



# Graph + AI: What is Next ?

## Democratizing Graph Technology Adoption

### - The TigerGraph Perspective

Jay Yu, Ph.D. - VP Product & Innovation, TigerGraph

Victor Lee, Ph.D. - VP ML & AI, TigerGraph

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# Speaker Bio



Jay Yu Ph.D.

Vice President of Product & Innovation

**TigerGraph**

Proven hands-on full-stack innovator, strategic thinker, leader, and evangelist for new technology and product, with 25+ years of industry experience in big tech companies like Intuit and Teradata.



Victor Lee Ph.D.

Vice President of ML / AI

**TigerGraph**

Product leader, author, and educator, with a passion for algorithms, languages, user experience, and ethics. 7 years at TigerGraph, 3 years as university professor, 20+ years in tech industry.

# Outline

1

Graph Overview & Adoption Challenges

2

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New Capabilities to Expand Adoption

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Graph + ML Advancement

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Summary

# Graph Overview & Adoption Challenges





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.<sup>1</sup>

“To Graph or Not to Graph? That Is *Not* the Question — **You Will Graph.**”<sup>2</sup>

**Gartner**<sup>®</sup>

<sup>1</sup>Gartner, *Top Trends in Data and Analytics for 2021*, 16 February 2021

<sup>2</sup>Gartner, *Graph Steps Onto the Main Stage of Data and Analytics: A Gartner Trend Insight Report*, 14, December 2021



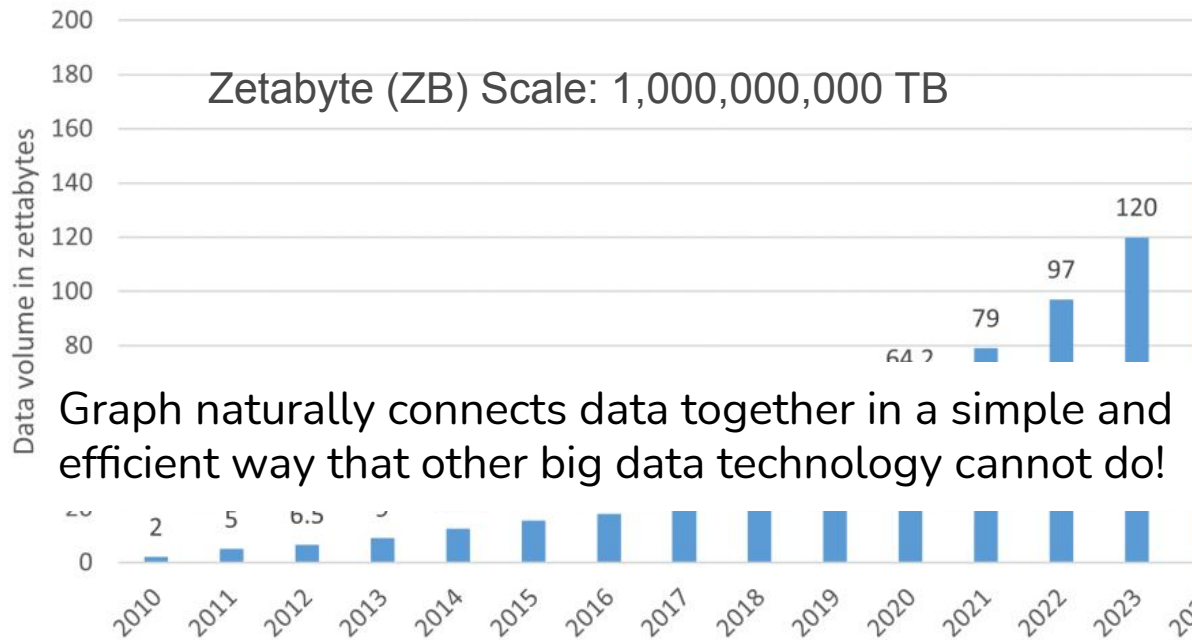
# Innovative Business Leaders Agree ...

- “**Graphs clarify relationships.** Put simply, relying upon entire paths or sets of relationships in a graph can **provide deeper insights** than just looking at nearest neighbors, which is what a typical database will afford you.” - Brad Spiers, JP Morgan Chase
- “Advanced analytics has **de-siloed** our business, contributing to **\$100M+ in incremental annual profit.**” - Harry Powell, *Jaguar Land Rover*
- “The value of graph, with AI algorithms on top, is that not only can we monitor an enterprise, **we can predict** - and that allows us to **avoid problems before they happen.**” - Ed Sverdlin, *UnitedHealth Group*



# Why Graph is becoming more and more Important ?

Volume of data created and replicated worldwide (source: IDC)



Graph naturally connects data together in a simple and efficient way that other big data technology cannot do!

