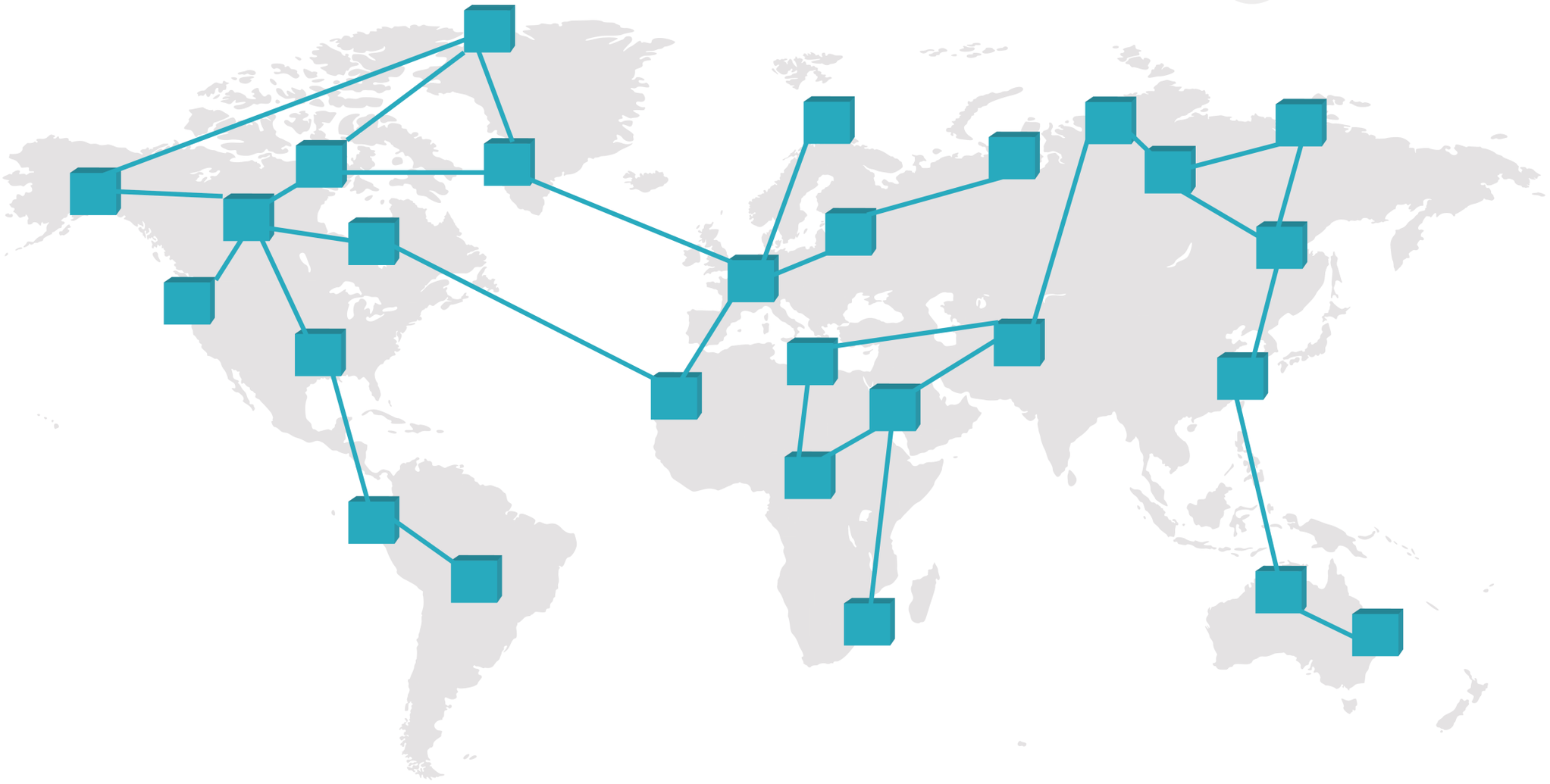
operating.systems

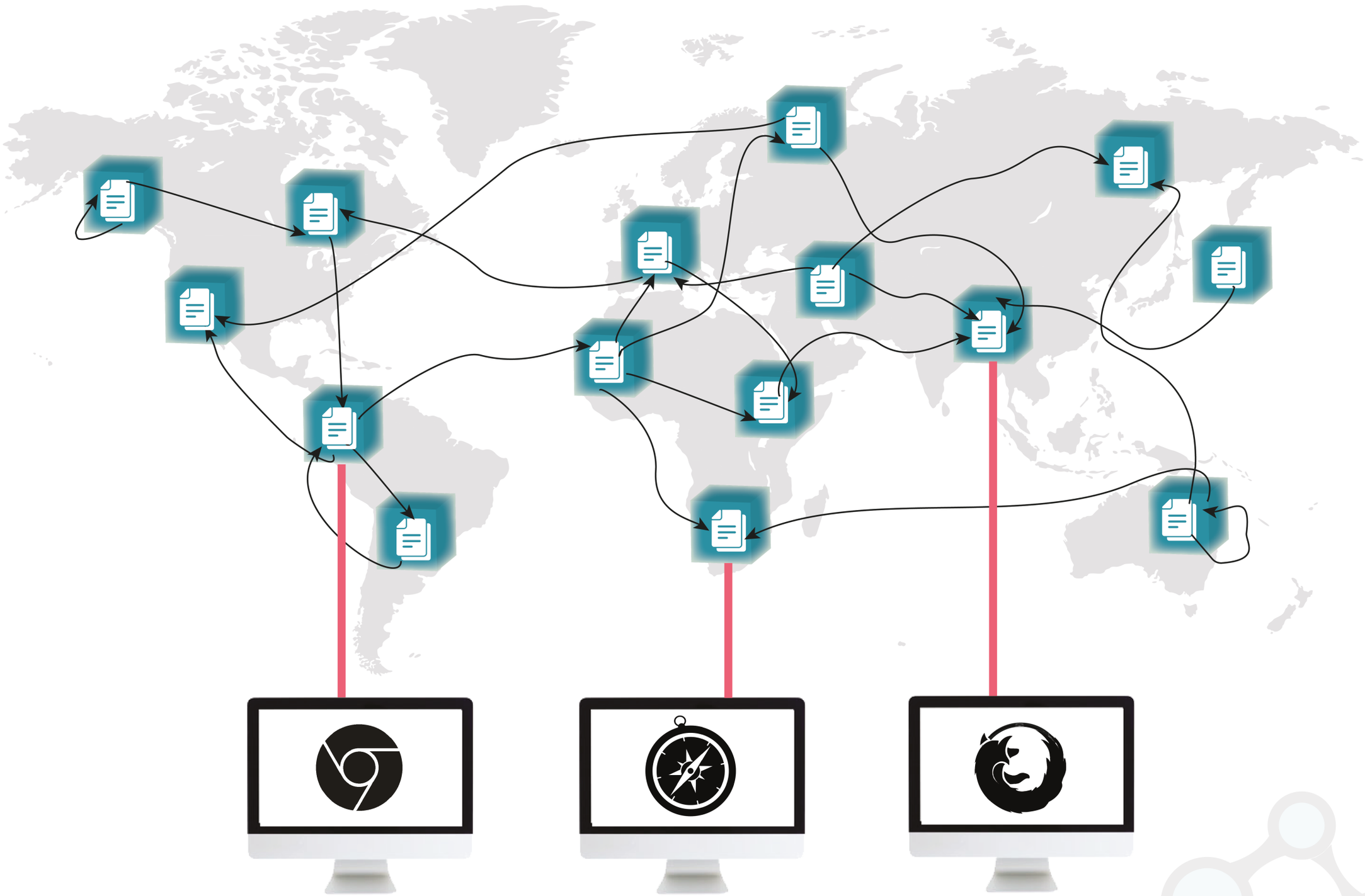
Introduction to Category Theory
and the Semantic web

