



Category Theory for Semantic Data Interoperability

Exchange and Consolidate Data for Agile PLM at Scale



Data Integration Challenges

<>requirement>> Climb: One-engine-inoperative	Requirement
FEDERAL AVIATION ADMINISTRATION (FAA) Title 14, Chapter 1, Subchapter C 25.121 ...(a) Takeoff; landing gear extended... the steady gradient of column... not less than 0.5 percent... for four-engine airplanes	

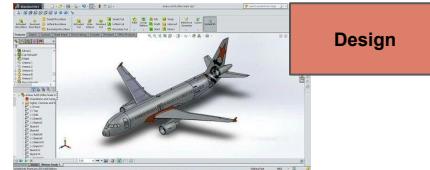
Data Integration Challenges

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Test Case	<<testcase>> Climb: One-engine-inoperative
	Perform simulation under conditions...

Data Integration Challenges

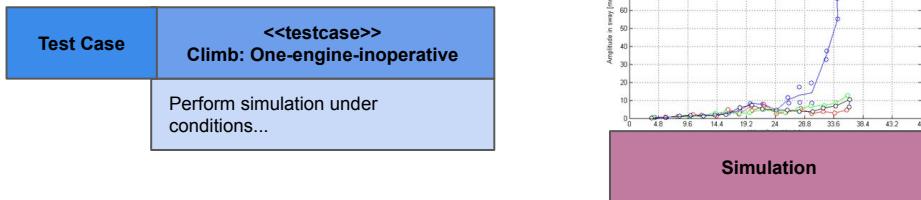
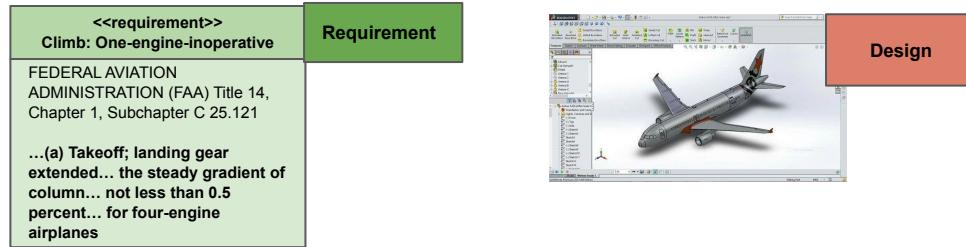
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Design

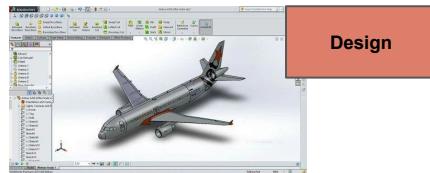
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Data Integration Challenges



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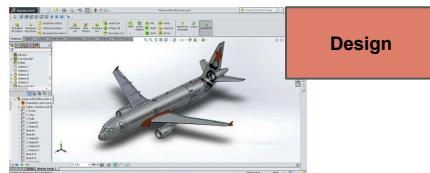
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Simulation

Data Integration Challenges

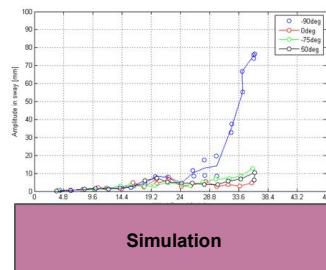
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Climb: One-engine-inoperative	
	Requirement
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... (a) Takeoff; landing gear extended... the steady gradient of column... not less than 0.5 percent... for four-engine airplanes	



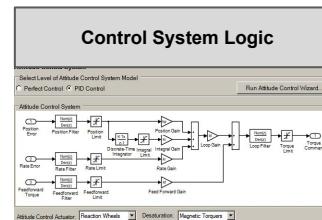
Design



Test Case	<<testcase>> Climb: One-engine-inoperative
Perform simulation under conditions...	

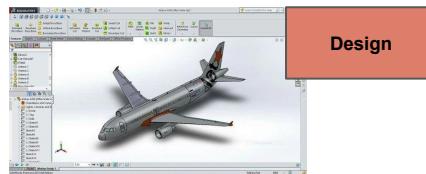


Simulation



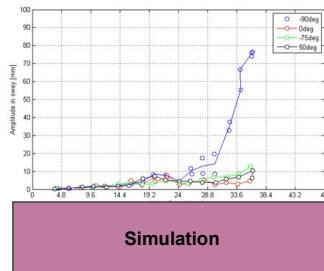
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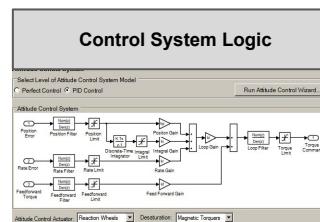


Design

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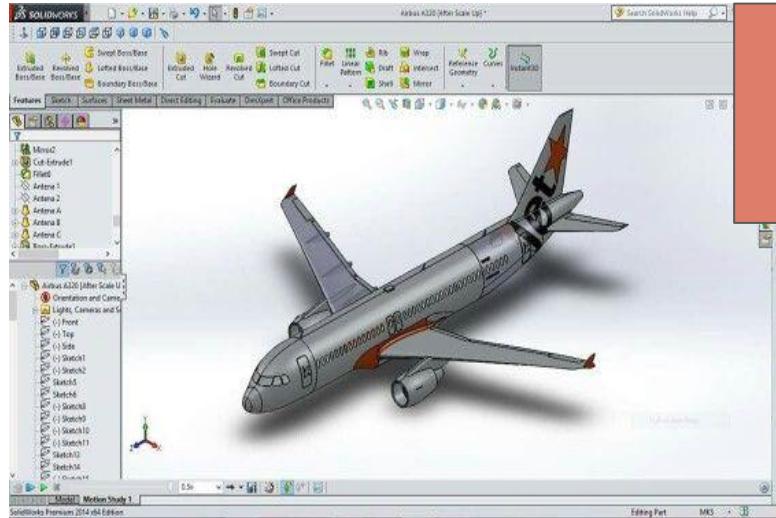


Simulation



Manufacturing Process Planning

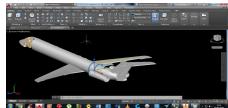
Data Integration Challenges



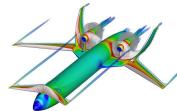
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Data Integration Challenges

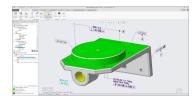
A AUTOCAD



I AUTODESK[®] INVENTOR[®]



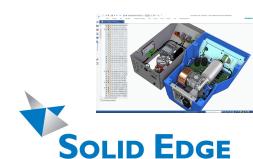
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NX

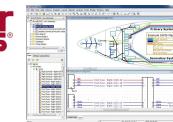


DS CATIA



SOLID EDGE

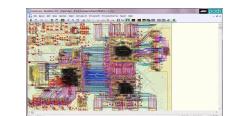
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DS SOLIDWORKS



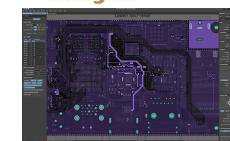
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personal automated design system



cadence[®]



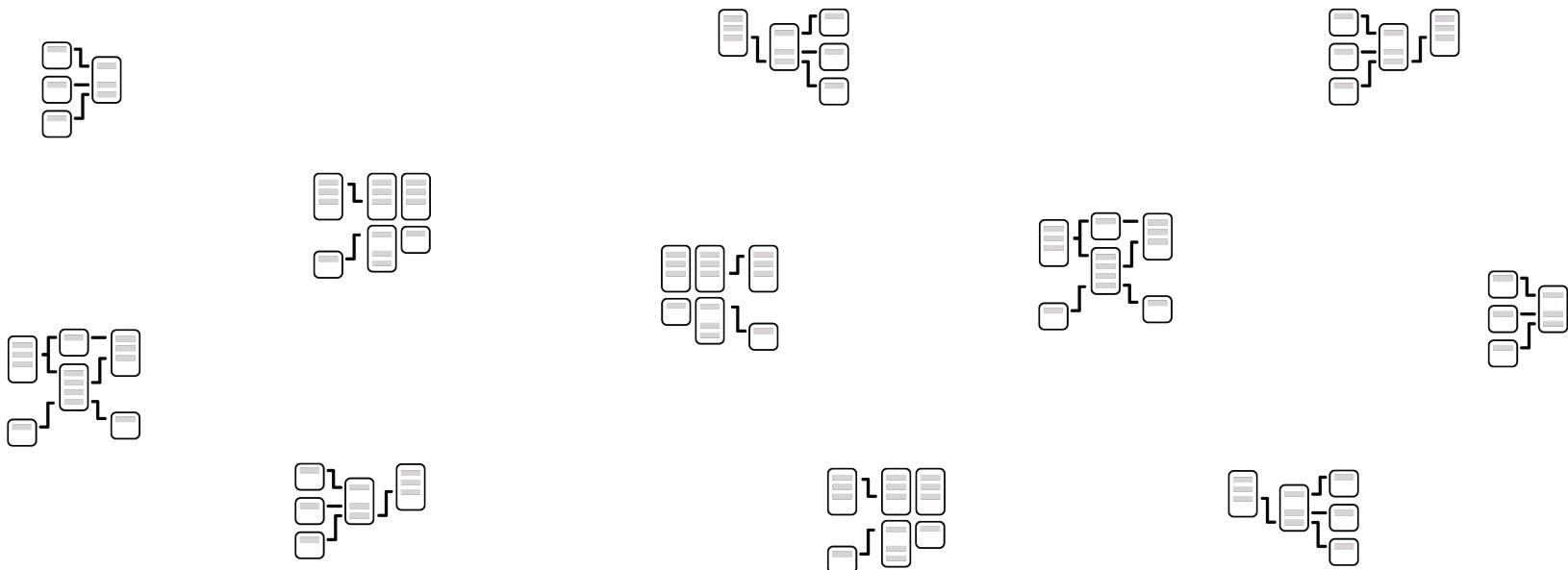
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Data Integration Challenges