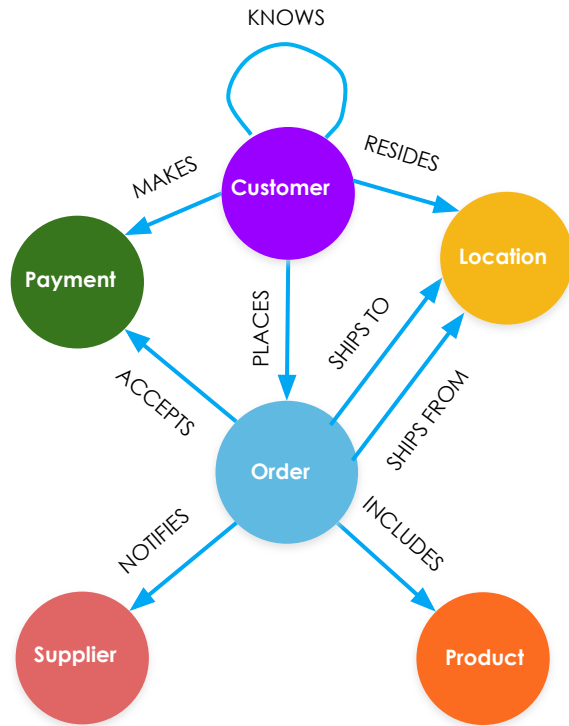
Data Silo



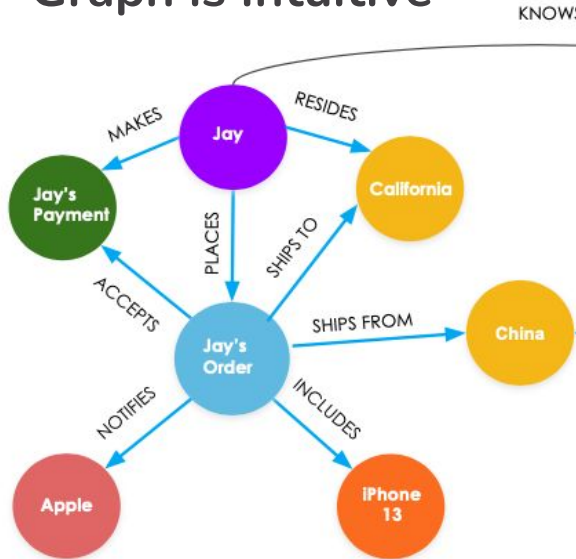
Data Swamp



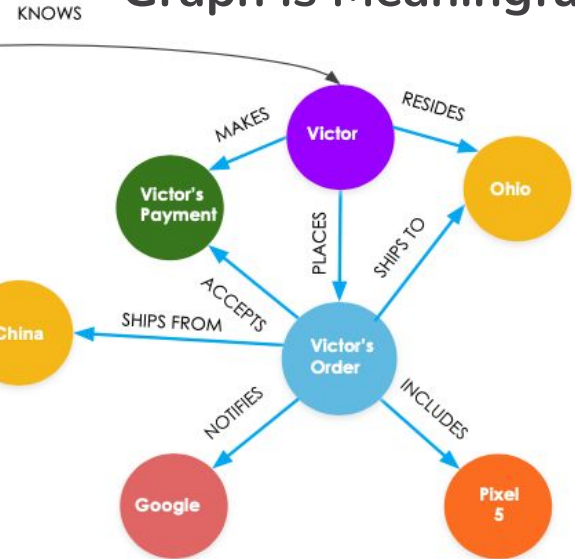
# What is Graph?



- Graph is Intuitive



- Graph is Meaningful



- Graph is Insightful

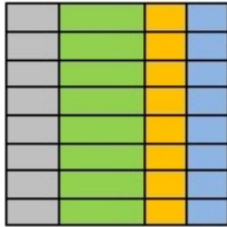
- Graph is Explainable

Graph Connects Data Together and Elevate Relationships to be the First Class Citizens!

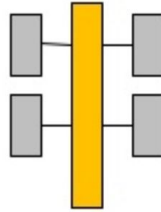


# How is Graph Model different than other Data Models ?

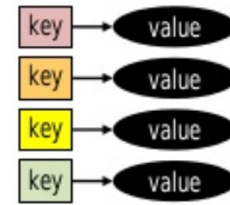
## Relational



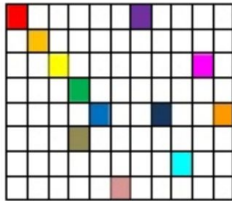
## Analytical (OLAP)



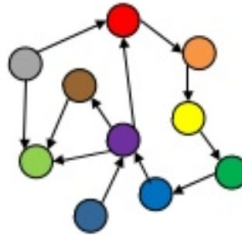
## Key-Value



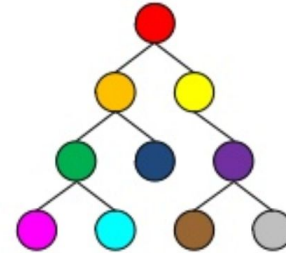
## Column-Family



## Graph



## Document



Graph Model can represent all other Data Models **Naturally** !

# What are the Barriers to Adopt Graph Tech?

- Is it valuable to business? customer benefit / business value?
- Is it real to scale? enterprise-scale ready?
- Is it hard to learn? by engineers / data scientists ...?
- Is it long to build? time to value?
- Is it costly to operate? huge effort to manage?

# Graph Adoption Successes So Far



# Fortune-500/1000 Companies' Graph Adoption

## CONNECT ALL DATASETS AND PIPELINES

Friction-free scale up from GB to TB to Petabyte with lowest cost of ownership

### UNITEDHEALTH GROUP®

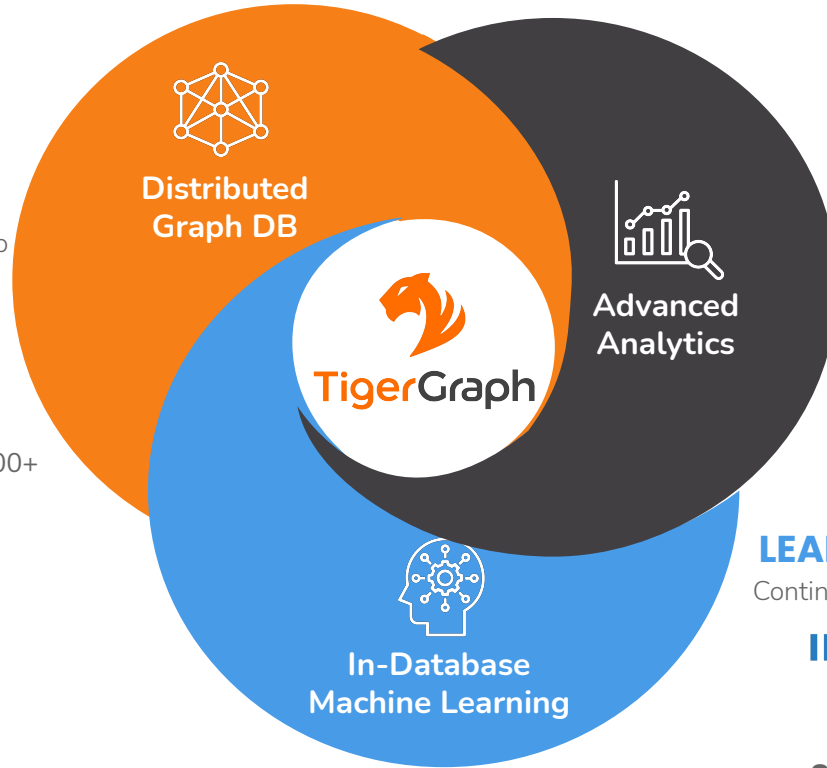
Customer 360 connecting 200+ datasets and pipelines

