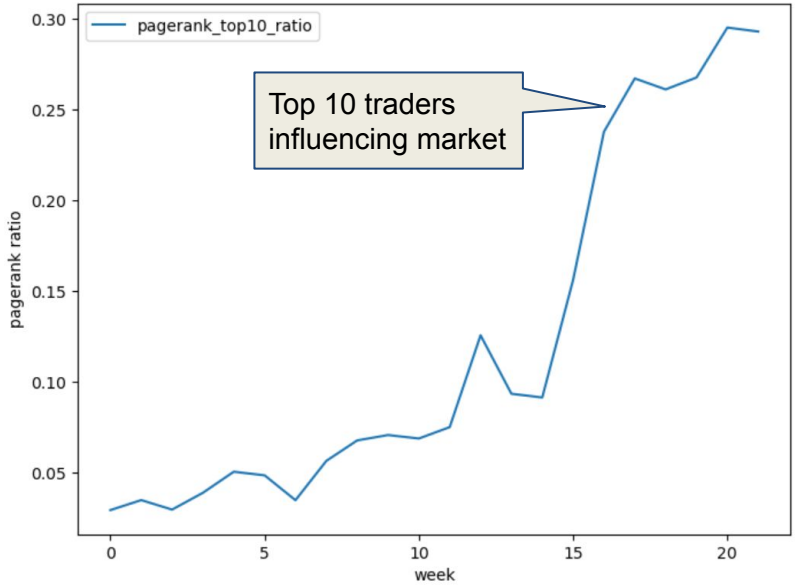


IEM Market Dominated by Small Group of Traders

PageRank sum of all traders and of top 10 traders

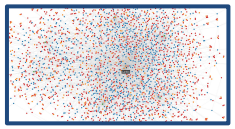


Ratio of sum of top 10 traders over sum of all traders

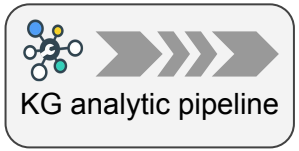


PageRank ratio shows market is dominated by the top 10 traders

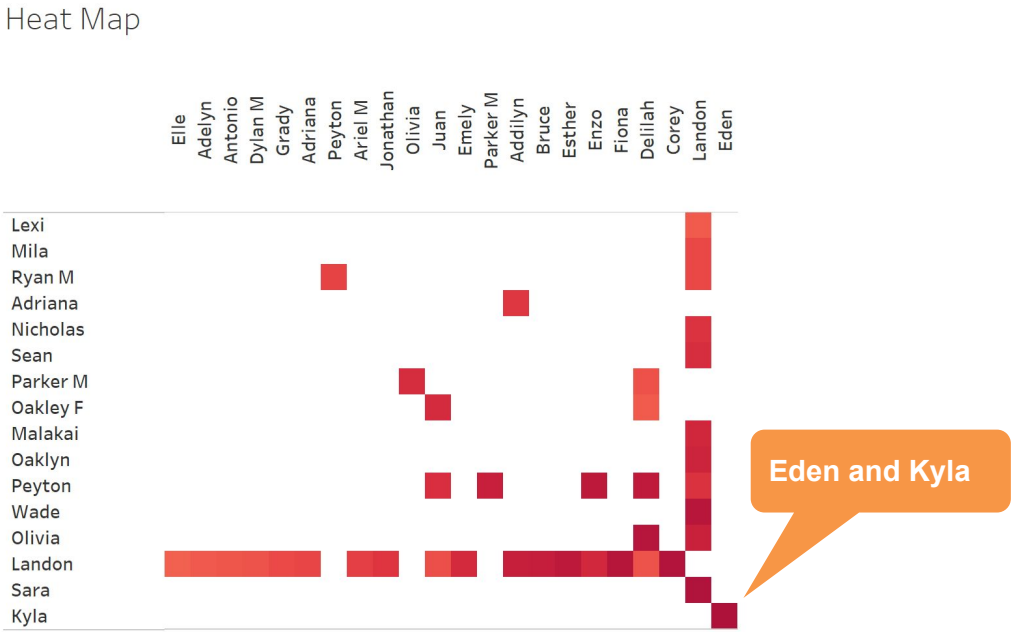
KG Summarized in a Heat Map



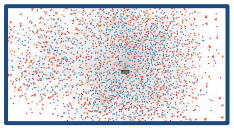
transaction KG



- analytic: trade/net
- filter:
  - trades > 1,000
  - ratio < 0.5
- visualize



KG Analytic Tools Transform KG into Insights:
Exploratory environment for transaction KGs using Tableau



