Supply Chain optimization with Graph Analytics by TigerGraph

Bruno Šimić, Solution Engineer

Juli 2021

By 2025, graph technologies will be used in 80% of data and analytics innovations, up from 10% in 2021, facilitating rapid decision making across the enterprise.[1]

"To Graph or Not to Graph? That Is *Not* the Question — You Will Graph."[2]
Mark Beyer, Distinguished VP Analyst

Gartner.®

[1]*Gartner, Top Trends in Data and Analytics for 2021, 16 February 2021*
[2]*Gartner, Graph Steps Onto the Main Stage of Data and Analytics: A Gartner Trend Insight Report, 14, December 2021*
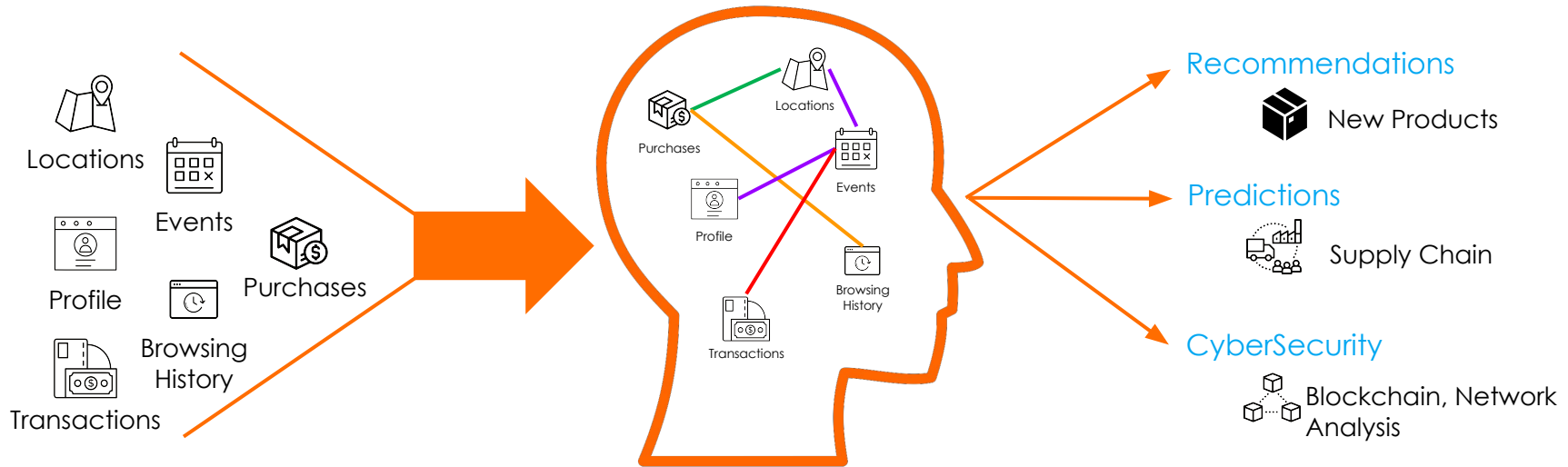
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Graph Is How WE THINK

Graph is the natural, adaptable model for transforming data into knowledge and insight.

Locations

Events

Profile

Purchases

Browsing History

Transactions

Locations

Purchases

Events

Profile

Browsing History

Transactions

Recommendations

New Products

Predictions

Supply Chain

CyberSecurity

Blockchain, Network Analysis

Gather data, organizing it into types and relationships

Use the power of relationships and deep analytics to provide insights

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A Sample Graph
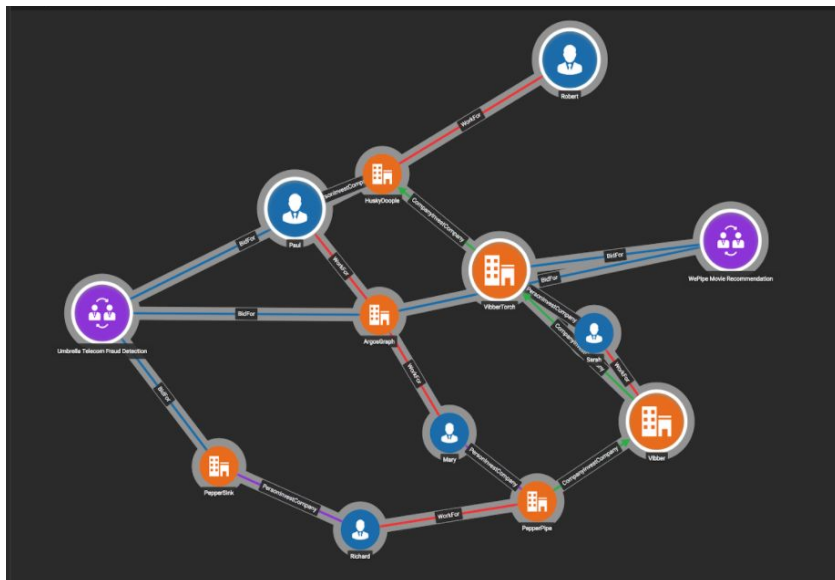
Graph databases consist of vertices and edges

- Vertices (Nodes) - data entities
    - for example - person, account, transaction

- Edges - the relationships between those entities
    - for example - person opens account, money moves from one account to another account

A graph stores the relationships between data entities - or can be used to uncover relationships between data entities

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Why Graph Analytics?