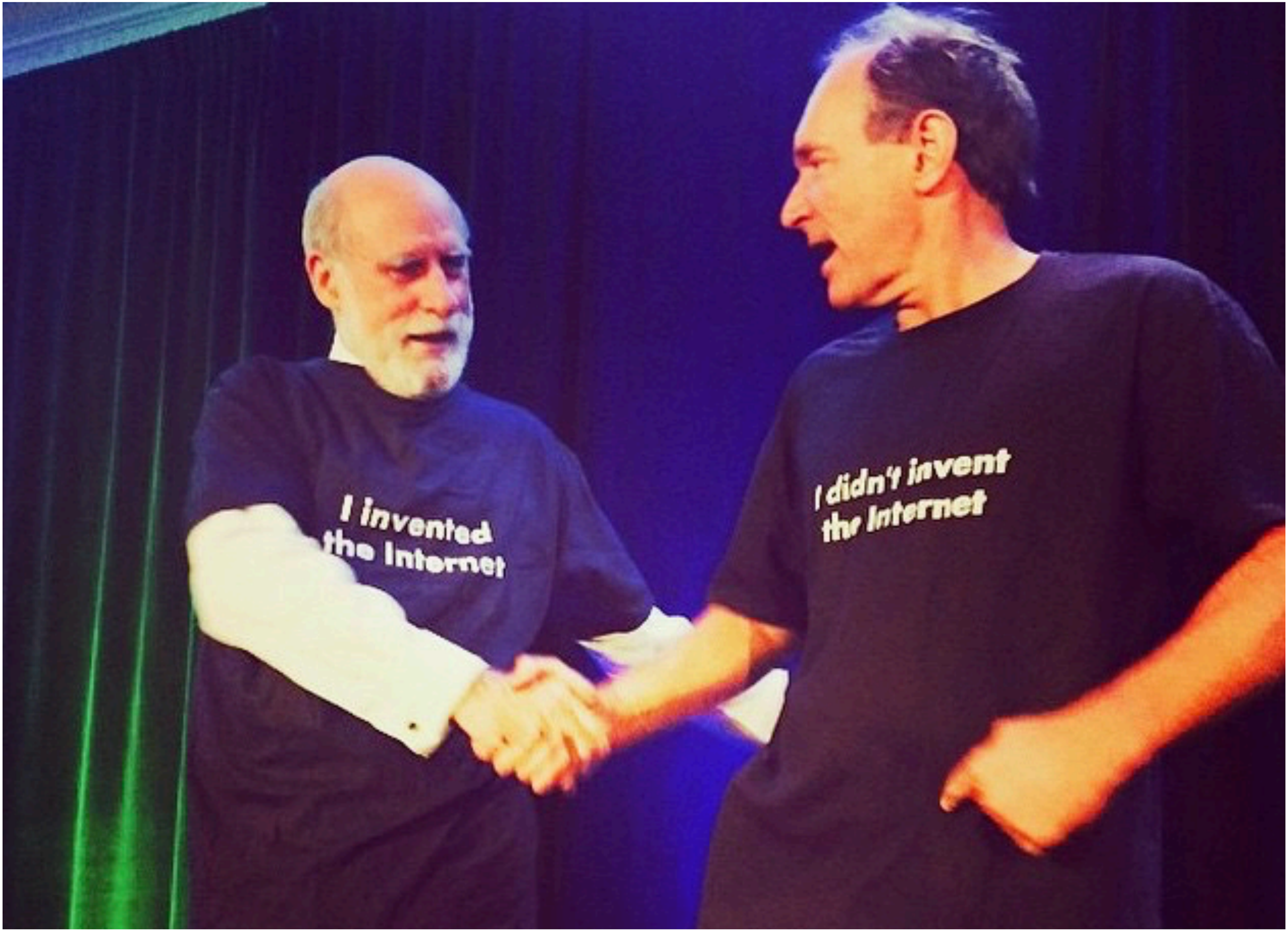
The Internet



Computers as peers form a fully connected graph

The Web

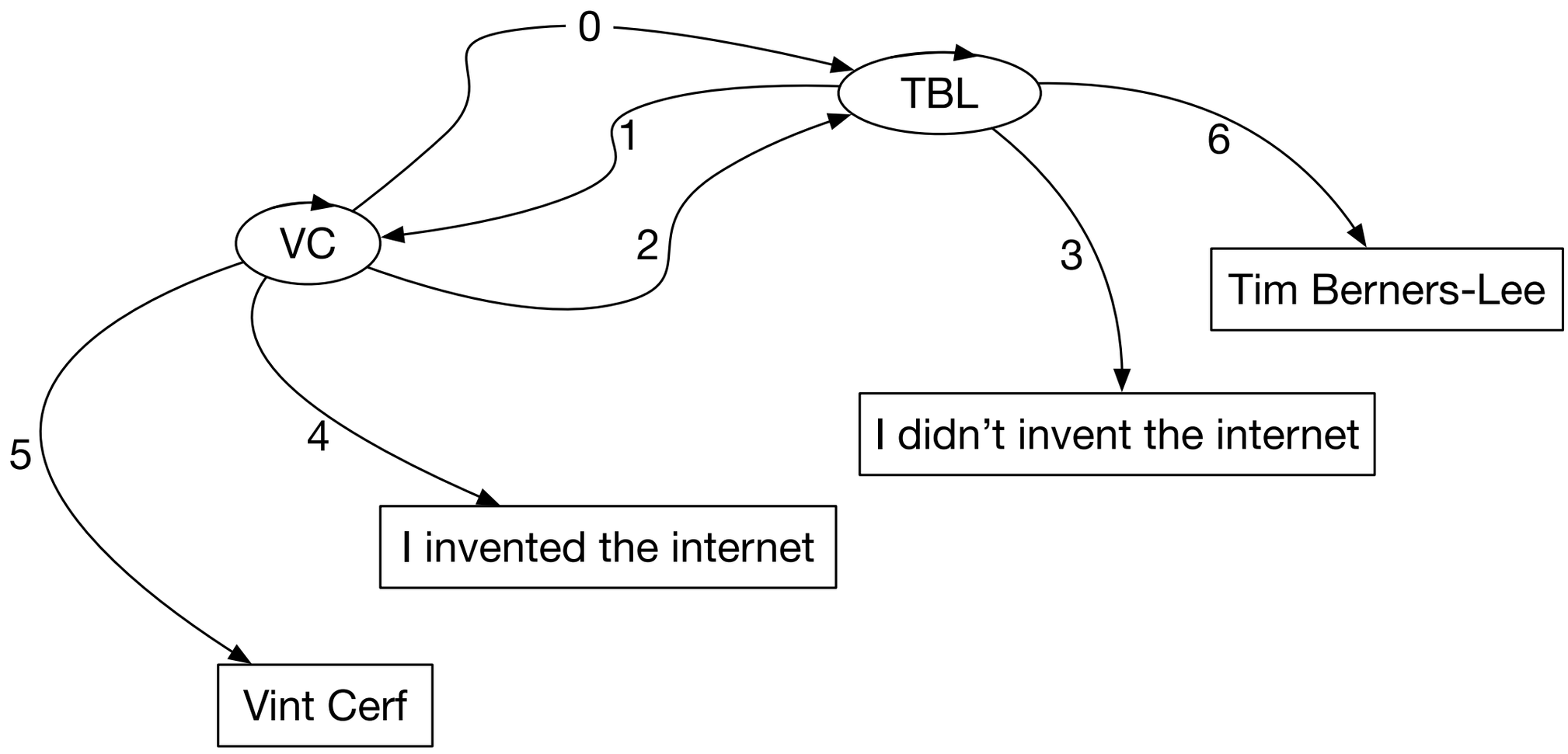



I invented
the Internet
I didn't invent
the Internet

Annotation with Directed Graph

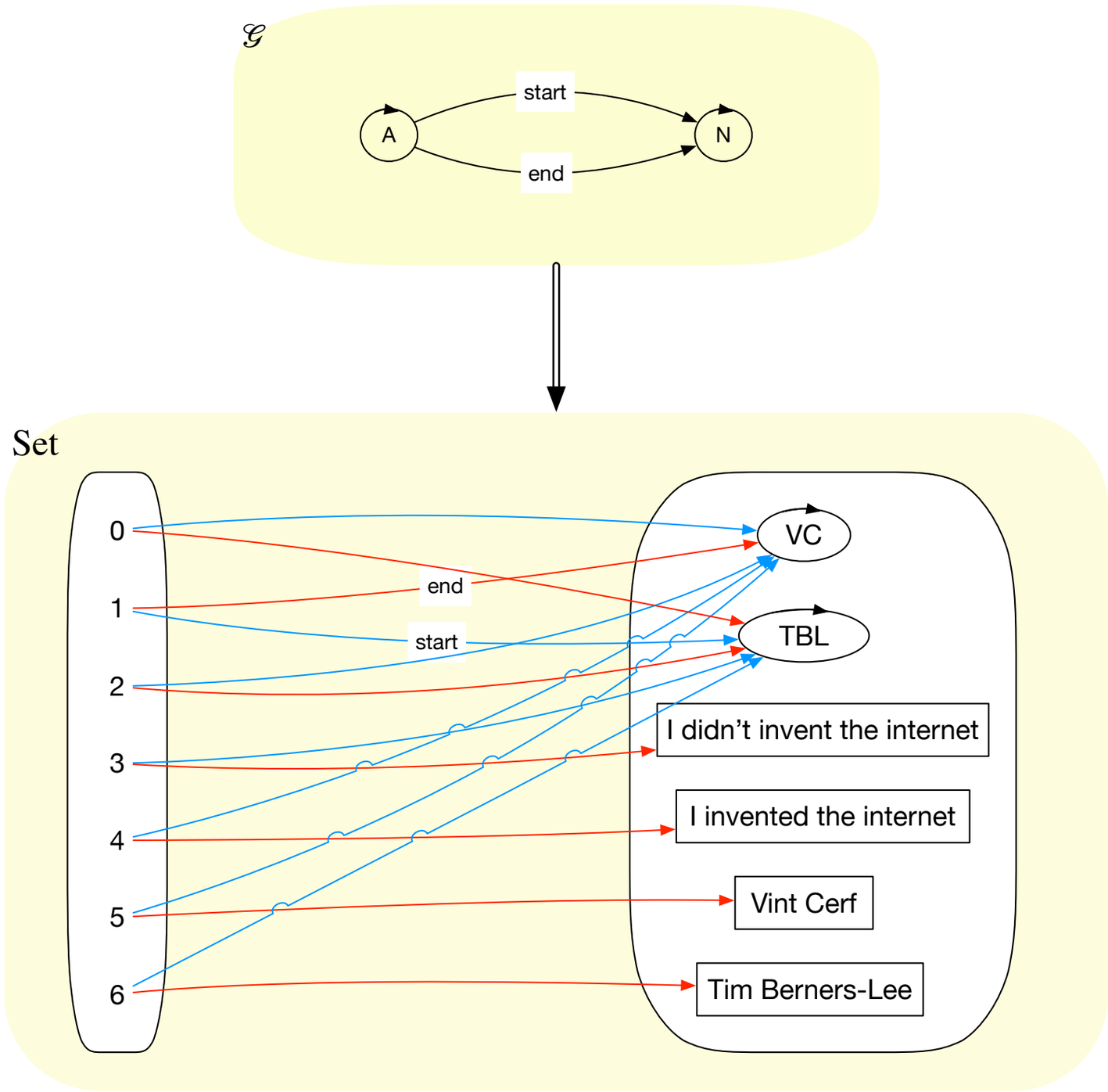
7 arrows between 4 nodes

Directed Graph (a.k.a Quiver)