Data Integration Challenges



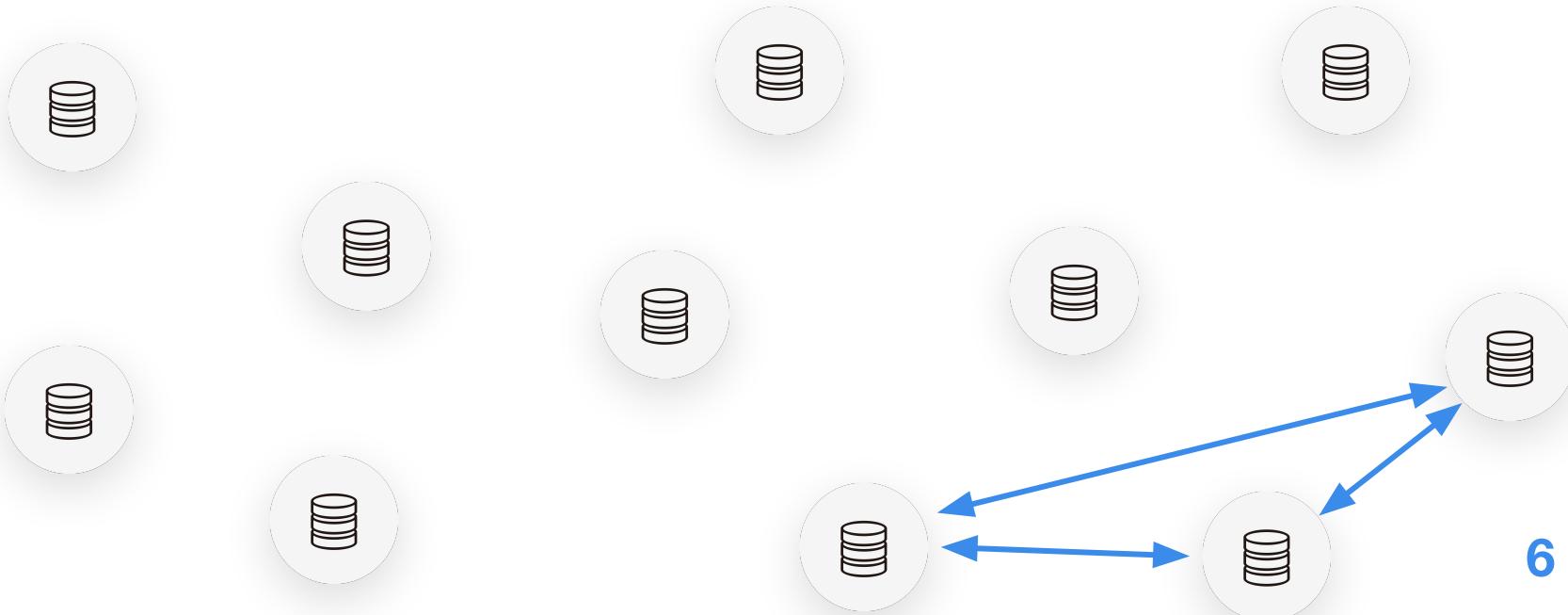
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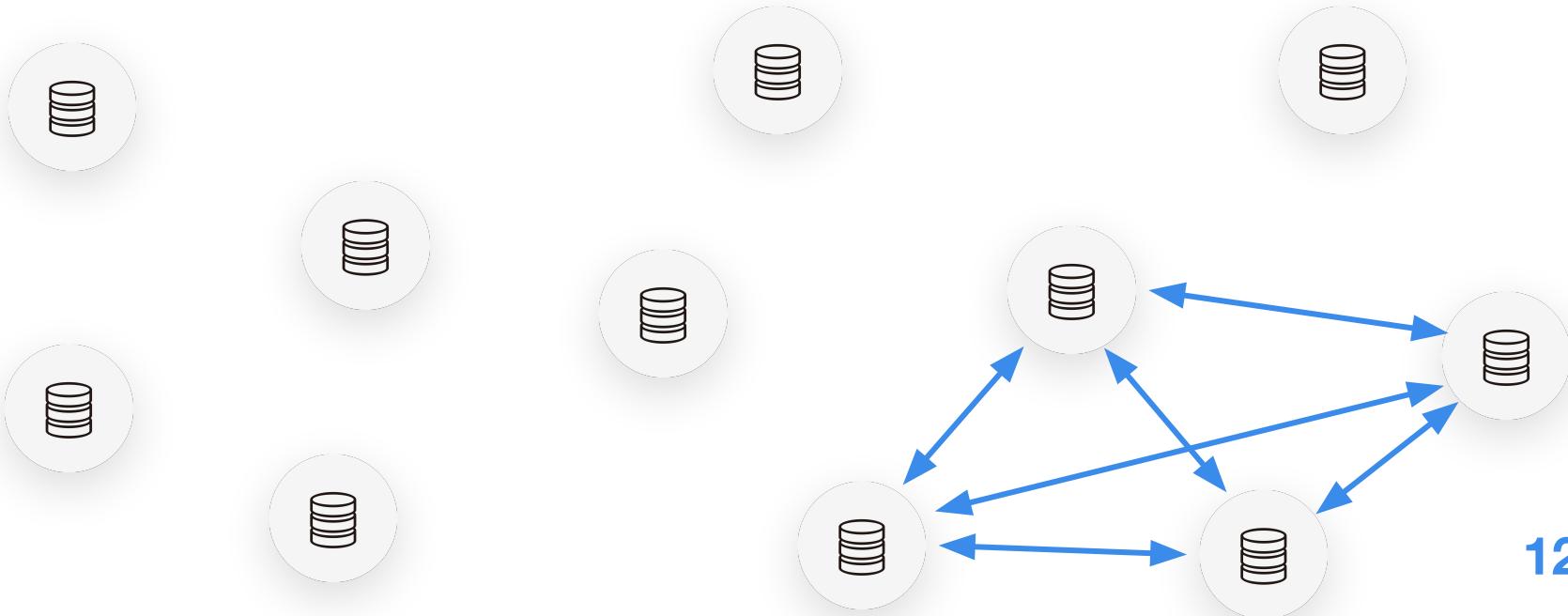
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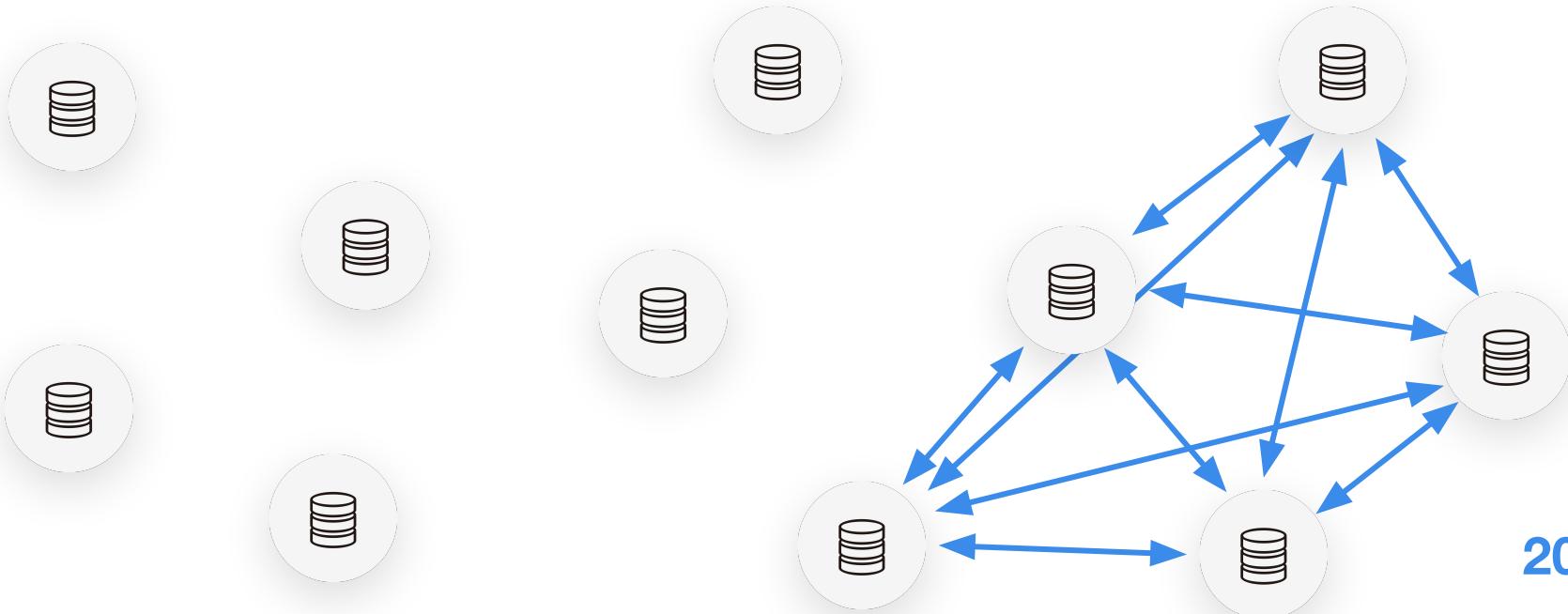
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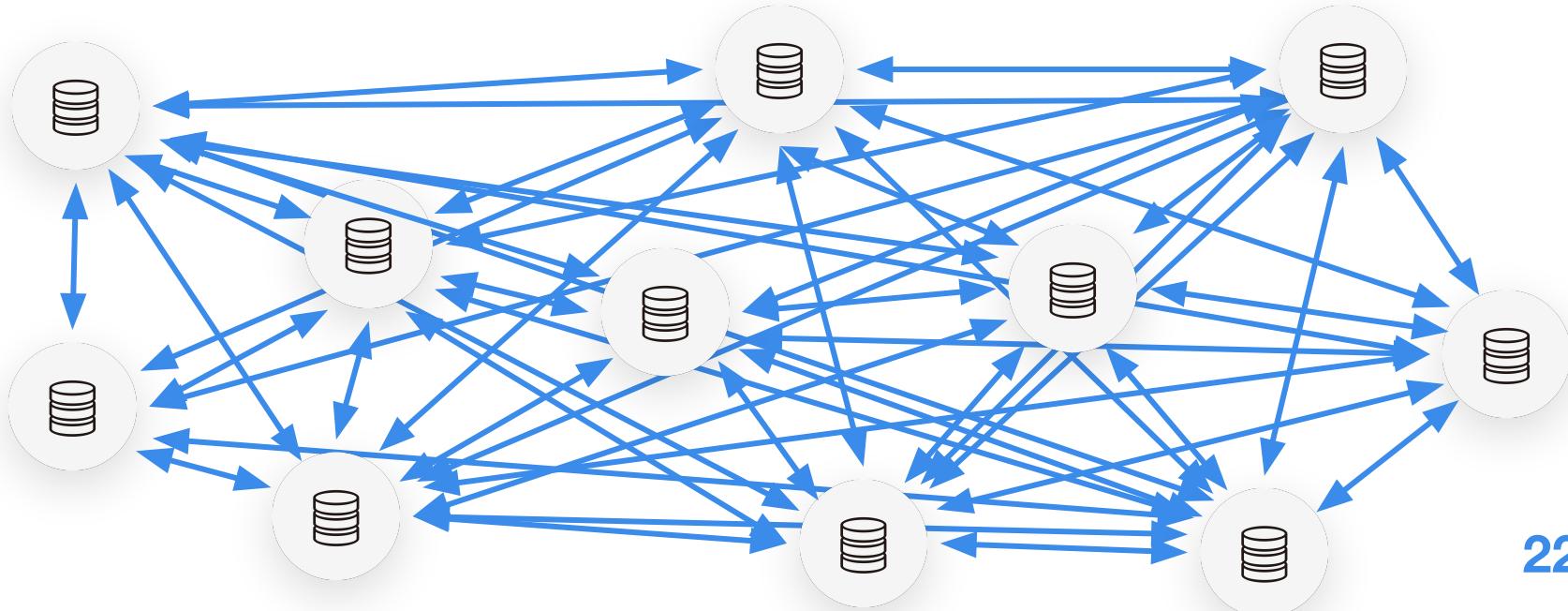
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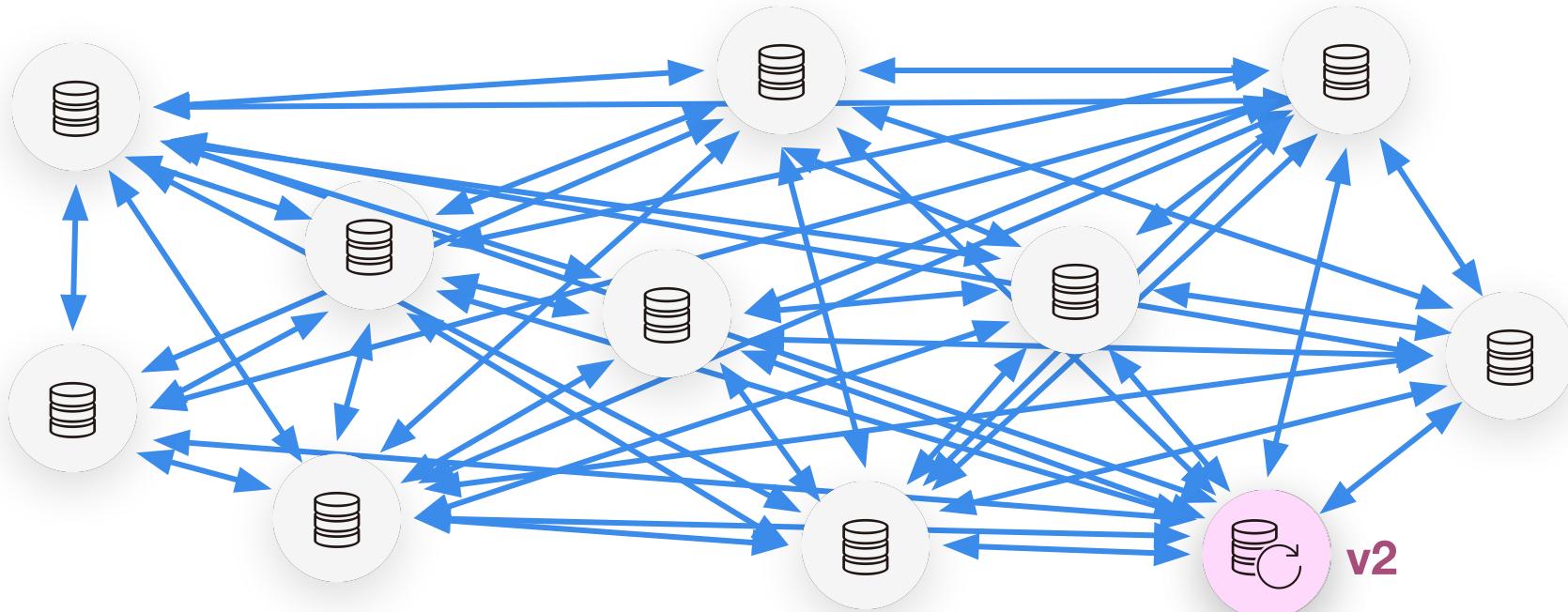
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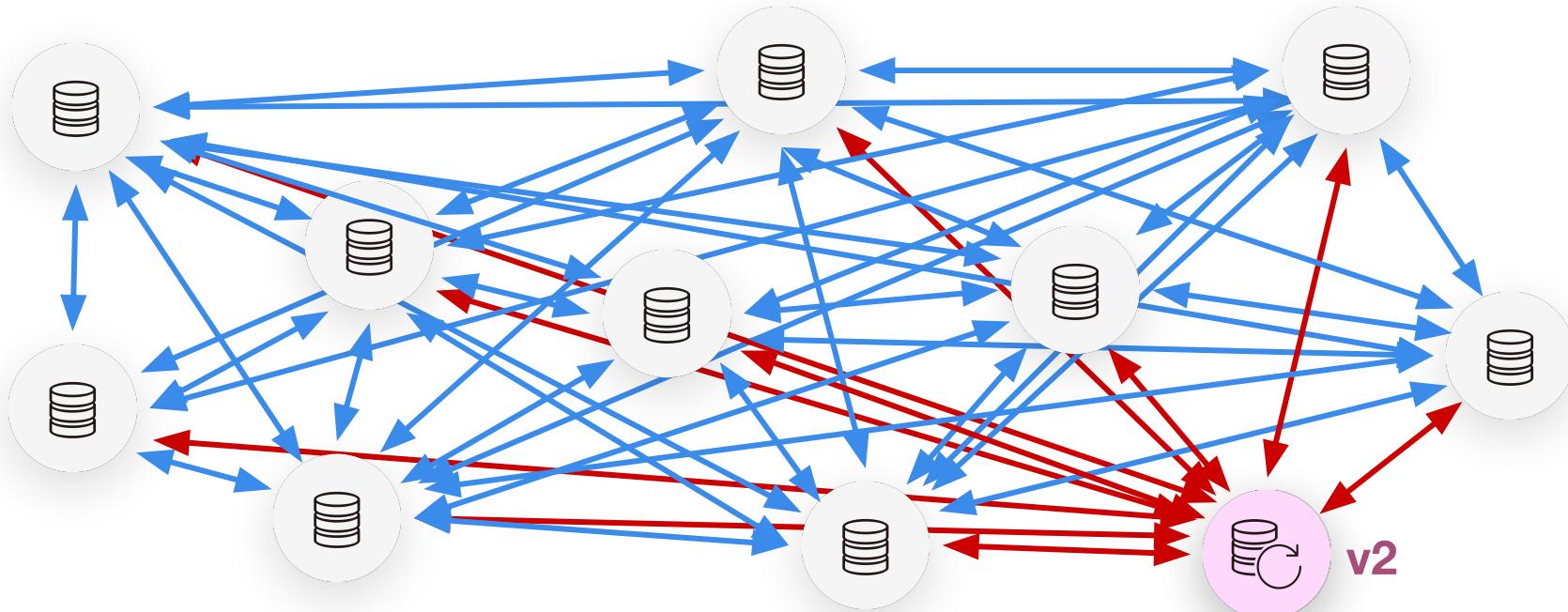
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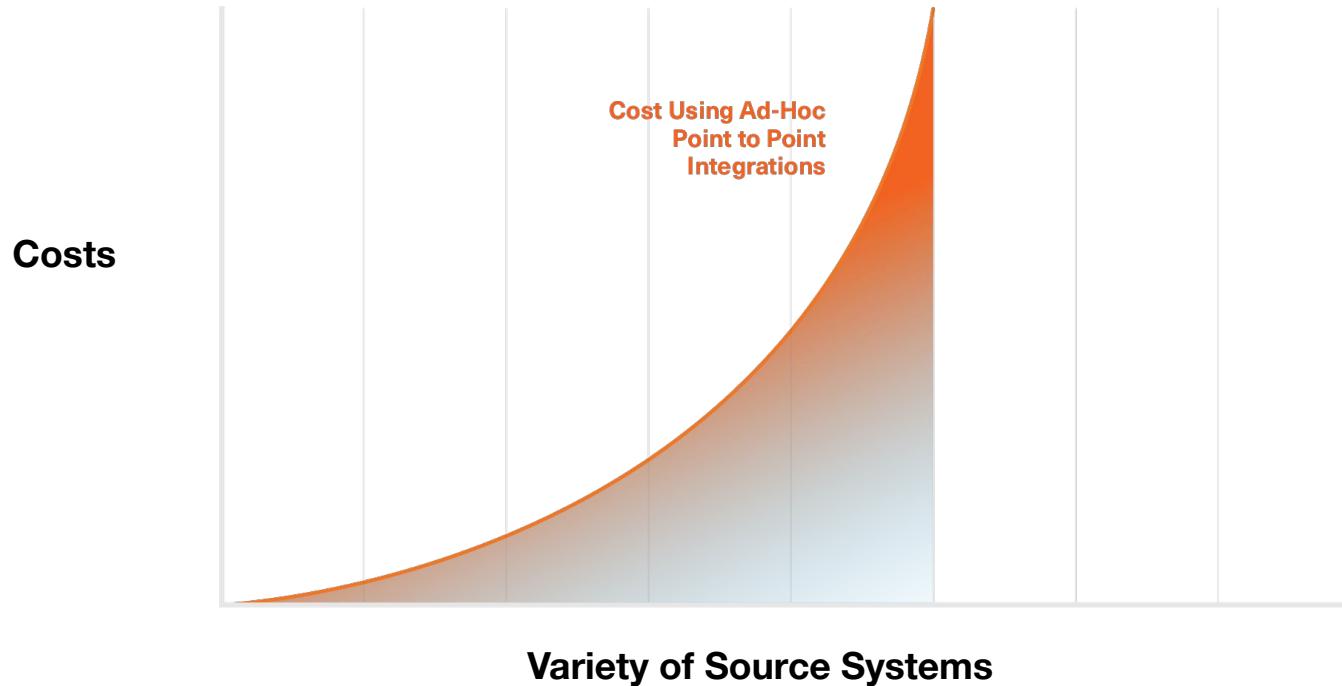
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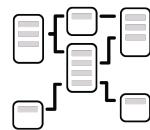
Data Integration Challenges