Connect Datasets and Pipelines

Friction-free scale out from GB to TB to PB with lowest cost of ownership
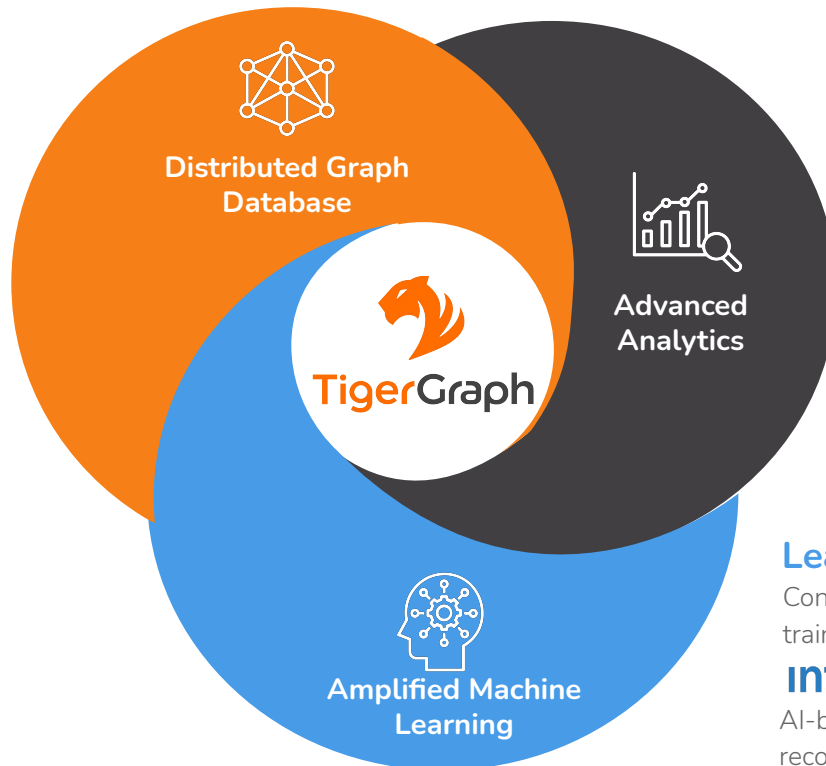
UNITEDHEALTH GROUP®

Customer 360 connecting 200+ datasets and pipelines

Fortune 50 Retailer

Item 360 for eCommerce across 100+ datasets

xandr   AT&T

Identity graph connecting 50+ data pipelines

Distributed Graph Database

TigerGraph

Advanced Analytics

Amplified Machine Learning

Analyze Connected Data

10-100x faster than current solutions

JAGUAR   LAND ROVER

Supply chain planning: 3 weeks to 45 minutes

China Mobile International

Fraud Detection: batch to real-time for 300M calls/day
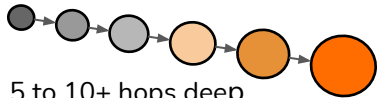
Learn from Connected Data

Continuous graph-based feature generation & training
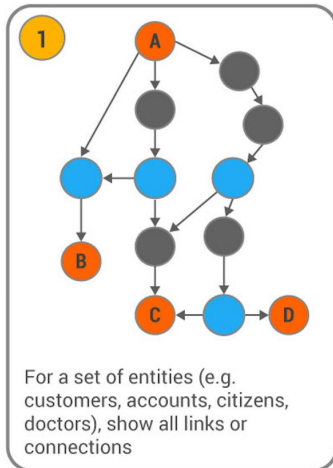
Intuit

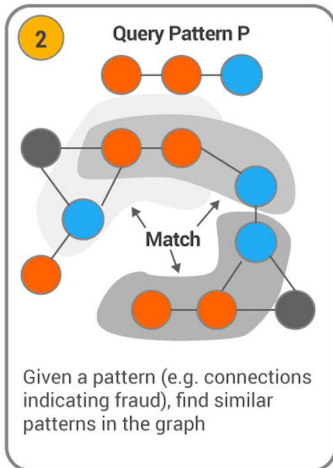AI-based Customer 360 for entity resolution, recommendation engine, fraud detection

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Why Graph Analytics?

Feature	Design Difference	Benefit
Deep-Link Pattern Discovery 5 to 10+ hops deep	• Native graph, for speed and efficiency	• Uncovers hard-to-find patterns • Operational, real-time analytics
Handling Massive Scale	• Distributed database architecture • Massively parallel processing • Compressed storage reduces footprint and messaging	• Integrates all your data • Automatic partitioning • Complete data → better detection
In-Database Analytics	• GSQL: High-level yet Turing-complete language • User-extensible graph algorithm library, runs in-database • ACID (OLTP) & Accumulators (OLAP)	• Avoids transferring data • Richer graph context • In-place machine learning

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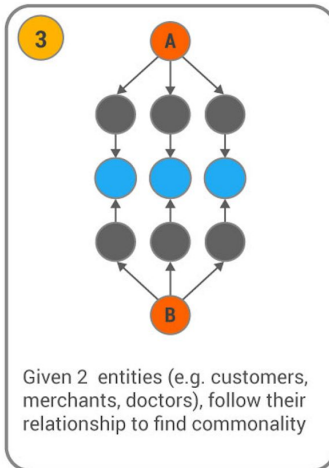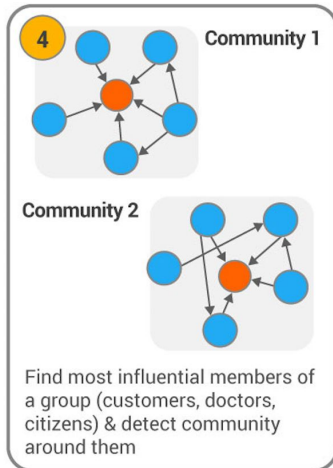# 7 Key Data Science Capabilities Powered By a Native Parallel Graph