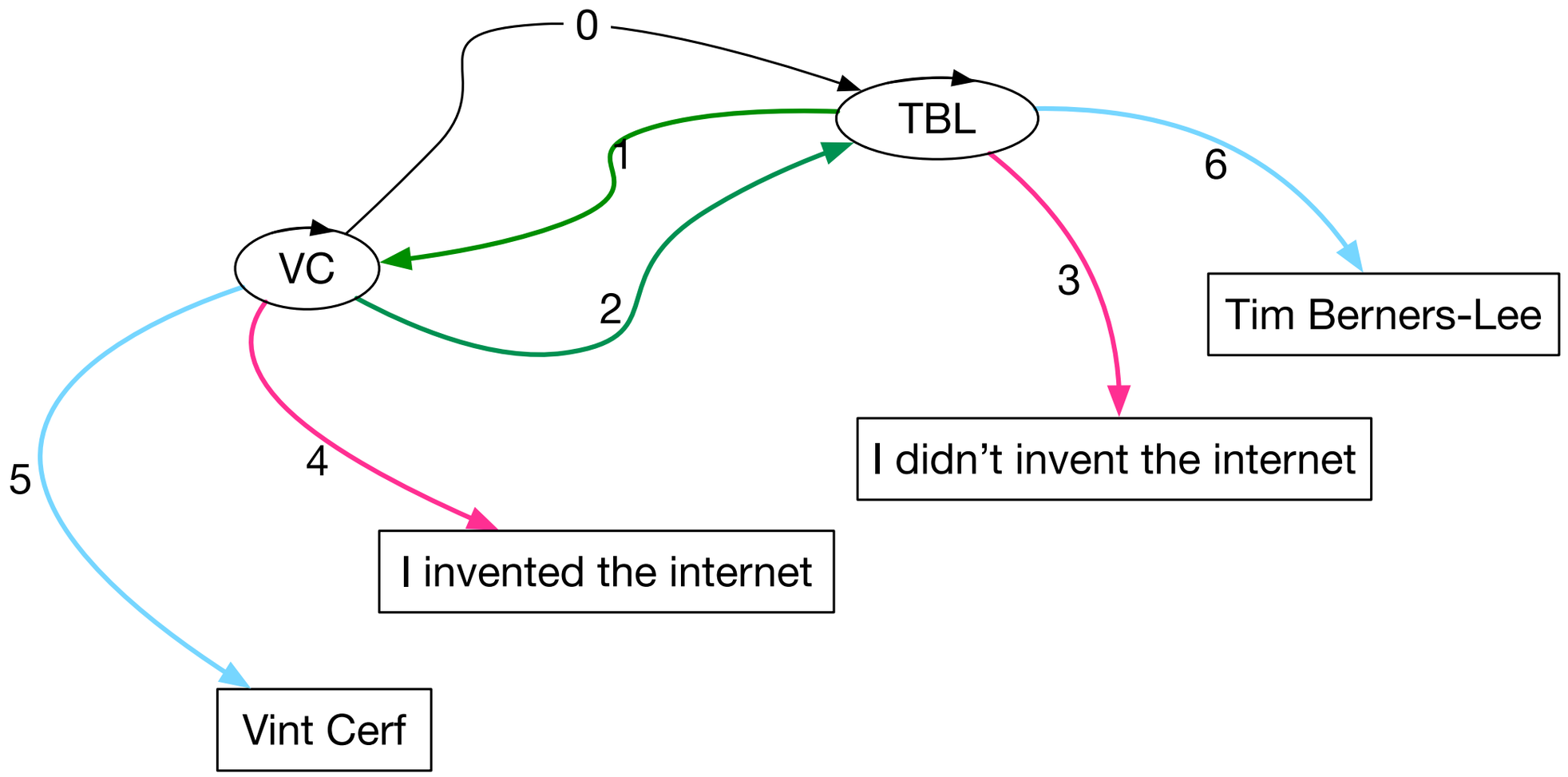


$$s, t : A \to N$$

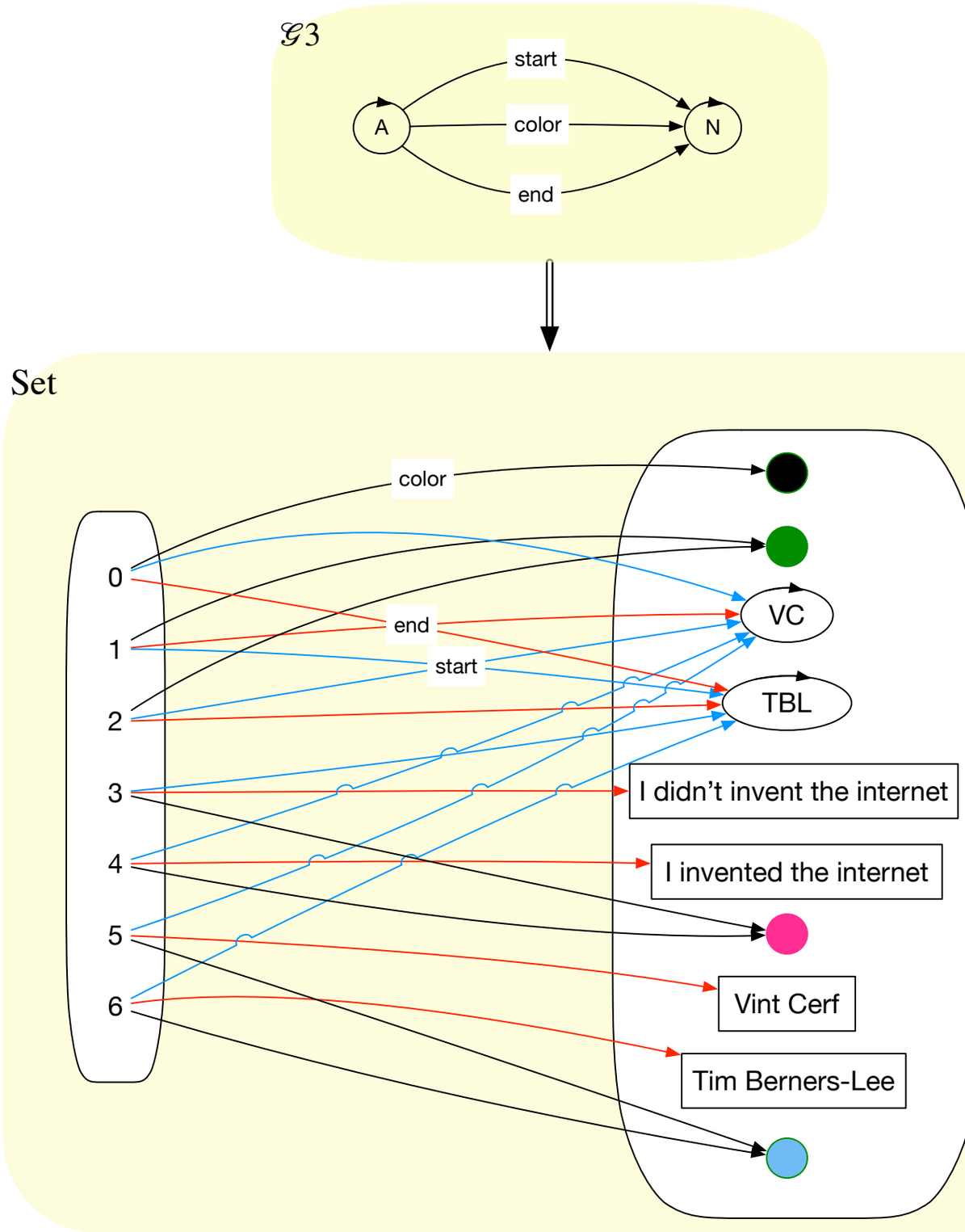
A Graph (aka Quiver) as a Functor from $\mathscr{G}$ to **Set**



Coloring the arrows



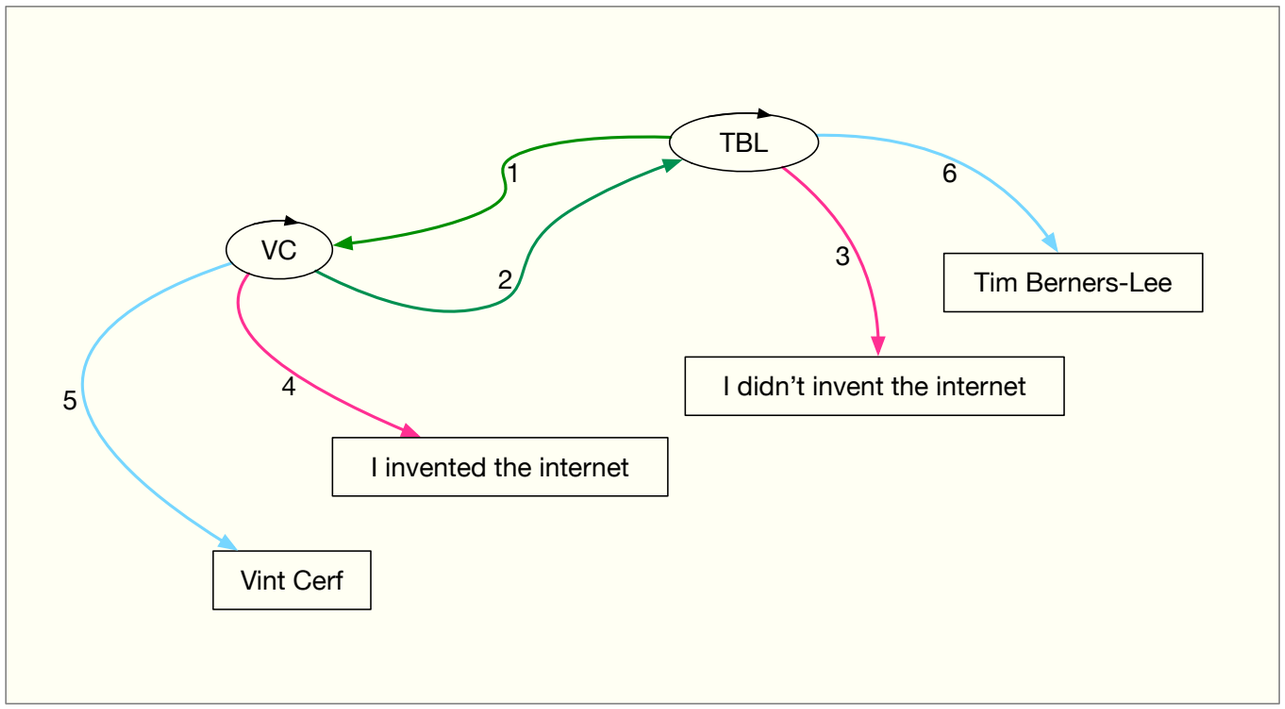
As a Functor from $\mathcal{G}3$ to **Set**