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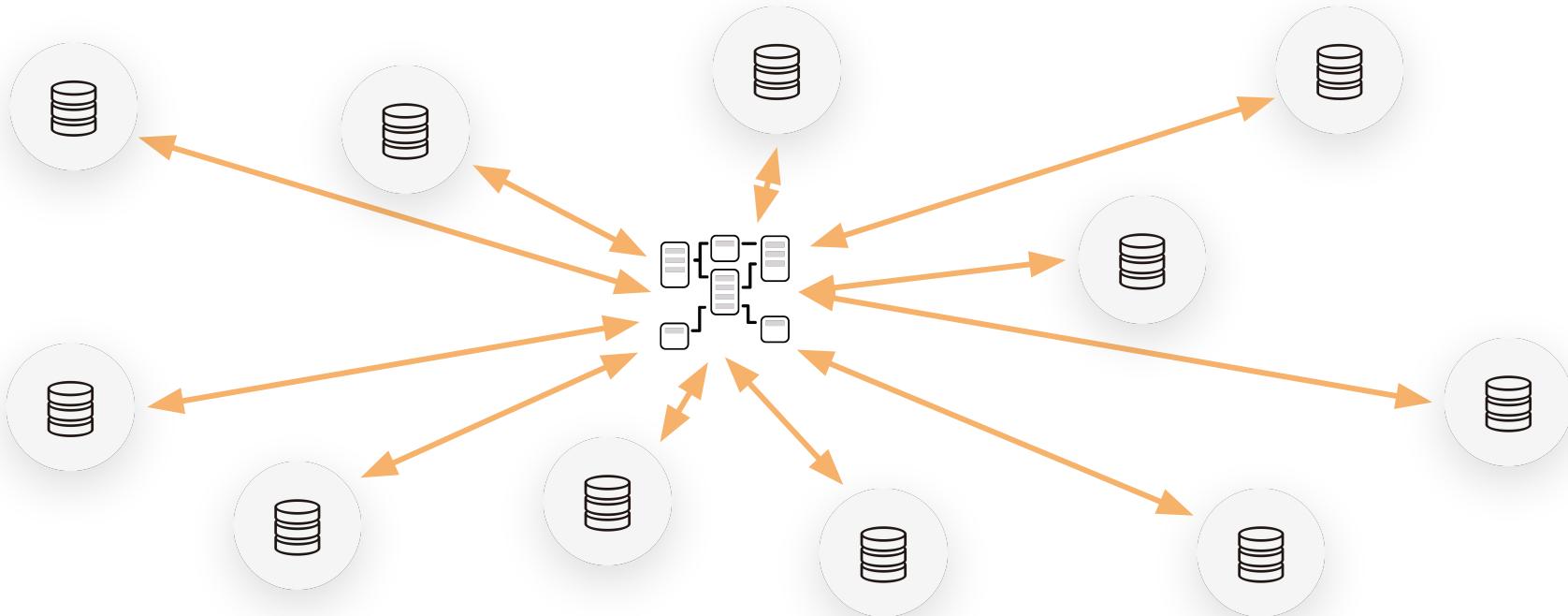
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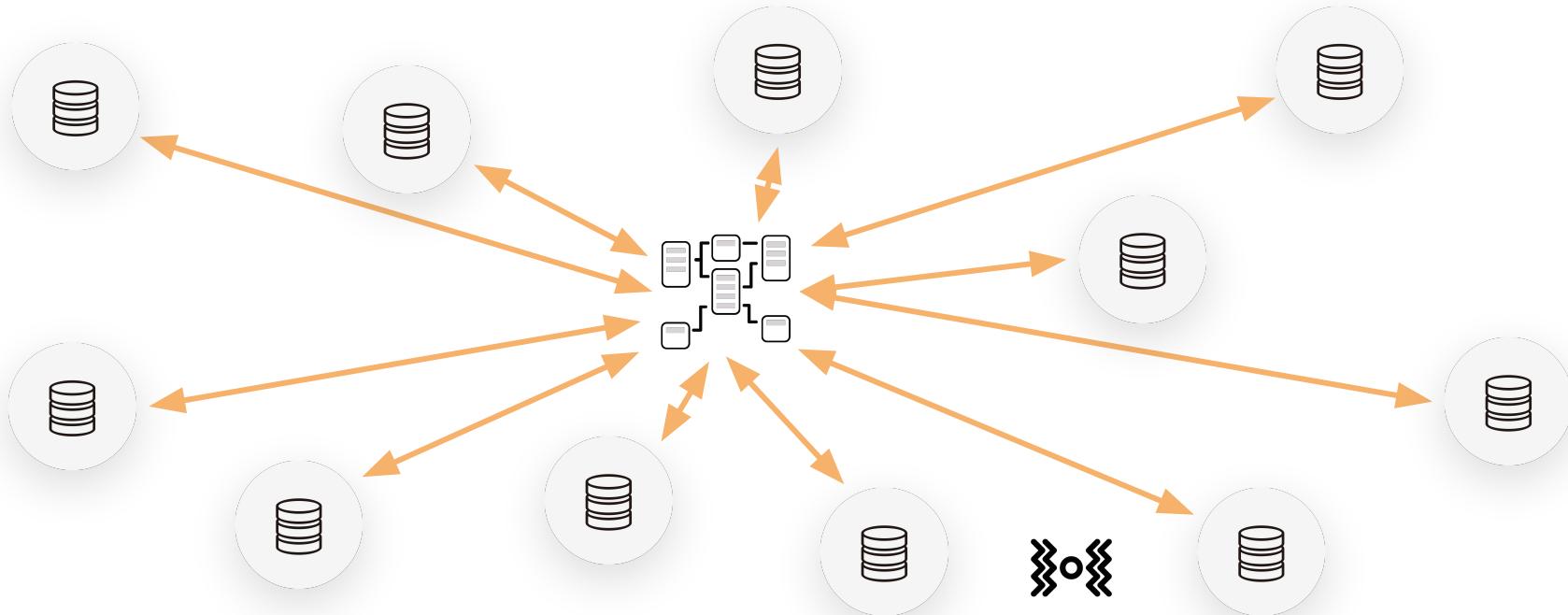
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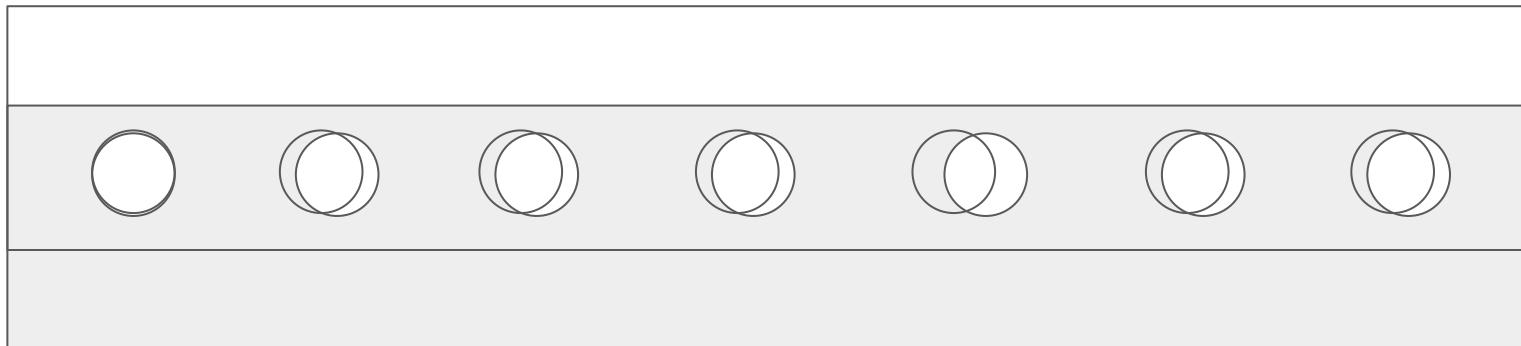
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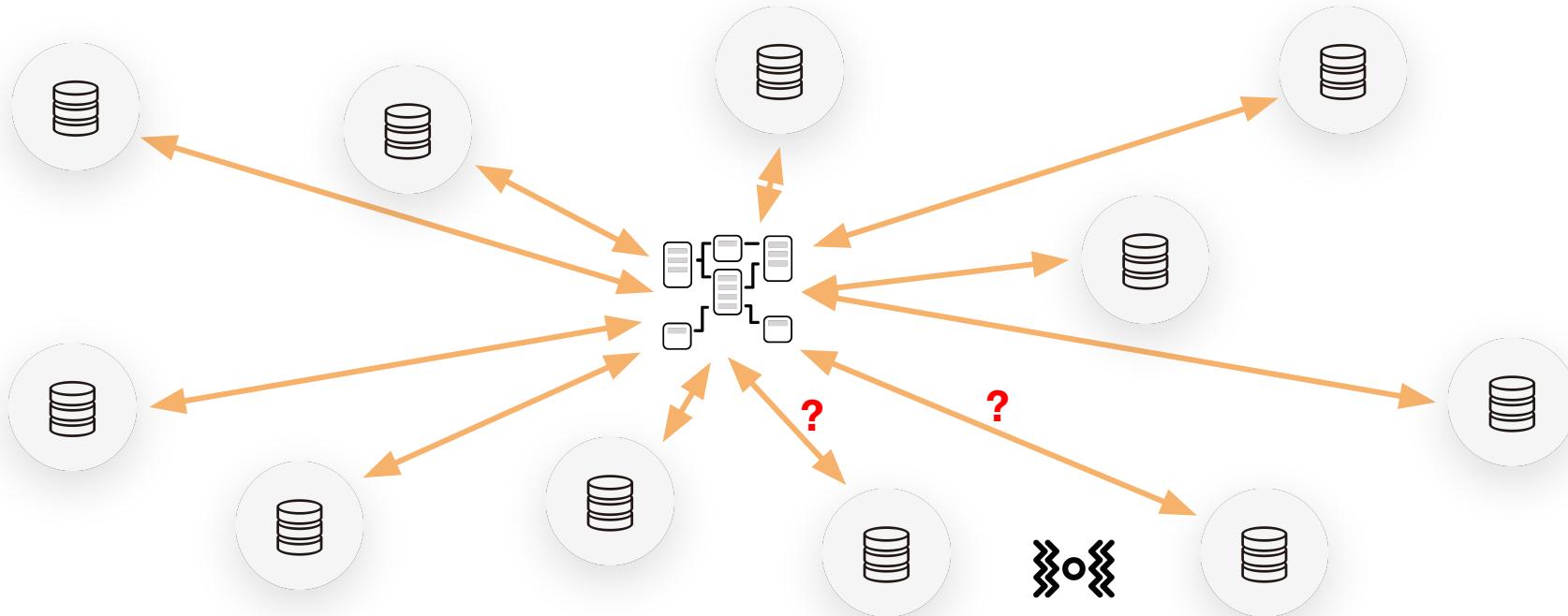
Data Integration Challenges