### Fortune 50 Retailer

Item 360 for eCommerce across 100+ datasets



Identity graph connecting multiple data pipelines



## ANALYZE CONNECTED DATA

10-100X faster than current solutions

### Jaguar Land Rover

Supply chain planning accelerated from 3 weeks to 45 minutes



Fraud Detection - batch to real-time for 750 million calls/day

## LEARN FROM CONNECTED DATA

Continuous graph-based feature generation and training

### intuit.

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

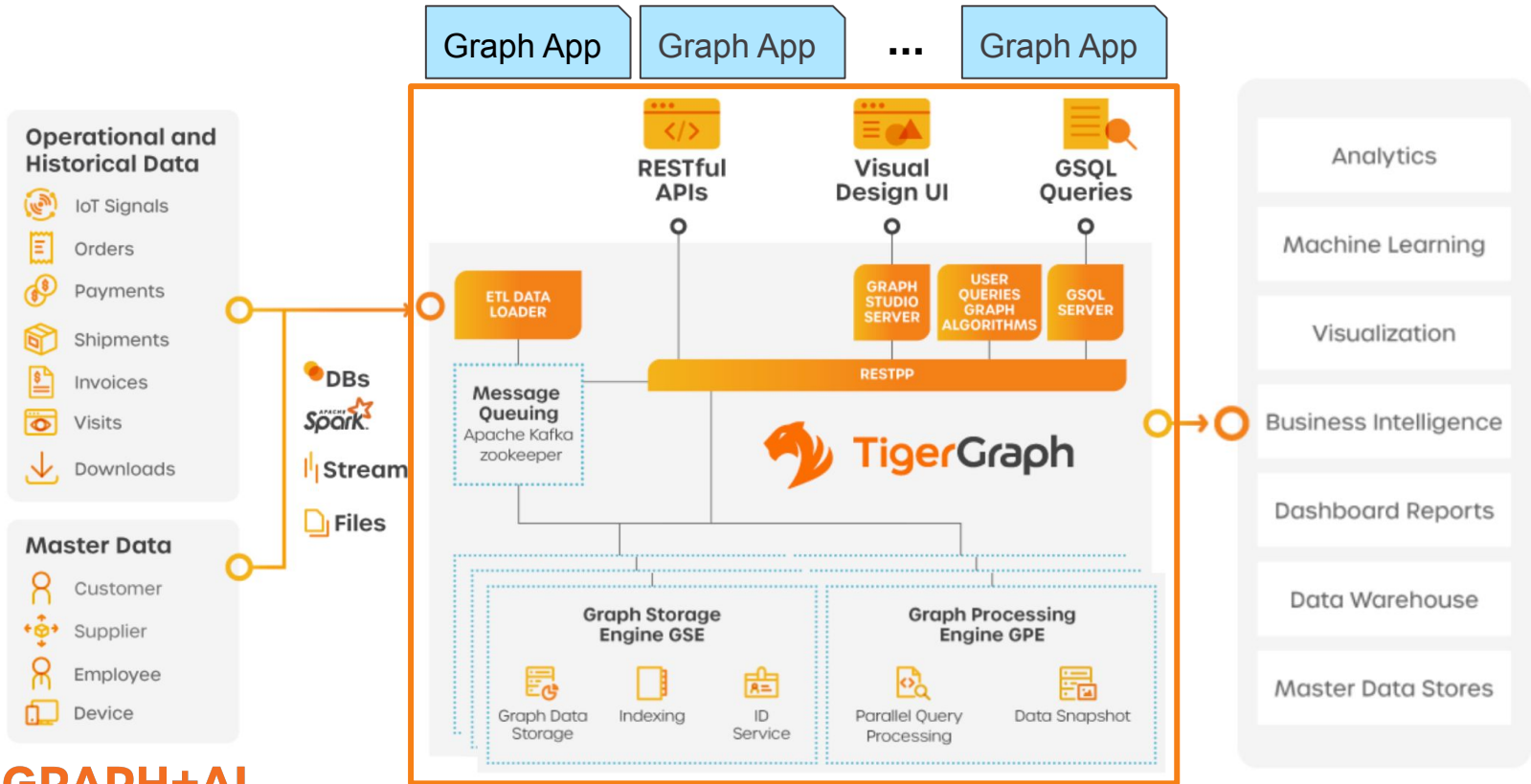
### 8 out of top 10 global banks

Real-time fraud detection and credit risk assessment

# Rapid Growing Customer Adoption - Use Cases



# How? - Performant and Scalable Graph DB



# How? - Familiar, Powerful Query Language (GSQL)



Schema-Based  
(Strong Typing)



SQL-Like



Parameterized  
Queries

The screenshot shows a GSQL query editor with a dark theme. On the left, a sidebar lists queries: 'CategorySpendQuery' (selected), 'SampleQuery', and 'ToySpendQuery'. The main editor contains the following GSQL code:

```
1 CREATE QUERY CategorySpendQuery(String category) FOR GRAPH SampleDemo SYNTAX v2 {
2   SumAccum<FLOAT> @total_category_spend;
3   Customers = {Customer.*};
4
5   // find each customer's total spend on the specified category
6   CategoryBuyers = SELECT c
7     // traverse the Customer --> Order --> Product relationships
8     FROM Customers:c -(places>:ep)- OnlineOrder:o -(includes>:ei) - Product:p
9     // only focus on products that are in the specified category
10    WHERE p.category == category
11    // calculate total spend for product of category for customer's orders
12    ACCUM c.@total_category_spend += p.price * ei.quantity;
13
14    // output customer name and total spend on the category
15    PRINT CategoryBuyers[CategoryBuyers.name, CategoryBuyers.@total_category_spend];
16 }
```

Below the code is a graph visualization with nodes: Customer (purple), Payment (green), OnlineOrder (blue), Supplier (red), Location (yellow), and Product (orange). Edges represent relationships: 'makes' (Customer to Payment), 'places' (Customer to OnlineOrder), 'resides' (Customer to Location), 'accepts' (Payment to OnlineOrder), 'ships\_to' (OnlineOrder to Location), 'ships\_from' (Location to OnlineOrder), 'notifies' (OnlineOrder to Supplier), and 'includes' (OnlineOrder to Product).



Control Flow (FOR,  
WHILE, IF/ELSE)



HTAP - Graph Updates  
& Analytics Queries



Built-in High  
Performance Parallelism

# How? - Delightful Developer Experience

The screenshot displays the GraphStudio application interface. On the left is a sidebar with navigation options: SampleDemo (superuser), Design Schema, Map Data To Graph, Load Data, Explore Graph (highlighted), Build Graph Patterns (BETA), and Write Queries. The main panel is divided into a search configuration area and a graph visualization area.

**Search Configuration:**

- Find paths between two vertices. To choose path Starting - Ending vertex, click the starting vertex or destination vertex id input box, then click one vertex from right side.
- Choose starting vertex: Vertex type: OnlineOrder, Vertex id: JayOrder00001
- Choose destination vertex: Vertex type: OnlineOrder, Vertex id: VictorOrder0000
- Find paths button
- Configuration:
  - Show one shortest path
  - Show all shortest paths (selected)
  - Show all paths
- Warning: Finding all shortest paths might be slow and the result graph might be too large to be visualized. Maximal path length: 6
- Paths going through vertex types:
  - All (checked)
  - Customer
  - OnlineOrder (checked)
  - Product
  - Payment
  - Supplier
  - Location

**Graph Visualization:**

The graph shows a central blue node (JayOrder00001) connected to several other nodes via edges labeled with relationships: 'ships\_from' to China, 'ships\_to' to California, 'places' to Jay, 'notifies' to Apple, 'accepts' to JayPymt00001, 'includes' to iPhone 13, 'ships\_to' to VictorOrder00001, 'ships\_from' to Ohio, 'places' to Victor, 'notifies' to Google, 'accepts' to VictorPymt00001, and 'makes' to VictorPymt00001. Jay is also connected to JayPymt00001 via 'makes' and 'resides' to JayPymt00001. Victor is connected to VictorPymt00001 via 'makes' and 'resides' to Ohio. JayPymt00001 is connected to Jay via 'places' and 'resides' to JayPymt00001. JayPymt00001 is connected to JayPymt00001 via 'places' and 'resides' to JayPymt00001. JayPymt00001 is connected to JayPymt00001 via 'places' and 'resides' to JayPymt00001.