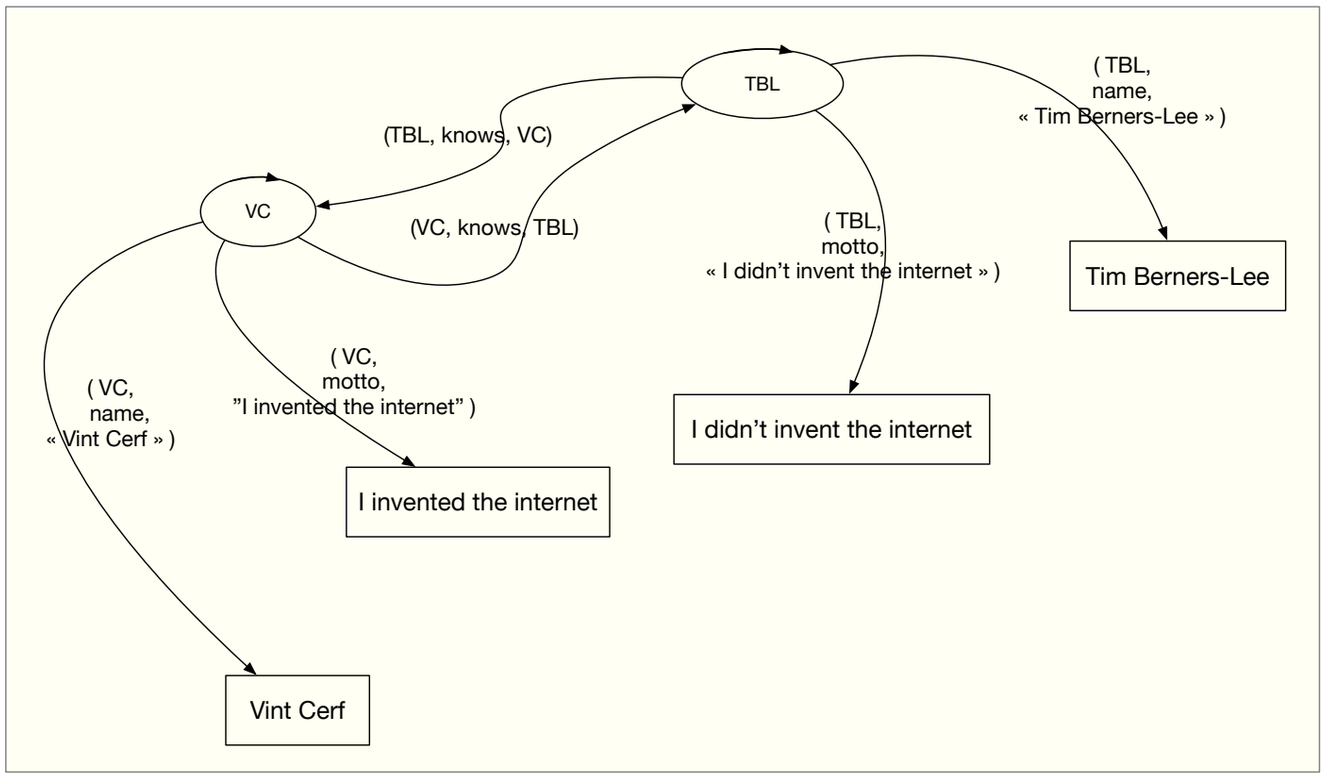
As a Table

A	subj	color	obj
1	TBL	●	VC
2	VC	●	TBL
3	TBL	●	”I didn’t invent the Internet”
4	VC	●	”I invented the Internet”
5	VC	●	”Vint Cerf”
6	TBL	●	”Tim Berners-Lee”

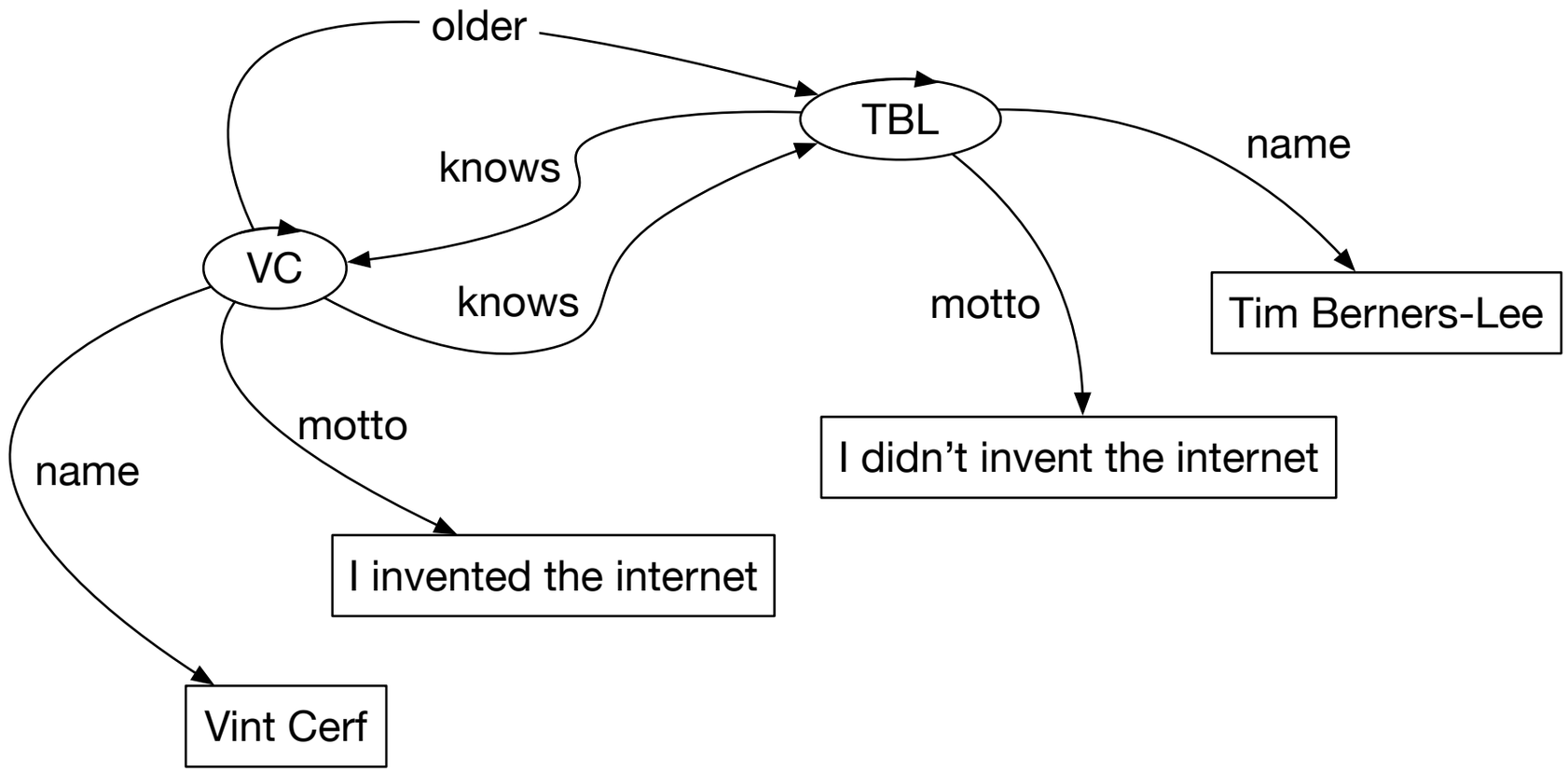
David Spivak
Ryan Wisnesky
Functorial DBs



A	subj	relationType	obj
0	VC	older	TBL
1	TBL	knows	VC
2	VC	knows	TBL
3	TBL	motto	”I didn’t invent the Internet”
4	VC	motto	”I invented the Internet”
5	VC	name	”Vint Cerf”
6	TBL	name	”Tim Berners-Lee”