Data Integration Challenges

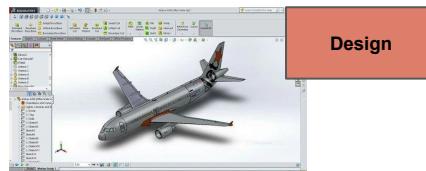


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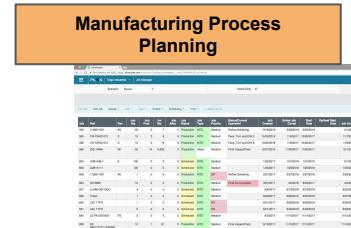


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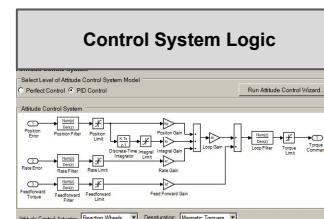
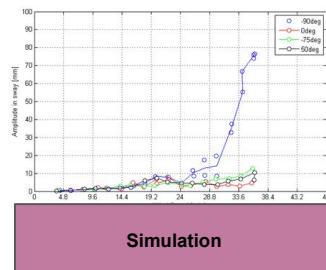
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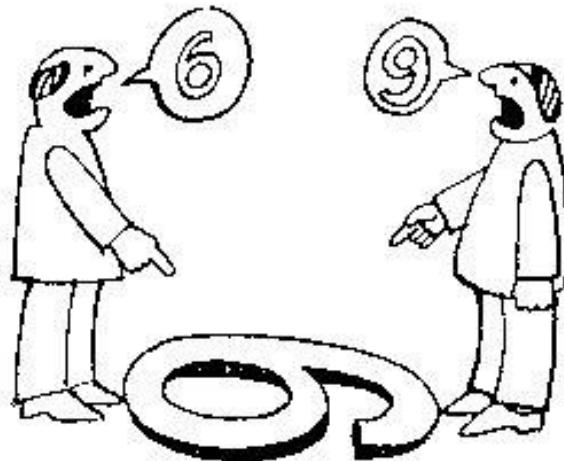
Design



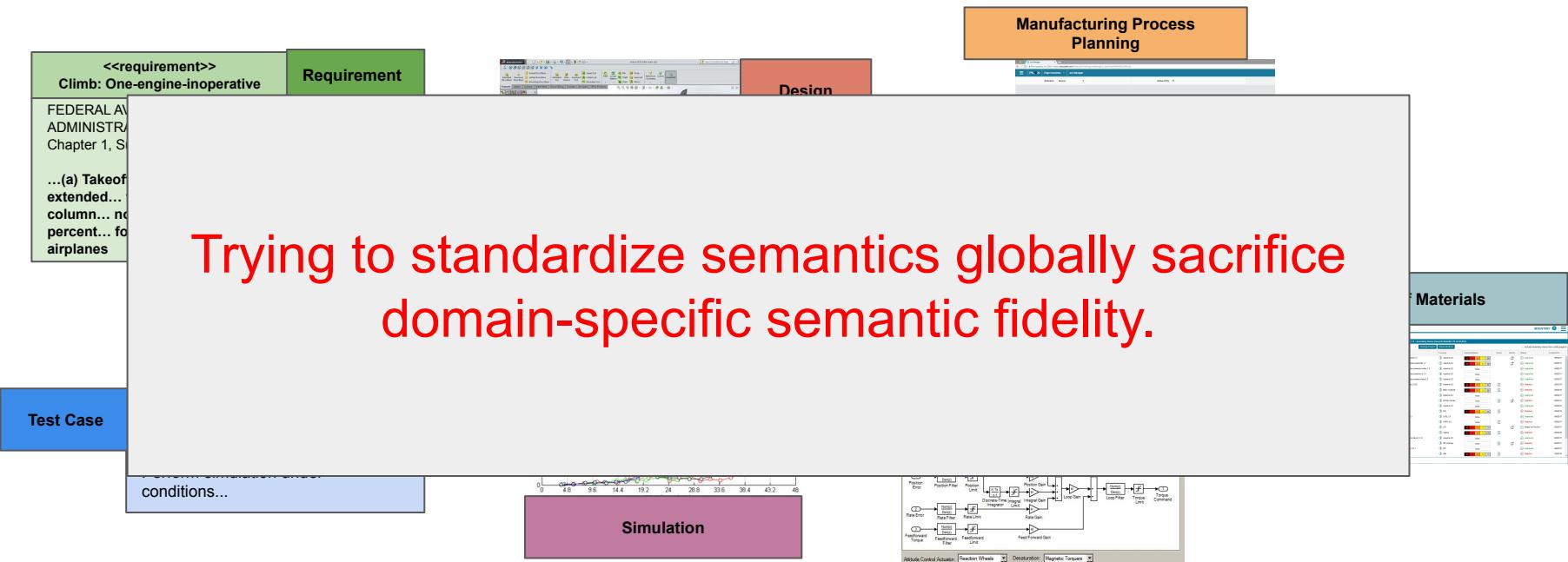
Test Case	<<testcase>> Climb: One-engine-inoperative
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Data Integration Challenges



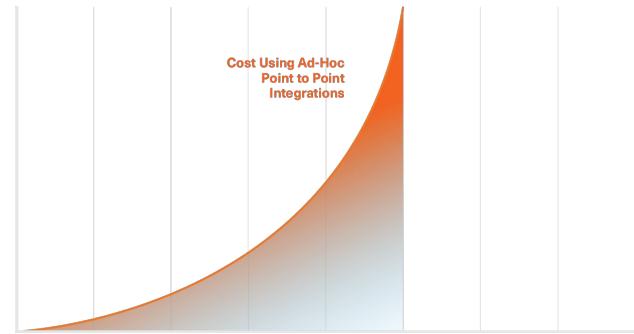
Data Integration Challenges



Data Integration Challenges

Sacrifice domain-specific semantic fidelity.

