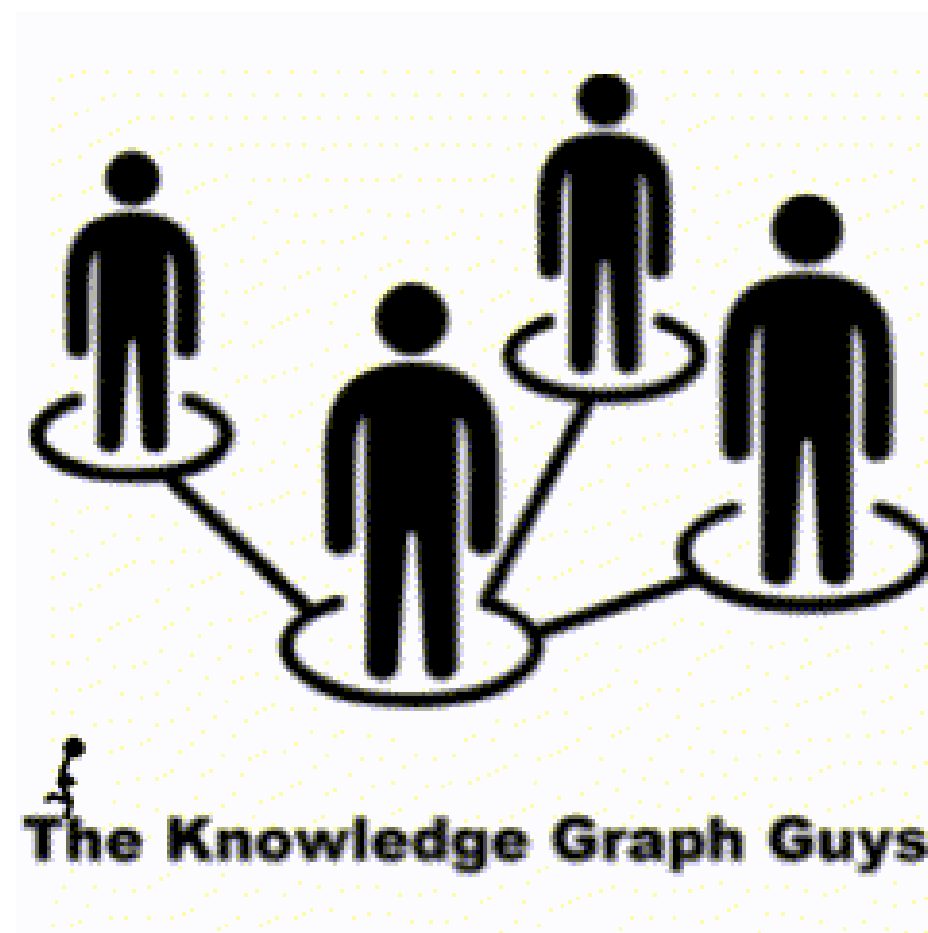
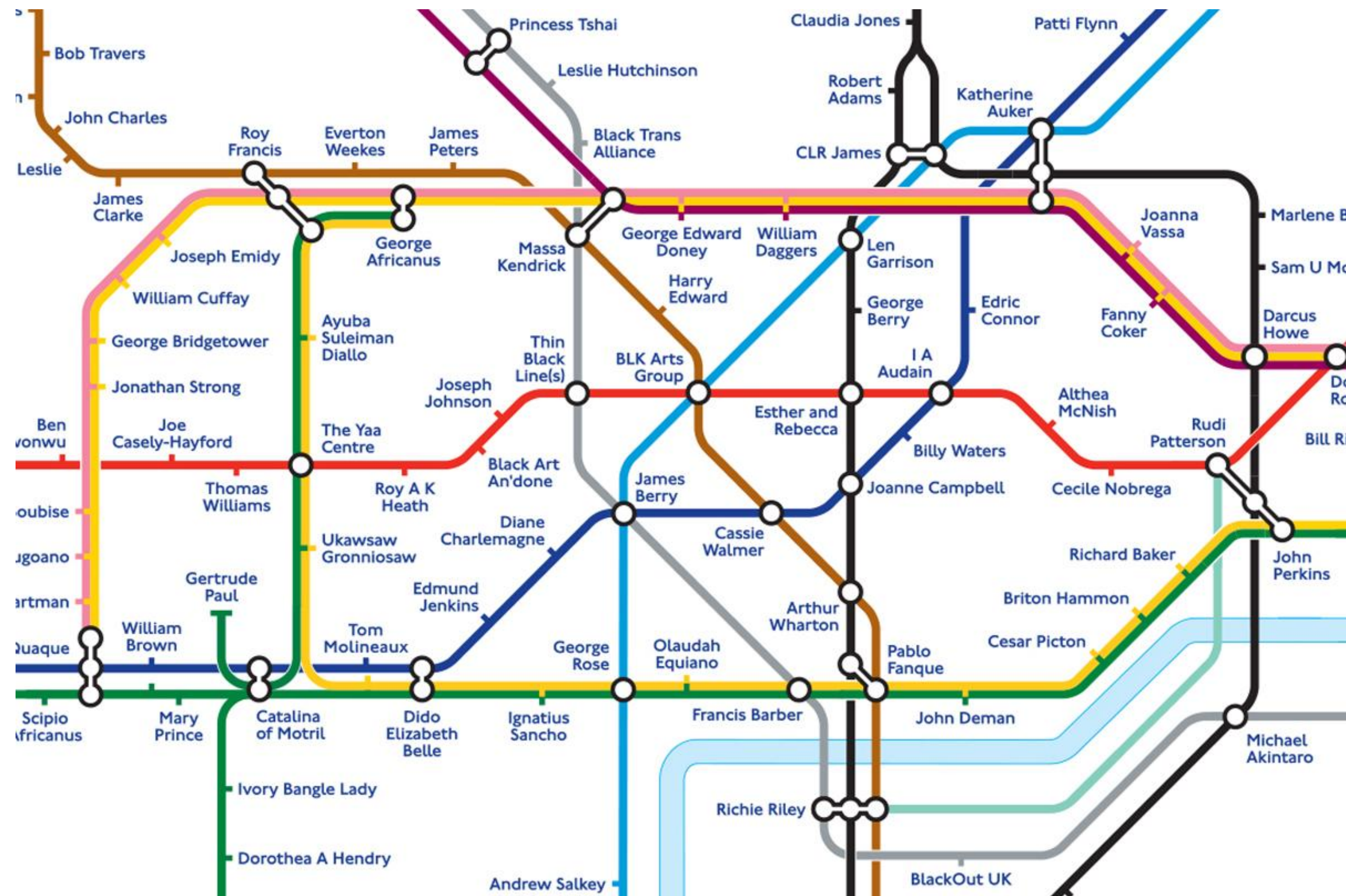


