I 202: Information Organization & Retrieval Fall 2025

Class 8: Ontologies; Tags vs Faceted Categories

Today's Outline

- Ontology Definition
- Ontology Examples
- AI-based Ontologies
- Tags vs Faceted Categories
- Upcoming Assignment

Exercise:
Create Faceted Metadata for this Image

Photo by J. Hearst, jhearst.typead.com

Faceted Metadata Limitation: Shows Attributes, but not **Relations between Attributes**

Photo by J. Hearst, jhearst.typead.com

Aquamarine
Red
Orange

Door
Doorway
Wall

- Does not show which color is associated with which object
- Ontologies can help with this limitation

What Is an Ontology?

Gr: *onto*: being, *logy*: science, study-of

- An information structure that often includes **relationships, constraints, and rules.**
- A method for describing **knowledge** in such a way that it can be process by a computer.
- The branch of metaphysics dealing with the nature of being (we are not using this sense of the word)

Jean-Baptiste, Ontologies with Python, O'Reilly, 2020
Oxford dictionary

https://www.forbes.com/sites/cognitiveworld/2019/03/24/taxonomies-vs-ontologies

Taxonomy vs Ontology

Taxonomy

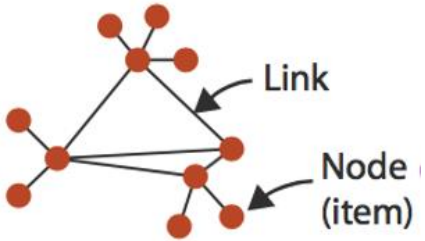
- Tree / Hierarchical in structure
- Relation is consistent throughout and signifies inclusion
  - *(type-of, part-of)*

Ontology

- Graph / Network in structure
- Relations can link objects to each other *without* inclusion
- Relations can represent attributes
- Often includes rules and constraints

Tree vs. Network / Graph

tree

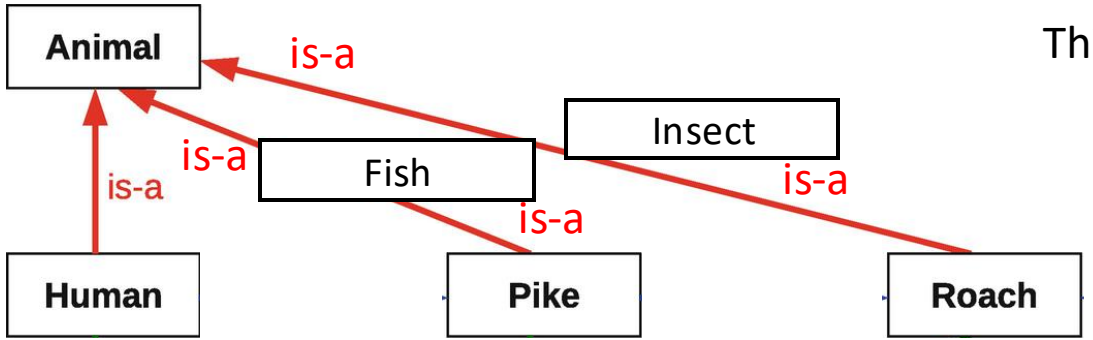


graph

BASIS FOR COMPARISON	TREE	GRAPH
Root node	It has exactly one root node.	Graph doesn't have a root node.
Cycles	No cycles are permitted.	Graph can have cycles.
Complexity	Less complex	More complex comparatively
Number of edges	n-1 (n = # of nodes)	Not defined
Model type	Hierarchical	Network

https://techdifferences.com/difference-between-tree-and-graph.html

Ontology Example: Inferences from a Taxonomy



This is a partial taxonomy

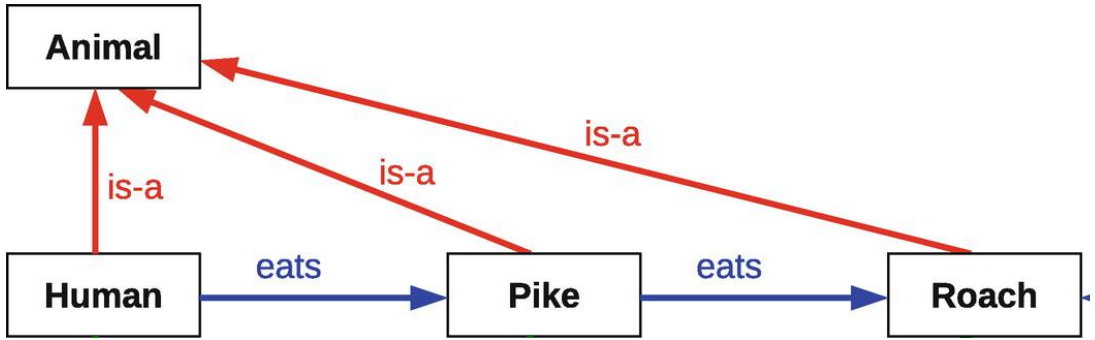
We can make inferences from taxonomies, using the implicit is-a rule:

$$isa(a, b)\ AND\ isa(b, c)\ \rightarrow isa(a, c)$$

In English:

A pike is a fish; a fish is an animal, therefore a pike is an animal.

Ontology Example
Relation Links Allow Additional Inferences



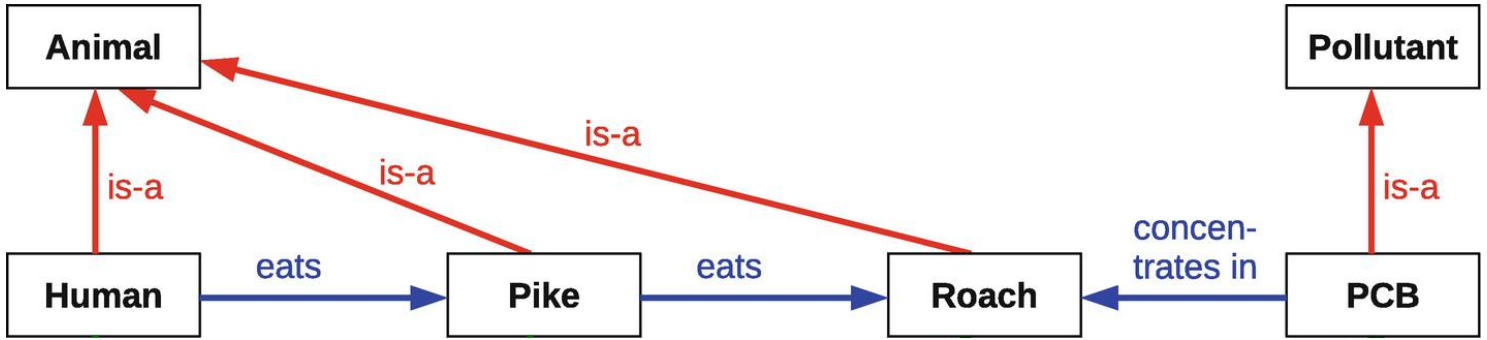
We've added eats() relation links; Now it is an ontology

We can now make new rule and inferences; create new knowledge

$$eats(a, b)\ AND\ eats(b, c) \rightarrow eats(a, c)$$

Humans (indirectly) eat roaches

Ontology Example: Adding More Inference Rules



More rules, more inferences

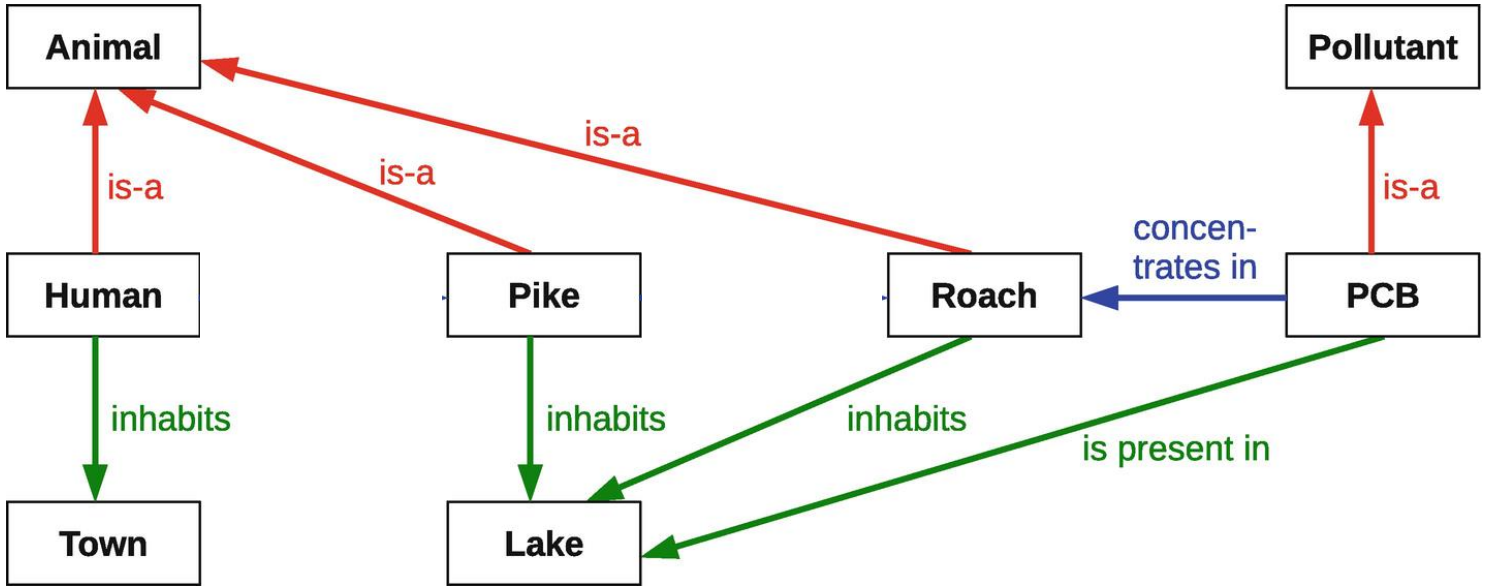
$$concentratedIn(p, a)\ AND\ eat(b, a) \rightarrow poisonedBy(b, p)$$

$$eats(a, b)\ AND\ eats(b, c)\ \rightarrow eats(a, c)$$

Can conclude:
Pike poisonedBy PCB, therefore
Human poisonedBy PCB

Jean-Baptiste, Ontologies with Python, O'Reilly, 2020

Ontology Example: Add more Relation Types



Ontology Example: IMDB

IMDb

Movies

- Release Calendar
- DVD & Blu-ray Releases
- Top Rated Movies
- Most Popular Movies
- Browse Movies by Genre
- Top Box Office
- Showtimes & Tickets
- In Theaters
- Coming Soon
- Movie News
- India Movie Spotlight

TV Shows

- What's on TV & Streaming
- Top Rated Shows
- Most Popular Shows
- Browse TV Shows by Genre
- TV News
- India TV Spotlight

Watch

- What to Watch
- Latest Trailers
- IMDb TV
- IMDb Originals
- IMDb Picks
- IMDb Podcasts

Awards & Events

- Oscars
- Best Picture Winners
- Golden Globes
- Emmys
- San Diego Comic-Con
- New York Comic-Con
- Sundance Film Festival
- Toronto Int'l Film Festival
- Awards Central
- Festival Central
- All Events