# How? - In-Database ML / Graph Data Science

- **Battle-tested by Production Use Cases at Scale**

Fraud Detection, Recommendation, Market Segmentation, Influence/Risk Scoring

- **Fast and Scalable**

Native MPP design means faster execution

- **Familiar**

Closely mirrors algorithmic pseudocode

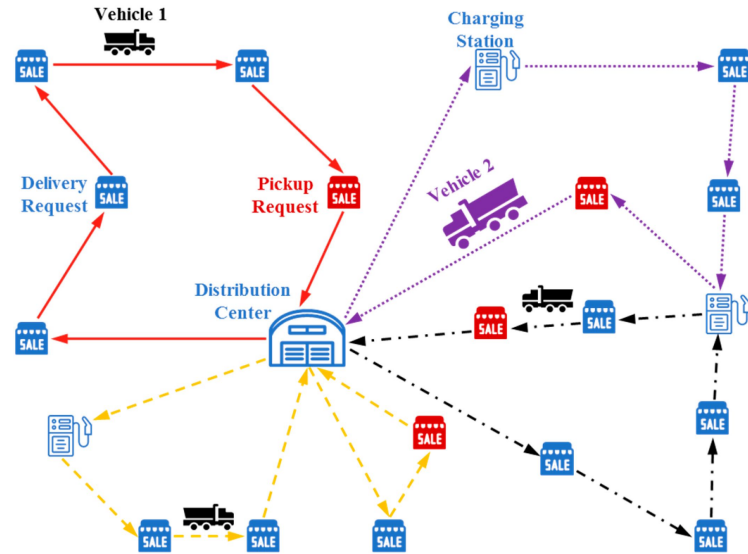
- **Open-source**

Free, accessible and modifiable

- **Comprehensive**

Over 40 algorithms, in several categories

... to be covered in detail later by Dr. Lee



# How? - Graph DB as a Service



Amazon Web Services



Microsoft Azure



Google Cloud

Also launchable from the Cloud Marketplaces



# How? - Rapid Growing and Engaging Community


- Graph + AI Summit Attendees
  - 9,000+ registered, 300% YoY growth
- Thriving Developer Community
  - 340% YoY growth in weekly visits
- Active Open Source Contribution
  - GitHub projects 700% YoY growth / pyTigerGraph
- Engaged Developers at All Levels, including Students ...



**San Jose State University**

WITH TIGERGRAPH AND PLOTLY  
START DATE: SEPTEMBER 7th

Win Prizes • Learn Latest Technologies • Network



Qi Chen

Following

50+ NEW FOLLOWERS

- Shrey Choudhary
- Shuo Ding
- Abish Kaul
- Muhammad Zinag
- TigerGraph

See all 50


Apr 5

### Creating an airport centrality data visualization web application with TigerGraph & Streamlit

**Introduction**  
Centrality measures are an important tool to analyze the networks, not only social network, but also every network like electrical web or a national road network. All this analysis can be done using some simple topological measures that score nodes by their importance as a part of the big network.

**TigerGraph**  
TigerGraph is a new kind of graph database, a native parallel graph database purpose-built for loading massive amounts of data (terabytes) in hours and analyzing as many as 10 or more hops deep in to relationships in real-time. TigerGraph supports transaction as well as analytical workloads, is ACID compliant, scales...


David Baker Effendi in Towards Data Science



**David Baker Effendi**  
Computer science student at Stellenbosch University focusing on the application of graph-driven analytics

Followed by 16 people


Following



### Efficient Use of TigerGraph and Docker

TigerGraph can be combined with Docker to run on nearly any OS...

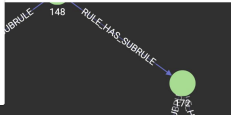
Parker Erickson in Towards Data Science



**Parker Erickson**  
Student at UMN. Interested in robotics, 3D printing, machine learning, and graph databases. <https://parkererickson.github.io>

Followed by 37 people

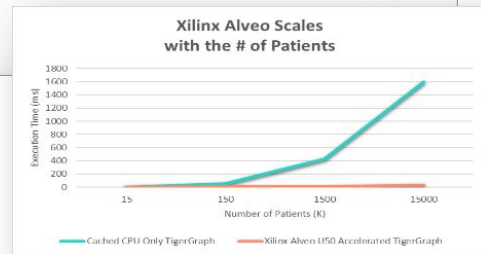
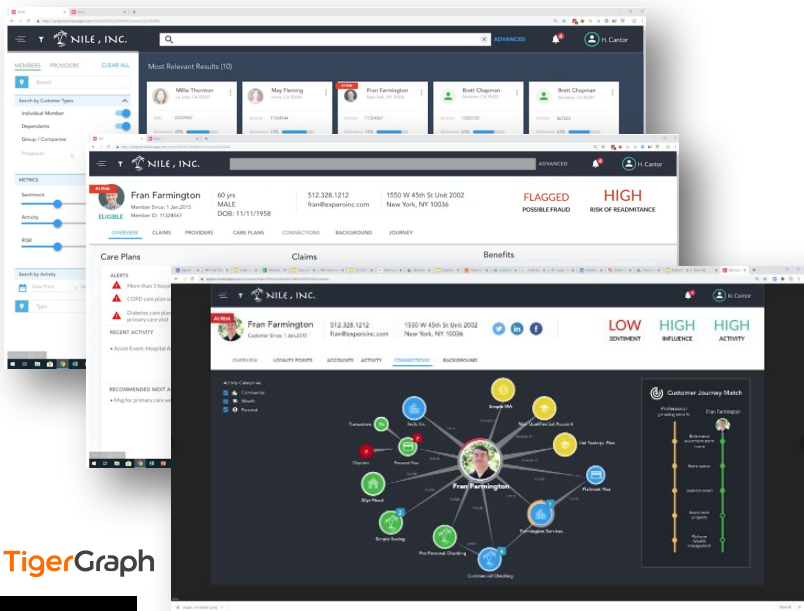
Following



### Decision Trees in TigerGraph

Make ML Classifications Inside Your Database

# How? - Ecosystem of Solution and HW Partners



Turn-key Graph Solutions built on TigerGraph reducing time-to-market and dev cost by **2-3X +** !