# The Power of Networks

Why The European Railways Needs a Knowledge Graph

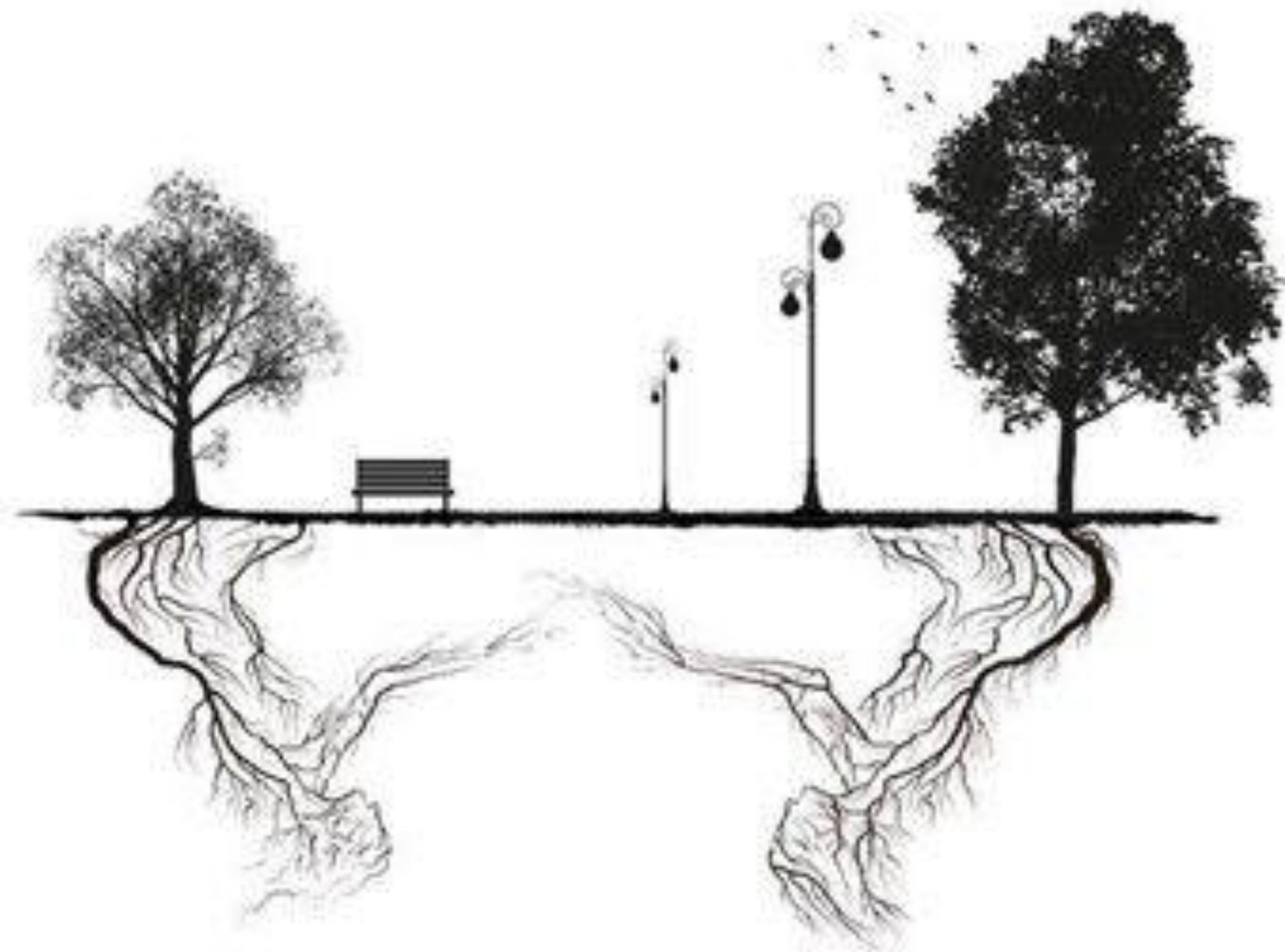


# What Makes a Great Railway Network?



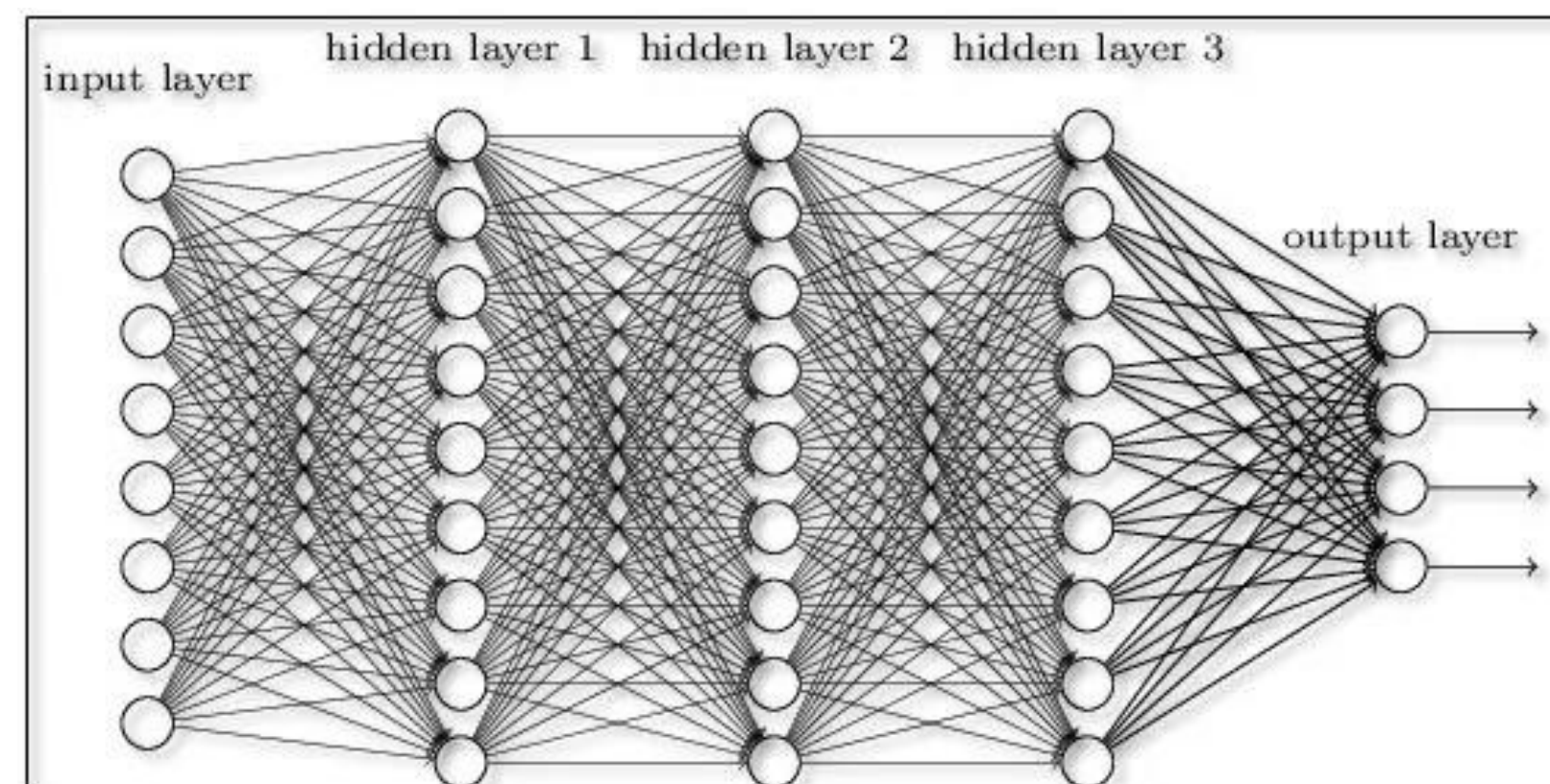
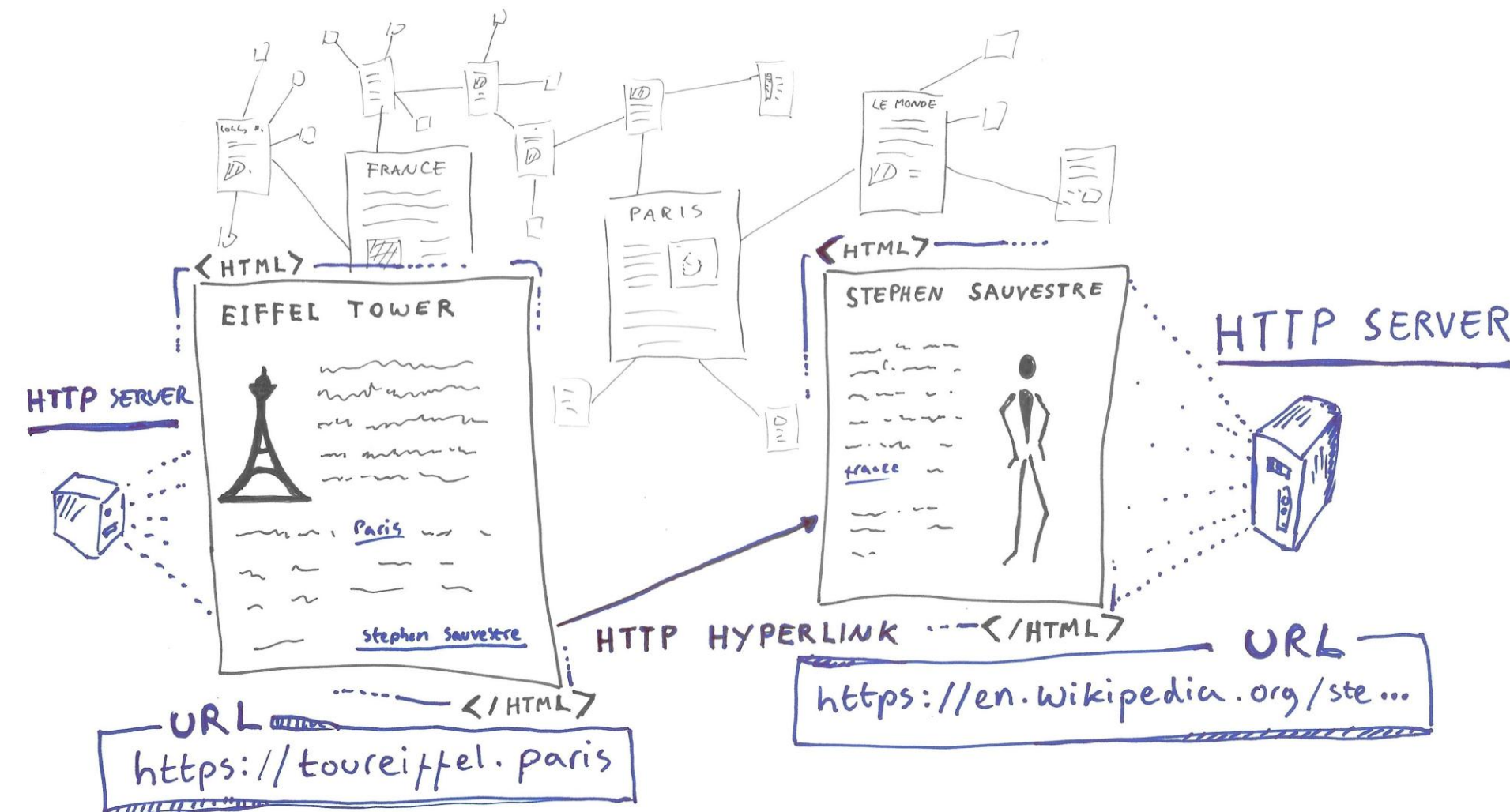