Celebs

- Born Today
- Most Popular Celebs
- Celebrity News

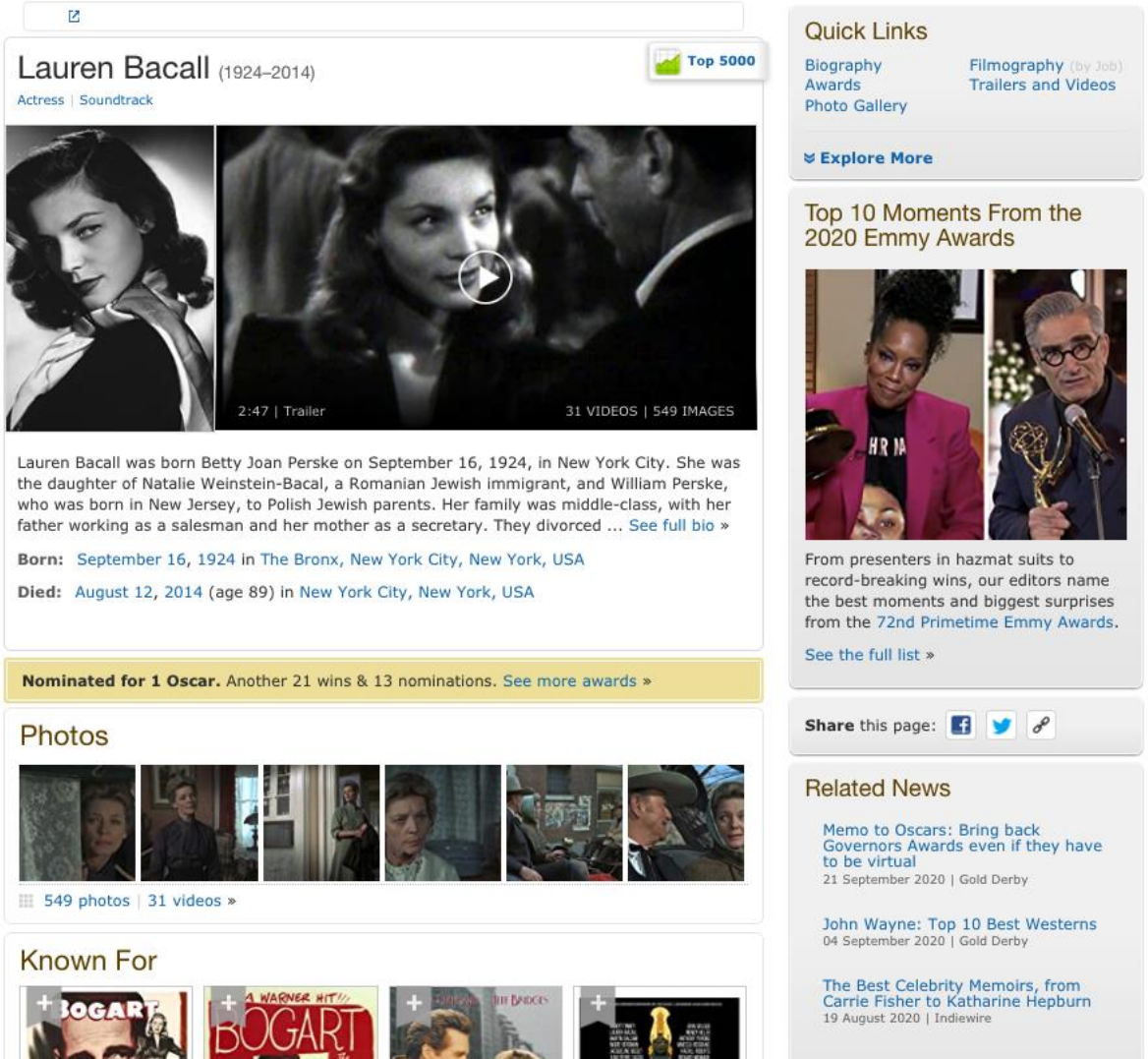
Community

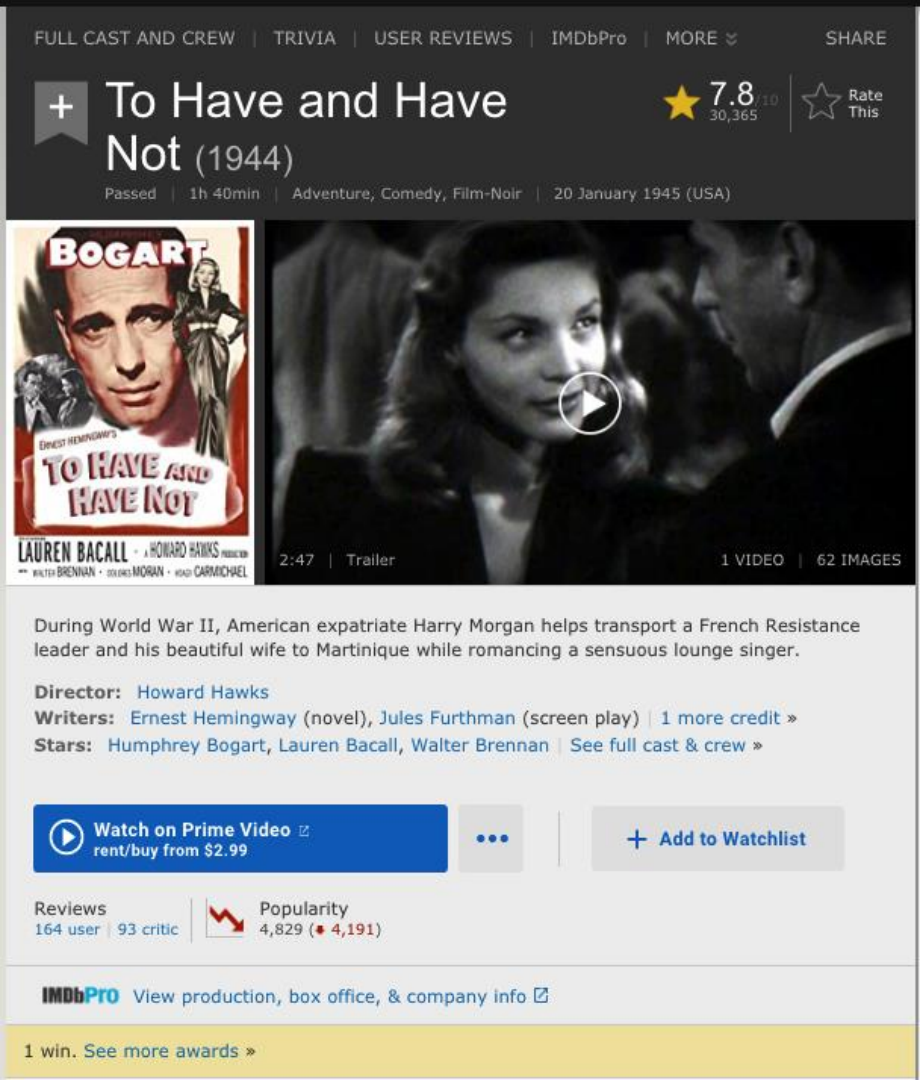
- Help Center
- Contributor Zone
- Polls

IMDB Entry: **Actor**

Many relation types!

- Acted in
- Photos of
- Biography of
- Known for
- Related News
- All actors born on Sept 16
- All actors born in 1924
- All actors with same astrological sign
- Nicknames
- Quotes



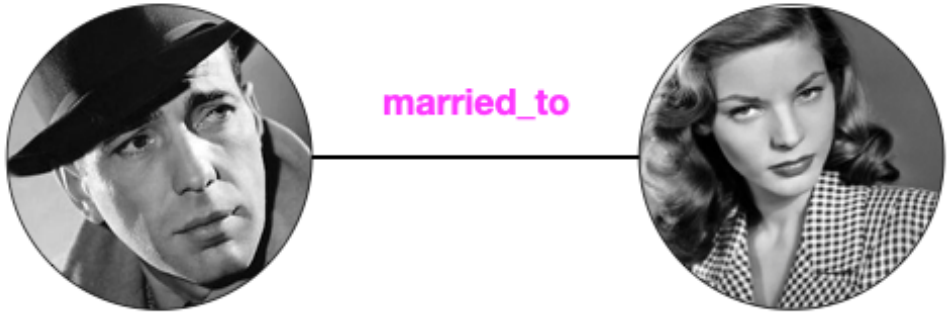


IMDB Entry: **Performance**

Many relation types!

- Directors
- Writers
- Actors
- Screenwriters
- Awards
- Reviews
- Box office statistics
- Videos
- Photos
- Plot
- Quotes
- Soundtracks

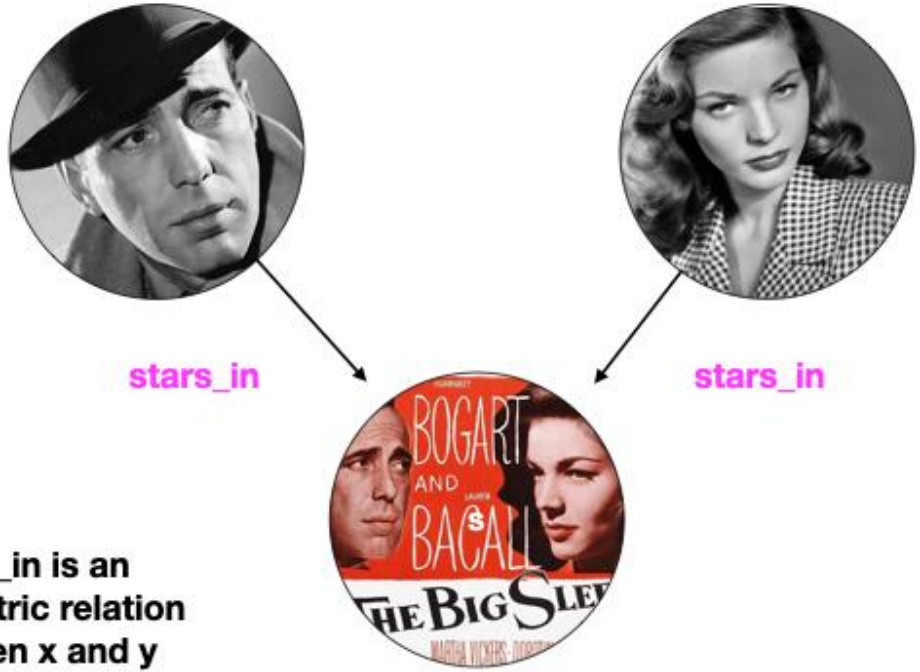
IMDB



married_to(x,y) is a symmetric relation that holds between “resources”

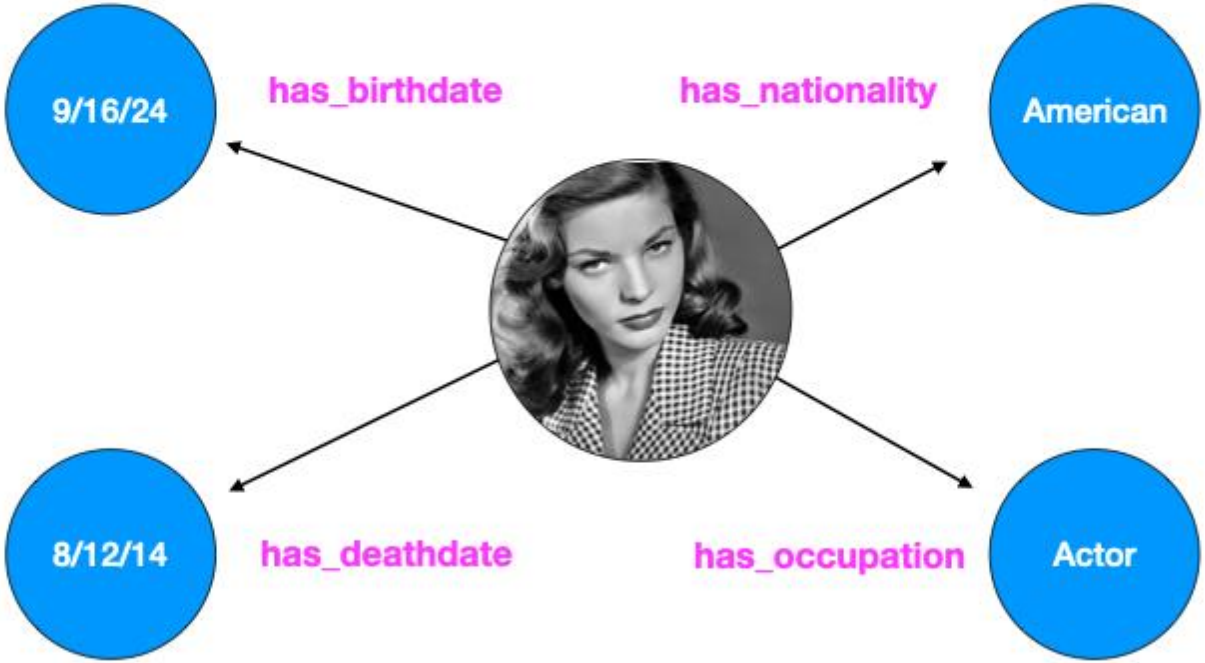
married_to(x,y) = married_to(y,x)