VS

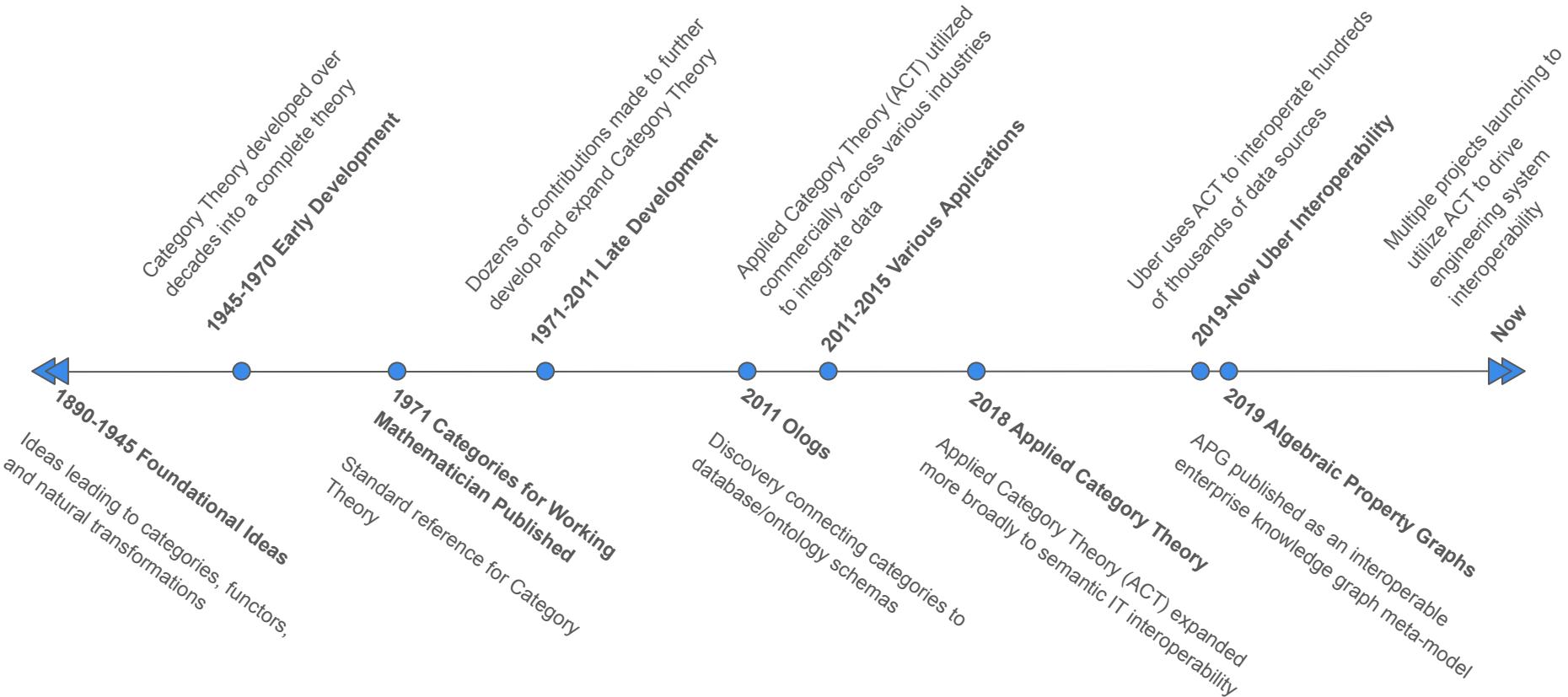




Semantic Data Interoperability

Enabled by Categorical Mathematics

Category Theory History



Category Theory History

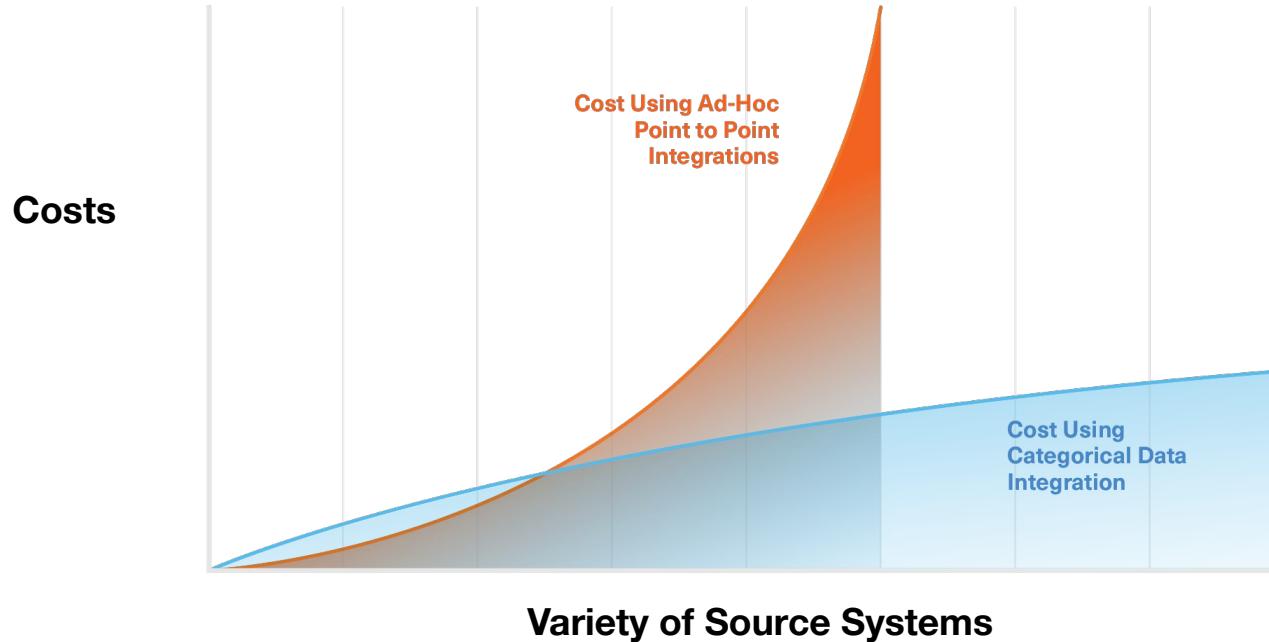


David Spivak
MIT



Ryan Wisnesky
MIT

Foundationally Better Cost Scaling



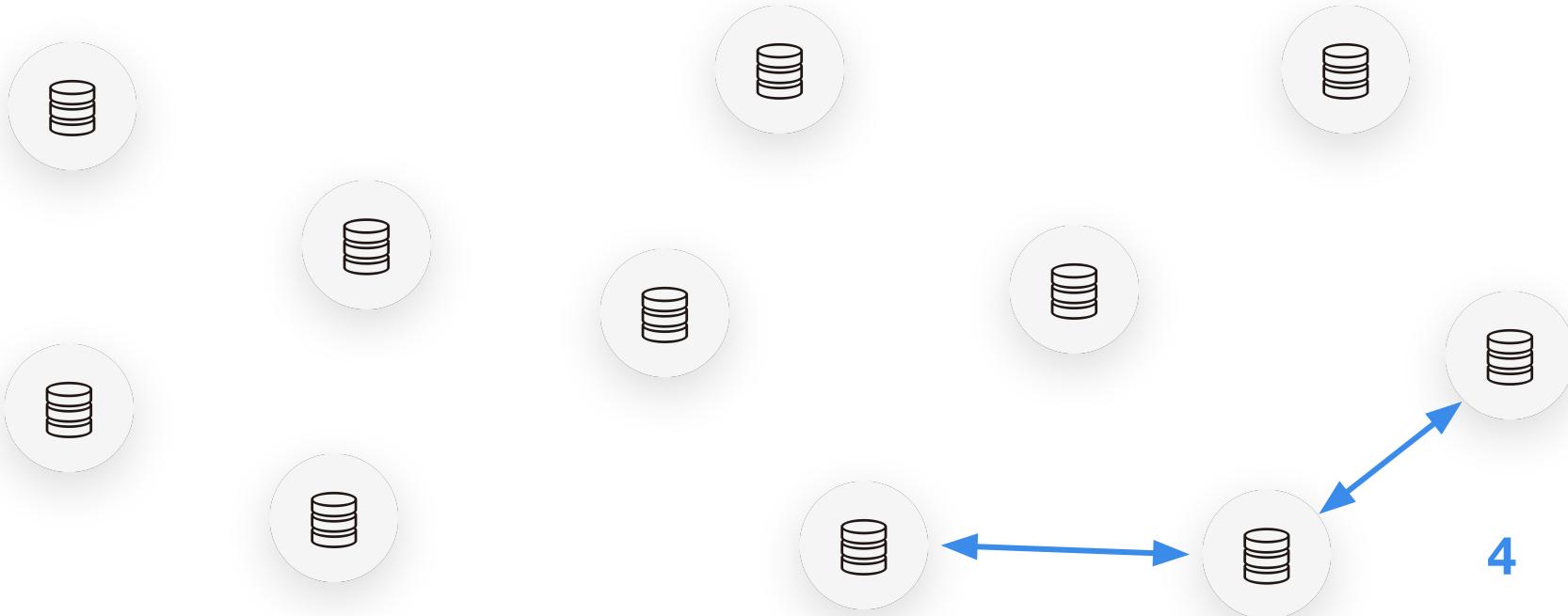
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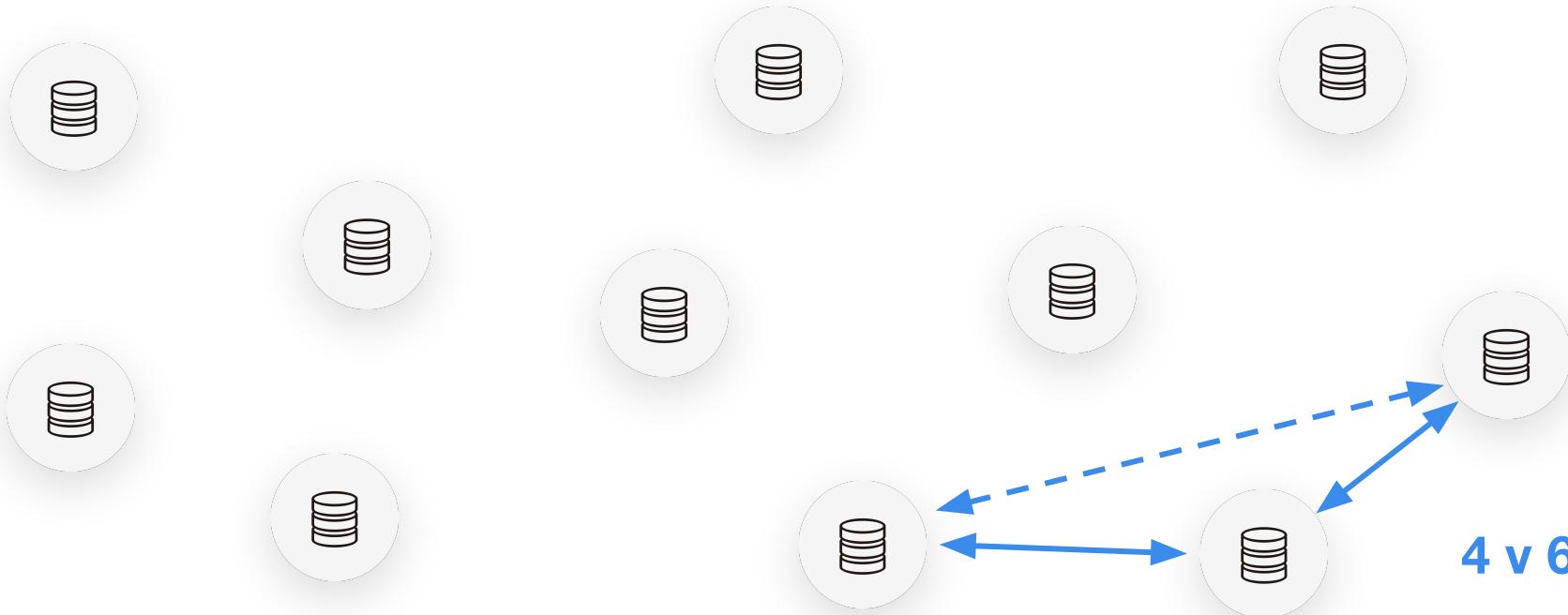
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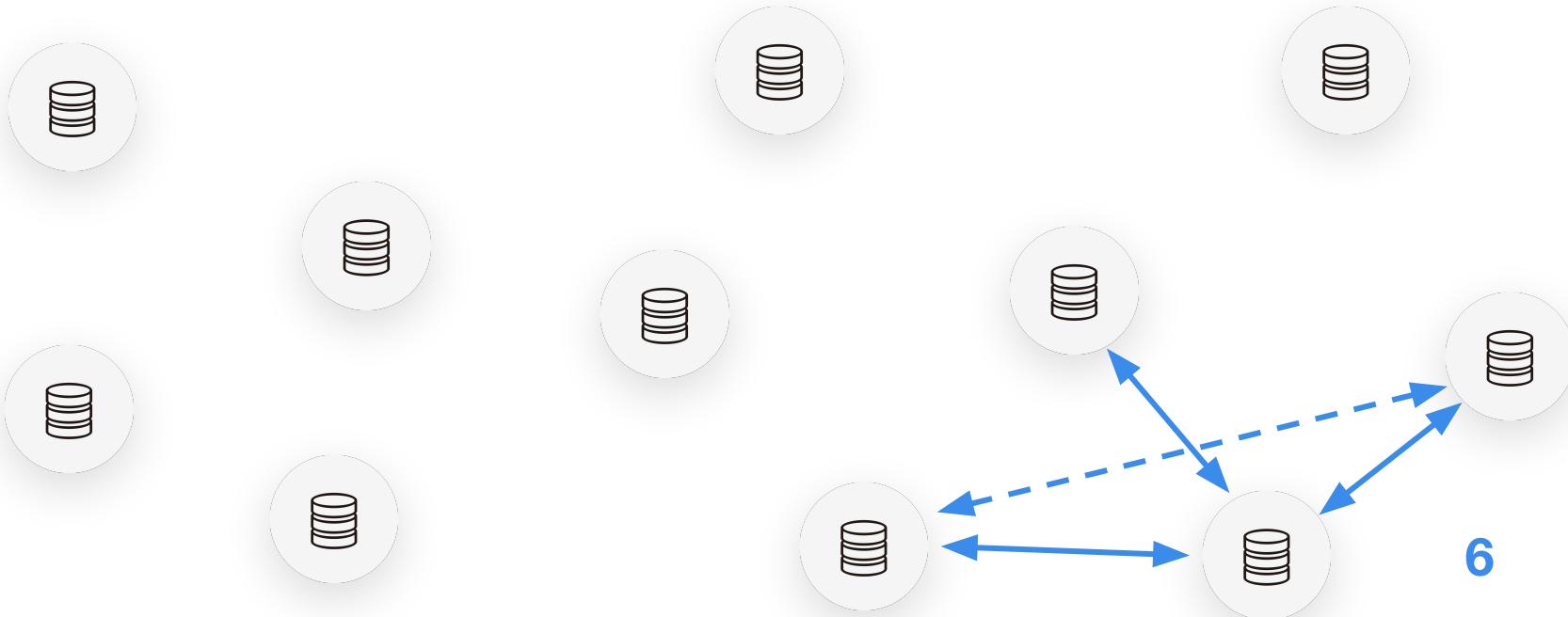
Foundationally Better Cost Scaling



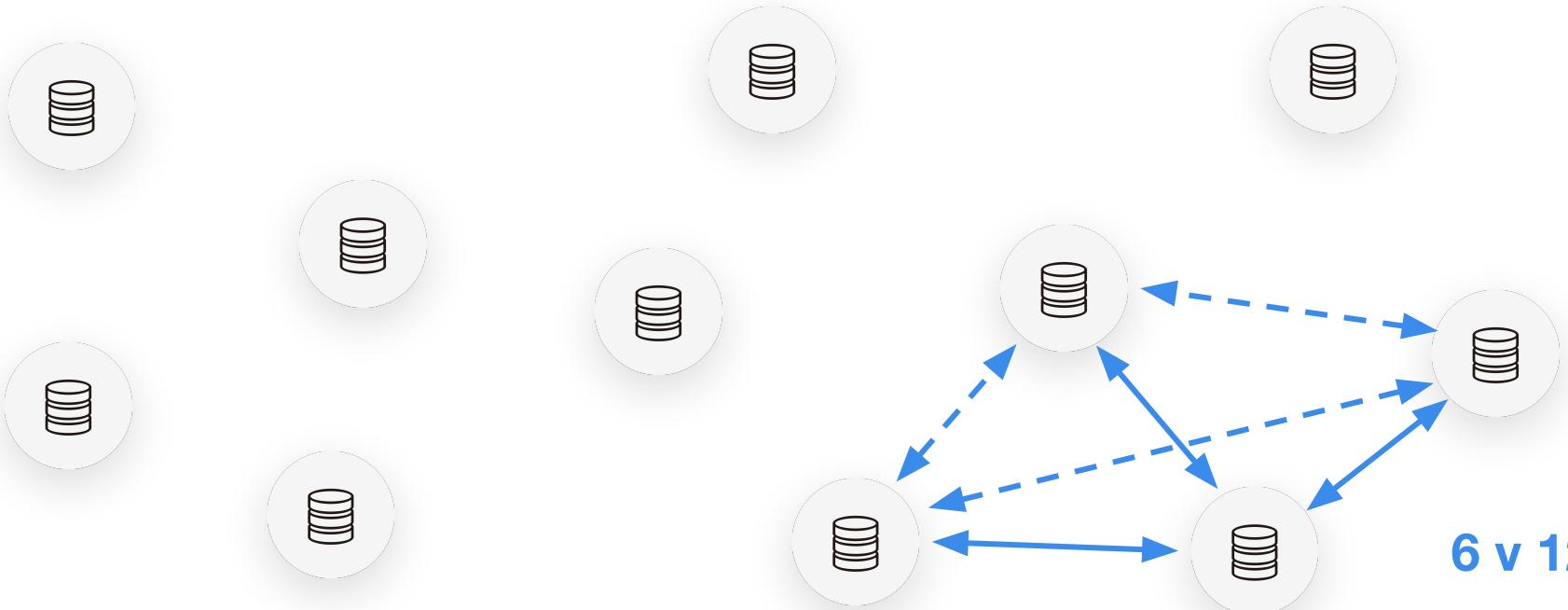
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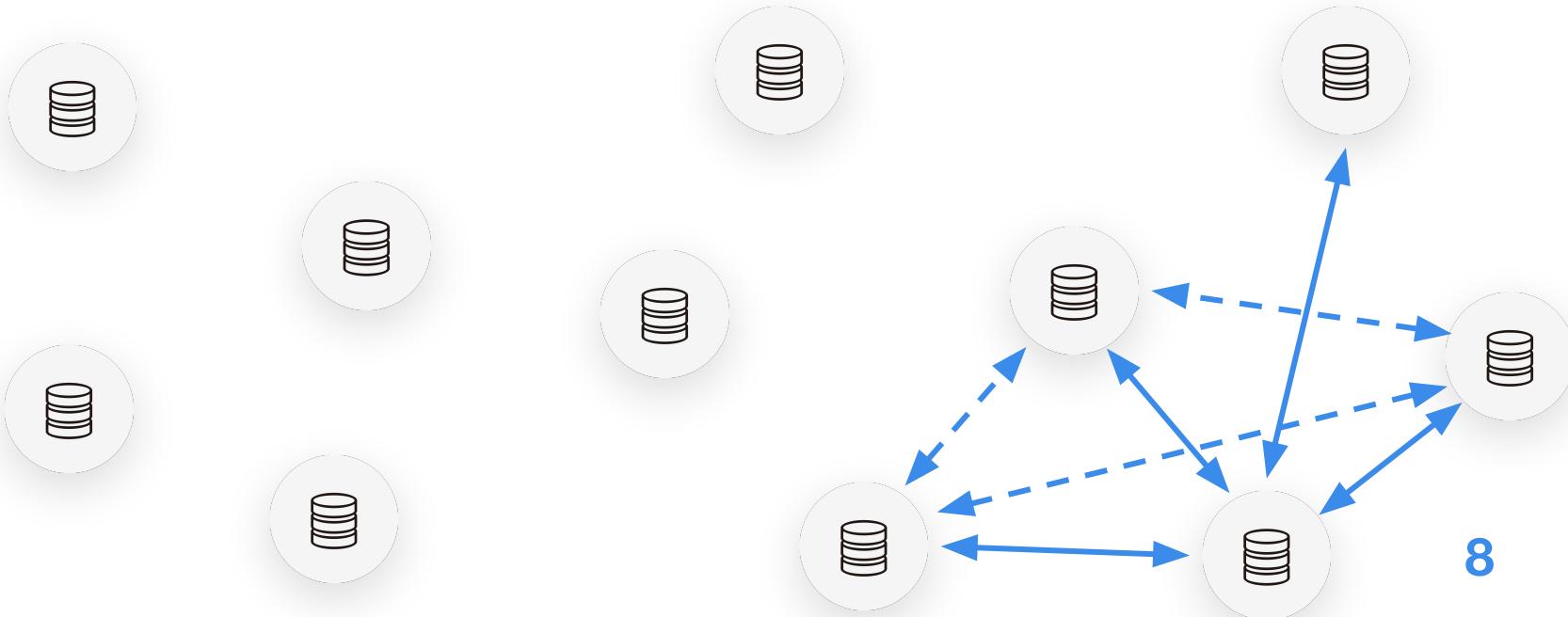
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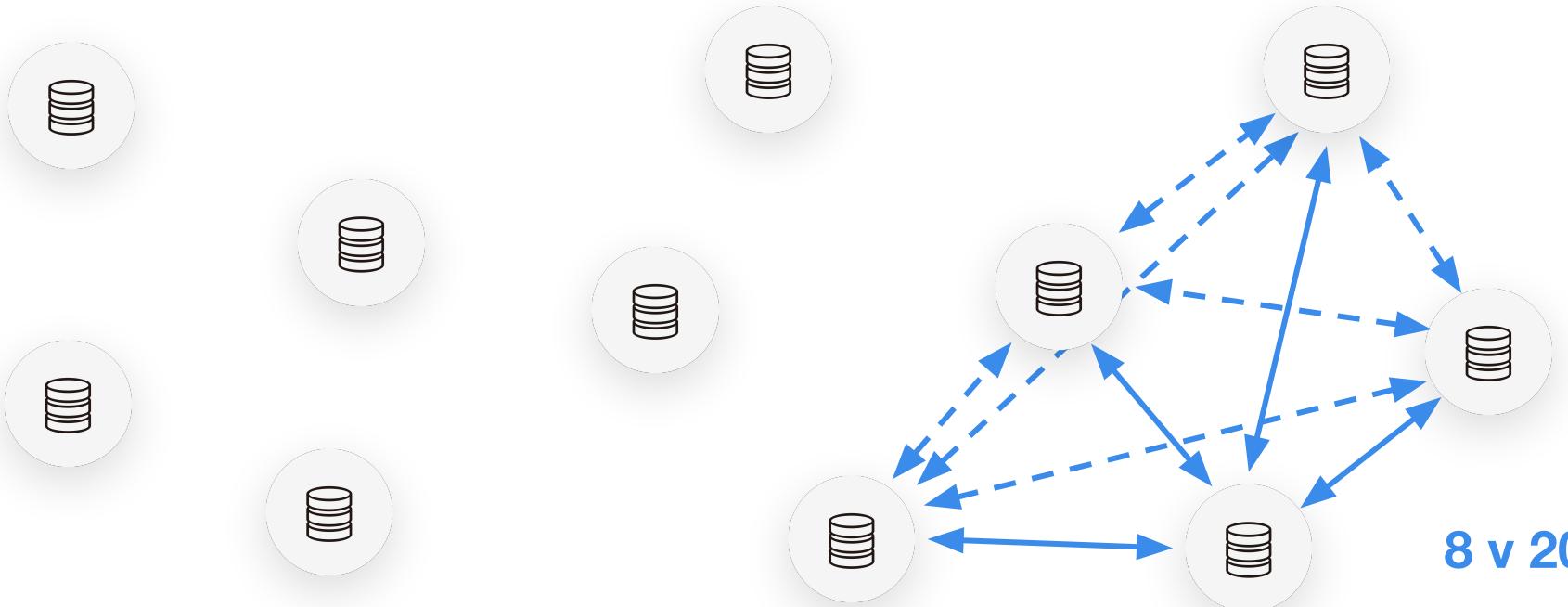
Foundationally Better Cost Scaling