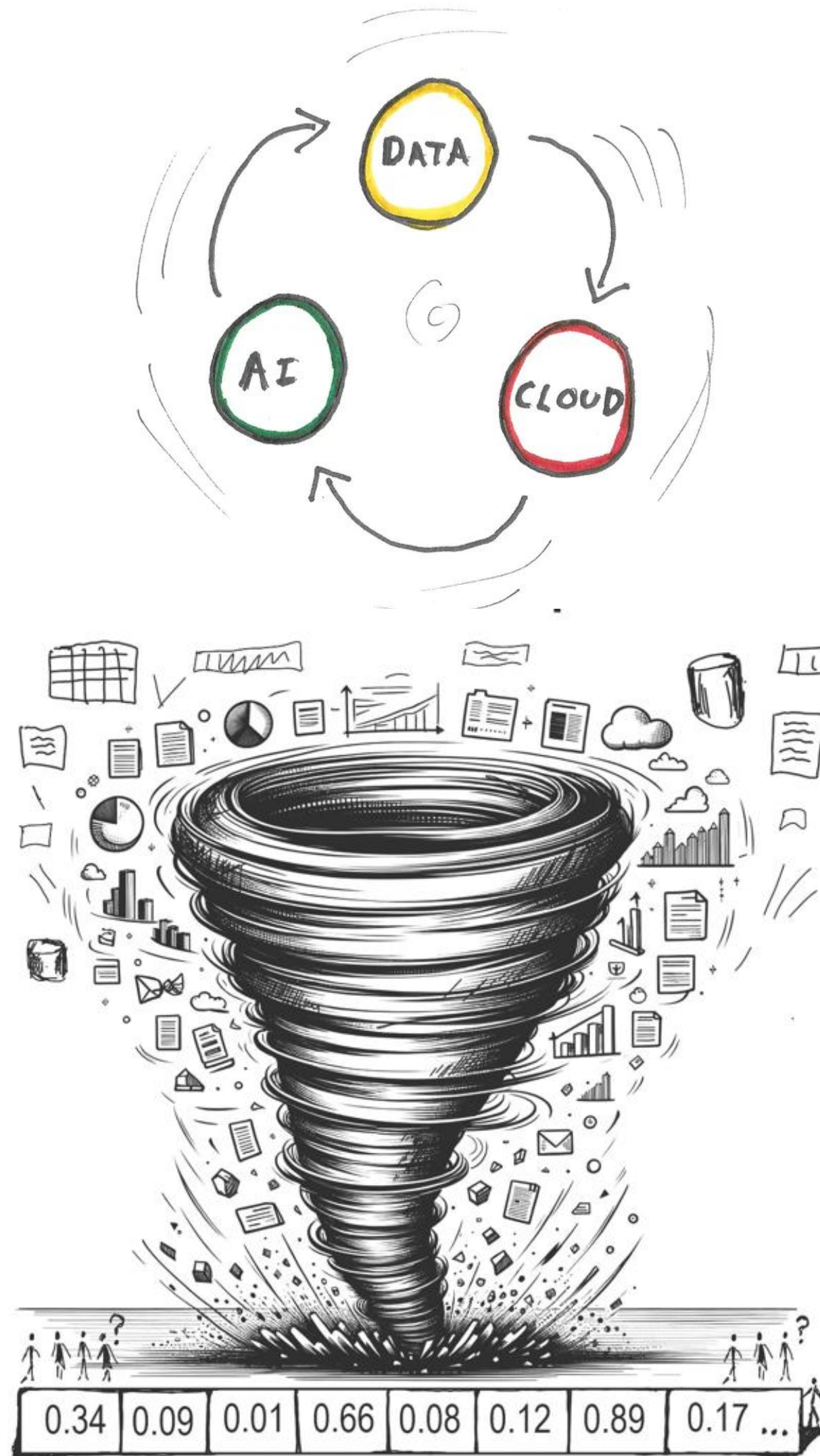
- Rich connectivity between stations
- Minimal friction between journeys
- Designed around actual routes people take
- Branches and trunks – like nature
- Common Standards