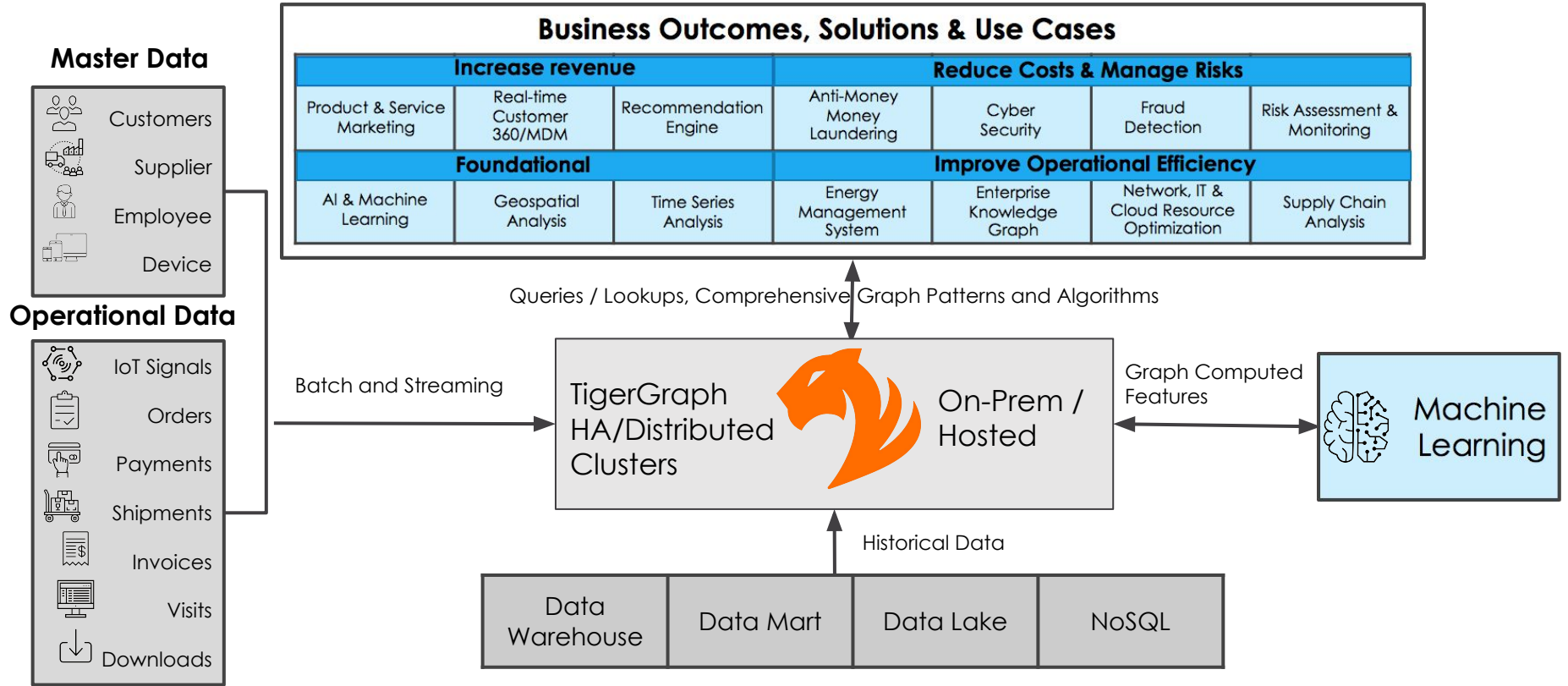
Deep HW Integration accelerating compute intensive graph algorithms by up to **20X** !



organized by TigerGraph | GRAPHAISUMMIT.COM | #GRAPHAISUMMIT

More to come ...

# How? - Strong Foundation for Business Outcomes



# New Capabilities to Expand Adoption

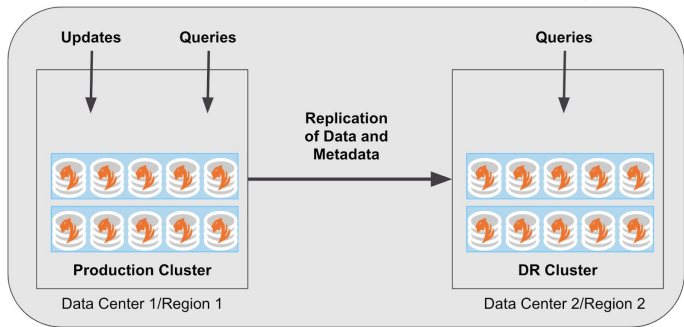


# Announcing TigerGraph Enterprise 3.2!

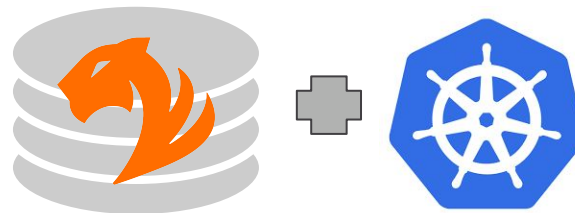
- Released on: 9/30/2021
- 7 months of hard work since 3.1
- 40+ New Features / Capabilities
- 400,000+ lines of code added / modified

# 3.2 Enterprise-grade Capability Highlights

## Cross-Region Replication



## Full Kubernetes Support



## Query Workload Management



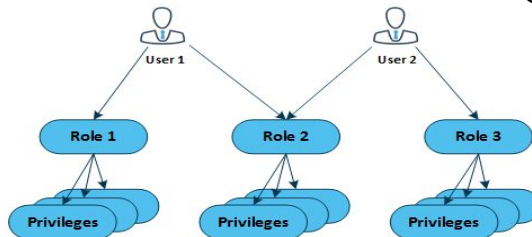
Fast, Small OLTP (4 CPU)

Big OLAP (8 CPU)

Fast, Med OLTP (8 CPU)



## Role Based Access Control





## 3.2 Query Language Capability Highlights

- **Running and Installing Queries**
  - Query argument flexibility: specify only what you care about
  - Query installation faster and more efficient: up to 3x - 10x improvement
- **Enhanced GSQL Capabilities**
  - Expanded library of built-in functions: 29 new string / math functions
  - Relaxed variable declaration rules: declare anywhere before you use
  - Dynamic subquery result: allow anonymous tuples in response
  - Function overloading: support object-oriented concepts