IMDB



stars_in is an asymmetric relation between x and y

IMDB


9/16/24
has_birthdate
has_nationality
American
8/12/14
has_deathdate
has_occupation
Actor

Uses for Digital Ontologies

- **Store and re-use knowledge**
  - *WordNet (will see next week)*
- **Link Knowledge Across Different Sources**
  - *Semantic Web*
  - *Knowledge Graphs*
- **Automated Reasoning**
  - *Formal logic, theorem provers, inference engines*
  - *HermiT OWL reasoner, Pellet reasoner*
  - *Graph-based Neural Net reasoning*

Understanding & Navigating Ontologies

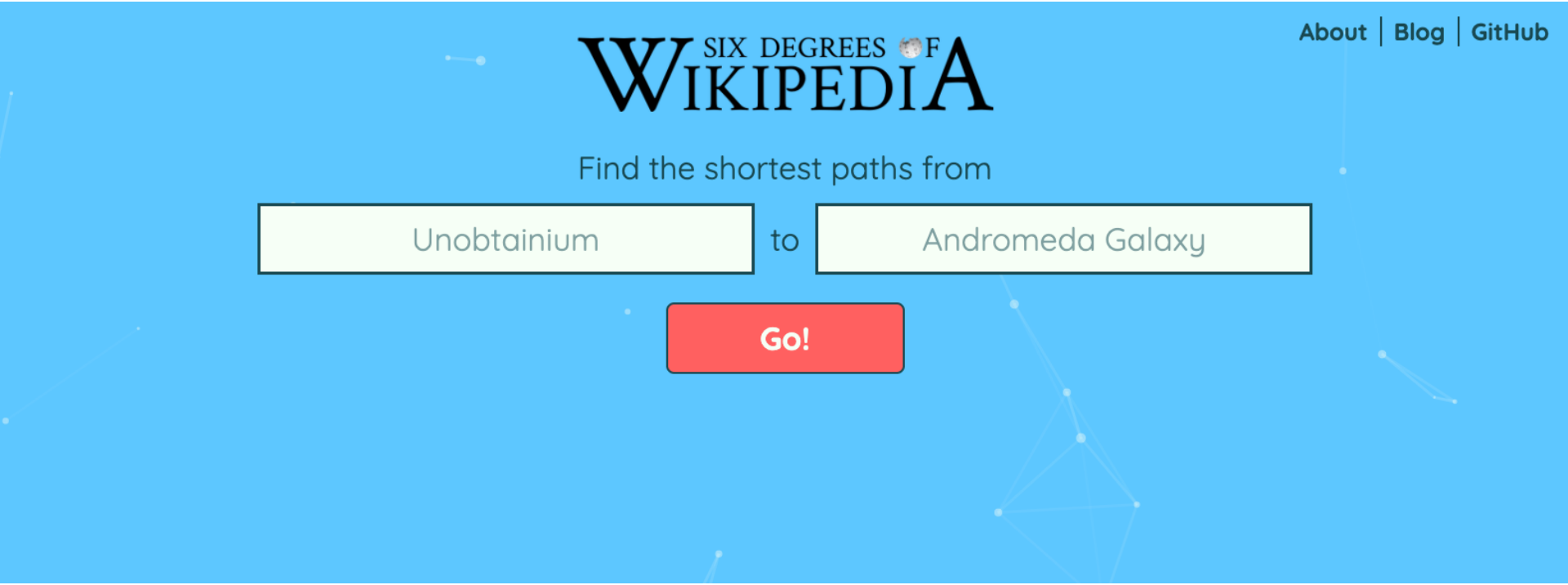
- Ontologies are difficult to show visually
- They are also difficult to convey how to navigate
- Most websites provide a simplified view
- Inference is not usually done where users can see it, but instead used behind the scenes to generate information
- Inference is usually much slower than what a relational database can do equivalently

Exercise: Linked-in

- What are the relations?
- What inferences can be done with them?
- How does the interface express these?

Inferring Ontologies from Data

- We can impose connections by following links
- The “6 degrees of Kevin Bacon game”
- Play it with Wikipedia links to find new knowledge



https://www.sixdegreesofwikipedia.com/

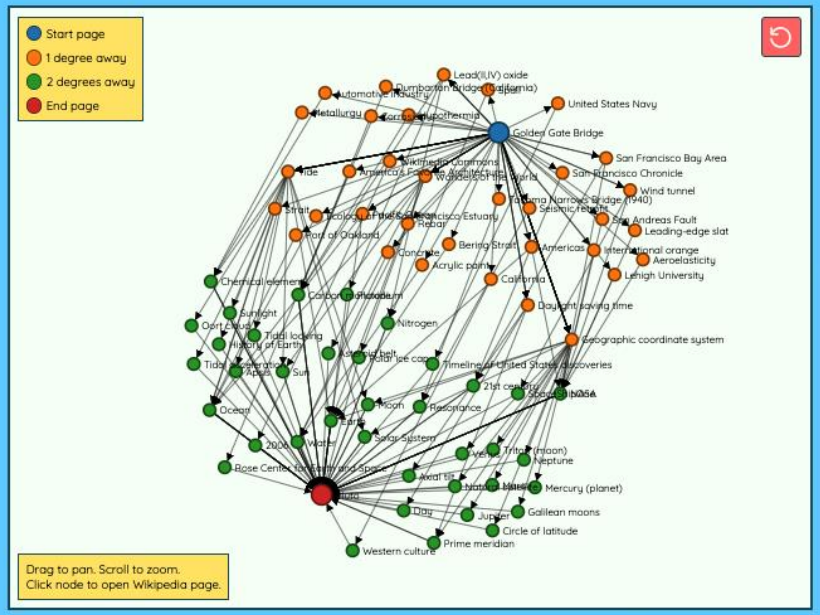
Find the shortest paths from

golden gate bridge ⇄ pluto

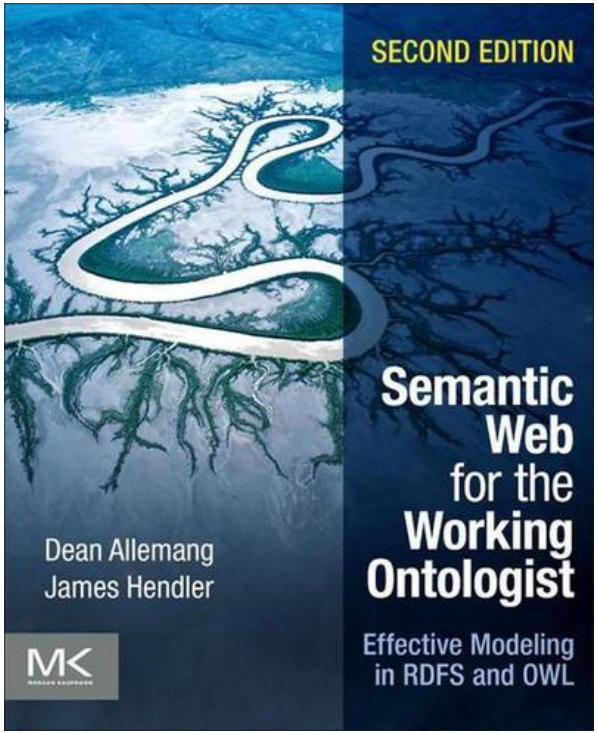
Go!

Found **69 paths** with **3 degrees** of separation from **Golden Gate Bridge** to **Pluto** in **3.53 seconds!**

Tweet result



The Semantic Web

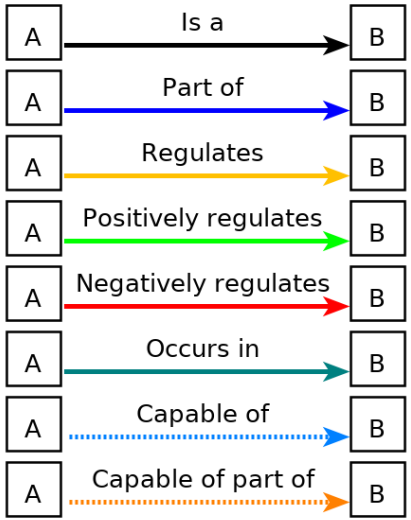


- Goal: support a distributed Web at the level of the data rather than at the level of the presentation.
- A data item can point to another, using global references called Uniform Resource Identifiers (URIs).
- Information about an entity can be distributed over the entire web.
- A way to achieve inter-operability
- Lots of people work on it, but it doesn't seem to ever really take off in practical applications

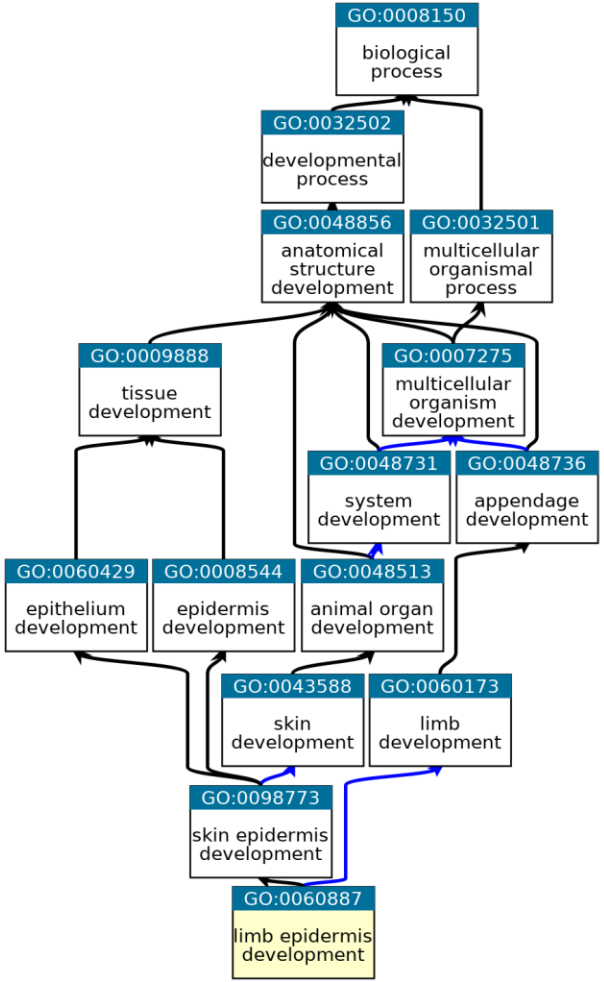
Allemang & Hendler, Semantic Web for the Working Ontologist, O'Reilly, 2nd edition, 2011

Gene Ontology (GO)

- Annotates gene function: molecular function, cellular components, biological processes
- Under active development for > 25 years!
- 40,000 terms
- 134,000 relations
- >9M annotated gene products