Deep Link Analysis

1 For a set of entities (e.g. customers, accounts, citizens, doctors), show all links or connections

Multi-dimensional Entity & Pattern Matching

2 Given a pattern (e.g. connections indicating fraud), find similar patterns in the graph

Relational Commonality Discovery & Computation

3 Given 2 entities (e.g. customers, merchants, doctors), follow their relationship to find commonality

Hub & Community Detection

4 Find most influential members of a group (customers, doctors, citizens) & detect community around them

5 **Geospatial Graph Analysis** — Analyze changes in entities & relationships with location data
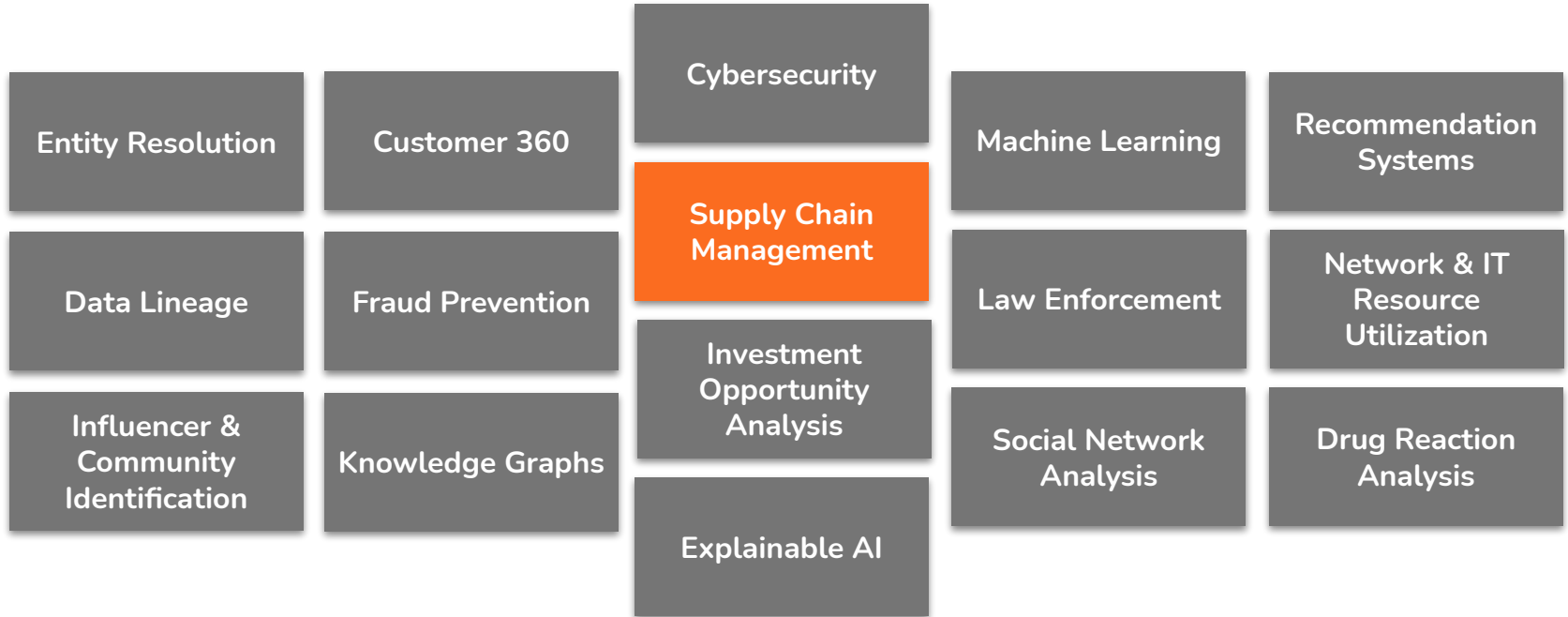
6 **Temporal (Time-Series) Graph Analysis** — Analyze changes in entities & relationships over time

7 **Machine Learning Feature Generation & Explainable AI** — Extract graph-based features to feed as training data for machine learning; Power Explainable AI

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Graph Use Cases

Entity Resolution

Customer 360

Cybersecurity

Machine Learning

Recommendation Systems

Data Lineage

Fraud Prevention

Supply Chain Management

Law Enforcement

Network & IT Resource Utilization

Influencer & Community Identification

Knowledge Graphs

Investment Opportunity Analysis

Social Network Analysis

Drug Reaction Analysis
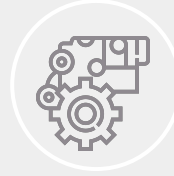
Explainable AI

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Small part of our expertise:

FINANCIAL CRIMES

- Internal Fraud - Entitlements
- AML & Fraud Rings
- Credit Card & Transaction Fraud
- Cyber - Malware
- Surveillance - IoT & Asset Fraud
- Audit & Compliance
- Claims, Dispute & Misappropriation
- Law Enforcement - Prosecution

SUPPLY CHAIN

- Capacity Planning
- Material Flow
- Inventory Optimization
- Transportation: Air, Ground & Water
- Logistics & Warehouses
- Distributed Networks
- Routing & Optimization
- Grids : Electric, Pipelines & Cities
- IoT – Telematics
- Digital twins
- Predictive, Analytics & Optimization

CUSTOMER 360

- Entity Resolution
- Customer Journey
- Churn Avoidance
- Segmentation & Recommendations
- Cross Sell | Upsell
- Prospect - Marketing & Loyalty
- Risk & Predictive & Analytics

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Graph Analytics in Automotive SCM

Supply Chain

Problem:

Incurring fines ($400M+) resulting from needing 12 weeks to understand if forecasts are accurate.
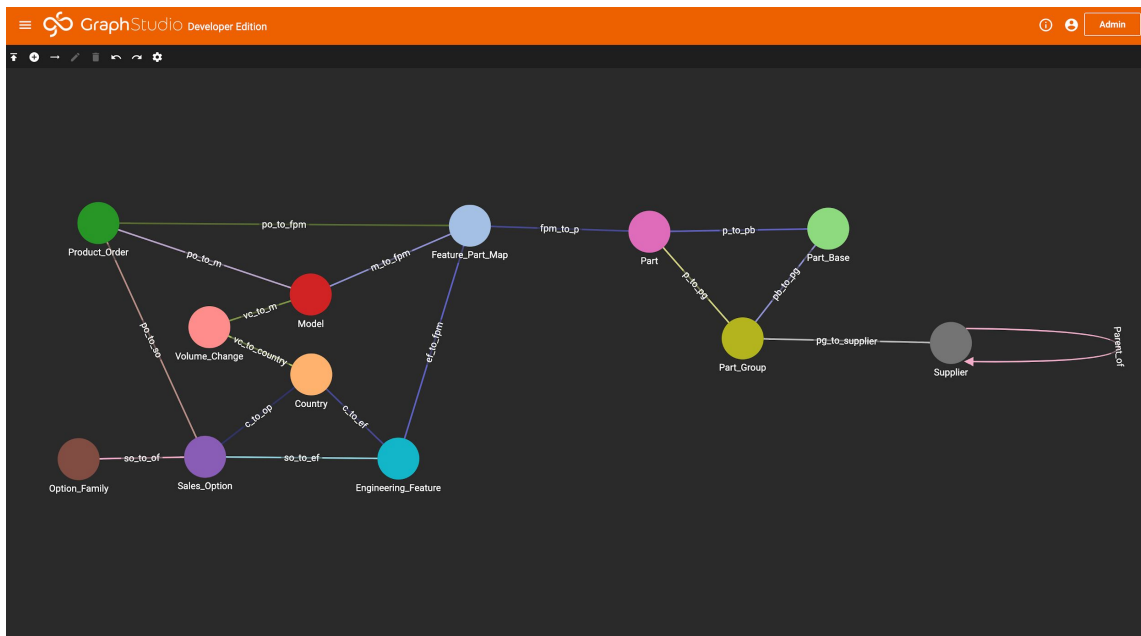
Solution:

By complementing its supply chain analytics with graph our customer has transitioned from contracts based on <u>estimated </u>volumes to bringing <u>real data</u> in <u>real-time </u>into its supply chain capacity planning models.

$20M+ savings/year with 1 query!

Building a Better Supply Chain with Graph Analytics

Graph analytics makes it possible to track every individual part through its entire lifecycle, from supplier through manufacturer to finished product

Business Value: Forecast versus Orders Supplier Impact

A large manufacturer identified that they would benefit (potentially by **£tens-hundreds of millions**) from a timely analysis of impact to their supply chain of changes to their forecast orders.
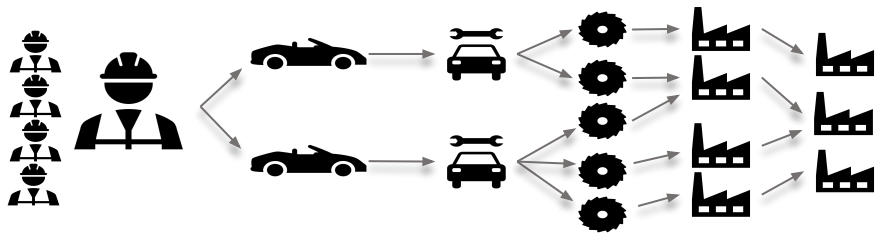
- Sales forecasts are typically years in advance so suppliers can tool-up
- Minimum buy volumes are committed from forecast to support investment
- Demand can vary widely and quickly from the forecast
- Costs to the business can significantly impact margins
- Having good information allows the executive to put mitigations in place

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Graph Analytics Opportunities in Automotive

Sales Order Book(SOB) and Build Planning

Targeted benefit – Increase average profit per unit and minimize aged inventory

What is the impact of part shortage on customer orders?

How much can we switch production of one model for another within constraints?

What would be the optimal sales order mix in order to minimize cost and disruption to supply chain and manufacturing?

Manufacturing Efficiency

Targeted benefit – Reduce Line & Role changes and reduce CPU & Network cost

What lines will be most impacted by the latest change to the SOB?

What change to the schedule would decrease the changes without impacting customer promise-dates ?

What optimum production level should be proposed to enable SOB optimisation?

Sales Orders	Marketing Feature	Engineering Feature	Parts	Suppliers

Answering historic blind spots

Identifying tactical opportunities

Optimisation

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Answering Critical Business Questions With Graph Analytics

Overview

Data and analytics leaders struggle to advance a shared understanding of data across business verticals and functions. Jaguar Land Rover demonstrates how graph analytics can give the business a connected view of supply and demand, enabling efficient answers to critical business questions.

Solution Highlights

1. Identify a common language for speaking business and data.
2. Connect supply and demand data in a knowledge graph and explore your most critical business problems by browsing up and down the graph. Examples:
   a) Demand for a model is suddenly surging in the US market. Do we have all the parts we need to meet this demand? Where do the supplier risks lie?
   b) Demand for a model is suddenly dropping drastically in the US market. What parts will we now have in surplus? How can we best use these parts?
   c) What is the profitability impact of changing a feature of a car?