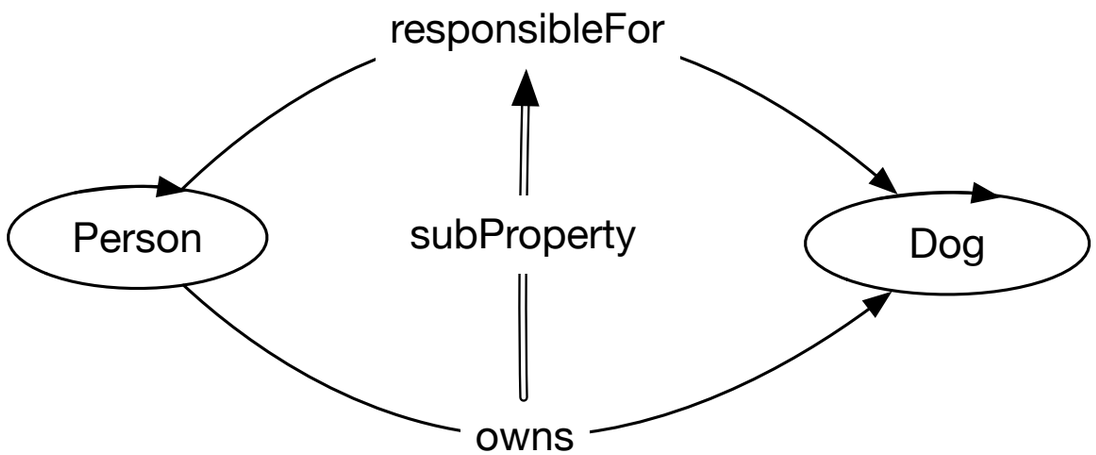
if we remove the duplication

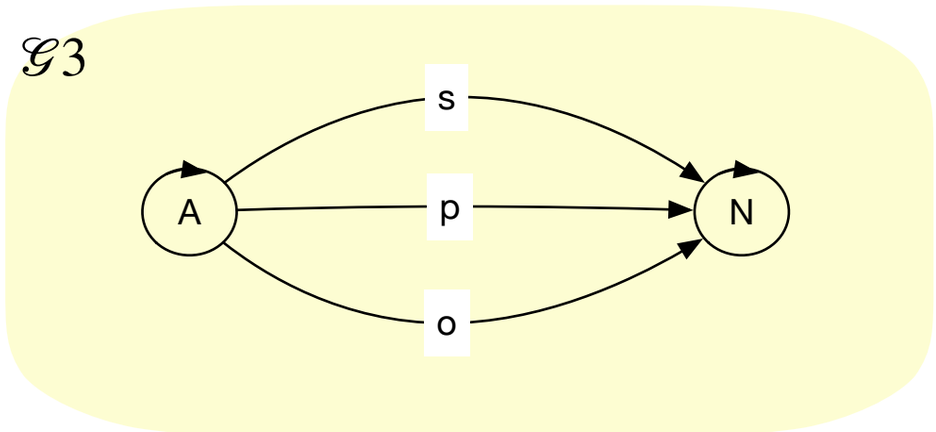


we get a cleaner graph representation
note: multiple arrows have the same name

Globes

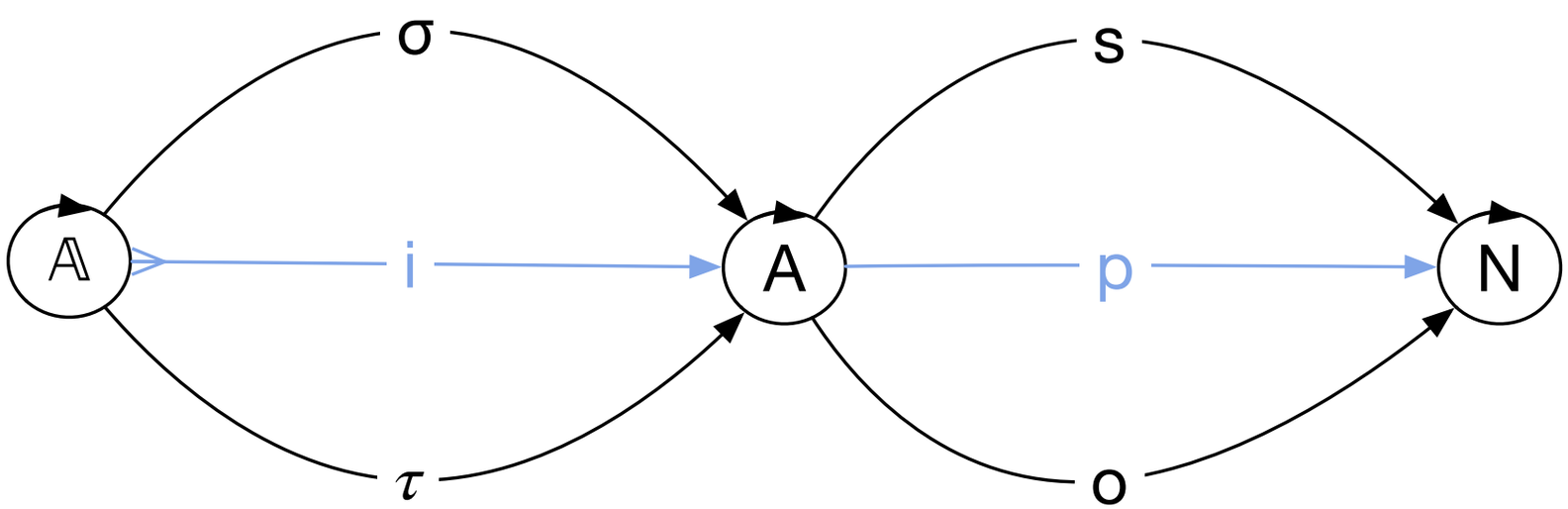
graphs with arrows between arrows





$$\sigma; s = \tau; s$$

$$\sigma; o = \tau; o$$



arXiv:1706.00526v2 [cs.AI] 1 Nov 2017

Knowledge Representation in Bicategories of Relations

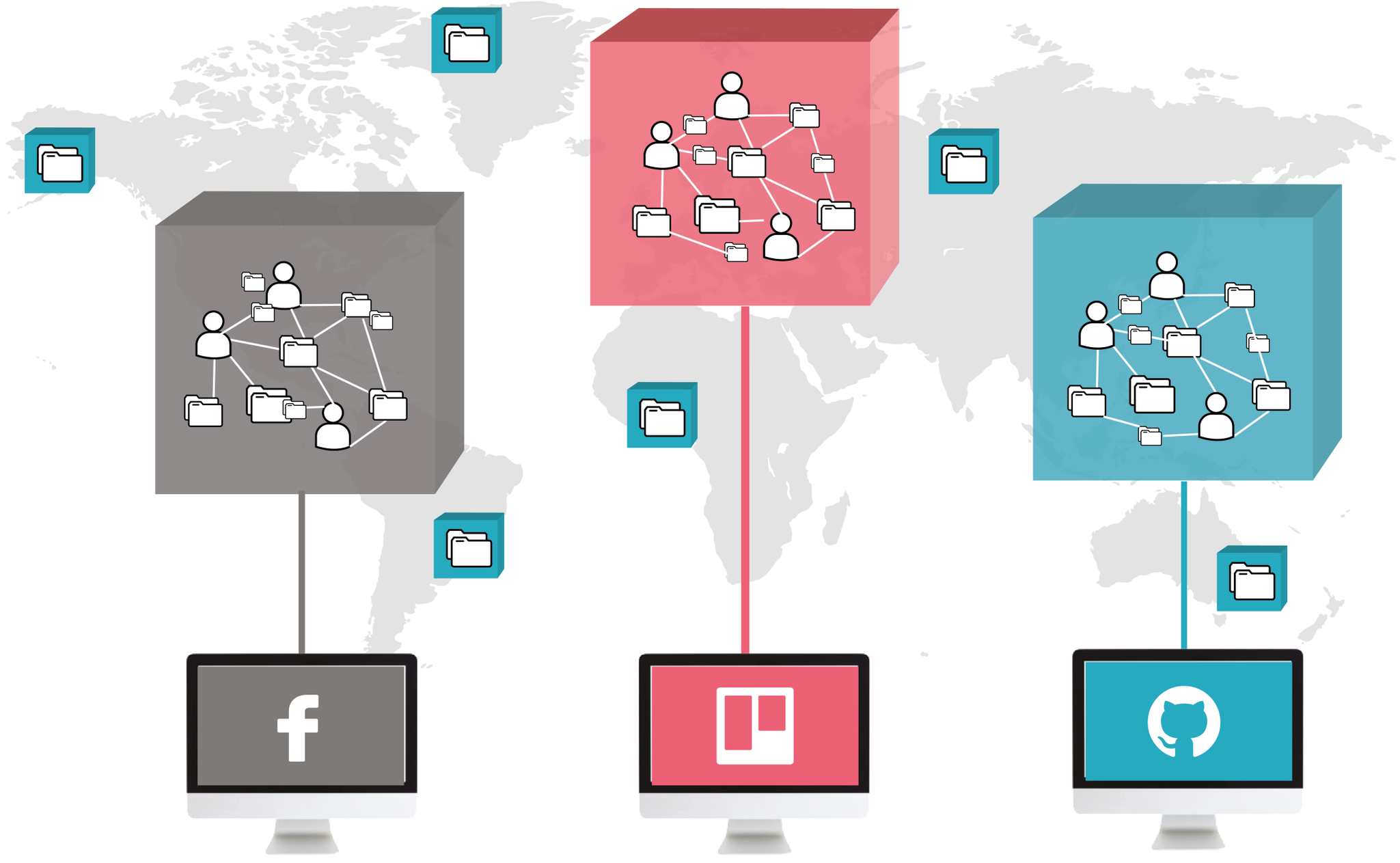
Evan Patterson
Department of Statistics, Stanford University

Abstract

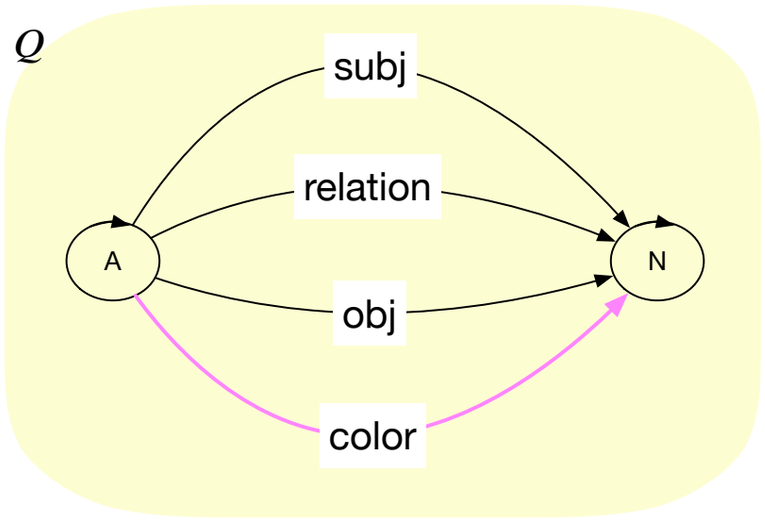
We introduce the *relational ontology log*, or *relational olog*, a knowledge representation system based on the category of sets and relations. It is inspired by Spivak and Kent's *olog*, a recent categorical framework for knowledge representation. Relational ologs interpolate between ologs and description logic, the dominant formalism for knowledge representation today. In this paper, we investigate relational ologs both for their own sake and to gain insight into the relationship between the algebraic and logical approaches to knowledge representation. On a practical level, we show by example that relational ologs have a friendly and intuitive—yet fully precise—graphical syntax, derived from the string diagrams of monoidal categories. We explain several other useful features of relational ologs not possessed by most description logics, such as a *type system* and a rich, flexible notion of *instance data*. In a more theoretical vein, we draw on categorical logic to show how relational ologs can be translated to and from logical theories in a fragment of first-order logic. Although we make extensive use of categorical language, this paper is designed to be self-contained and has considerable expository content. The only prerequisites are knowledge of first-order logic and the rudiments of category theory.