Go Ontology Example



QuickGO - https://www.ebi.ac.uk/QuickGO

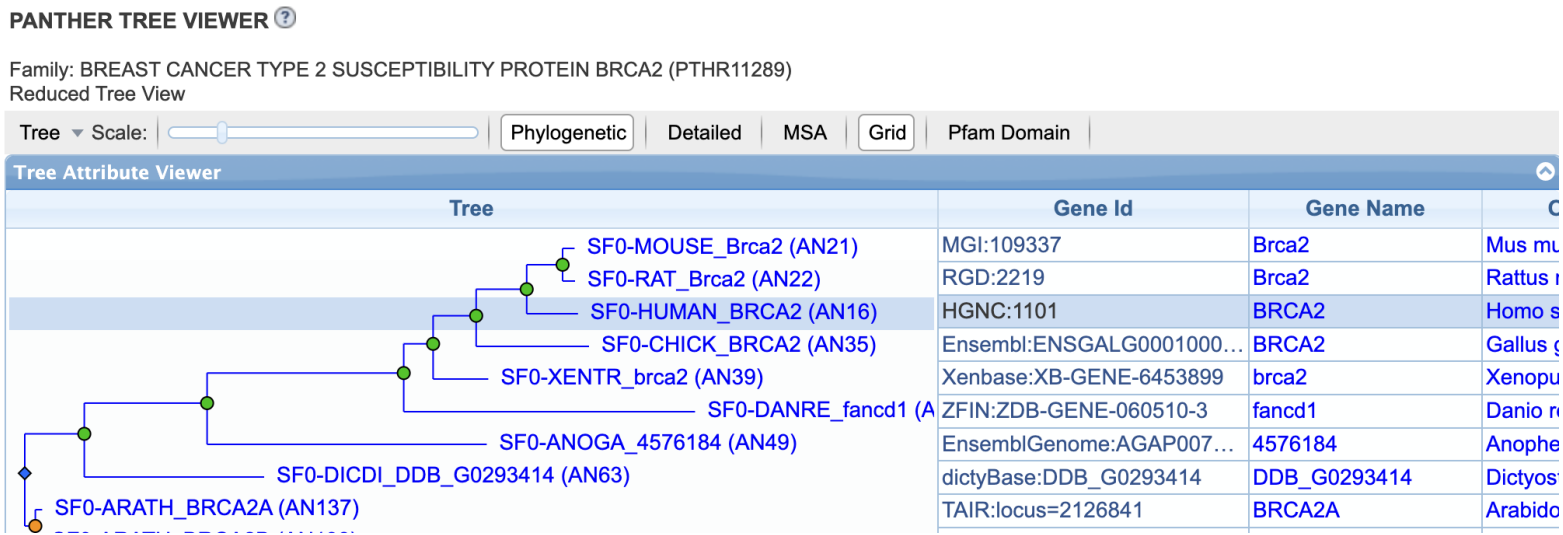
Taxon Constraints

The use of this term should conform to the following taxon constraints:

Ancestor GO ID	Ancestor GO Term Name	Relationship	Taxon ID	Taxon
GO:0008544	epidermis development	Never in Taxon	33090	Viridiplantae
GO:0009888	tissue development	Never in Taxon	147554	Schizosaccharomycetes
GO:0009888	tissue development	Never in Taxon	33630	Alveolata
GO:0009888	tissue development	Never in Taxon	33682	Euglenozoa
GO:0009888	tissue development	Never in Taxon	38254	Glaucocystophyceae
GO:0009888	tissue development	Never in Taxon	4891	Saccharomycetes

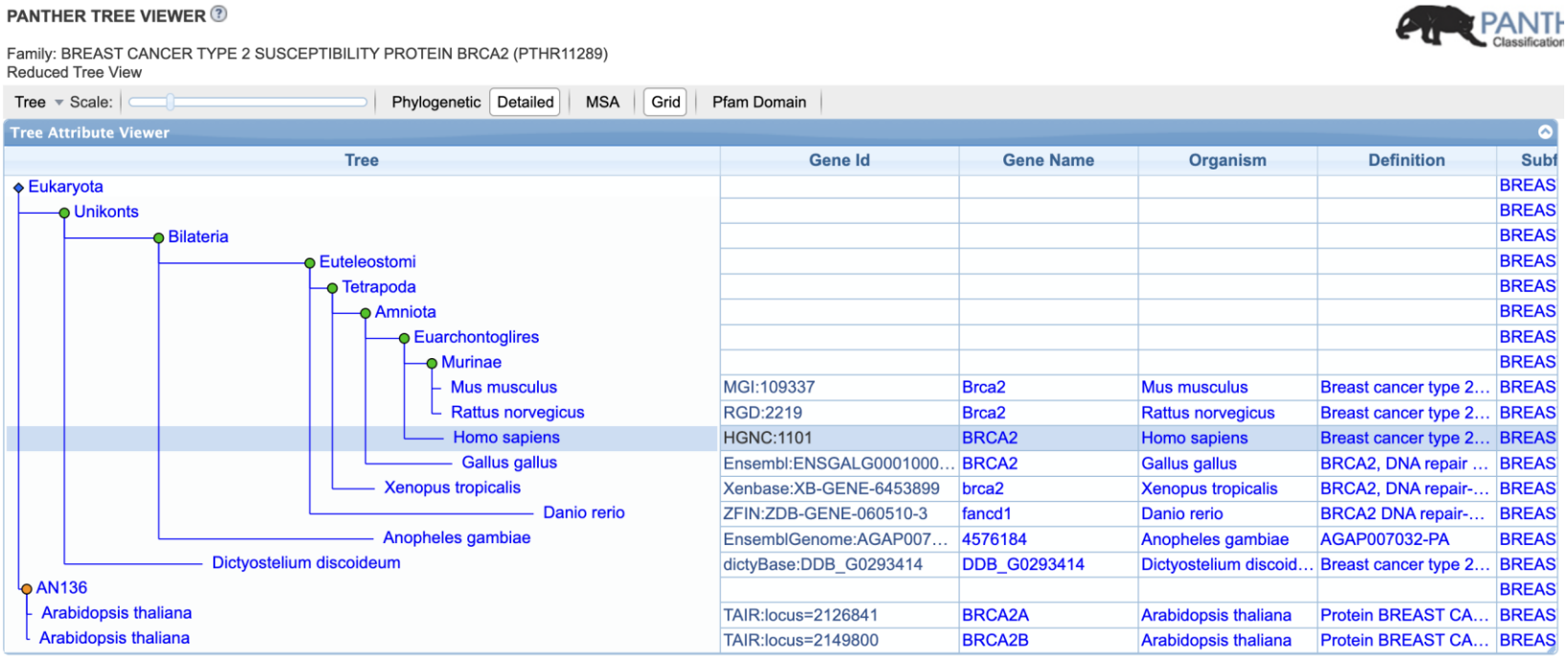
https://www.ebi.ac.uk/QuickGO/term/GO:0060887

BRCA1 Gene Example



https://pantherdb.org/treeViewer/treeViewer.jsp?book=PTHR11289&species=agr&seq=HGNC=1101

BRCA1 Gene Example



https://pantherdb.org/treeViewer/treeViewer.jsp?book=PTHR11289&species=agr&seq=HGNC=1101

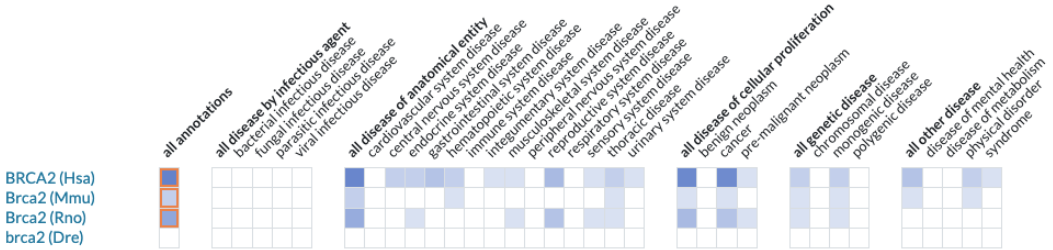
BRCA1 Gene Example: Disease Associations

Disease Associations

Compare Ortholog Genes

Stringency: Stringent | Species

Include Negative Annotations — Cases where the expected disease association was NOT found



Cell color indicative of annotation volume

Species	Gene	Association	Disease	Evidence	Source	Based On	References
Homo sapiens	BRCA2	is implicated in	breast cancer	IAGP	OMIM *via* RGD		RGD:7240710
Homo sapiens	BRCA2	is marker for	colorectal cancer	IEP	RGD		PMID:16533773
Homo sapiens	BRCA2	is marker for	colorectal carcinoma	IEP	RGD		PMID:11497291
Homo sapiens	BRCA2	is implicated in	ductal carcinoma in situ	IAGP	RGD		PMID:16280055
Homo sapiens	BRCA2	is implicated in	endometrial cancer	IAGP	RGD		PMID:10451700
Homo sapiens	BRCA2	is implicated in	endometrial serous adenocarcinoma	IAGP	RGD		PMID:16650962
Homo sapiens	BRCA2	is implicated in	esophagus squamous cell carcinoma	IAGP	RGD		PMID:21279724