# Networks Are Nature's Pattern



- Root systems
- Ecosystems
- Blood vessels
- Brains

# Our Digital Infrastructure is Also a Network

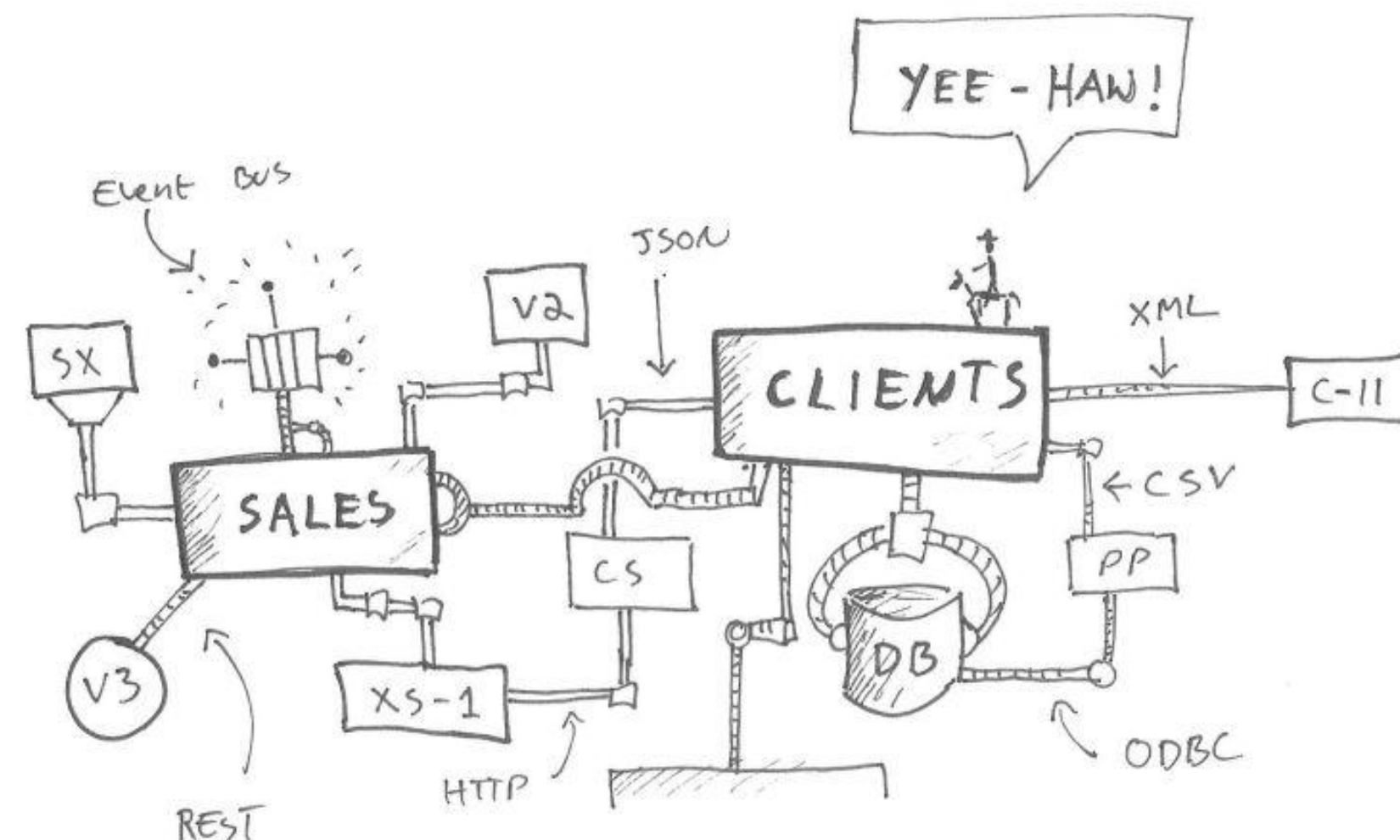


- The Internet: **networked** computers
- The Web: a linked **network** of documents
- Neural **networks**: trained on text connections