transaction KG

KG analytic pipeline

- analytic: compute balances
- filter: optional
- reusable Tableau dashboards

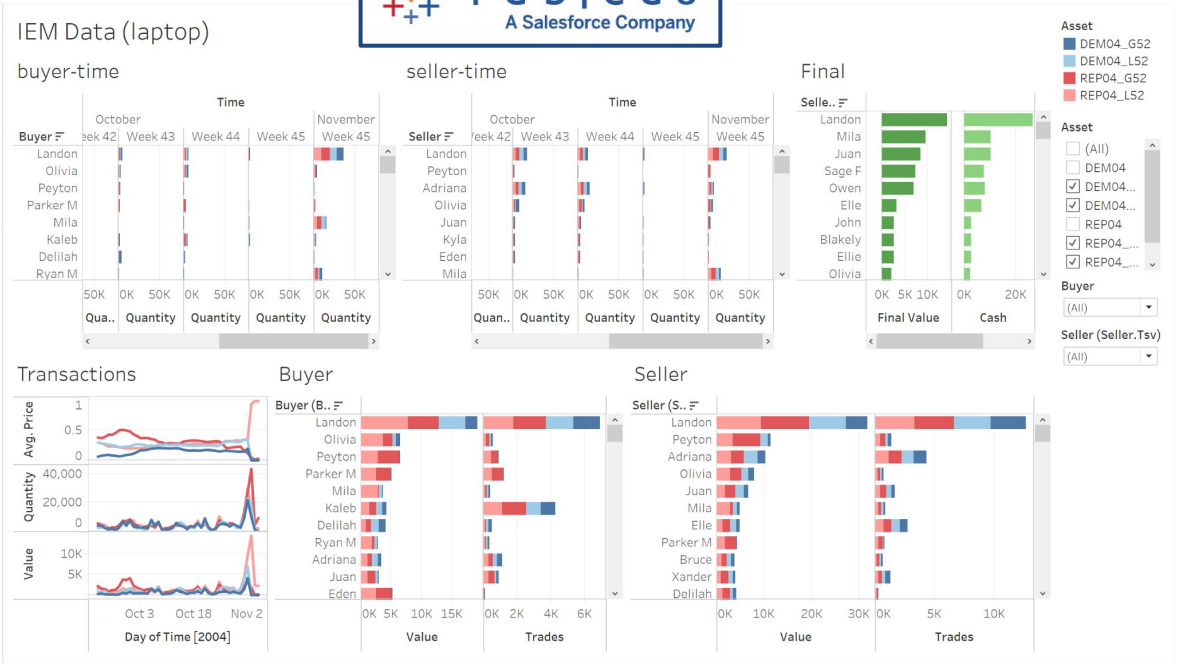
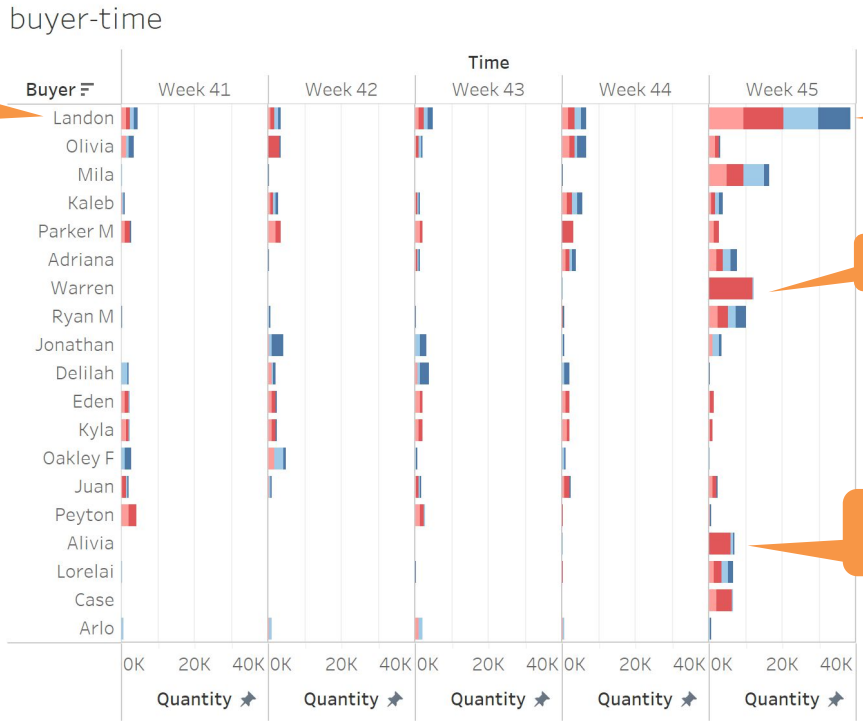