https://www.alliancegenome.org/gene/HGNC:1101

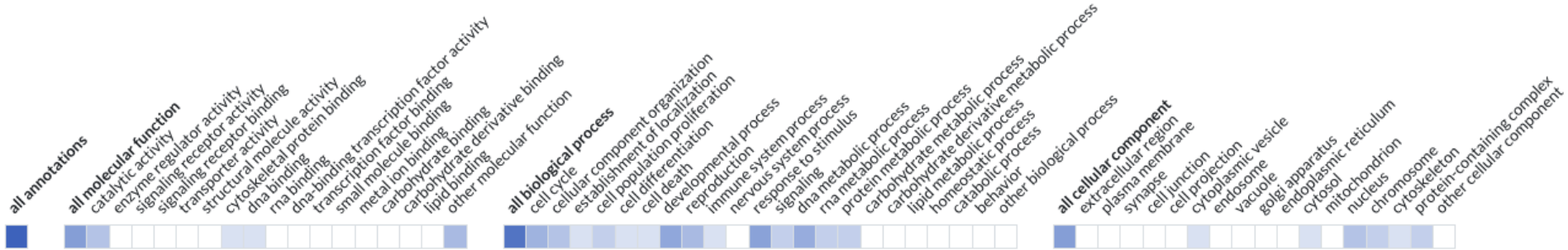
BRCA1 Example

Function - GO Annotations

Compare Ortholog Genes

Stringency: Stringent | Species

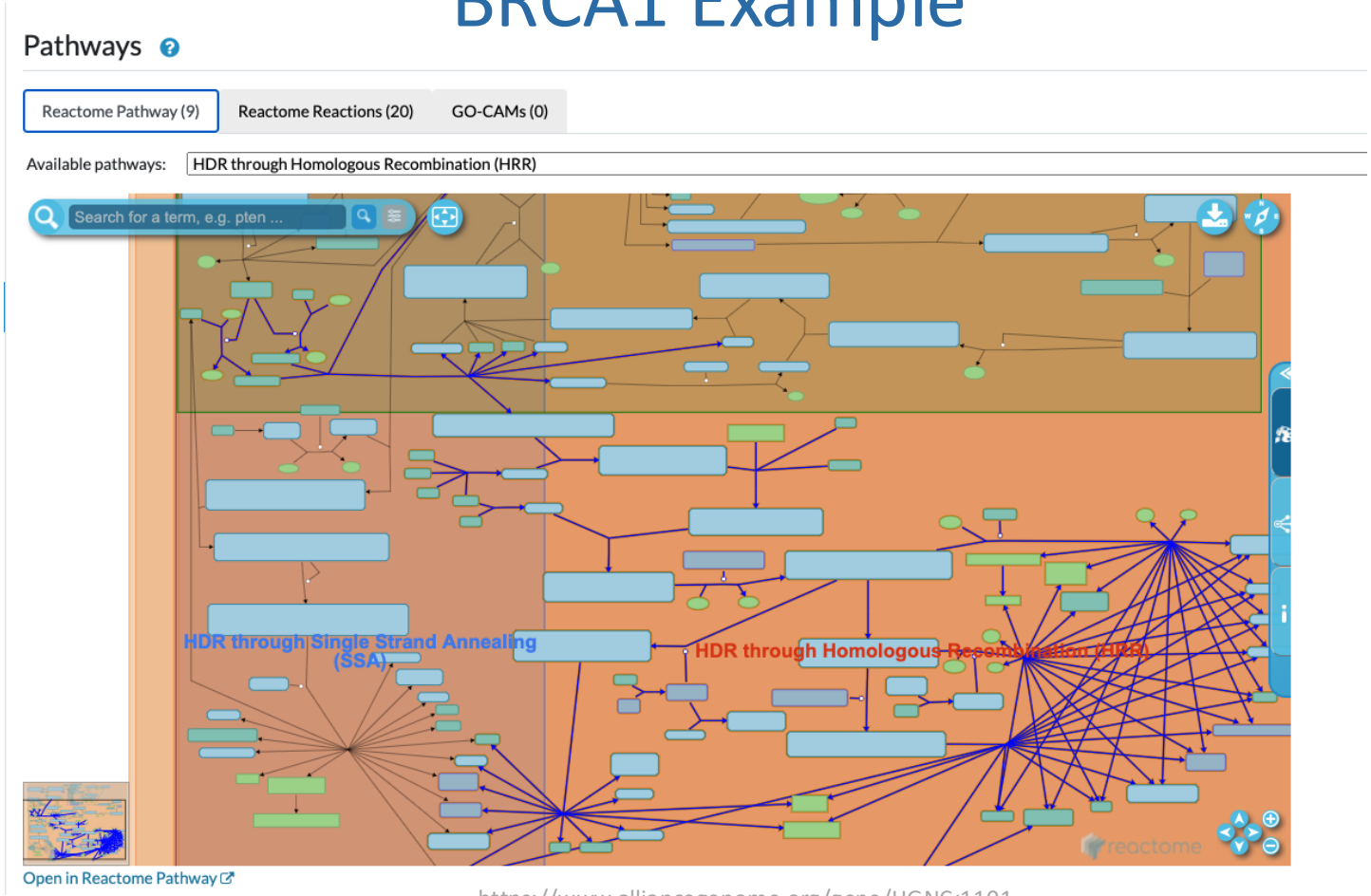
Show Functions With At Least One Experimental Evidence



Cell color indicative of annotation volume

https://www.alliancegenome.org/gene/HGNC:1101

BRCA1 Example

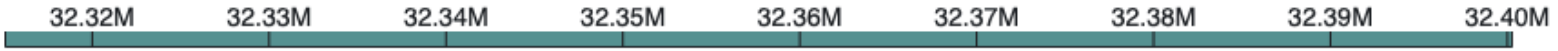


https://www.alliancegenome.org/gene/HGNC:1101

BRCA1 Example

Alleles and Variants

Genome Location	Chr13:32315086...32400268 + (85.18 kb)
Assembly Version	GRCh38



https://www.alliancegenome.org/gene/HGNC:1101

Maintaining the Go Knowledge Base

- Experts read papers and enter information
- Other experts can report on problems
- The standards used have evolved over time, reflecting improvements in knowledge representation
- Algorithms analyze the data to help researchers analyze results and formulate hypotheses
- Visualizations have been developed to simplify the complexity

Exercise: Explore the Gene Ontology

- Search for quickgo, click on the link
  - *https://www.ebi.ac.uk/QuickGO/annotations*
- Explore one of the genes there
- See what kinds of relations are supported
- Follow links, look at the graph structures, the Ontology tab

Download table as: [YAML | JSON-LD | RDF/Turtle]

bfo	Basic Formal Ontology CC BY	The upper level ontology upon which OBO Foundry ontologies are built. Detail	
chebi	Chemical Entities of Biological Interest CC BY	A structured classification of molecular entities of biological interest focusing on 'small' chemical compounds. Detail	
doid	Human Disease Ontology PUBLICDOMAIN	An ontology for describing the classification of human diseases organized by etiology. Detail	
go	Gene Ontology CC BY	An ontology for describing the function of genes and gene products Detail	
obi	Ontology for Biomedical Investigations CC BY	An integrated ontology for the description of life-science and clinical investigations Detail	
pato	Phenotype And Trait Ontology CC BY	An ontology of phenotypic qualities (properties, attributes or characteristics) Detail	
po	Plant Ontology CC BY	The Plant Ontology is a structured database resource that links plant and growth and development to p	
pr	PRotein Ontology (PRO) CC BY	An ontological representation of p Detail	

A Collection of Ontologies

http://www.obofoundry.org/

Principles: Overview

- Overview
- Open (principle 1)
- Common Format (principle 2)
- URI/Identifier Space (principle 3)
- Versioning (principle 4)
- Scope (principle 5)
- Textual Definitions (principle 6)
- Relations (principle 7)
- Documentation (principle 8)
- Documented Plurality of Users (principle 9)
- Commitment To Collaboration (principle 10)
- Locus of Authority (principle 11)
- Naming Conventions (principle 12)
- Maintenance (principle 16)

View Edit

This page is generated via _layouts/principle.html. See edit guide

These principles are intended as normative for OBO Foundry ontologies, and ontologies submitted for review will be evaluated according to them. We consider these to be generally good practice, and recommend they be considered even if there are no plans to submit an ontology for review by the Foundry. Where we use capitalized words such as “MUST”, and “SHOULD”, they will be interpreted according to RFC 2119: Key words for use in RFCs to Indicate Requirement Levels when the principles are applied during reviews of ontologies for inclusion in the Foundry.

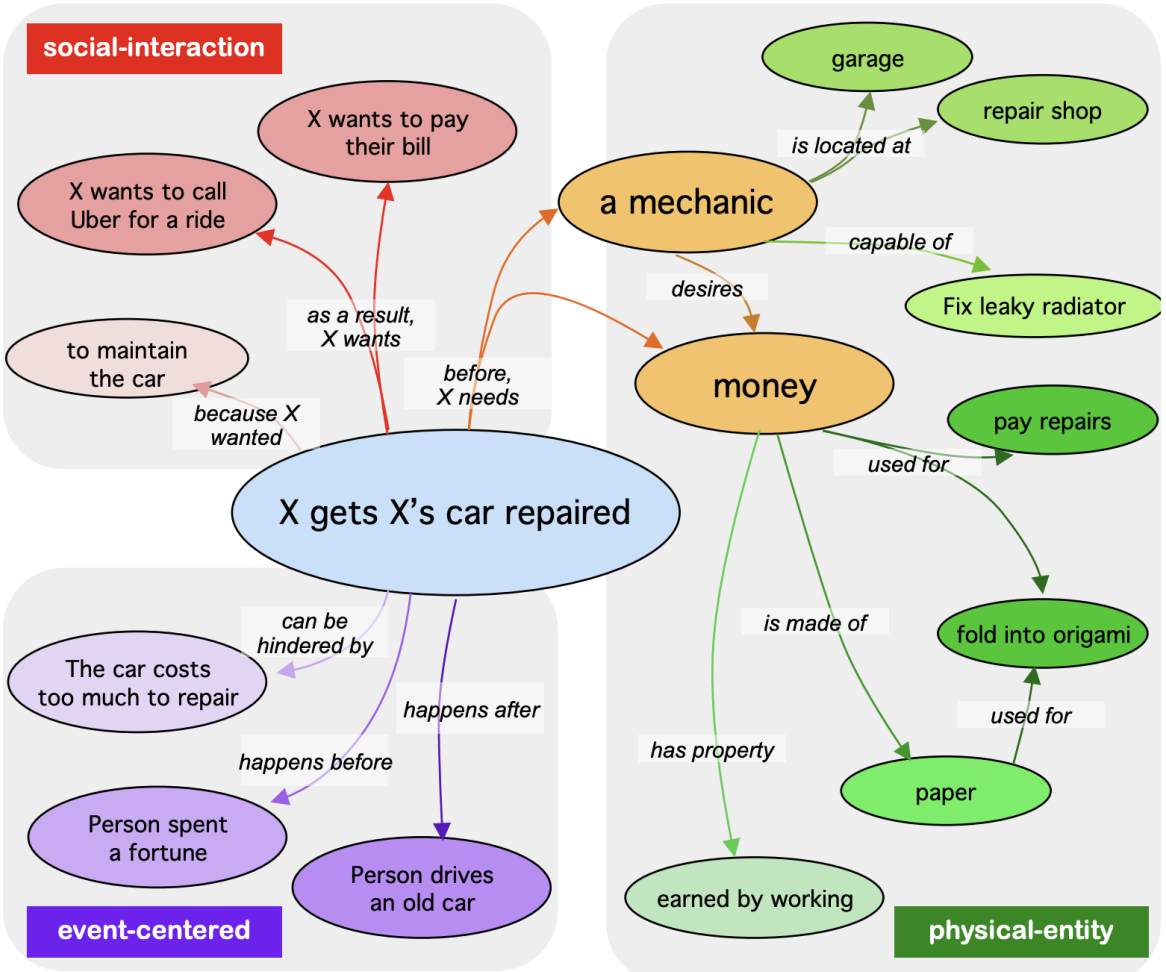
There is currently an ongoing process to clarify the wording of the principles and expand on their purpose, implementation, and criteria to be used to evaluate ontologies for compliance with each principle. We have gone through this process for the following principles: open, common format, users, collaboration, locus of authority. The new wording has been posted for these and we are continuing to work on the others. Please use the issue tracker to let us know if there are further clarifications that you would like to see addressed for any of the principles.

Principles for Ontology Creation

http://www.obofoundry.org/

AI-Based Common-Sense Reasoning

- Pre-LLM work in natural language processing
- Makes use of large datasets and deep neural nets
- Getting some interesting results now



https://github.com/allenai/comet-atomic-2020

AI2 Allen Institute for AI

Mosaic Knowledge Graphs

- Model
  - People & Events (COMeT 2020)
  - Entities (COMeT 2020)
  - Images (VisualCOMET)
- Knowledge Graph
  - ATOMIC 2020
- About

Commonsense Inferences about Entities (COMmonsensE Transformers on Atomic2020)

A commonsense knowledge graph with 1.33M everyday inferential knowledge tuples about entities and events. It represents a large-scale common sense repository of textual descriptions that encode both the social and the physical aspects of common human everyday experiences. We also provide COMET-ATOMIC-2020 model which can generate representative knowledge for new, unseen entities and events. | read the paper / download the data