# 3.2 Developer Tool Capability Highlights

**Locate vertices in result**

```
CREATE QUERY ic_6(VERTEX<Person> personId, STRING tagName) FOR GRAPH Idbc_snb syntax v2 {
  TYPEDEF tuple<STRING tagName, INT postCount> tagStats;

  SetAccum<VERTEX<Post>> @@postAll;
  SumAccum<INT> @postCount;
  HeapAccum<tagStats>(10, postCount DESC, tagName ASC) @@tagStatsTop;

  vPerson = { personId };
  aggPersonPostTag =
  SELECT t3
  FROM vPerson:s
  -((Person_KNOWS_Pe
  -(-Post_HAS_CREATO
  -(Post_HAS_TAG_Tag
  WHERE s != t1
  ACCUM CASE WHEN t3.nam

  vPost = { @@postAll };
  vTag =
```

Search content  
Allen

Search vertex id  Search vertex label

T\_Company

flight\_to flight\_to

# 3.2 Scalability: New Record in LDBC Benchmark



## INTRODUCTION

Home / Introduction

The Linked Data Benchmark Council (LDBC) is processing technologies. LDBC consists of me

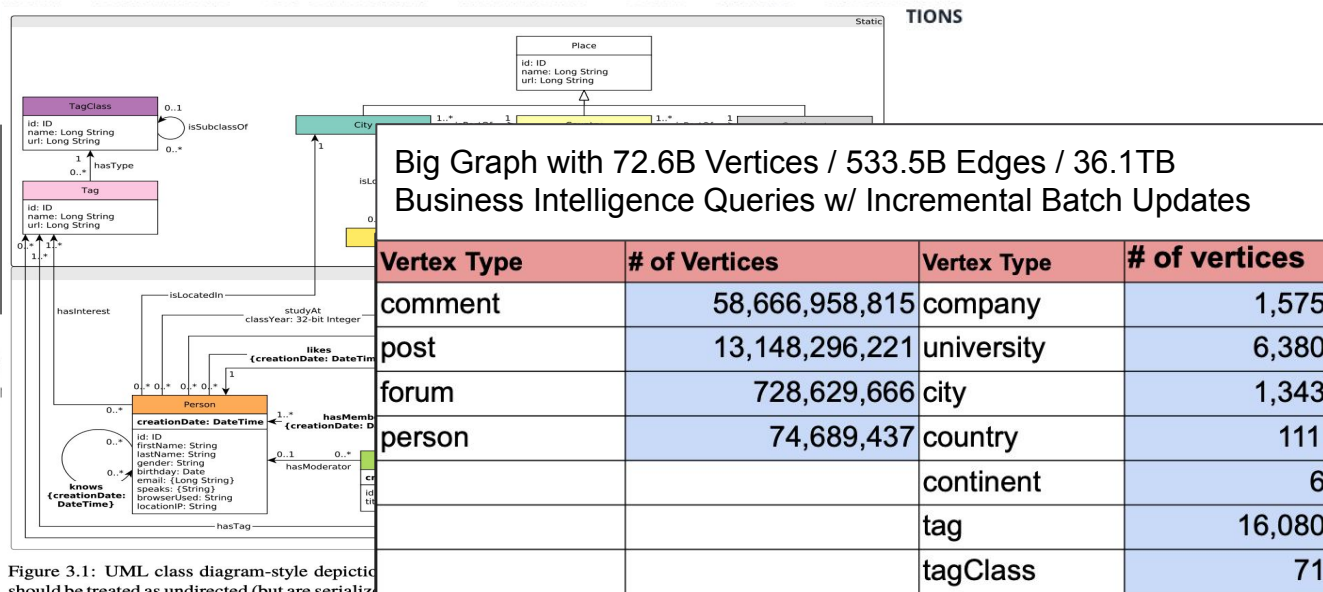


Figure 3.1: UML class diagram-style depiction of the LDBC benchmark graph. The graph should be treated as undirected (but are serialized as directed). The multiplicity of the edge has changed between version 0.3.x (where it was exactly 1) and version 0.4.x (where it is 0..1).

TigerGraph: *the first and only vendor* completed LDBC SNB-SF30K BI at 36TB!



organized by TigerGraph | GRAPHASUMMIT.COM | #GRAPHASUMMIT

# Innovation to Accelerate Adoption



# A Glimpse into Work-in-Progress Innovations

- What if we can get 100,000+ application / service developers to adopt graph easily ?
- What if we can get business users to get deep graph insights without the need to code ?
- What if we can dramatically reduce the time and effort to develop a complete e2e graph solution ?

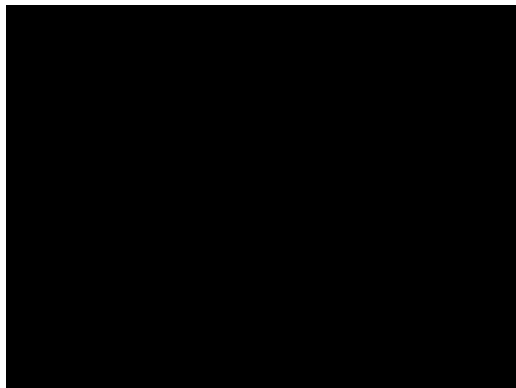
# Demo: GraphQL Query API on TigerGraph



For Developers:



GraphQL



Renchu Song

Sr. Dev Manager, Tools and Applications

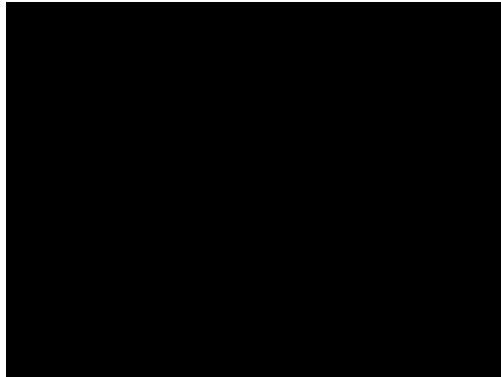
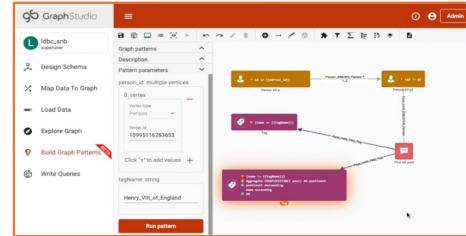
TigerGraph

**100,000+** developers can use familiar and state-of-art GraphQL Data API language to query data directly in TigerGraph !