About the Company

Jaguar Land Rover (JLR)

Industry: Manufacturing   Revenue: GBP 25.8 Billion (2021)
Headquarters: Coventry, UK   Employees: 44,101 (2021)

Gartner case study for Jaguar Land Rover - Answering Critical Business Questions with Graph Analytics (Jaguar Land Rover), October 28, 2021, Gartner ID G00733557

Harry Powell
Director of Data
and Analytics

Alice Grout-Smith
Data Scientist

Martin Brett
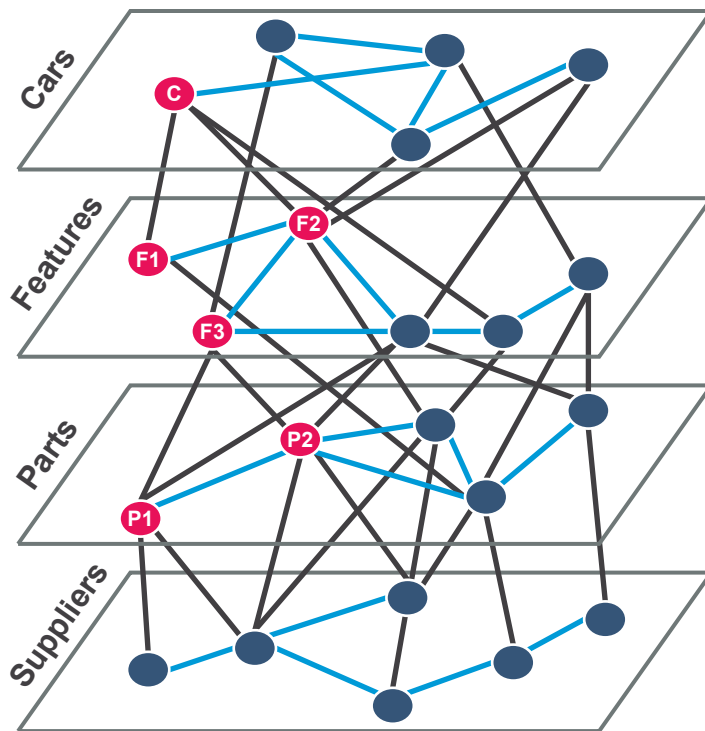Senior Data Architect

Hazel Scourfield
Data Scientist

Clear Two-Way Line of Sight Between Demand and Supply

JLR's Demand-Supply Graph

Car C contains the feature F1.

Features F1 and F2 are connected because they are both features of car model C.

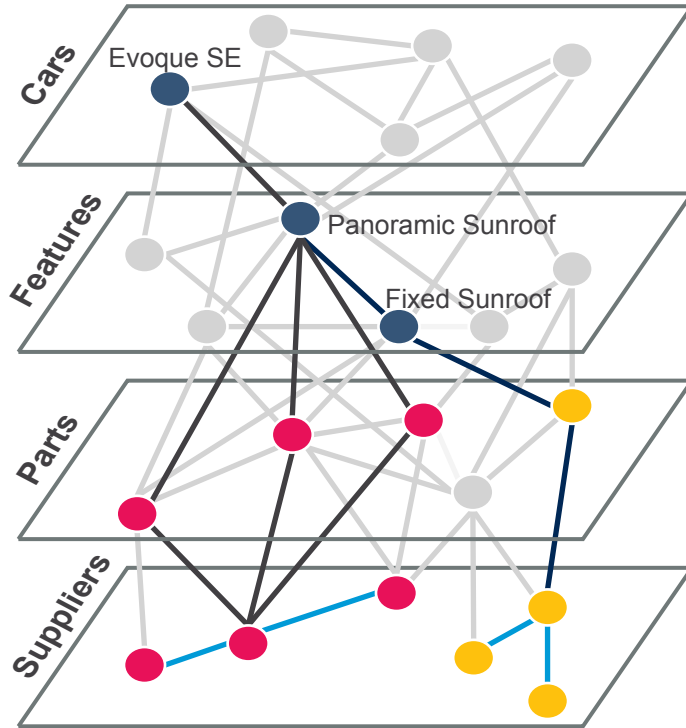Parts P1 and P2 are connected because they are both parts for feature F3.

Demand

Show dependencies between Suppliers → Parts → Features → Cars

Include costs and constraints

Supply

Source: Adapted From Jaguar Land Rover

Identifying and Reducing Supply Chain Risks

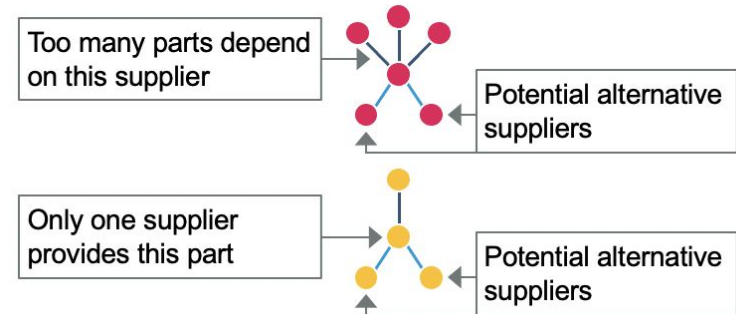## JLR's Demand-Supply Graph for Exploration & Discovery

Source: Adapted From Jaguar Land Rover

Critical Business Questions: Demand for the Evoque model is suddenly surging in the US market. Do we have all the parts we need to meet this demand? Where do the supplier risks lie?
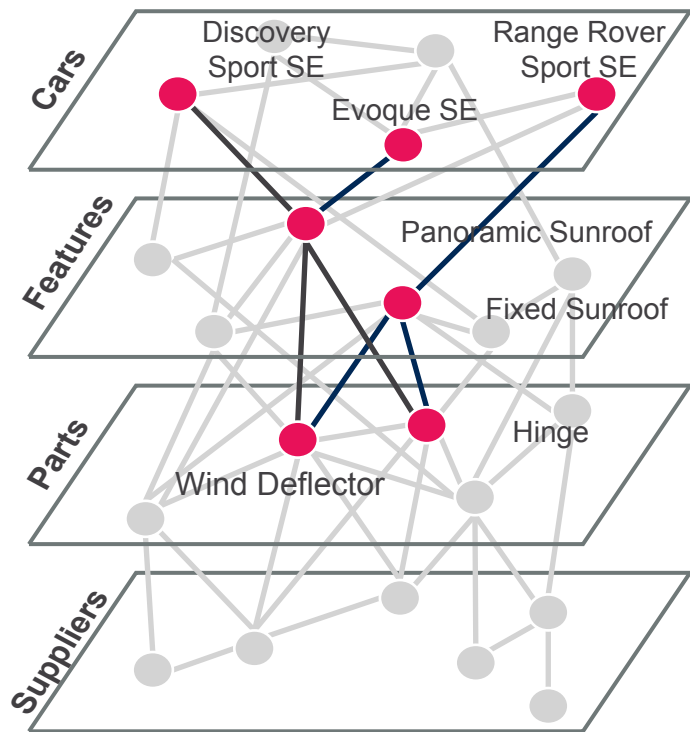
Procedure for Exploration:

1. Browse the graph to identify all features for Evoque SE.

2. For each feature, browse the graph to find all parts needed for the feature.

3. For each part, browse the graph to identify all the suppliers for the part.

4. Look for graph substructures such as fan-in and fan-out patterns to identify and mitigate supplier risk.

Too many parts depend on this supplier

Potential alternative suppliers

Only one supplier provides this part

Potential alternative suppliers

Making the Most of Surplus Inventory

JLR's Demand-Supply Graph for Investigation & Inference

Cars
- Discovery Sport SE
- Range Rover Sport SE
- Evoque SE

Features
- Panoramic Sunroof
- Fixed Sunroof

Parts
- Hinge
- Wind Deflector

Suppliers

Source: Adapted From Jaguar Land Rover

Critical Business Questions: Demand for Discovery Sports is suddenly dropping drastically in the US market. What parts will we now have in surplus? How can we best use these parts?

Procedure for Investigation:

1. Browse the graph to identify all features of Discovery Sport SE. Let's call these features SF1.

2. Identify models that are in greater demand. For each model, identify the features to build the car. Let's call these features SF2.

3. Find the intersection of sets SF1 and SF2. These are the features this car model has in common with the Discovery Sport SE model. These features can be used to build this more in-demand car model instead.

4. For the features that are not shared between the car models, identify the parts that are used by the Discovery Sport SE alone. For each of these parts, look for the following fan-in and fan-out patterns.

Browsing Direction

This part could be used to build a feature for Range Rover Sport SE
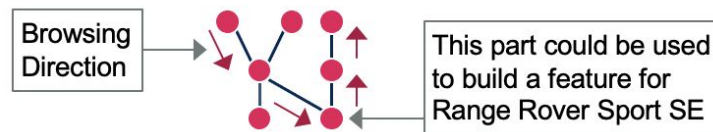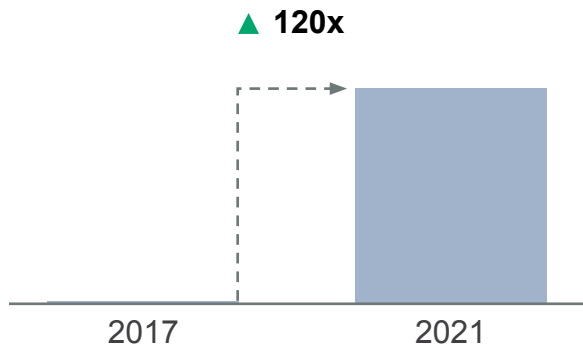
Solving an Intractable Optimization Problem

Critical Business Question: What is the profitability impact of changing a feature of a car?
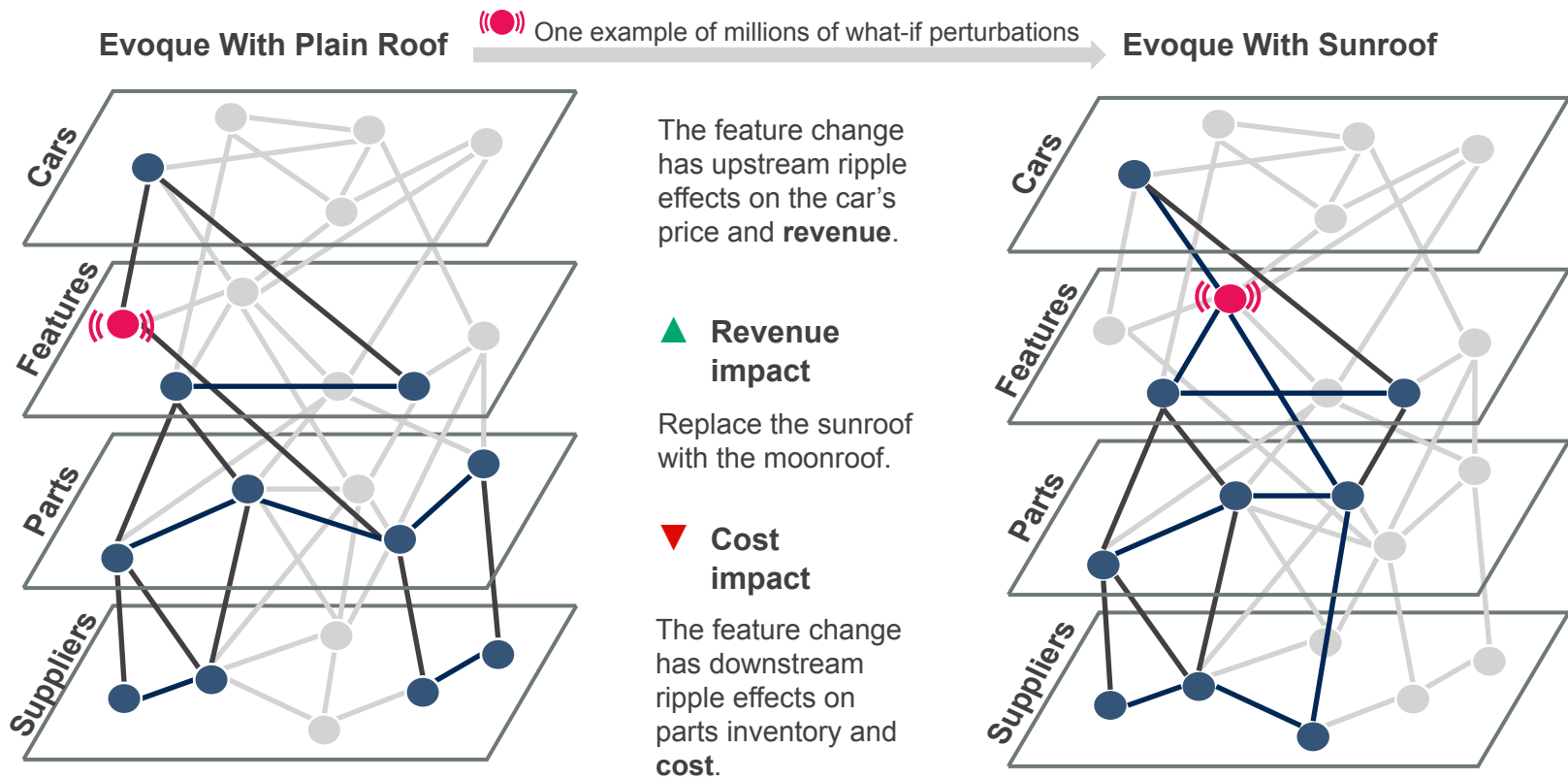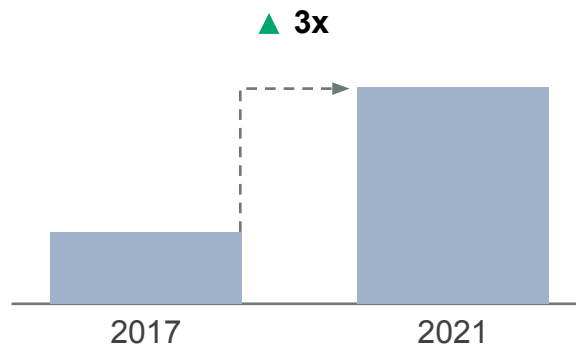