1. Introduction

But we still end up with siloed apps

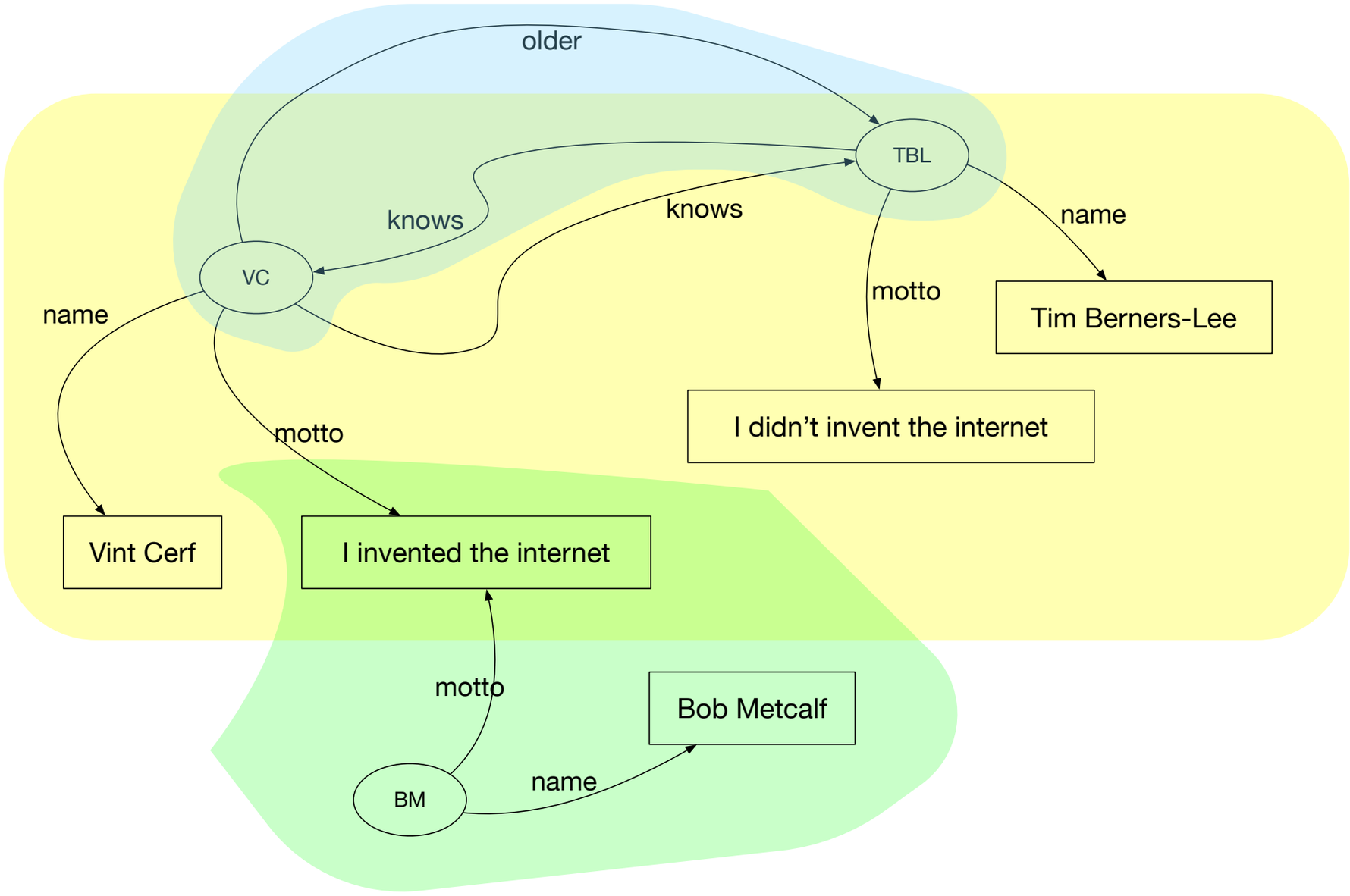


why, we'll see next

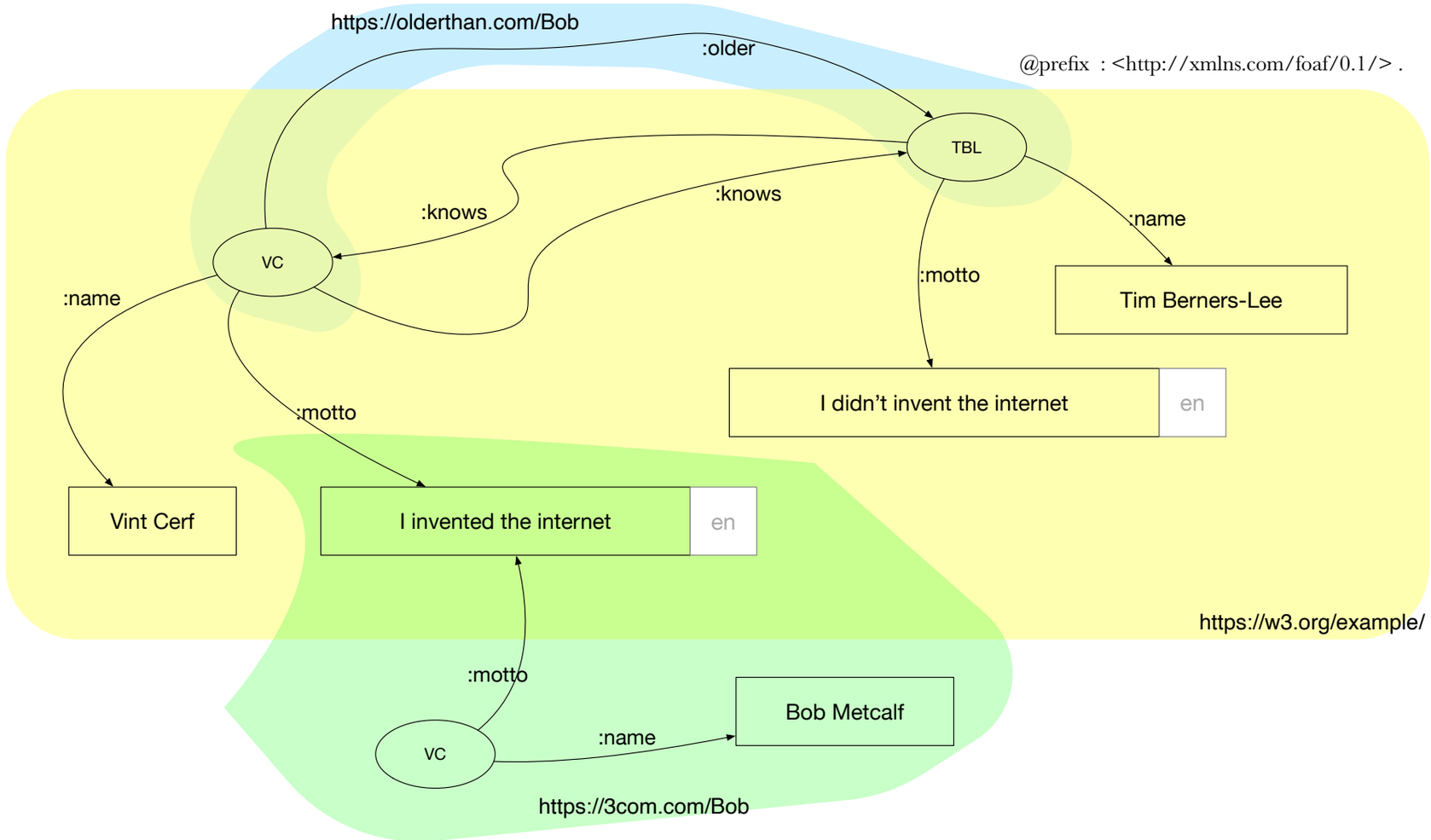


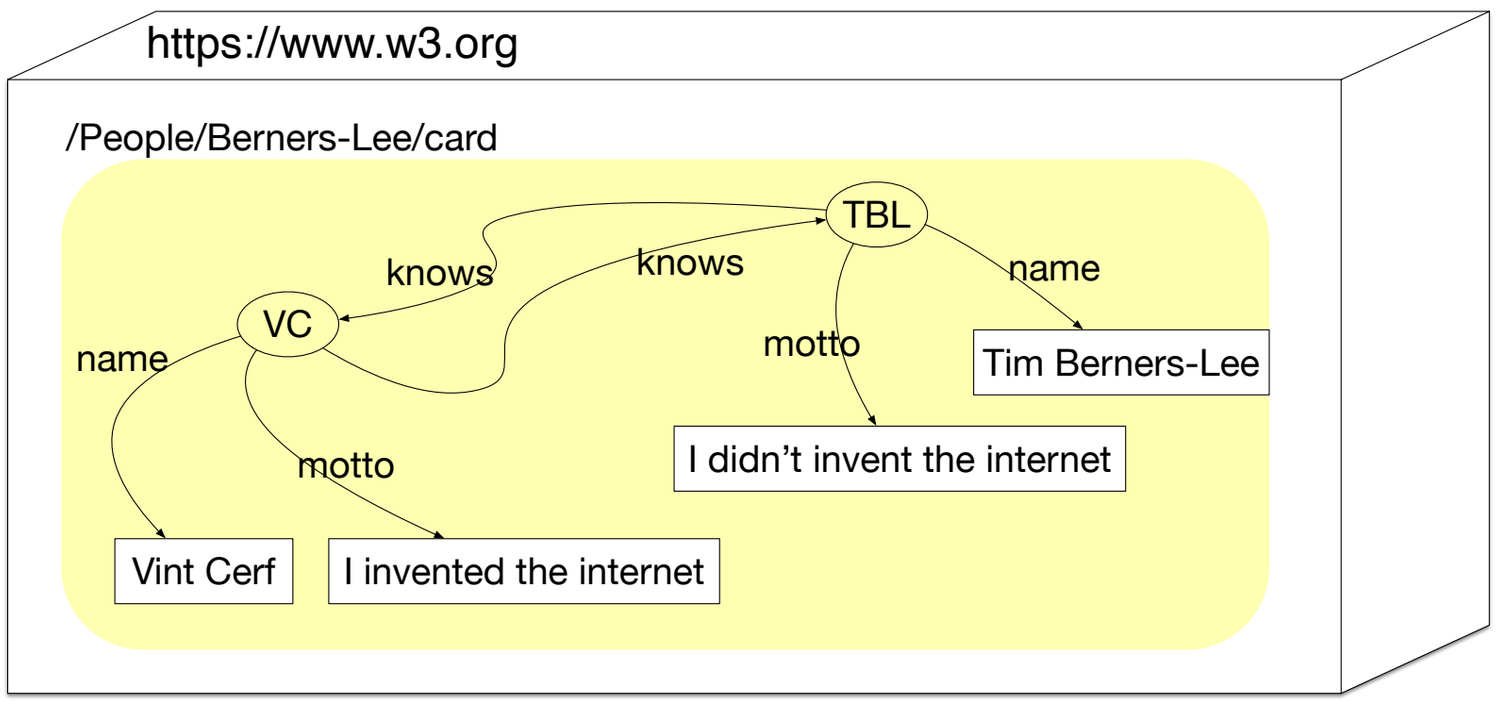
A	subj	relation	obj	color
0	VC	:older	TBL	
1	TBL	:knows	VC	
2	VC	:knows	TBL	
3	TBL	:motto	”I didn’t invent the Internet”	
4	VC	:motto	”I invented the Internet”	
5	VC	:name	”Vint Cerf”	
6	TBL	:name	”Tim Berners-Lee”	
7	BOB	:name	”Bob Metcalf”	
8	BOB	:motto	”I invented the Internet”	
9	BOB	:older	TBL	

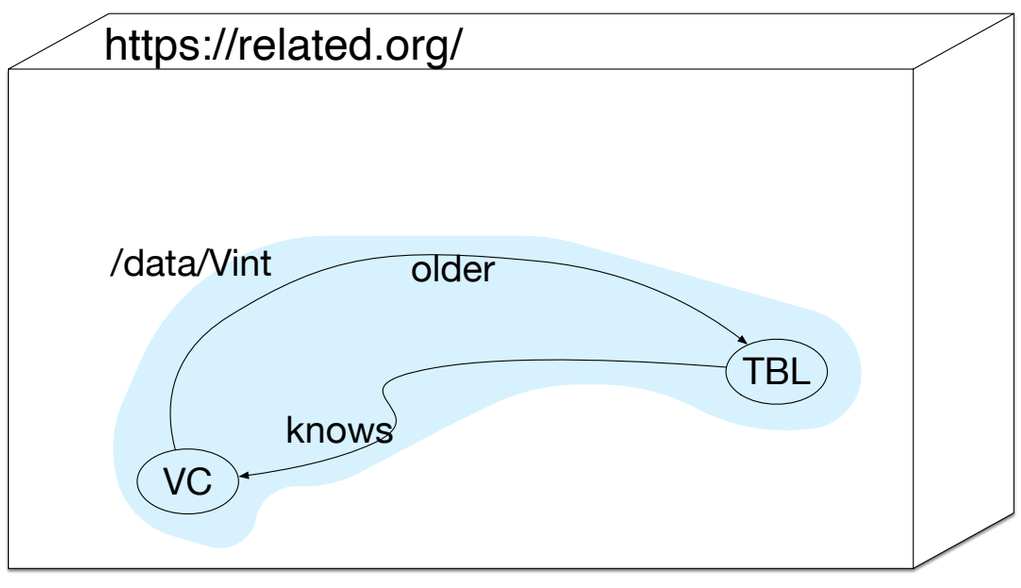
hypergraphs

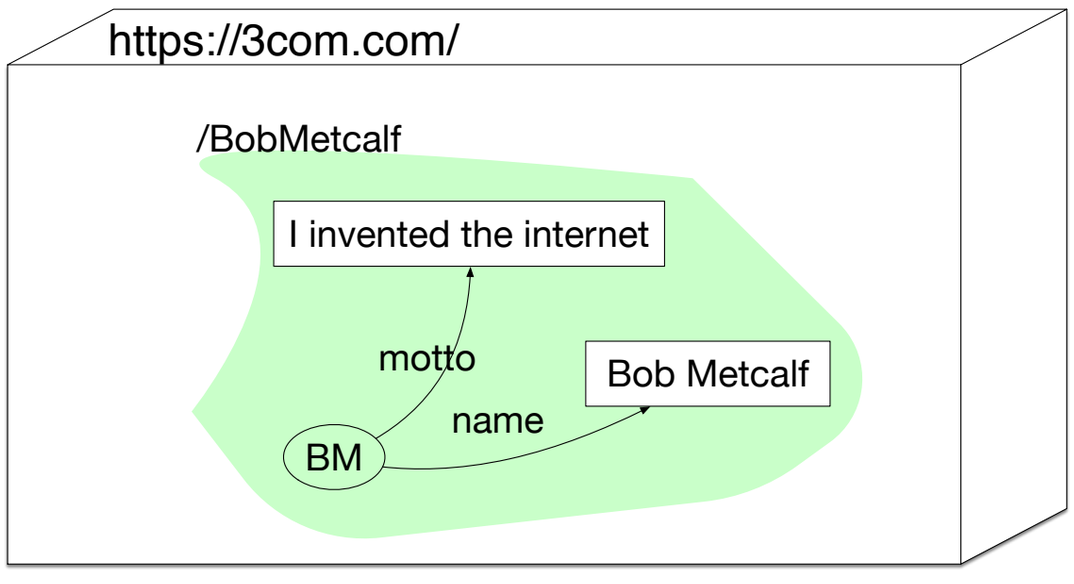


A	subj	relation	obj	Graph Name
1	TBL	:knows	VC	https://w3.org/example/
2	VC	:knows	TBL	https://w3.org/example/