# Demo: No-Code Visual Query Builder



For Domain Experts:



Renchu Song

Sr. Dev Manager, Tools and Applications

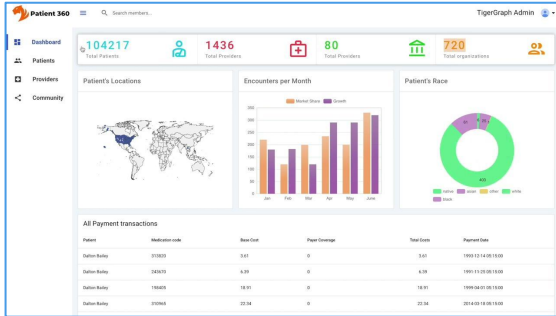
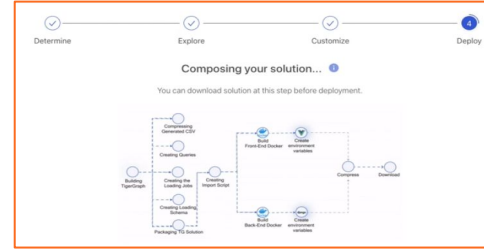
TigerGraph

Domain Experts / Data Analysts / Data Scientists ... can **visually describe their queries** without the need to learn and code GSQL!

# Demo: Graph Solutions and Solution Accelerator



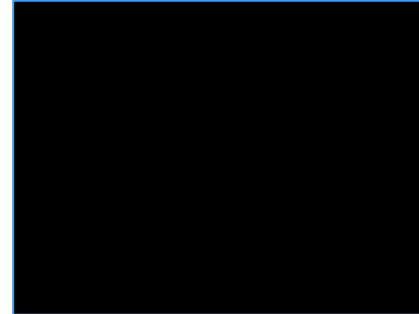
For Business Leaders on  
e2e Development:



Jon Herke

Sr. Dev Manager, Dev Relations

TigerGraph



Renchu Song

Sr. Dev Manager, Tools and Applications

TigerGraph

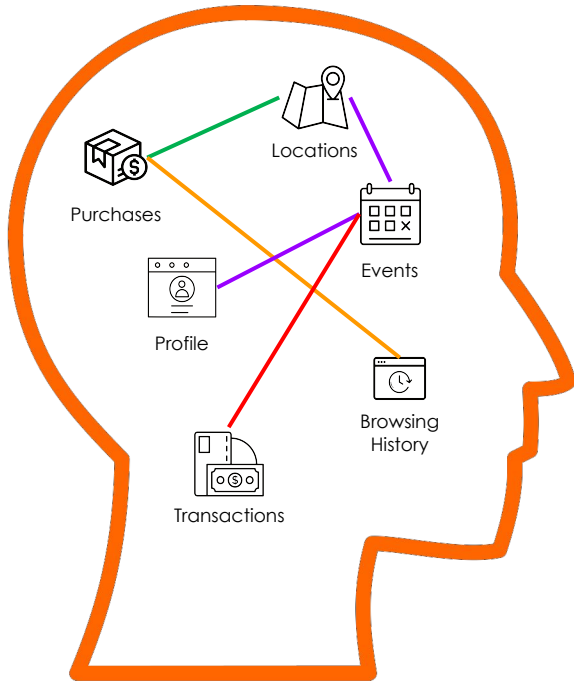
Accelerate end-to-end Graph Solution / App Building and Deployment:  
**3X+ Reduction** in Development Cost, and **4X+ Speedup** for Time-to-value !



# Graph + ML Advancement



# Why Graph + ML?



- Natural Merging of Data + Learning: Relationships are Fundamental
- Meaningful Patterns
- Enhances Conventional ML/AI
- Explainable Results

# TigerGraph ML Today

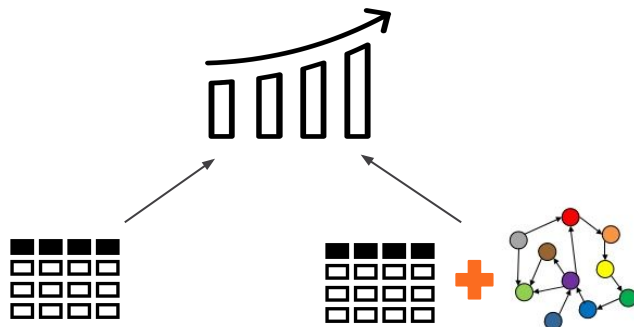
## In-Database Graph Algorithms

- 40+ algorithms for similarity, clustering, best paths, community
- No export needed. Live, updatable data
- Open-source, customizable
- Scalable, Ultra-fast MPP graph engine
- Toolkit, building blocks for problem-solving



## Graph Features Enriching ML Quality

- Graph enriches ML training data: quality in  $\Rightarrow$  quality out
- Use graph algorithms, pattern-matching queries, or graph embedding



Solving Enterprise-Scale Business Problems

# Today: Industry-leading Business Value

## Healthcare:

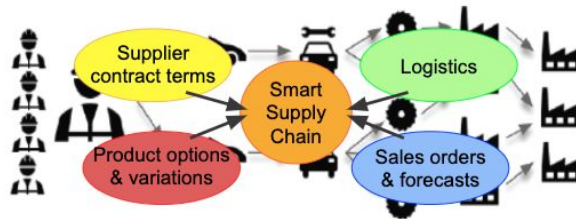
Real-time recommendations



- 1.3TB graph brain
- Real-time care recommendations
- Improving healthcare, lowering cost

## Industrial Supply Chain:

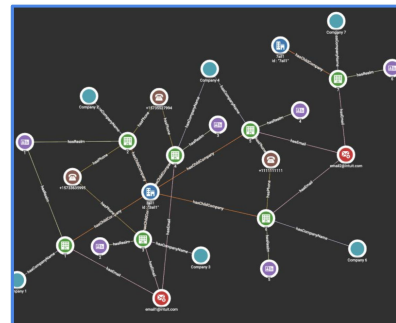
Analytics for decisions



- Analytics: weeks → minutes
- Reveal opportunities, optimize tactical & strategic decisions
- Saving \$100M+/yr

## Financial Services:

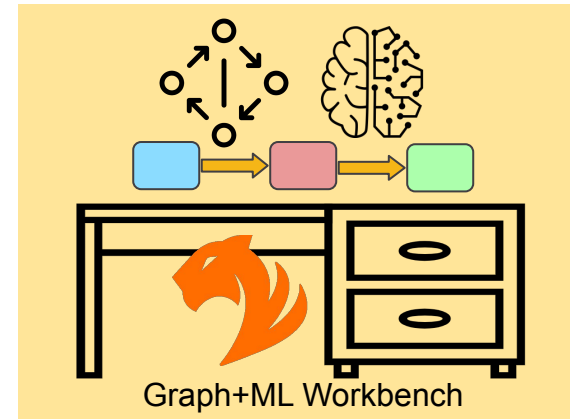
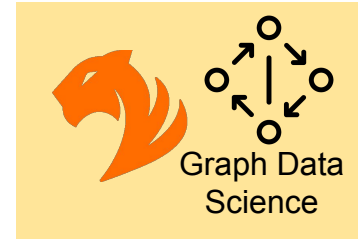
Real-time fraud detection