# But Our Structured Data is Still in Boxes!

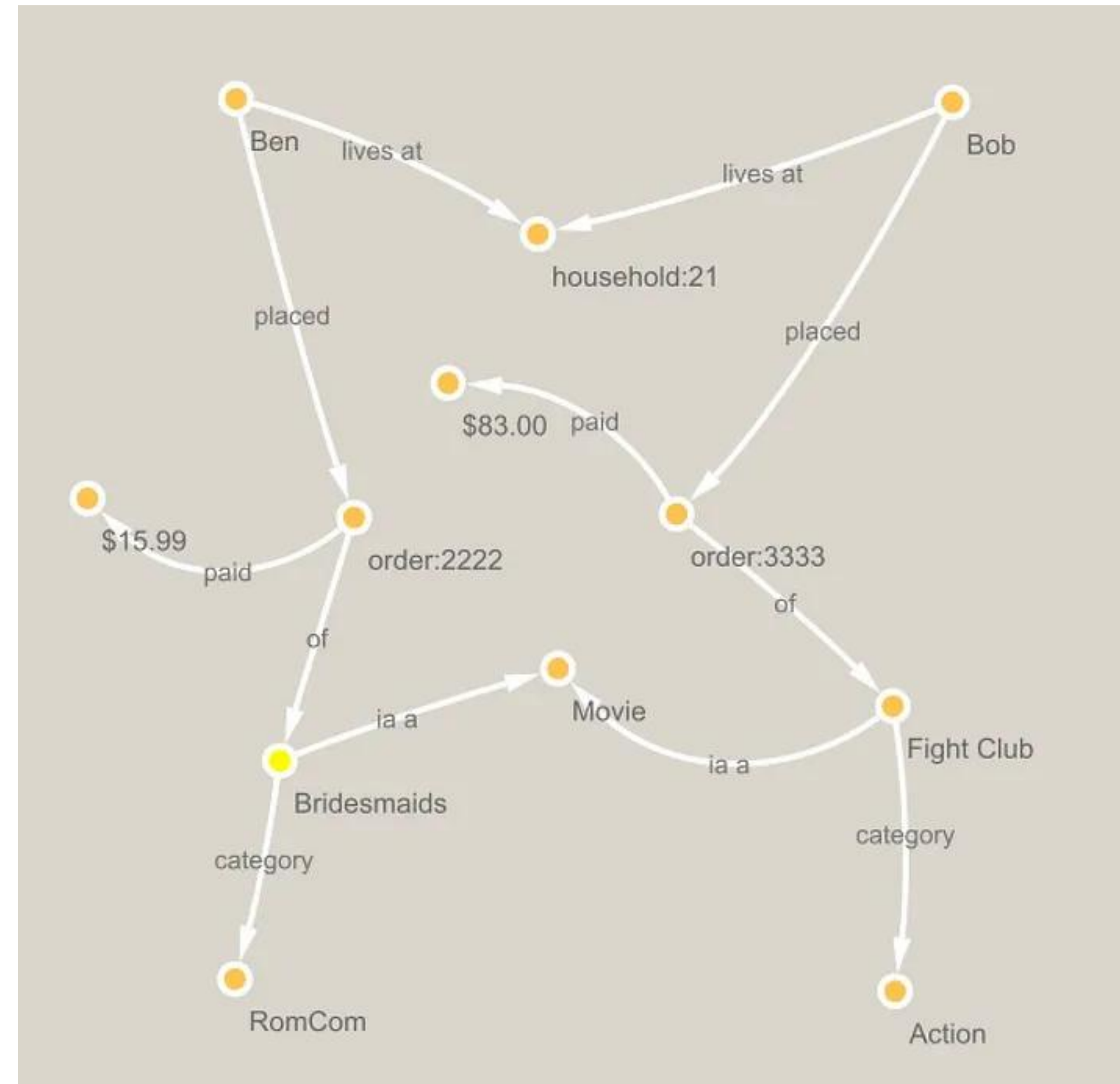
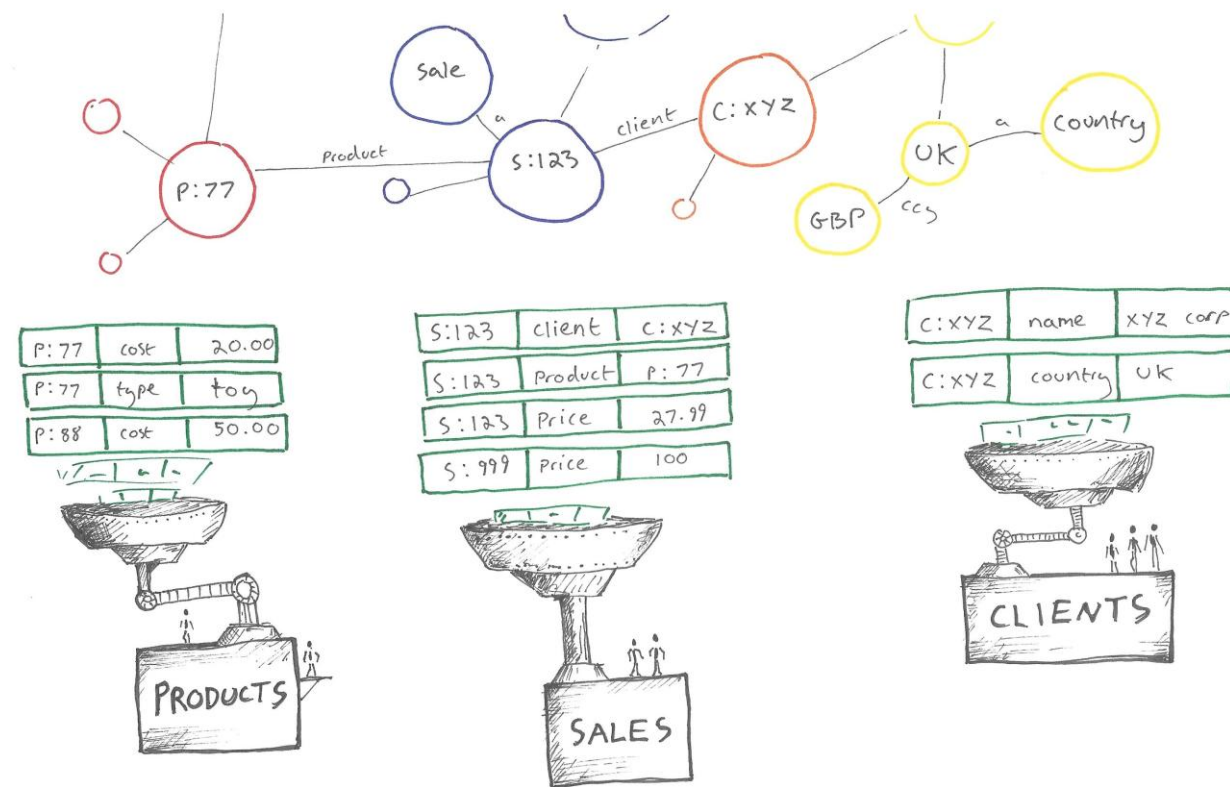
PEOPLE				
Person ID	First Name	Order ID	Household	
1111	Ben	2222	21 Longview Road	
1112	Bob	3333	22 Longview Road	
ORDERS				
Order ID	Amount	Product ID		
2222	\$15.99	55555		
3333	\$83.00	55556		
PRODUCTS				
Product ID	Type	Name	Stock	Category
55555	Movie	Bridesmaids	20	RomCom
55556	Movie	Fight Club	70	Action
COLUMNS				
Model ID	Table	Column	Description	
1	Person	First name	The persons name	
2	Person	Order ID	The ID of the order	