Source: Adapted From Jaguar Land Rover
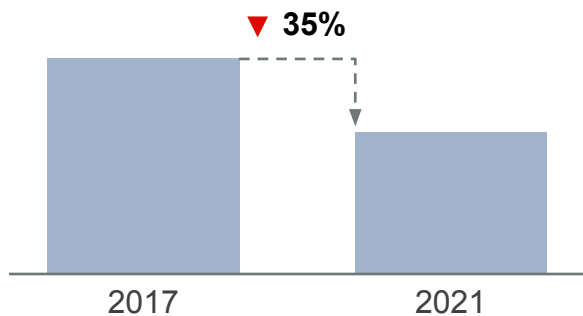
Results

Decision Speed

▲ **120x**

Source: Adapted From Jaguar Land Rover

Business Value

▲ **3x**

Source: Adapted From Jaguar Land Rover

Supplier Risk

▼ **35%**

Source: Adapted From Jaguar Land Rover

"As we began using the same data as our commercial and manufacturing partners, it has become a lot easier to work together and address our business problems in greater depth."

Director of Purchasing, JLR

Jaguar Land Rover (JLR): Production Planning Optimisation for Highly Complex Supply Chains

Business Challenge

Sales forecasts are typically made years in advance so suppliers can prepare and tool-up highly specialised production lines. JLR were incurring large fines from their suppliers due to being unable to perform timely analysis of impact to their supply chain of changes in their forecast orders.

Solution

- Seamless joining of complex tables across multiple systems allows data access across customers, vehicles, features, parts, and suppliers.
- Advanced production planning using predictive analytics, real-time simulations and scenario modelling.

Business Benefits

Having up-to-date and highly qualitative information allows business stakeholders to quickly put mitigations in place. With TigerGraph, JLR are benefiting from a timely impact analysis of changes to their forecast orders to their supply chain, minimising and potentially avoiding fines from their suppliers of millions of pounds.

Speed of Planning with TigerGraph

"We used the graph to re-sequence how our vehicle orders were to be built in our factory in response to a supplier failure. A process which in the past might have taken days was both modelled and evaluated in less time than it took to write the PowerPoint slide to present the idea."

New Insights with TigerGraph

"With TigerGraph we can join sources of data together and make connections within the data that previously we couldn't. We can now answer questions that, for the last 20 years, we didn't think were possible to ask."

Customer Testimonial - Jaguar Land Rover

Martin Brett
Senior Data Architect, JLR

Harry Powell
Director of Data & Analytics, JLR

Harry's blog outlining **£100 million in incremental annual profit** for Jaguar Land Rover with Advanced Analytics - https://www.linkedin.com/pulse/unicorn-attic-harry-powell

Selection Process

"TigerGraph was the only solution that was able to execute our highly complex use case at scale. Other solutions we tried could do queries on use cases with quite limited interconnectivity but as soon as that was scaled up, the solution no longer worked."

Ease of Deployment & Flexibility

"We were really impressed with the speed and ease at which TigerGraph was deployed. Also being reasonably schema-loose allows design changes to be made fairly last minute and provides a highly flexible option that also offers extensibility to add additional datasets as the needs of the graph change over time."

All testimonials - https://www.tigergraph.com/testimonials/

TigerGraph

Jaguar Land Rover Featured on CIO.com

Harry Powell
Director of Data & Analytics, JLR

Accelerate planning at JLR - weeks to minutes

The software, from TigerGraph, detected when suppliers would fail to meet quota demands.