Explore

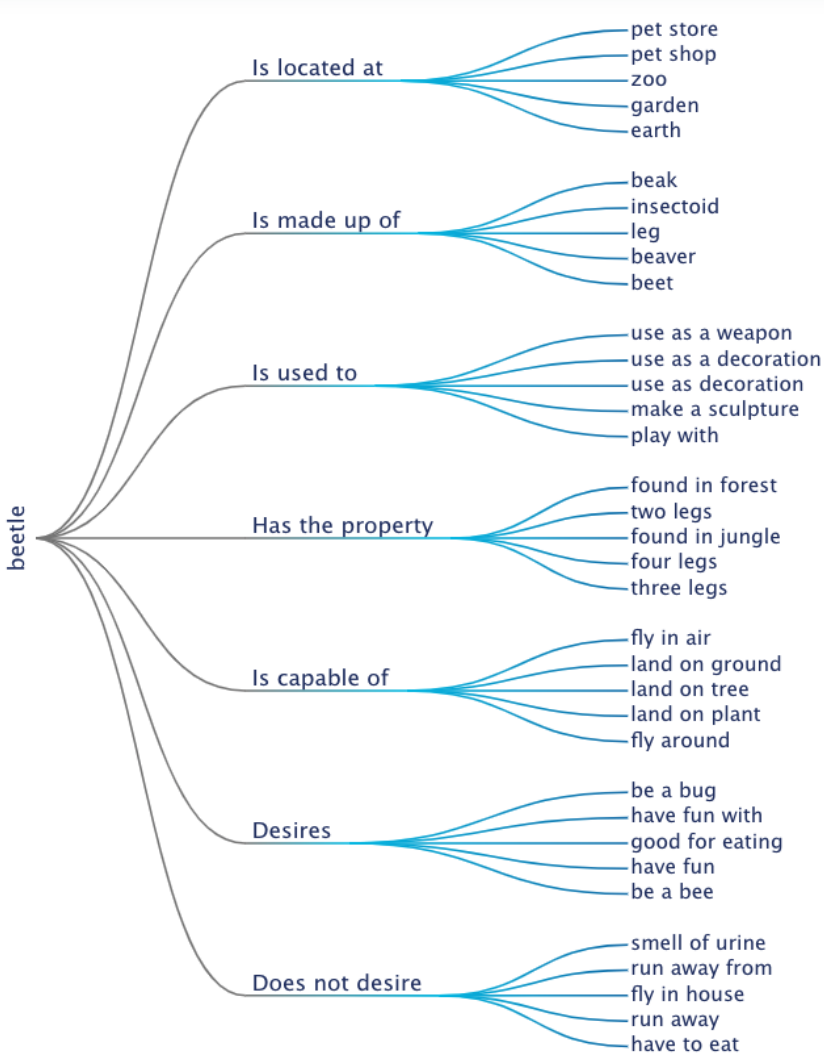
beetle

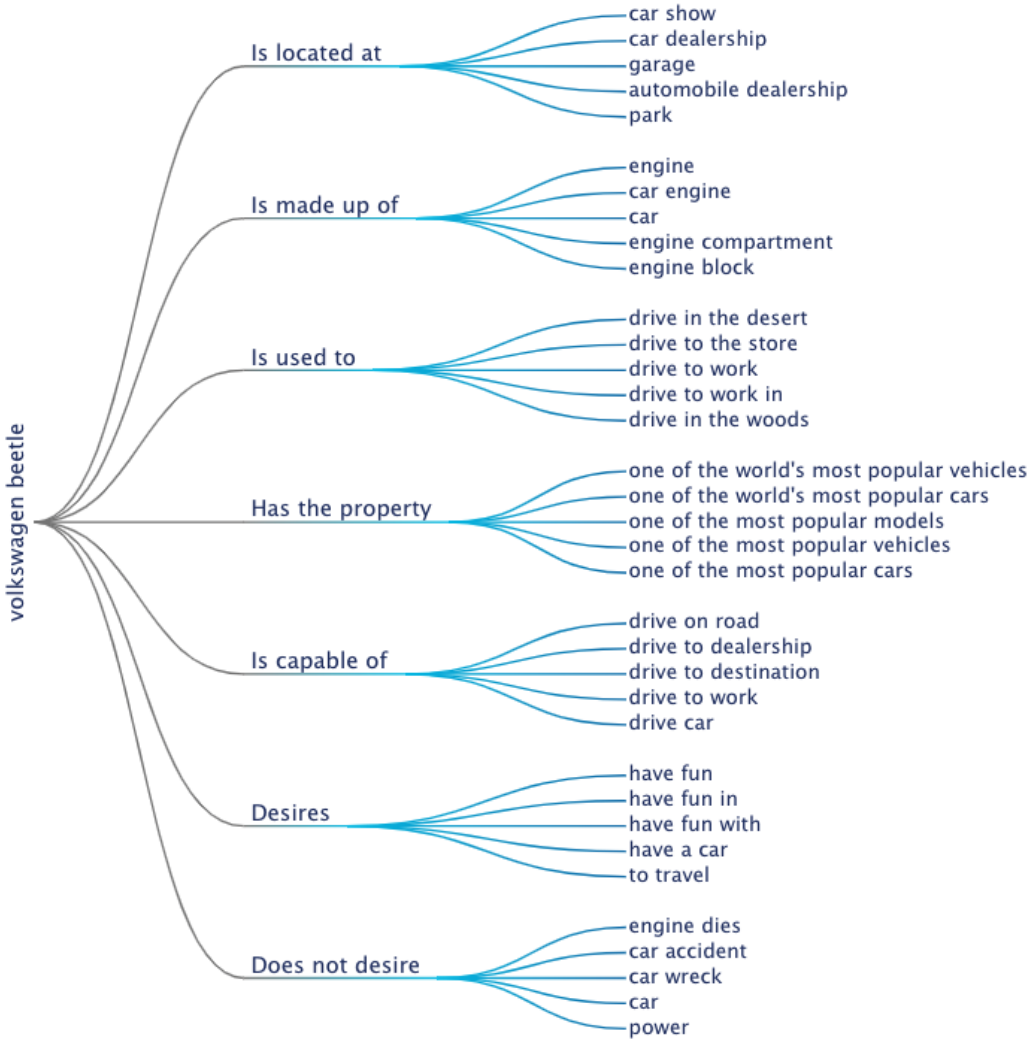
Predict

Try: car, student, brain, artificial intelligence

Project link no longer active

https://mosaickg.apps.allenai.org/model_comet2020_entities


beetle
Is located at
pet store
pet shop
zoo
garden
earth
Is made up of
beak
insectoid
leg
beaver
beet
Is used to
use as a weapon
use as a decoration
use as decoration
make a sculpture
play with
Has the property
found in forest
two legs
found in jungle
four legs
three legs
Is capable of
fly in air
land on ground
land on tree
land on plant
fly around
Desires
be a bug
have fun with
good for eating
have fun
be a bee
Does not desire
smell of urine
run away from
fly in house
run away
have to eat


volkswagen beetle
Is located at
car show
car dealership
garage
automobile dealership
park
Is made up of
engine
car engine
car
engine compartment
engine block
Is used to
drive in the desert
drive to the store
drive to work
drive to work in
drive in the woods
Has the property
one of the world's most popular vehicles
one of the world's most popular cars
one of the most popular models
one of the most popular vehicles
one of the most popular cars
Is capable of
drive on road
drive to dealership
drive to destination
drive to work
drive car
Desires
have fun
have fun in
have fun with
have a car
to travel
Does not desire
engine dies
car accident
car wreck
car
power

Commonsense Inferences about People and Events (COMmonsensE Transformers on Atomic2020)

A commonsense knowledge graph with 1.33M everyday inferential knowledge tuples about entities and events. It represents a large-scale common sense repository of textual descriptions that encode both the social and the physical aspects of common human everyday experiences. We also provide COMET-ATOMIC-2020 model which can generate representative knowledge for new, unseen entities ... Expand | read the paper / download the data

Explore

student

Predict

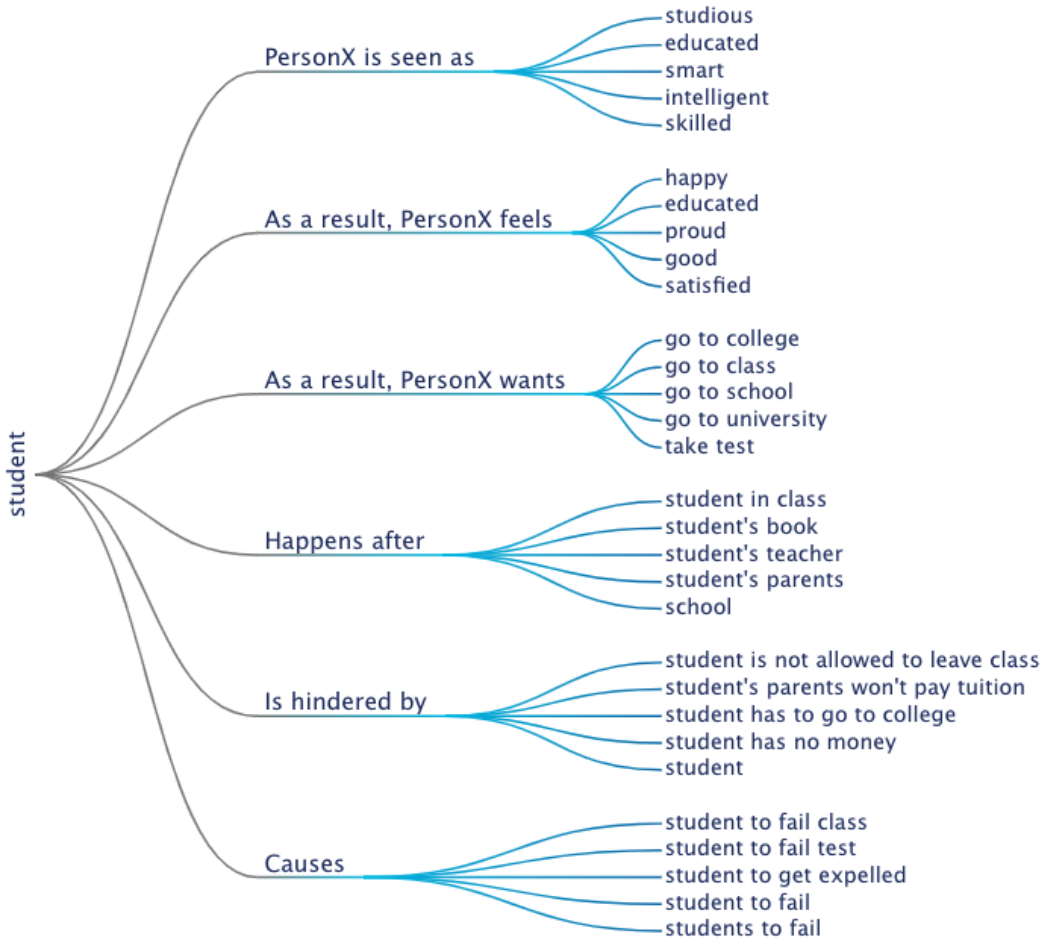
Try: PersonX acts quickly, PersonX is a big deal, My boss is very good

Select one or more relations.

- [x] **Select all**

- [x] PersonX is seen as
- [ ] Before, PersonX needed
- [x] As a result, PersonX wants
- [ ] As a result, others want
- [x] Is hindered by
- [ ] PersonX then
- [x] As a result, PersonX feels
- [ ] Others then
- [ ] Happens before
- [x] Causes
- [ ] Because PersonX wanted
- [ ] As a result, PersonX reasons
- [ ] As a result, others feel
- [x] Happens after

The model has predicted these relationships for 'student'



Summary: Ontologies

- Goes beyond taxonomies and faceted metadata to express relationships, constraints, and rules
- Useful (maybe) for computer-assisted analysis
- Complex to build and maintain
- Difficult to show in an interface for everyday use
- AI methods are making progress in automating creation

Tags vs Faceted Categories

Faceted Categories vs Tags

Faceted categories

- Multiple facets per item
- Hierarchical (often)
- Intentionally Constructed Organization
- Controlled vocabulary
- Collection owner

Tags

- Multiple tags per item
- Flat categories (usually)
- Any term is ok
- User-driven

Home

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Tags

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Jobs

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Tags

A tag is a keyword or label that categorizes your question with other, similar questions. Using the right tags makes it easier for others to find and answer your question.

Show all tag synonyms

Filter by tag name

Popular | Name | New

javascript

For questions regarding programming in ECMAScript (JavaScript/JS) and its various dialects/implementations (excluding ActionScript). This tag is…

2086025 questions — 605 asked today, 5388 this week

java

a popular high-level programming language. Use this tag when you're having problems using or understanding the language itself. Th…

1711975 questions — 324 asked today, 3104 this week

python

a multi-paradigm, dynamically typed, multipurpose programming language. It is designed to be quick to learn, understand, and use, and enforce a…

1534354 questions — 842 asked today, 6957 this week

c#

a high level, statically typed, multi-paradigm programming language developed by Microsoft. C# code usually targets Microsoft's .NET famil…

1435109 questions — 193 asked today, 2177 this week

php

a widely used, high-level, dynamic, object-oriented and interpreted scripting language primarily designed for server-side web development. Us…

1370376 questions — 210 asked today, 1849 this week

android

Google's mobile operating system, used for programming or developing digital devices (Smartphones, Tablets, Automobiles, TVs, Wear, Glass, IoT)….