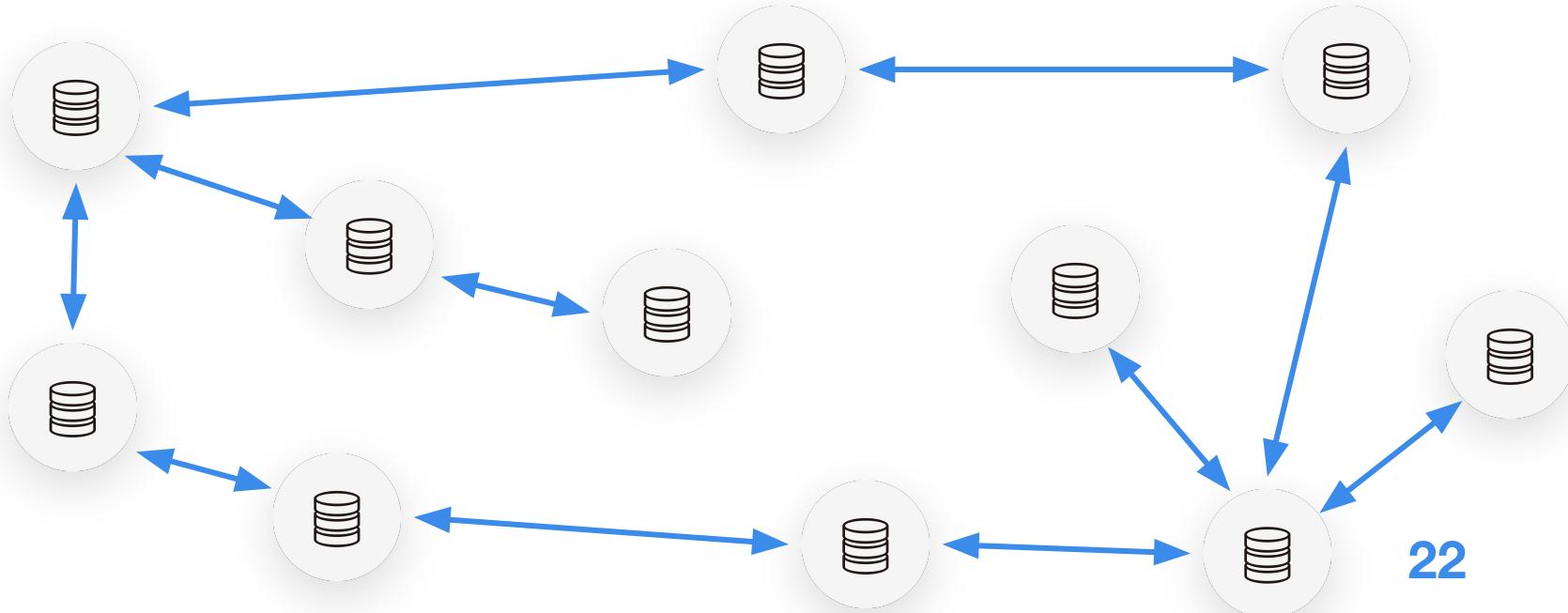
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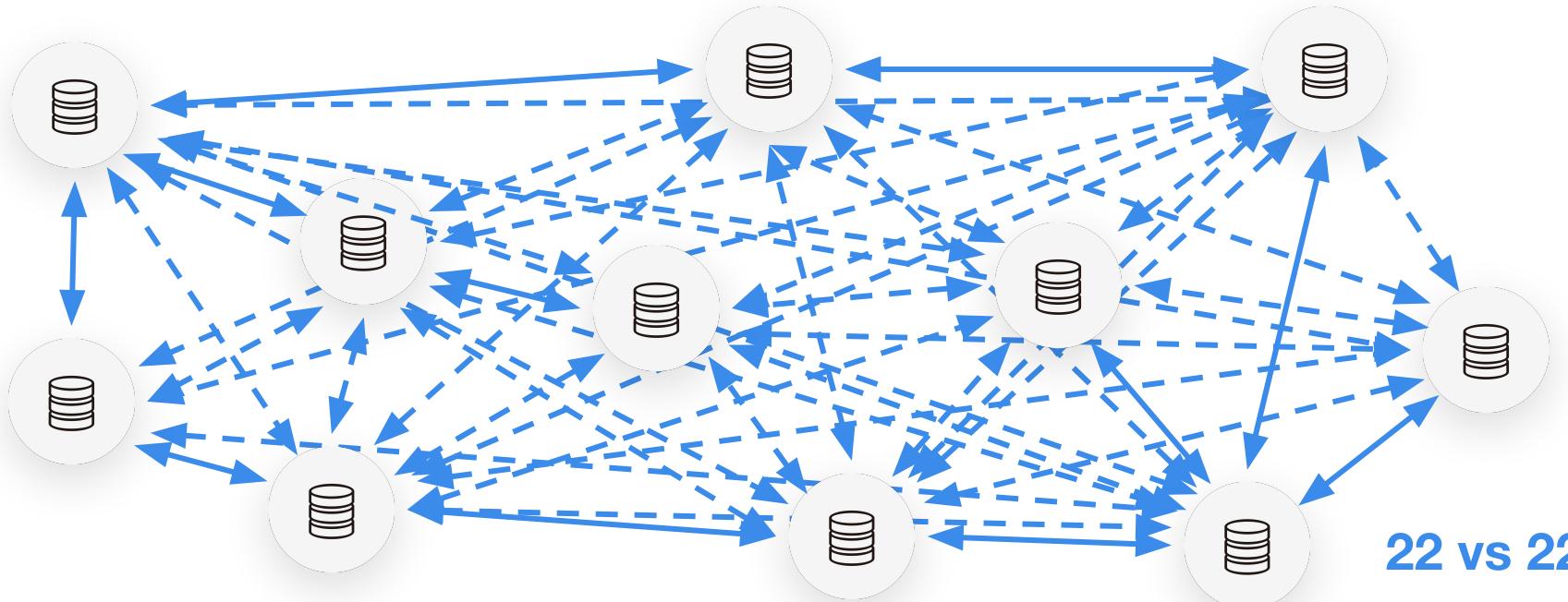
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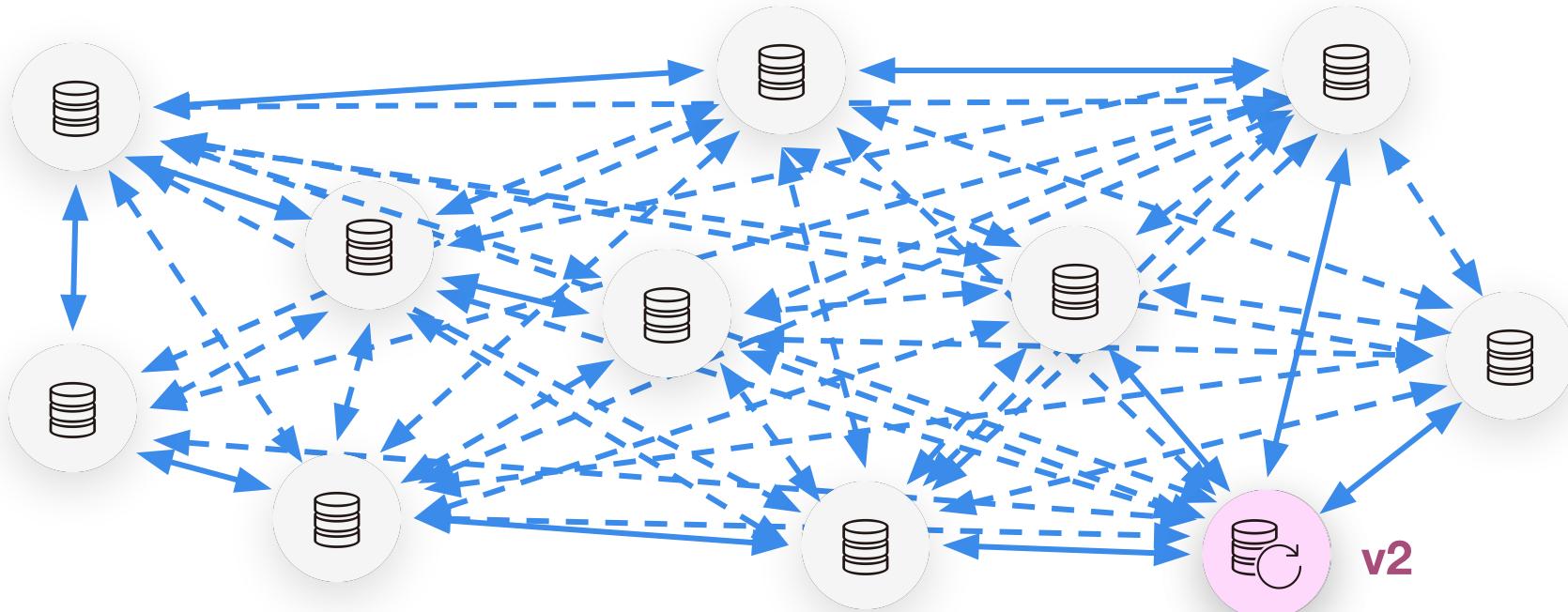
Foundationally Better Cost Scaling