"We used the graph to re-sequence how our vehicle orders were to be built in our factory in response to a supplier failure," Powell says.
Queries across the supply chain model now take 30 to 45 minutes compared to weeks using SQL relational database software.

CIO.com article - The pandemic pivot: IT leaders innovate on the fly, August 13 2021
https://www.cio.com/article/3570423/the-pandemic-pivot-it-leaders-innovate-on-the-fly.html

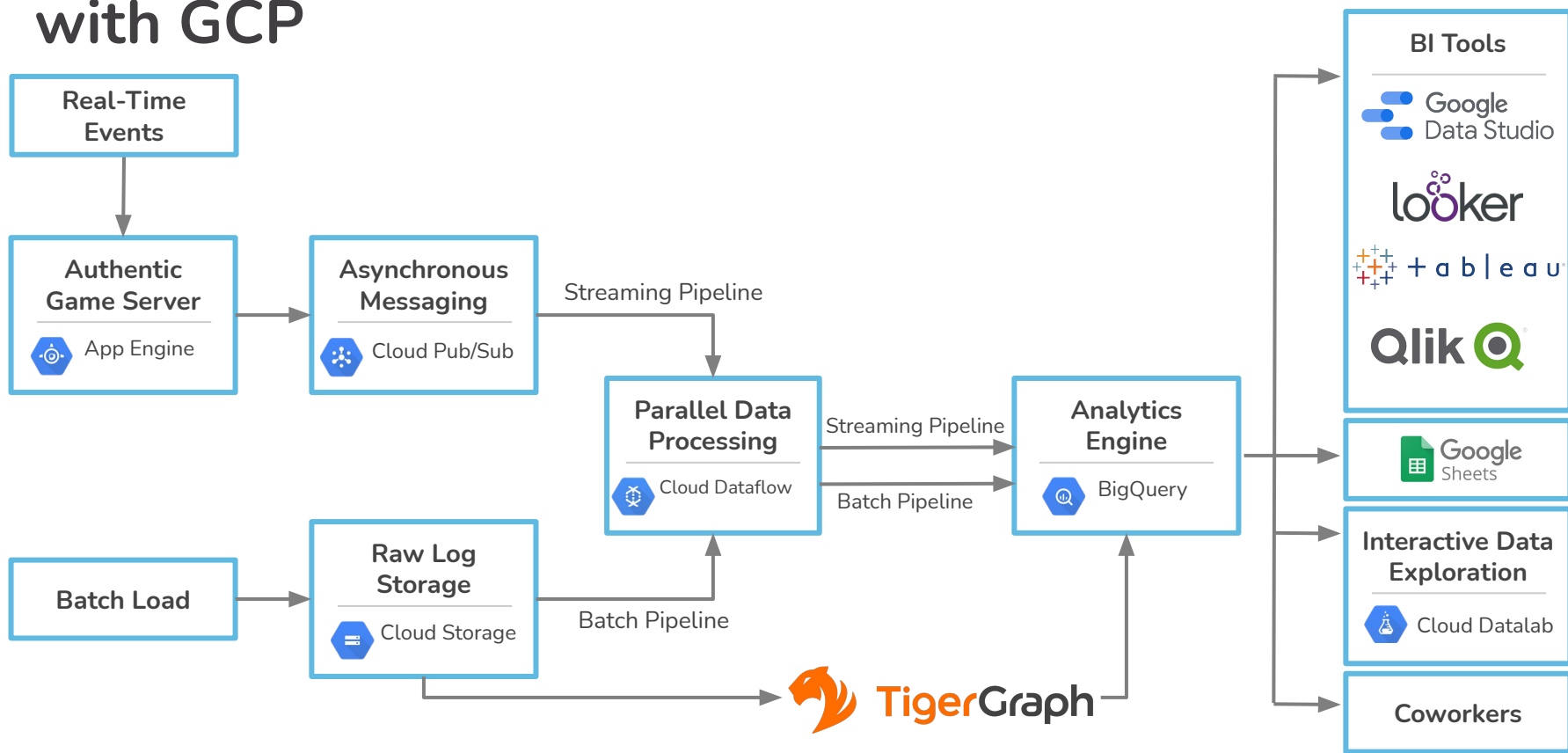TigerGraph

Jaguar Land Rover 2nd Featured on CIO.com

Harry Powell
Director of Data & Analytics, JLR

"The task, in which JLR combined **12 data sources** in a graph equivalent to **23 relational database tables**, helped JLR make connections within the data - such as exactly what it can build at the moment with parts in hand - that it previously couldn't." Powell says. **The analysis took only 45 minutes compared to the weeks it would take to join the data using relational systems.**

CIO.com article - Emerging tech soothes pandemic-disrupted supply chains - August 18th, 2021
https://www.cio.com/article/3570487/emerging-tech-soothes-pandemic-disrupted-supply-chains.html?utm_campaign=organic&utm_medium=social&utm_content=content&utm_source=twitter

TigerGraph

Jaguar Land Rover Infrastructure: Direct Integration with GCP

Who is TigerGraph?

We provide **advanced analytics and machine learning on connected data**

- The only scalable graph database for the enterprise: 40-300x faster than competition
- Foundational for AI and ML solutions
- Designed for efficient concurrent OLTP and OLAP workloads
- SQL-like query language (GSQL) accelerates time to solution
- Available on-premise & on: Google GCP, Microsoft Azure, aws

Our customers include:

- The largest companies in financial, healthcare, telecom, media, utilities and innovative startups in cybersecurity, ecommerce and retail

Founded in 2012, HQ in Redwood City, California

Corporate Overview Video

TigerGraph

Thank you!

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bruno@tigergraph.com
https://www.linkedin.com/in/brunosimic/