1298309 questions — 275 asked today, 2169 this week

html

the main markup language for creating web pages and other information to be displayed in a web browser. Questions regarding HTML should include a…

1021249 questions — 243 asked today, 2143 this week

jquery

a JavaScript library, consider also adding the JavaScript tag. jQuery is a popular cross-browser JavaScript library that facilitates Document Obje…

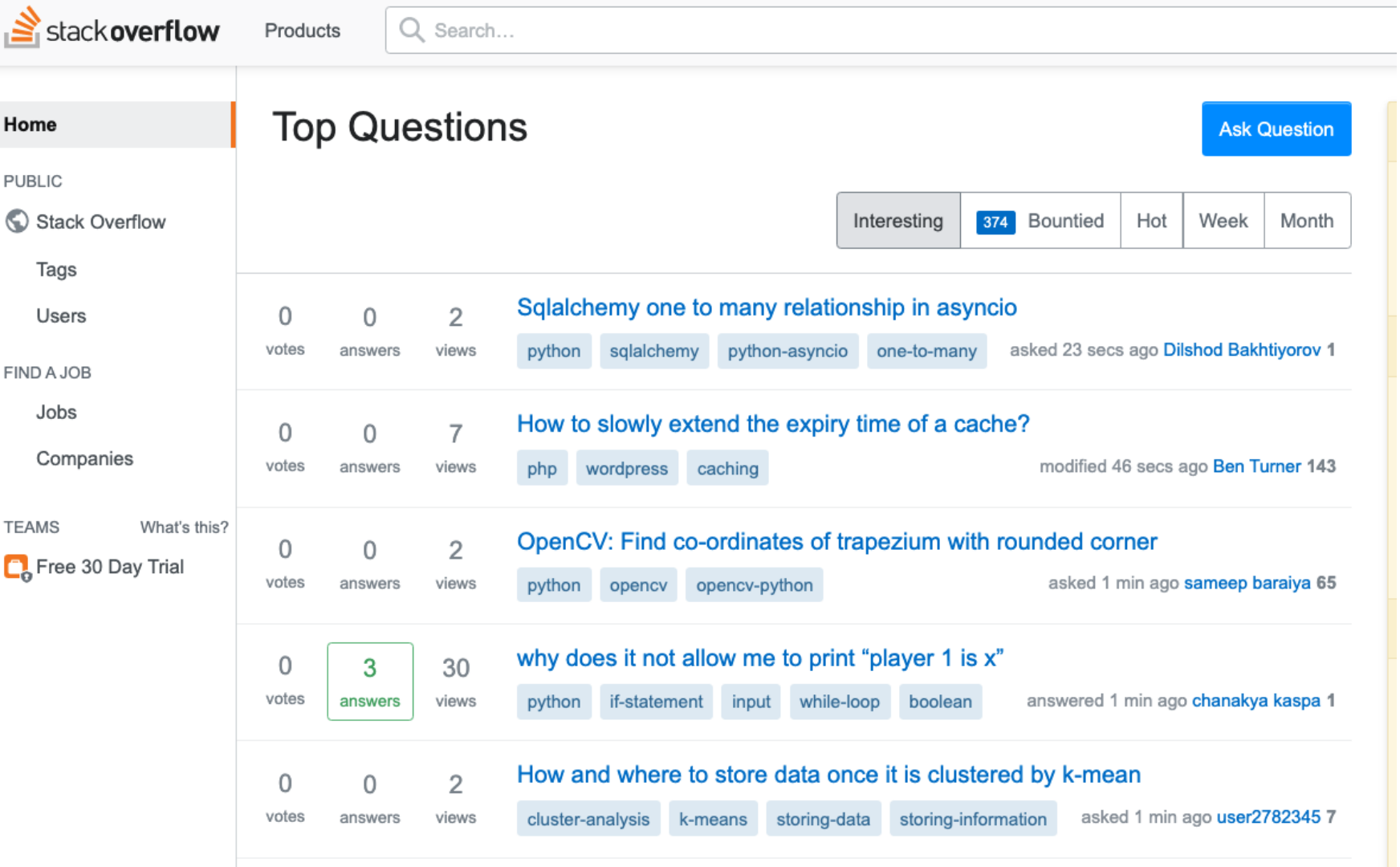
996899 questions — 83 asked today, 830 this week

c++

css

ios

mysql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374
Bountied
Hot
Week
Month
0 votes
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2 views
Sqlalchemy one to many relationship in asyncio
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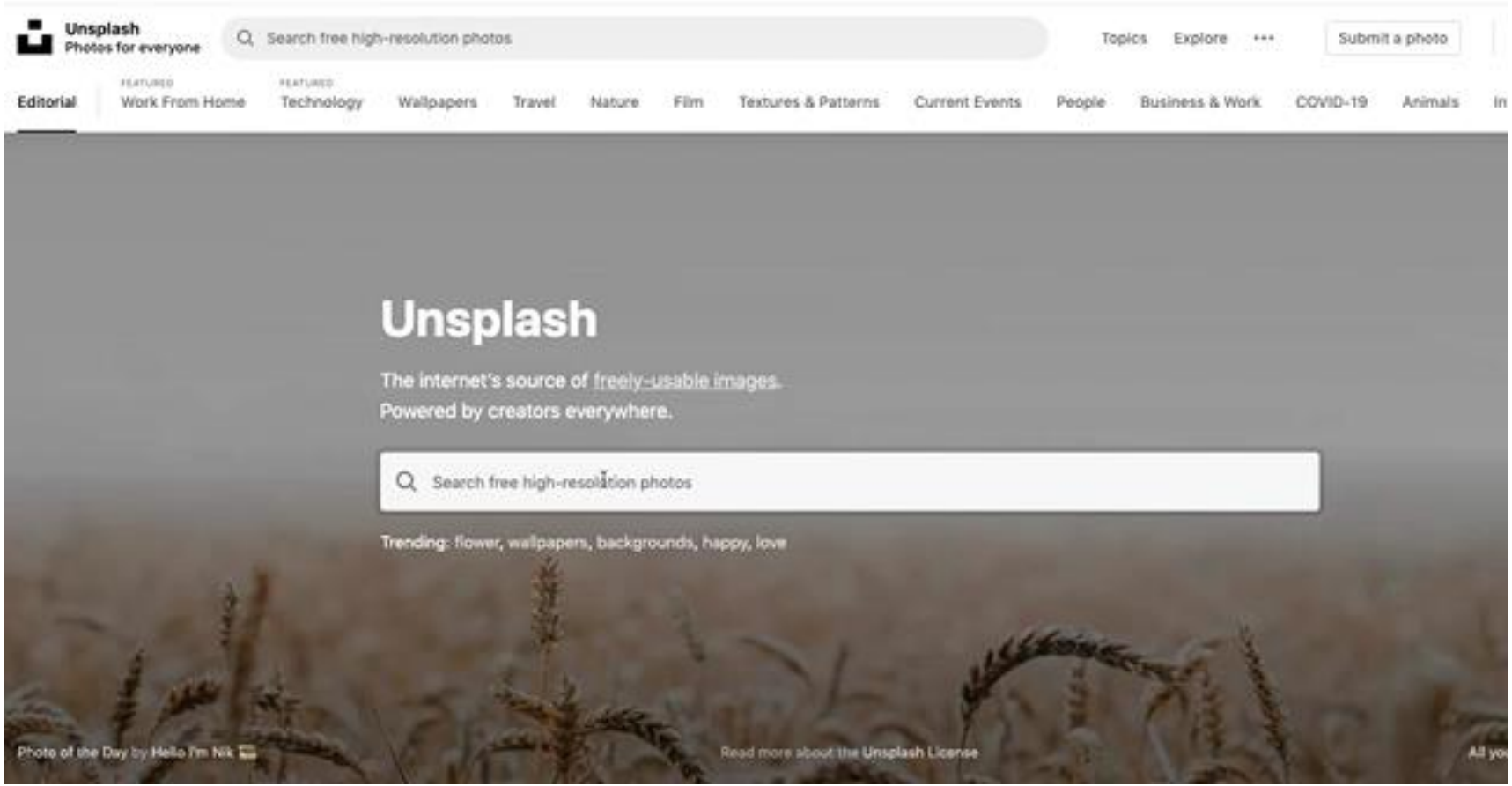
sqlalchemy
python-asyncio
one-to-many
asked 23 secs ago Dilshod Bakhtiyorov 1
0 votes
0 answers
7 views
How to slowly extend the expiry time of a cache?
php
wordpress
caching
modified 46 secs ago Ben Turner 143
0 votes
0 answers
2 views
OpenCV: Find co-ordinates of trapezium with rounded corner
python
opencv
opencv-python
asked 1 min ago sameep baraiya 65
0 votes
3 answers
30 views
why does it not allow me to print “player 1 is x”
python
if-statement
input
while-loop
boolean
answered 1 min ago chanakya kaspa 1
0 votes
0 answers
2 views
How and where to store data once it is clustered by k-mean
cluster-analysis
k-means
storing-data
storing-information
asked 1 min ago user2782345 7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Topics
Explore
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Wallpapers
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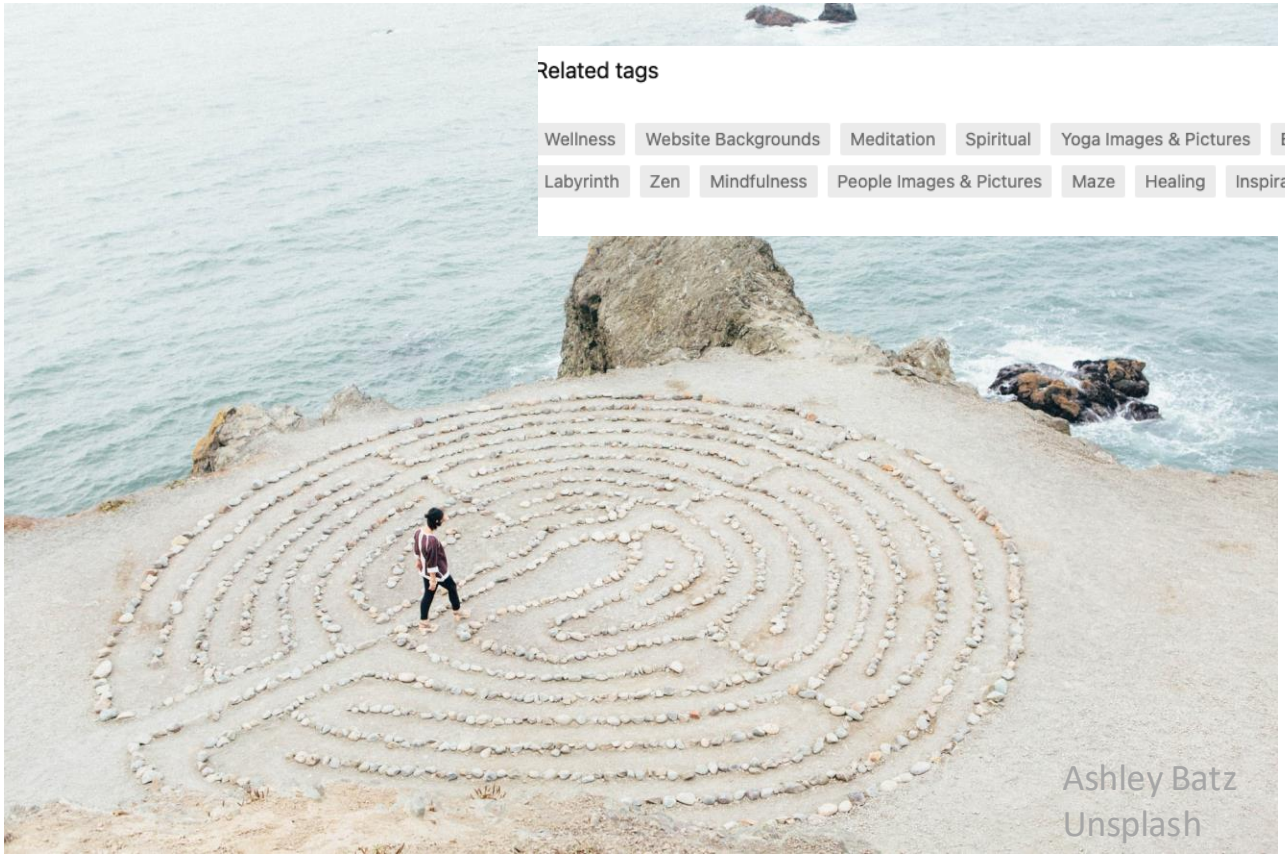
Tags for an Unsplash Image