- **Tables**, silos, files
- Primary/foreign keys – at best
- **Data** is the odd one out - it is in a **Box** - not in a Network!



# The Solution: A Network of Data

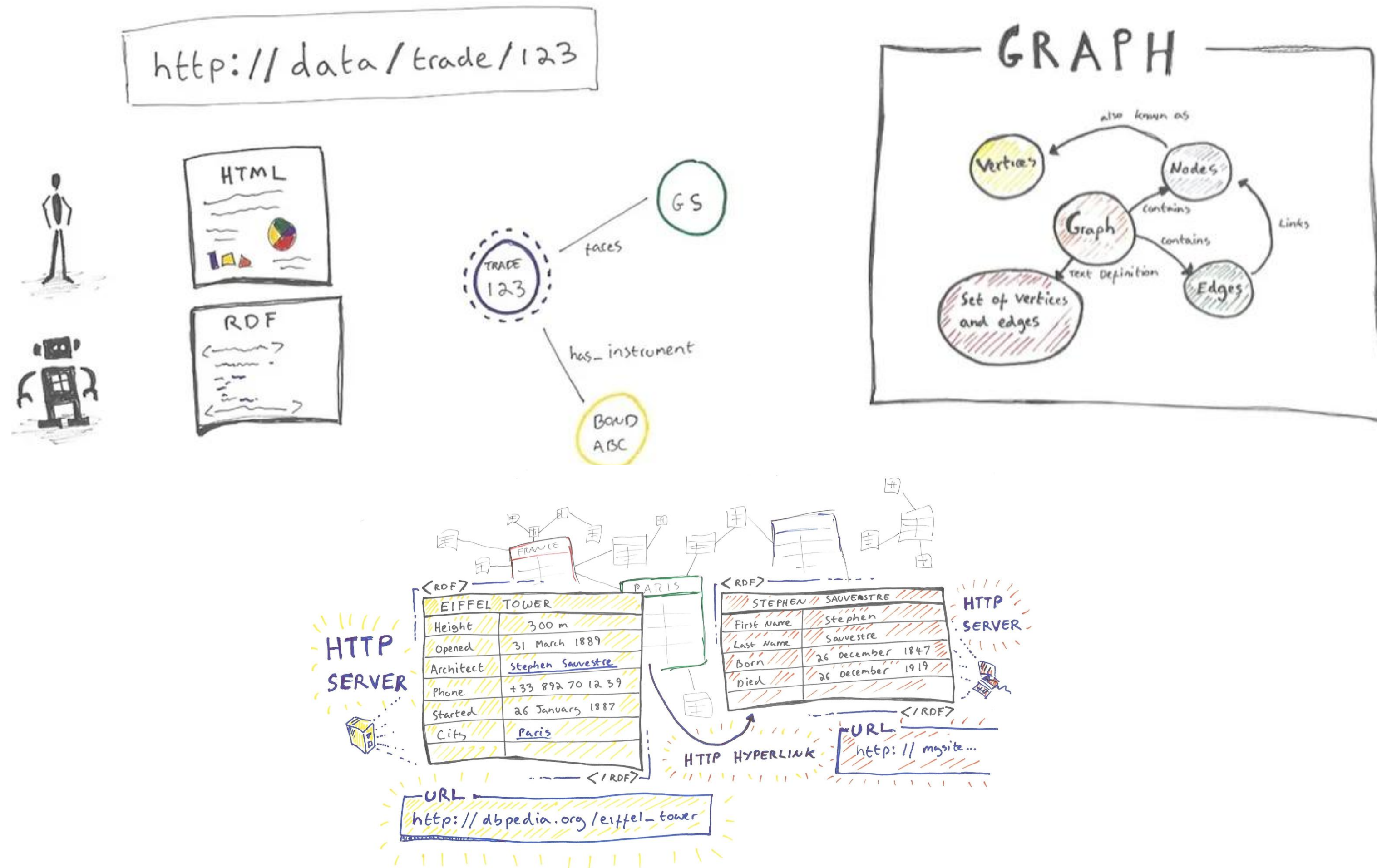
Item	Relationship	Object
Person: Ben	Placed Order	Order: 2222
Person: Ben	Household	Household: 21 Longview
Order: 2222	Amount	\$15.99
Order: 2222	Product	Product: Bridesmaids
Product: Bridesmaids	Type	Movie
Product: Bridesmaids	Category	RomCom
Person: Bob	Placed Order	Order: 3333
Person: Bob	Household	Household: 21 Longview
Order: 3333	Amount	\$83.00
Order: 3333	Product	Product: Fight Club
Product: Fight Club	Type	Movie
Product: Fight Club	Category	Action
Movie	Type	Concept
Movie	Property	First Name
First Name	Description	The persons name