3	TBL	:motto	”I didn’t invent the Internet”	https://w3.org/example/
4	VC	:motto	”I invented the Internet”	https://w3.org/example/
5	VC	:name	”Vint Cerf”	https://w3.org/example/
6	TBL	:name	”Tim Berners-Lee”	https://w3.org/example/
7	BOB	:name	”Bob Metcalf”	https://3com.com/Bob
8	BOB	:motto	”I invented the Internet”	https://3com.com/Bob
9	BOB	:older	TBL	https://olderthan.com/Bob




https://www.w3.org
/People/Berners-Lee/card
TBL
knows
knows
name
VC
name
motto
Tim Berners-Lee
I didn’t invent the internet
motto
Vint Cerf
I invented the internet


https://related.org/
/data/Vint
older
TBL
knows
VC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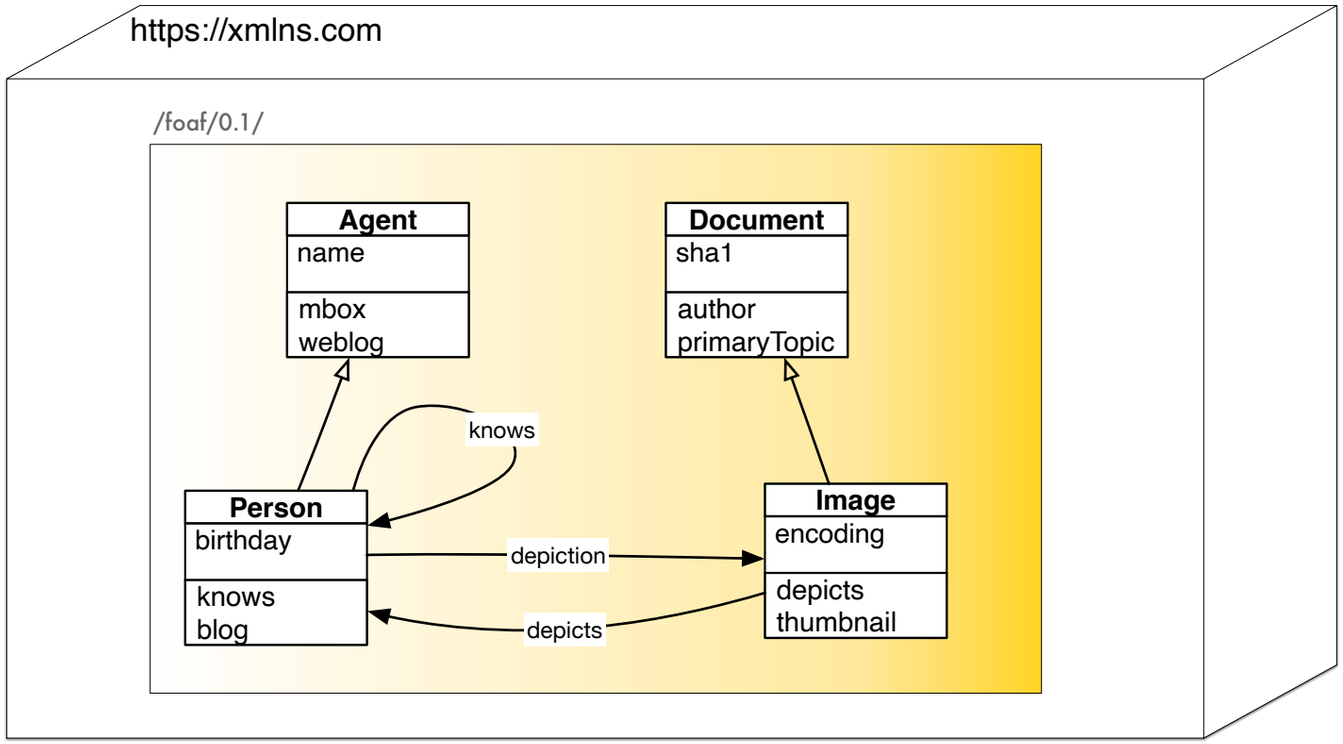
/BobMetcalf
I invented the internet
motto
Bob Metcalf
name
BM