- Integrates multiple tools
- "Magical" real-time visual results for investigators
- Scalable for growth

# Looking Forward: Enterprise Graph ML

- In-Database Graph Data Science Library
- In-Database Machine Learning
- Graph+ML Workbench
- **TigerGraph's Scale & Performance**



# TigerGraph In-Database *Graph Data Science Library*

Signals our commitment to serving the needs of data scientists

- More algorithms (15 released this week)
  - Graph Embedding
  - Link prediction
  - Similarity
  - Centrality
- More than just algorithms

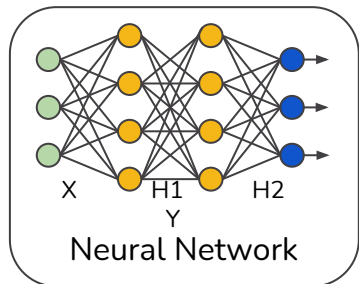
## In-Database

- No export needed
- Live, updatable data
- Scalable, Ultra-fast engine
- GSQL query language

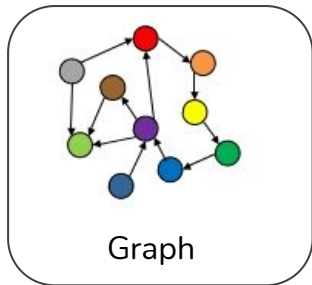
## For Data Scientists

- easier and faster to run
- include ML, such as graph embeddings
- will integrate with feature & model management
- will integrate with Graph+ML Workbench

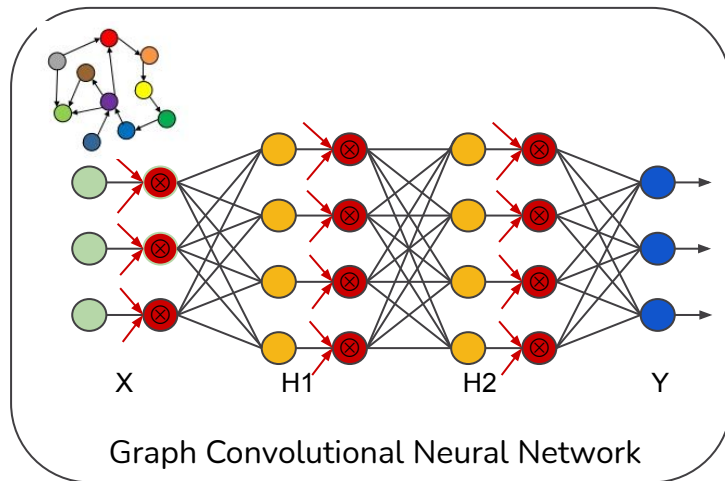
# Graph Neural Networks



Powerful Machine Learning to  
Predict and Classify



Insight from Connected Data

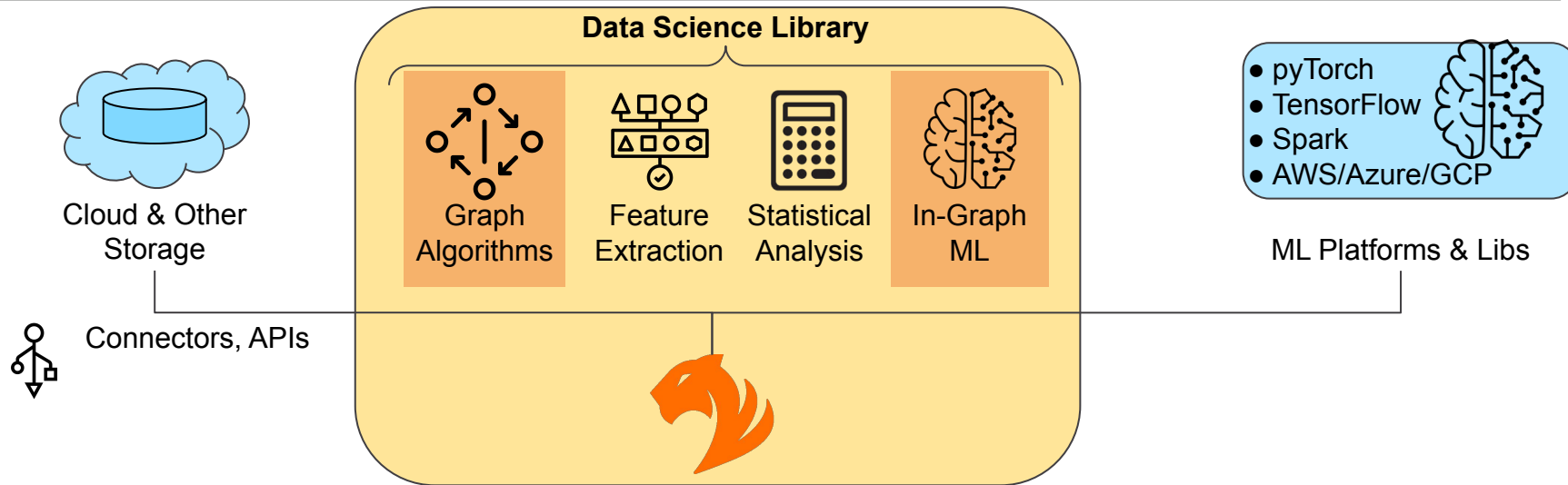


- Combines the added insight from connected data with the modeling power of neural networks
- Uses the graph during training; in-database training is the ideal.

# Graph + ML Workbench

- The added power of graph
- The same convenience of conventional MLOps

Graph ML Workbench (Notebook, APIs, GUI)





# Summary



# Key Takeaways

Graph technology is **mature, scalable and available** for you to adopt ...

- Graph is **beautiful** - the most natural way to model all data
- Graph is **valuable** - backed by many success stories from our customers
- Graph is **real** - world's leading scalable graph technology
- Graph is **easy** - delightful developer and business user experience
- Graph is **quick** - rapid development by turn-key solutions and toolkits
- Graph is **peaceful** - operation delegated to cloud
- Graph is **intelligent** - AI/ML made easy by in-db graph data science libraries

**Any excuses for not to graph now ?**



# Question and Answer

- Try [TigerGraph Cloud \( tgcloud.io \)](https://tgcloud.io) - Free to Start
- Download [TigerGraph's Developer Edition](#)
- Take a [Test Drive - Online Demo](#)
- Get TigerGraph [Certification](#)
- Join the [Community](#)



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