- Interconnected
- Distributed
- Machine-understandable

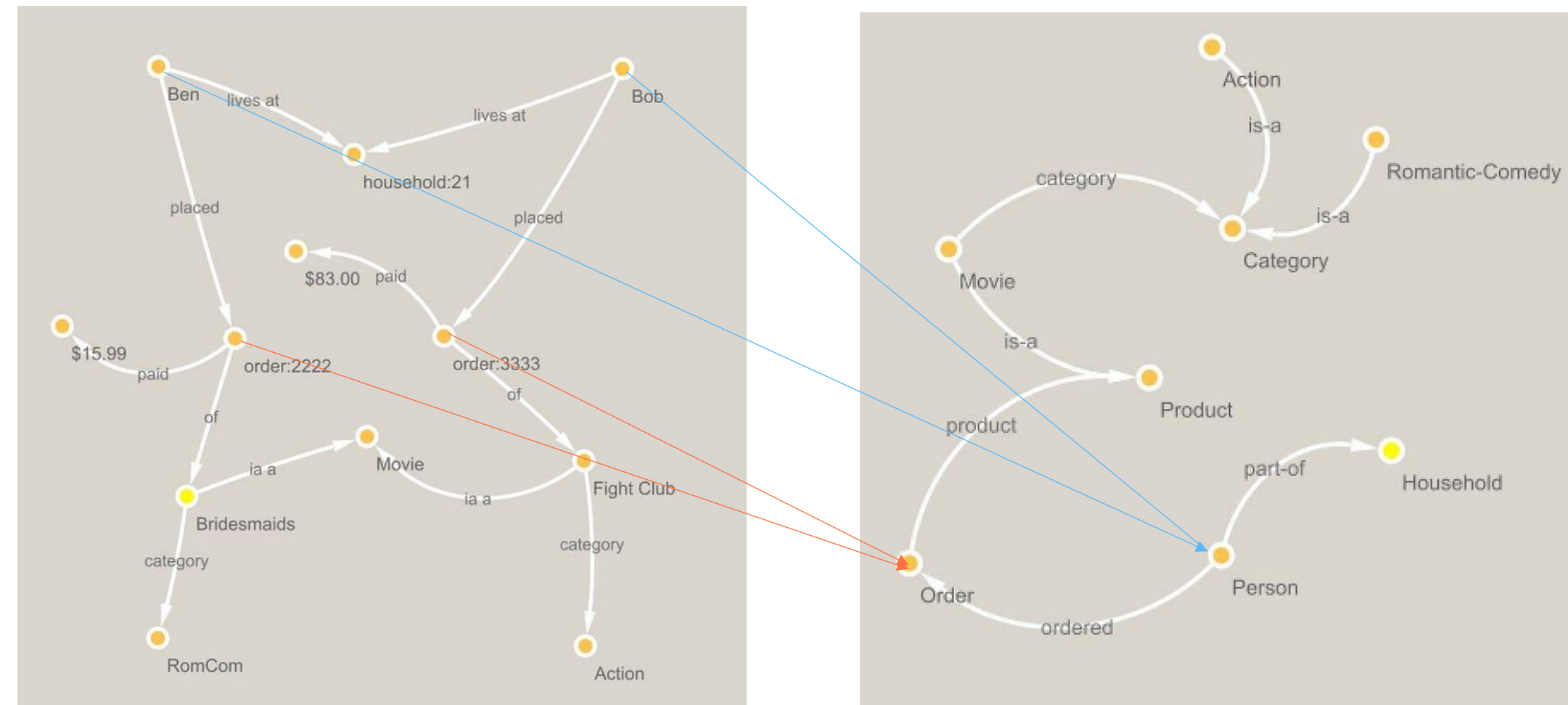
# What is a Knowledge Graph?

Item Link	Relationship Link	Object Link
<a href="https://abc.org/person/ben">https://abc.org/person/ben</a>	<a href="https://abc.org/schema/placedOrder">https://abc.org/schema/placedOrder</a>	<a href="https://abc.org/order/2222">https://abc.org/order/2222</a>



- Every item has a URL and the URLs Hyperlink to each other
- Use RDF to describe data like HTML described documents
- Use shared vocabularies to define meaning