https://xmlns.com
/foaf/0.1/
Agent
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mbox
weblog
Document
sha1
author
primaryTopic
knows
Person
birthday
knows
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depiction
depicts
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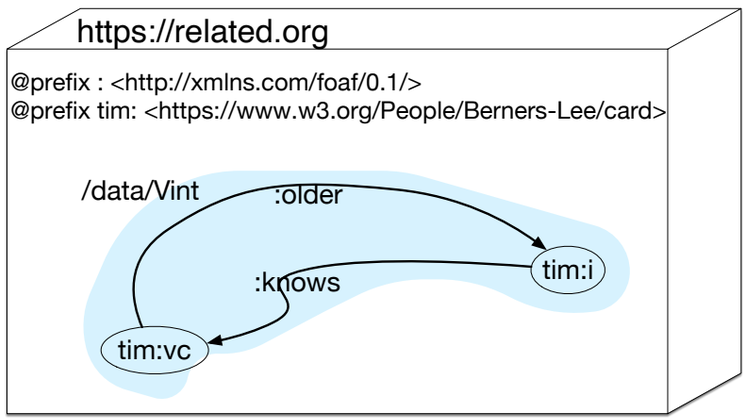
encoding
depicts
thumbnail


https://related.org
@prefix : <http://xmlns.com/foaf/0.1/>
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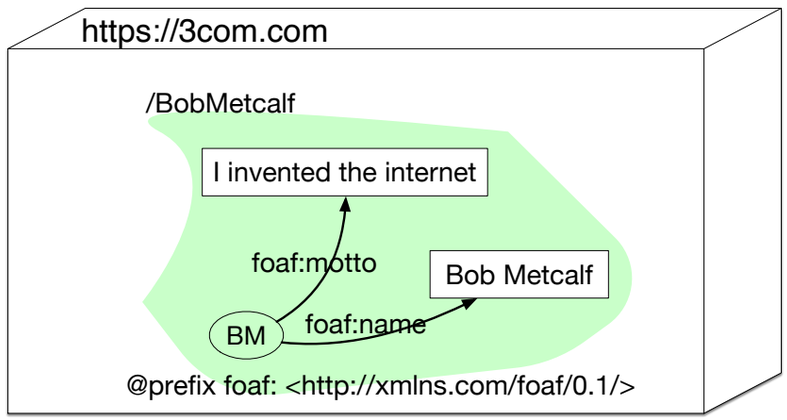
/data/Vint
:older
tim:i
:knows
tim:vc


https://3com.com
/BobMetcalf
I invented the internet
foaf:motto
Bob Metcalf
BM
foaf:name
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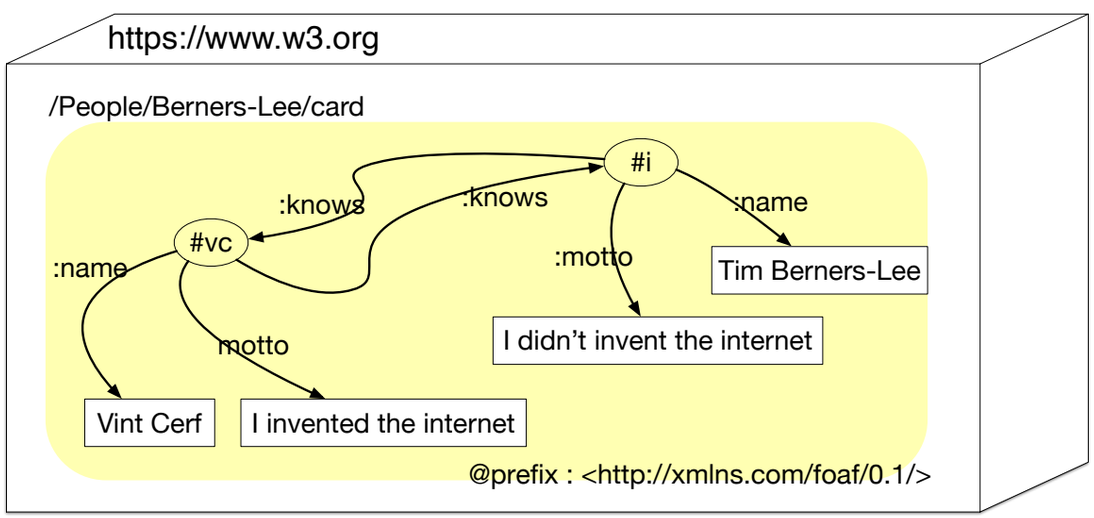
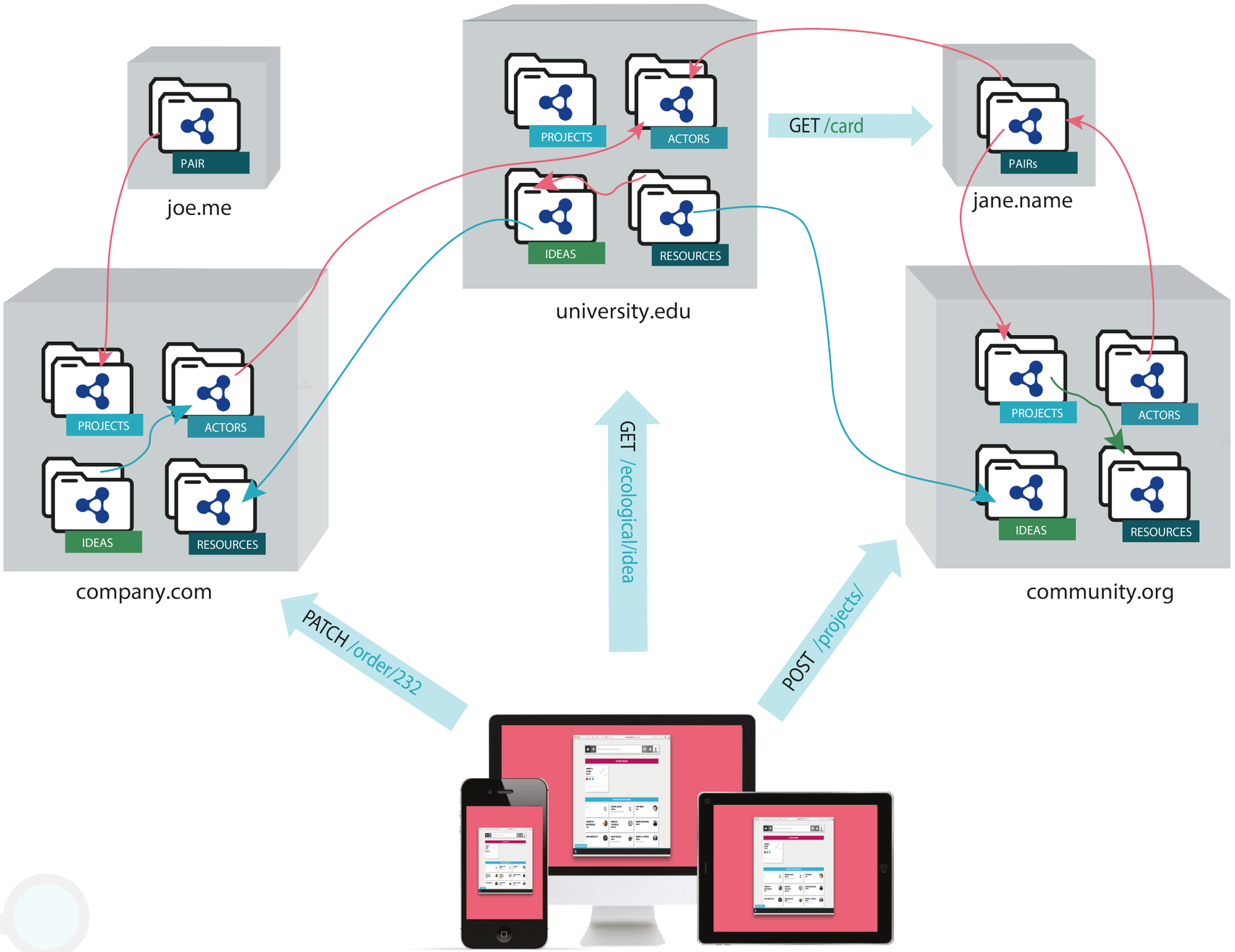

https://www.w3.org
/People/Berners-Lee/card
#i
:knows
:knows
:name
#vc
:name
:motto
Tim Berners-Lee
I didn't invent the internet
motto
Vint Cerf
I invented the internet
@prefix : <http://xmlns.com/foaf/0.1/>


PAIR
joe.me
PROJECTS
ACTORS
IDEAS
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university.edu
GET /card
PAIRs
jane.name
PROJECTS
ACTORS
IDEAS
RESOURCES
company.com
community.org
GET /ecological/idea
PATCH /order/232
POST /projects/

SOCIAL LAYER

collaboration & knowledge sharing of projects, ideas, actors, resources (PAIR)

HUMAN INTERFACE

Interoperable & co-operative Applications build on Linked Data

LINKED DATA WEB

Linked Data, Ontologies such as FOAF, “PAIR” - Projects, Actors, Ideas & Resources...

SOCIAL LINKED DATA SERVER

(SoLiD- Social Linked Data, HTTP, LDP, WebID, Web ACL, Blockchain...)

OPEN HARDWARE & OPERATING SYSTEM

e.g. Freedom Box (hardware drivers, TCP/IP, TOR, I2P...)

https://web-cats.gitlab.io/

Twitter: @bblfish

https://solidproject.org/