Tableau Dashboards Give Quick Insights



most active trader

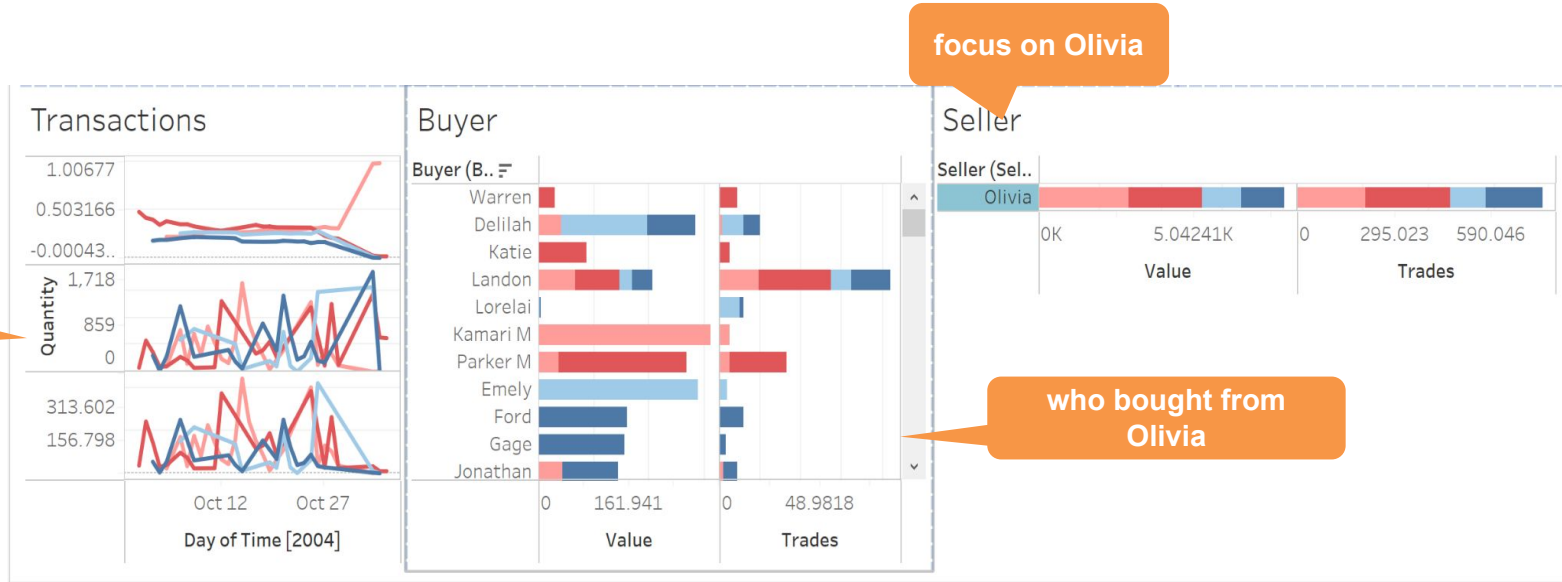
trade equal quantities of each asset

bet on the wrong horse

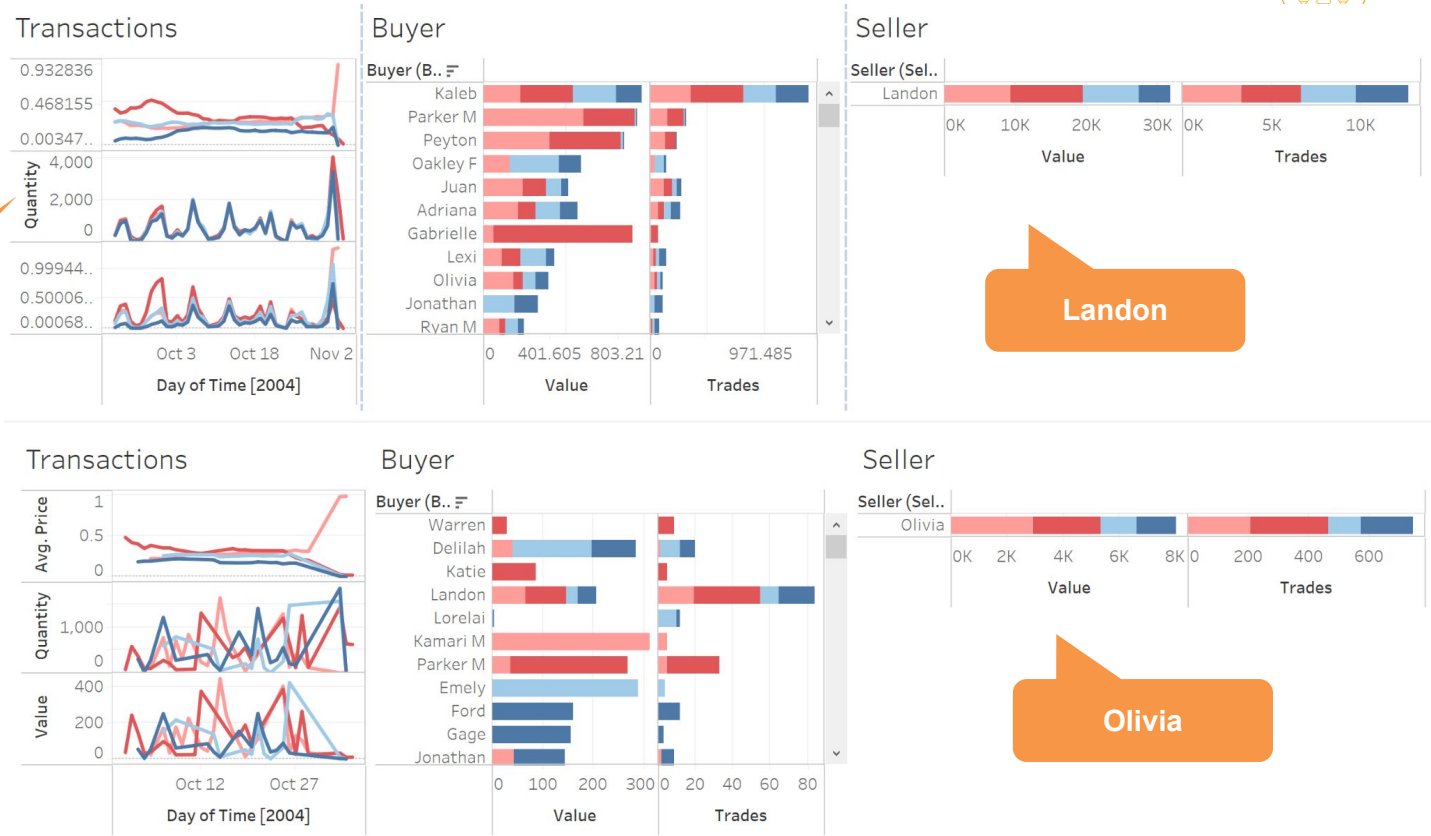
bet at the end of the competition

Exploratory Environment with Drill-down

Focus on Olivia

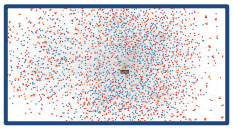


trading behavior



Analytic for Identifying Potential Collusion

Trading partners with larger than expected transaction counts



transaction KG

analytic: pairwise expected count of transactions assuming equal chance of trading partner

Observed buyer-seller quantities

	Landon (17389)	Peyton (18019)	Olivia (10138)	Juan (18305)
Landon (17389)	0	9758	2308	2218
Peyton (18019)	5706	0	1522	1500
Olivia (10138)	3086	7860	0	198

Expected buyer-seller quantities assuming independence

	Landon (17389)	Peyton (18019)	Olivia (10138)	Juan (18305)
Landon (17389)	0	7438	6295	7199
Peyton (18019)	5828	0	1481	1693
Olivia (10138)	7074	2124	0	2056