# What is an Ontology?

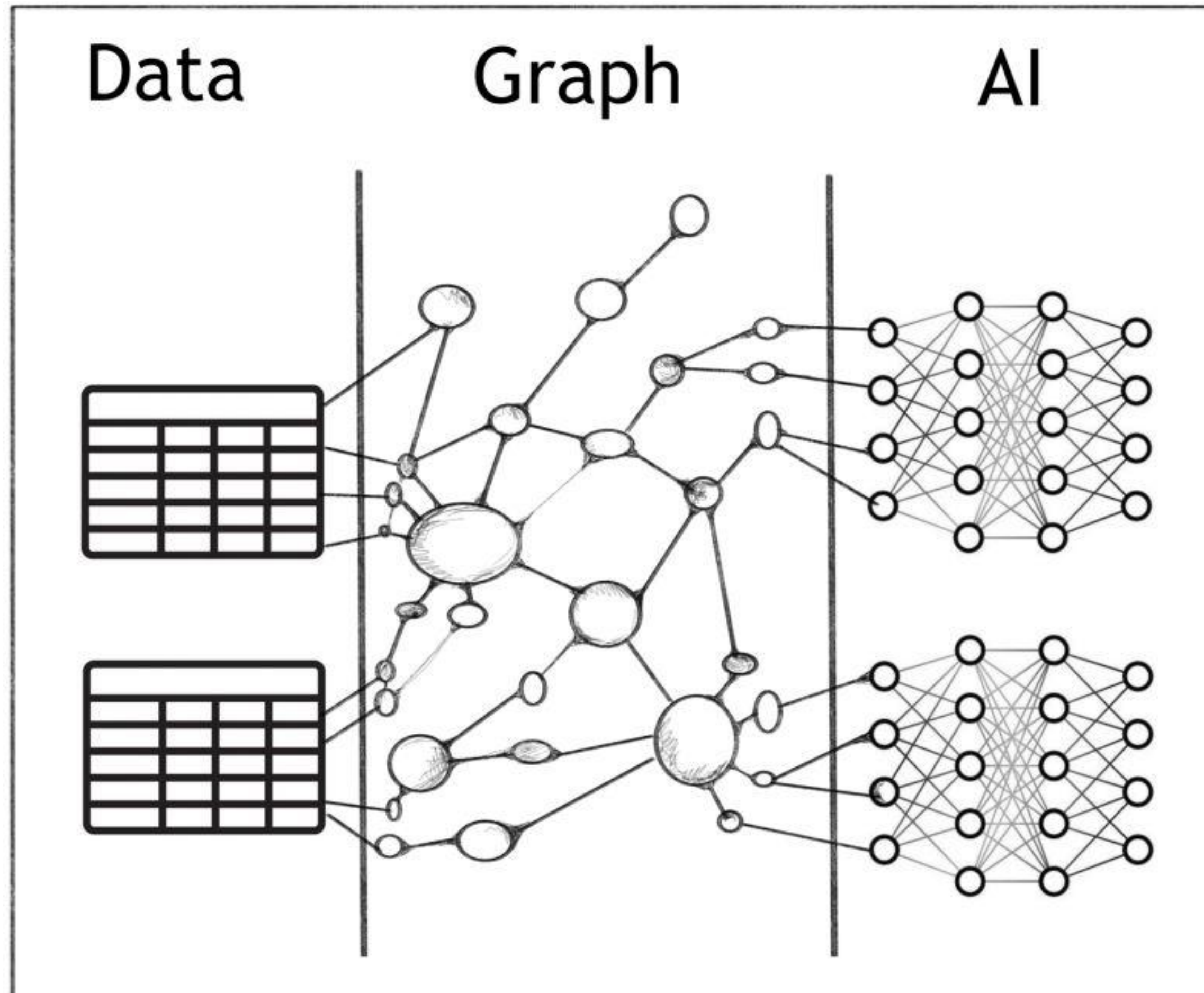


- Model **Meaningful** Abstractions

- Share the Ontologies using HTTP

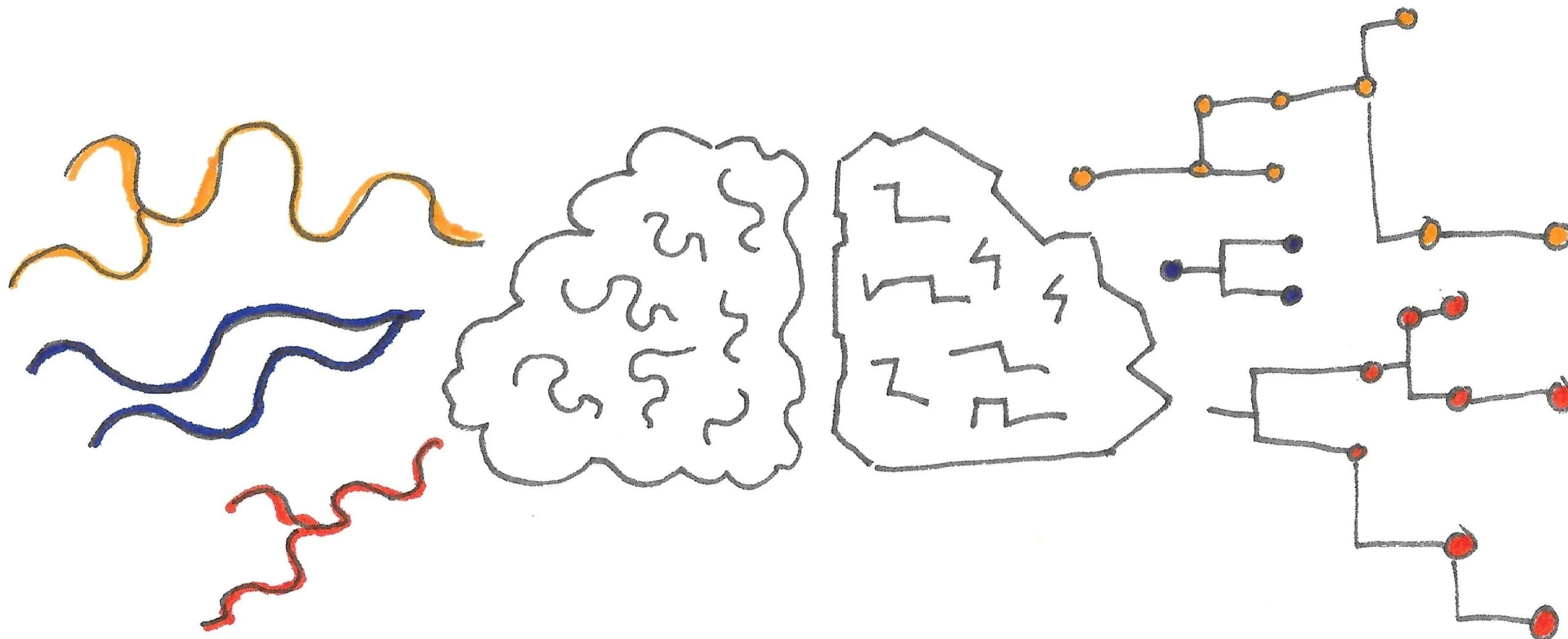
Schema.org		
Docs	Schemas	Validate About
Recipe		
A Schema.org Type		
Thing > CreativeWork > HowTo > Recipe		
A recipe. For dietary restrictions covered by the recipe, a few common restrictions are enumerated via <code>suitableForDiet</code> . The <code>keywords</code> property can also be used to add more detail.		
Property	Expected Type	Description
Properties from Recipe		
<code>cookTime</code>	Duration	The time it takes to actually cook the dish, in ISO 8601 duration format.
<code>cookingMethod</code>	Text	The method of cooking, such as Frying, Steaming, ...
<code>nutrition</code>	NutritionInformation	Nutrition information about the recipe or menu item.
<code>recipeCategory</code>	Text	The category of the recipe—for example, appetizer, entree, etc.
<code>recipeCuisine</code>	Text	The cuisine of the recipe (for example, French or Ethiopian).
<code>recipeIngredient</code>	Text	A single ingredient used in the recipe, e.g. sugar, flour or garlic. Supersedes <code>ingredients</code> .
<code>recipeInstructions</code>	CreativeWork or ItemList or Text	A step in making the recipe, in the form of a single item (document, video, etc.) or an ordered list with <code>HowToStep</code> and/or <code>HowToSection</code> items.
<code>recipeYield</code>	QuantitativeValue or Text	The quantity produced by the recipe (for example, number of people served, number of servings, etc).
<code>suitableForDiet</code>	RestrictedDiet	Indicates a dietary restriction or guideline for which this recipe or menu item is suitable, e.g. diabetic, halal etc.

# Why This Matters for Rail



- Rail data becomes machine-navigable
- Supports AI, reasoning, automation
- Builds a digital twin of rail infrastructure

# The New Shift: Physical $\leftrightarrow$ Digital



- Simulate the real world with digital twins
- Manage complex systems digitally
- Use Neural Networks and Computer Networks to Improve Rail Networks

# Final Thought

A well-organised railway network is a sign of a healthy society.

In the age of AI a well-organised data network is the sign of a healthy railway.