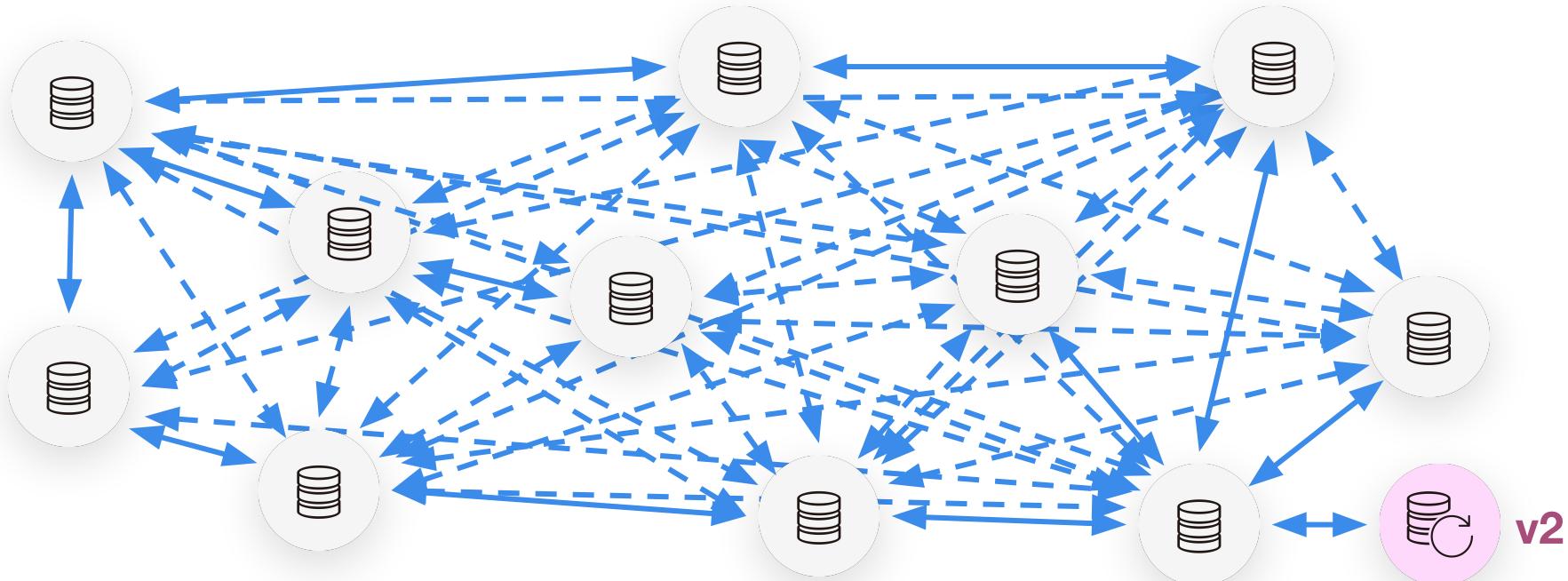
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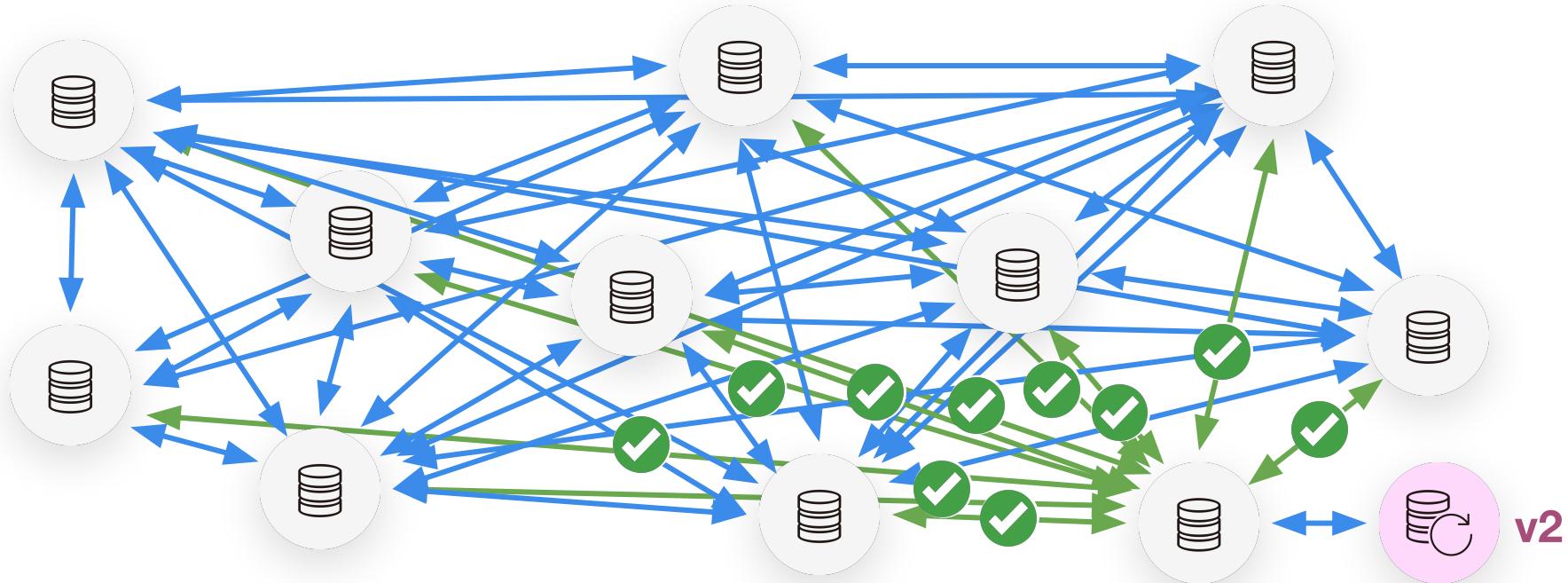
Foundationally Better Cost Scaling



Foundationally Better Cost Scaling

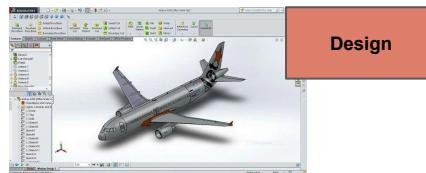


Foundationally Better Cost Scaling

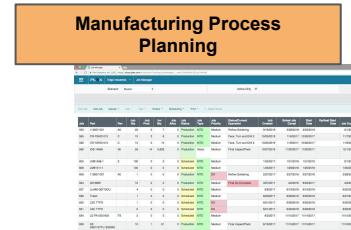


New Data Integration Paradigm

<<requirement>>	
Climb: One-engine-inoperative	
Requirement	
FEDERAL AVIATION ADMINISTRATION (FAA) Title 14, Chapter 1, Subchapter C 25.121	
(a) Takeoff; landing gear extended... the steady gradient of column... not less than 5 percent... for four-engine airplanes	

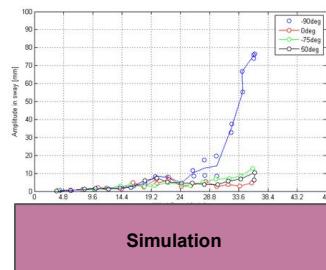


Design

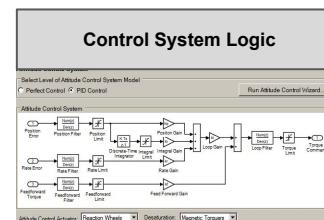


Manufacturing Process Planning

Test Case	<<testcase>>
Climb: One-engine-inoperative	
Perform simulation under conditions...	



Simulation



Control System Logic



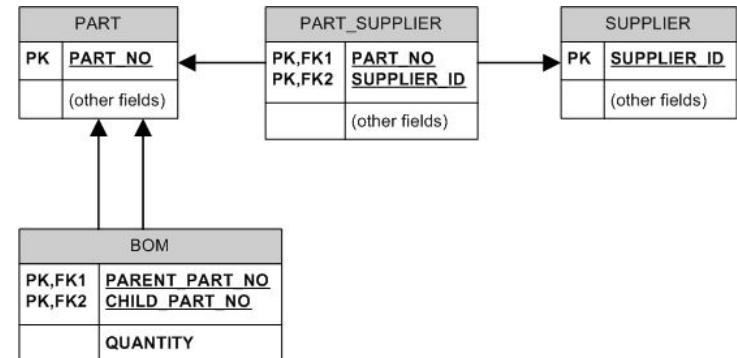
Bill of Materials

New Data Integration Paradigm

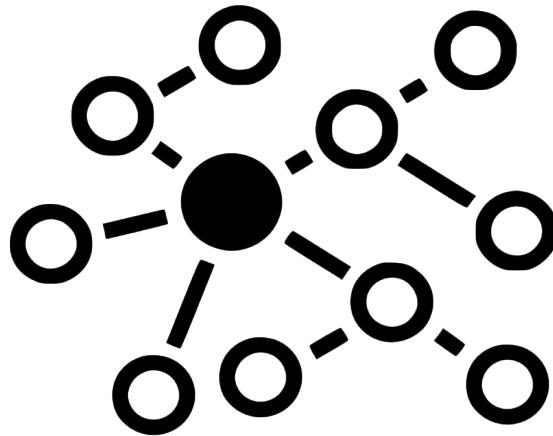
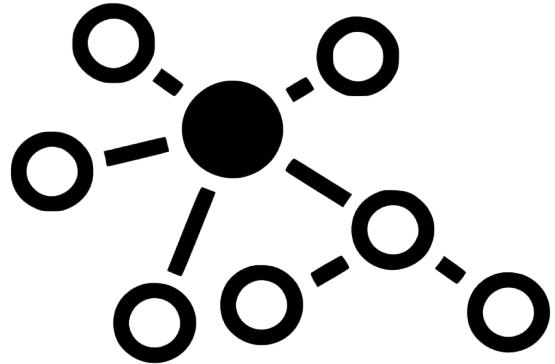
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- <bundle name="Electrical Bundle1.1">
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    <property name="Bend Radius" val="6mm" />
    <property name="Length" val="115.122mm" />
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    <extremity pin="Number01" device="PN-27112000-1700.1" type="From" />
  - <connectedwires>
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+ <wire name="Signal BWire1.1" />
+ <wire name="Signal CWire1.1" />
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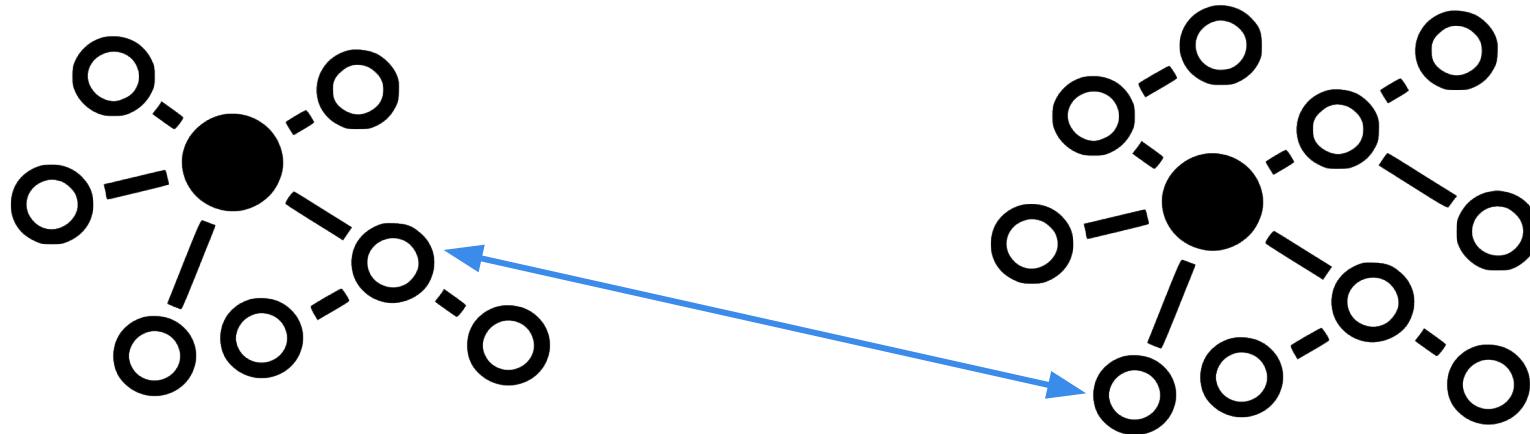
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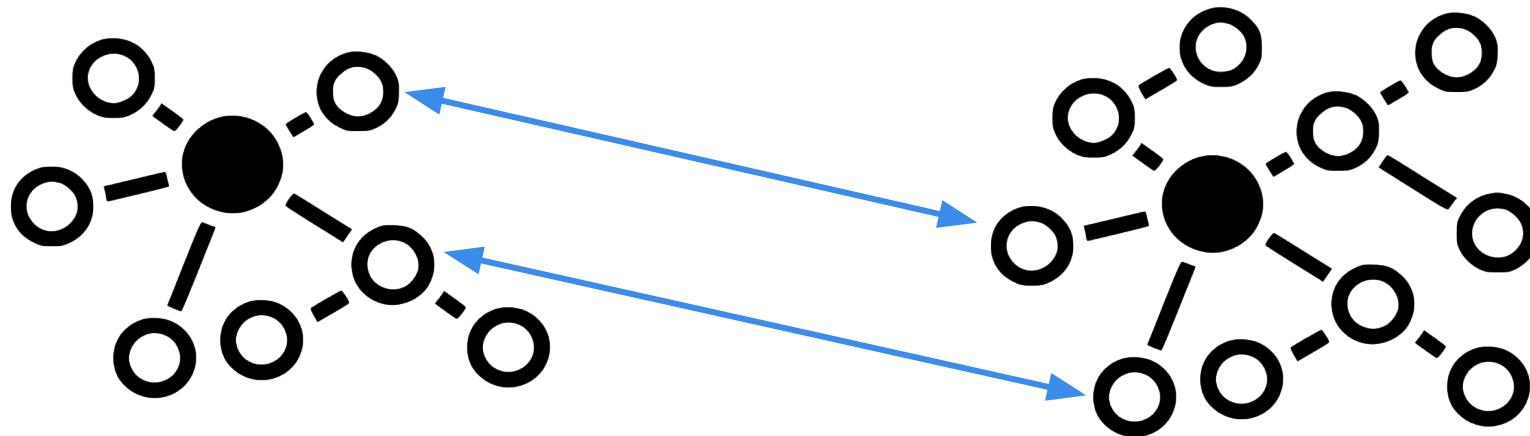
New Data Integration Paradigm



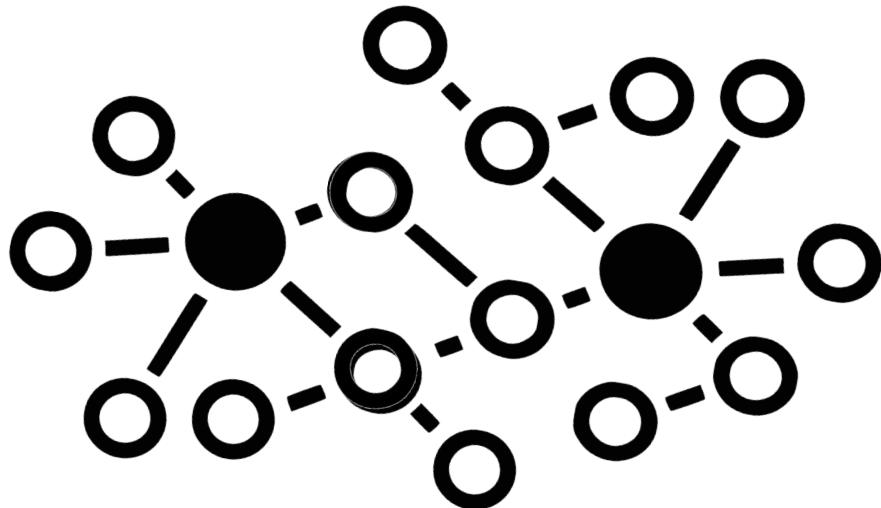
New Data Integration Paradigm



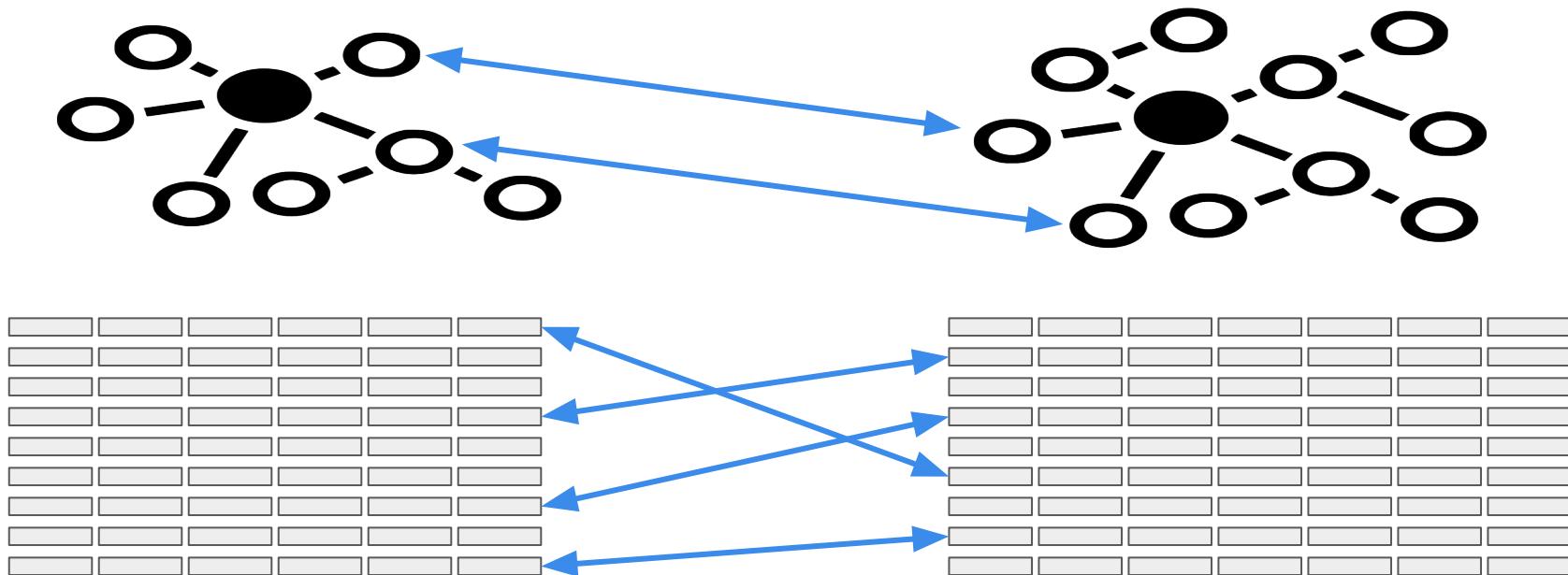
New Data Integration Paradigm



New Data Integration Paradigm



New Data Integration Paradigm

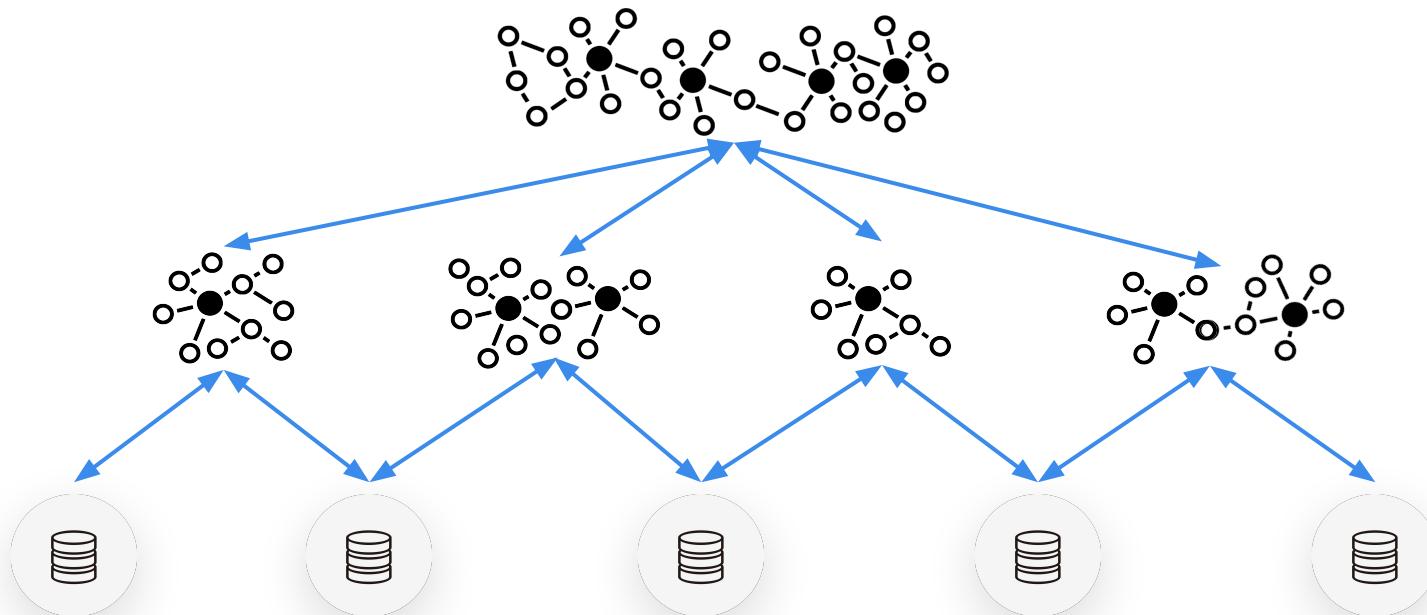


Automatically Compose Data Sources

Required Inputs

- Data Schema
- Data Records
- Schema Links (as schema)
- Record Links (as records)
- Rules (declarative)

Automatically Compose Data Sources



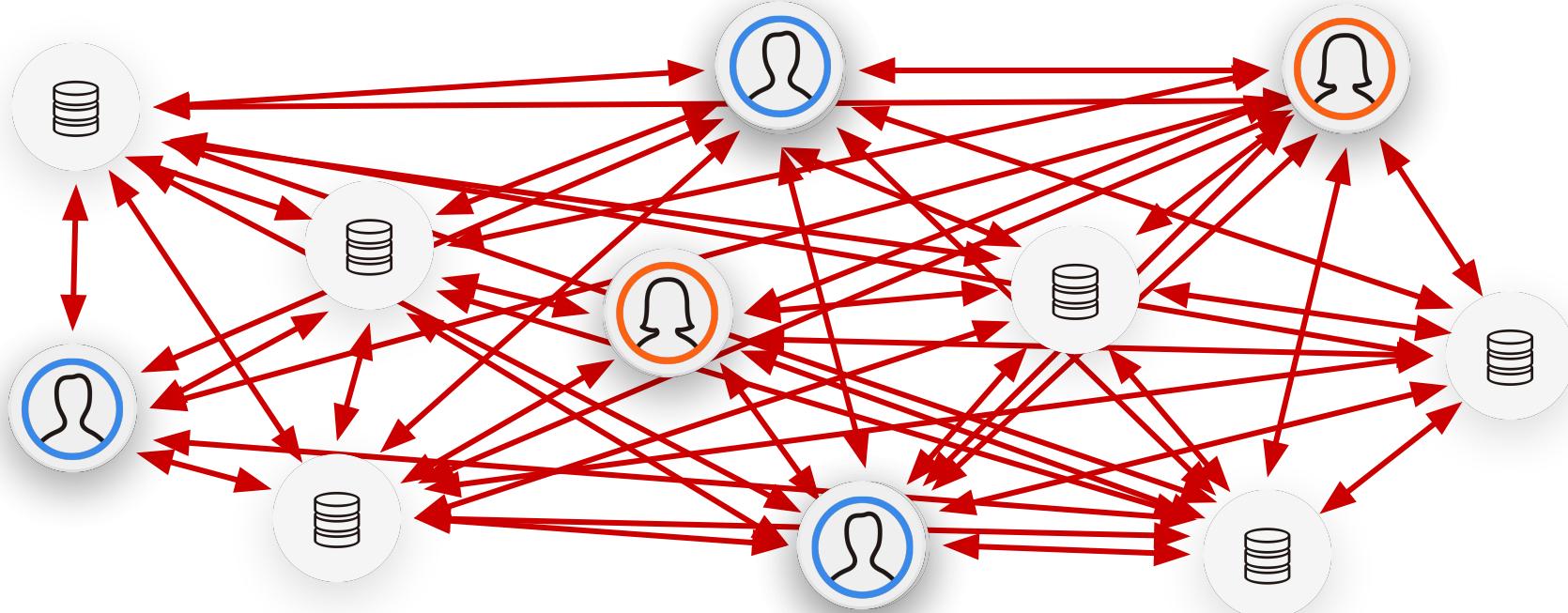
Data, Concepts, Relationships & Rules AKA Records, Attributes, References & Constraints

Conexus Enables New Paradigm

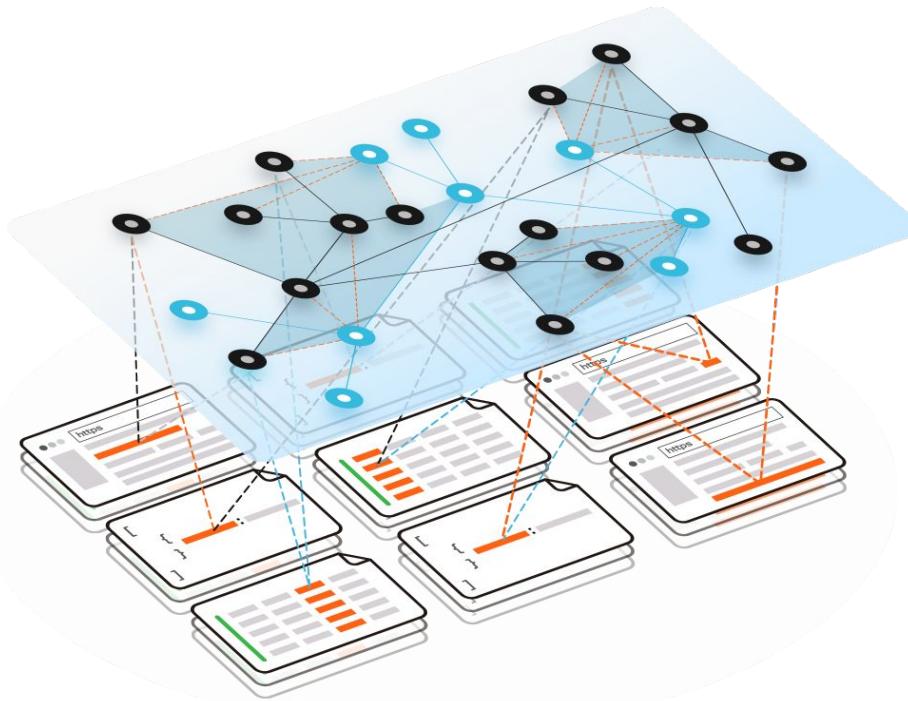
Exploiting Categorical Mathematics

- Automate composition of integrations
- Merge data models, schemas and ontologies safely
- Exchange and consolidate data
- Enable forward and backward compatibility
- Curate and add sources incrementally
- Enforce global and domain-specific rules
- Machine-verify integrity of integrations
- Quantify implications of imperfect integrations
- Interoperate between any kind of data structure

Semantic Fabric



Semantic Fabric





Semantic Data Interoperability

Enabled by Categorical Mathematics