Related tags

Wellness | Website Backgrounds | Meditation | Spiritual | Yoga Images & Pictures | Balance | Nature Images | Blog | Ritual | Coaching | Spirit

Labyrinth | Zen | Mindfulness | People Images & Pictures | Maze | Healing | Inspiration | Health Images | Sand | Backgrounds

Google image groupings vs facets

Example: query on “string”

If this were organized, we’d have categories like:

- material (nylon, plastic)
- appearance (transparent, colors)
- uses (jewelry > bracelets, instruments > guitar, etc)

Faceted Categories vs Automated Tags (google images, etc)

Faceted categories

- Multiple facets per item
- Hierarchical (often)
- Controlled vocabulary
- Collection owner
- Category labels intentionally selected from an organized topic or field

Tags

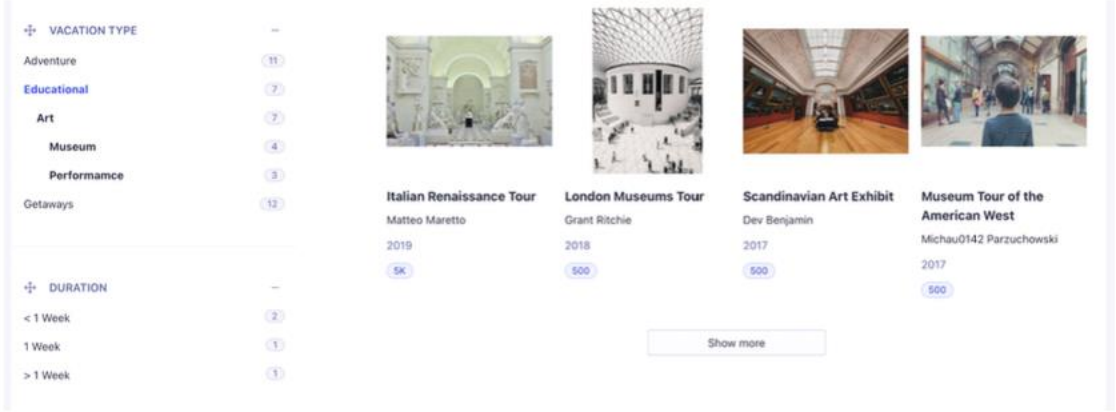
- Multiple tags per item
- Flat categories (usually)
- Any term is ok
- Algorithmically and data driven
- Categories data-driven, and uneven in content coverage.

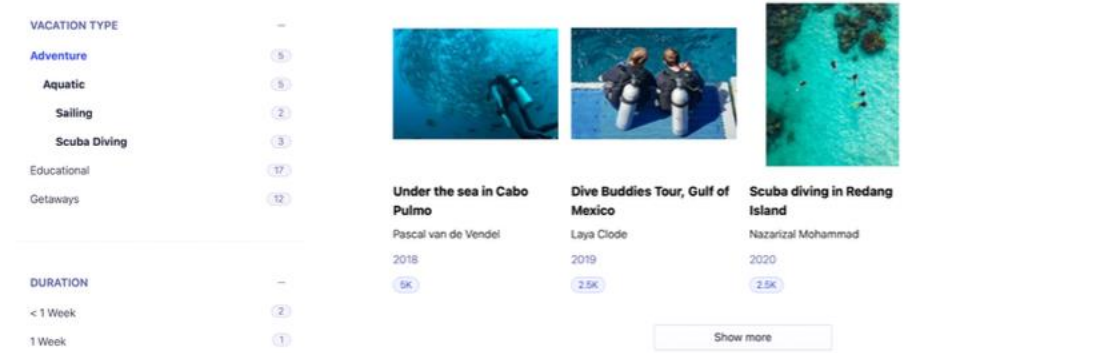
Assignment: Create a Faceted Image Search and Navigation Interface

1. Select 25 images for a collection
2. Create the faceted hierarchical category structure
3. Assign the categories to the images
4. Put everything into the Algolia system
5. Write up your assignment

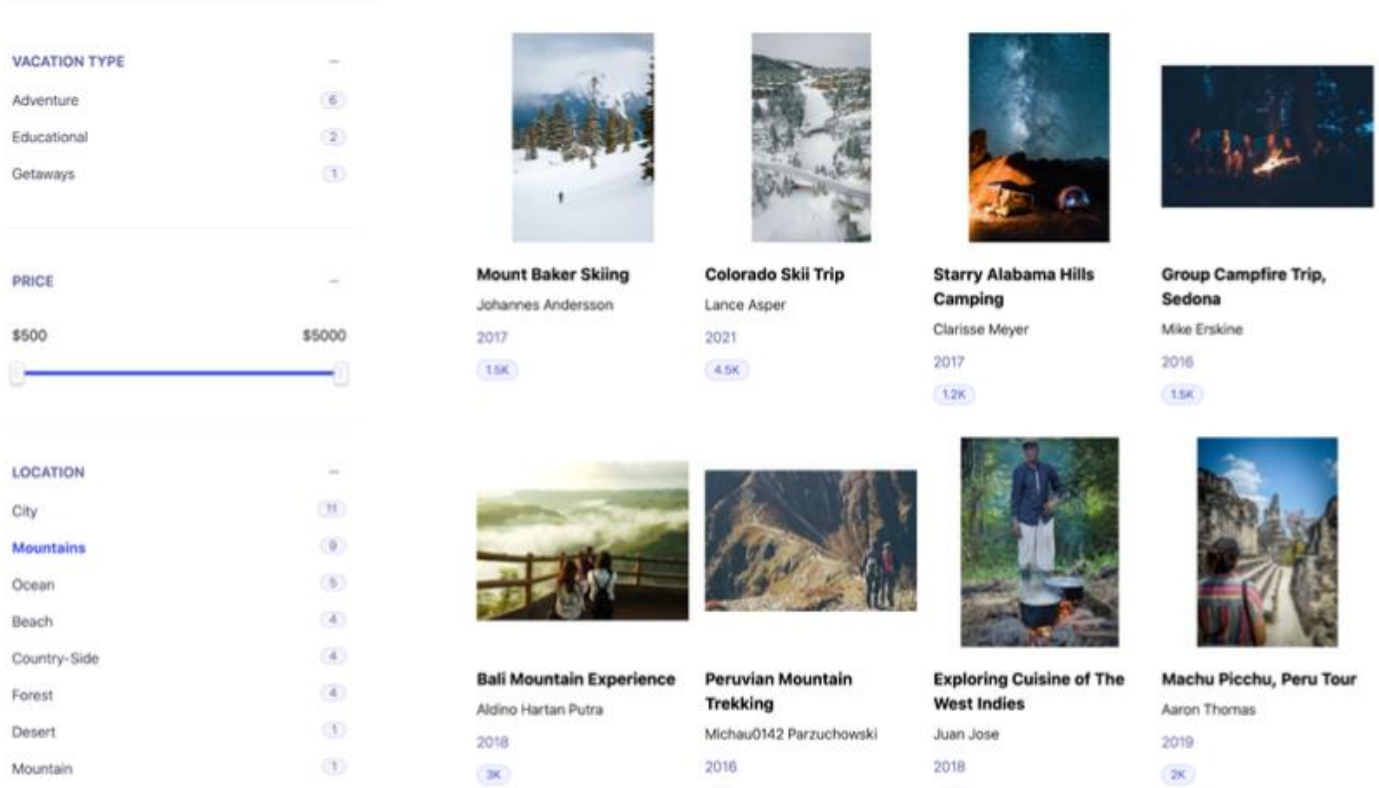
FACETED IMAGE SEARCH INTERFACE

Renad Abdallah and Shreshta Bhat Alevooru





Example from previous class



Example from previous class

HIERARCHICAL FACETS

FACET 1: TYPE OF TRIPS

- **Category 1: Getaways**
  - a. Health & Wellness
    - i. Spiritual
    - ii. Spa
  - b. Retreats
    - i. Eco Tours
    - ii. Lodging & Treehouses
- **Category 2: Educational**
  - c. Culture
    - i. Archeological Site-Seeing
    - ii. Culinary Tours
  - d. Art
    - i. Performance
    - ii. Museums
- **Category 3: Adventure**
  - e. Mountain
    - i. Trekking
    - ii. Skiing & Snowboarding
  - f. Aquatic
    - i. Sailing
    - ii. Scuba Diving

CET 2: LOCATION

- **Category 1: International:**
  1. Continent
     - a. Country
- **Category 2: Domestic:**
  1. State
     - a. City

3: TYPE OF BOOKINGS

- **Category 1: Solo Bookings**
  - a. Meet Other Travelers
    - i. Women Only
    - ii. Co-Ed
  - b. Just you
    - i. Escorted
    - ii. Self-Guided
- **Category 2: Group Bookings**
  - c. Travel with Loved Ones
    - i. Families
    - ii. Couples
  - d. Field Trip Options
    - i. Students
    - ii. Team Bonding

FLAT FACETS

Environment:

- City
- Beach
- Forest
- Mountains
- Country-side
- Desert
- Savanna

Duration

- < 1 Week
- 1 week
- > 1 Week

Cost:
Range from 500-5,000 (USD)

Example from previous class

Assignment Details

- Assigned one partner to work with
- Need to create a JSON file
  - *describes both the categories and the images*
  - *Be sure to use a code editor to create the JSON*

Algolia JSON Format

```
{
    "name": "bold t-shirt",
    "desc": “Be bold, wear a t-shirt with only one color”,
    "color": “white”,
    "sleeves": "short"
},
{
    "name": "Hippie Vest with Fringes",
    "desc": “Be hip: get back to where you belong, peace + love”,
    "color": ["red", “orange”, “yellow”, “green”, "blue"],
    "sleeves": "long"
}
```

These are flat facets

Notice that you can have a list of attributes for a given item (colors in this example)

https://www.algolia.com/blog/engineering/facets-data-model-of-json-records

Algolia JSON Format

```
{
    "name": "Ursula K. Le Guin",
    "categories": [
        "level0": "Books",
        "level1": ["Books > Science Fiction", "Books > Literature & Fiction"],
        "level2": ["Books > Science Fiction > Time Travel", "Books > Literature & Fiction > Literary"]
    ]
}
```

This is a hierarchical facet

Notice that you can have a list of facet attributes for a given item (two kinds of level1 and two kinds of level2 in this example)
Thus, you can assign Le Guin to be an author of both Scifi and Lit,
And within scifi, to Time travel and within lit to Literary.

https://www.algolia.com/blog/engineering/facets-data-model-of-json-records

JSON format example
including hierarchical facet with multiple assignments

```
,
{
   "title": "Hawaiian Sunset sailimg",
   "artist": "Joel Moysuh",
   "year": 2021,
   "description": "Sunset sail cruise off the coast of Kapolei, Hawaii.",
   "image": "https://images.unsplash.com/photo-1620261952751-b294980bcdbc?
   q=80&w=387&auto=format&fit=crop&ixlib=rb-
   4.1.0&ixid=M3wxMjA3fDB8MHxwaG90by1wYWdlfHx8fGVufDB8fHx8fA%3D%3D",
   "activity_type": {
     "at_level0": "Water Sport",
     "at_level1": "Water Sport > Boating",
     "at_level2": "Water Sport > Boating > Sailing"
   },
   "location": {
     "loc_level0": "Country",
     "loc_level1": "Country > U.S.A.",
     "loc_level2": "Country > U.S.A. > Hawaii",
     "loc_level3": "Country > U.S.A. > Hawaii > Waikiki"
   },

   "natural wonder": {
     "nw_level0": ["Mountains", "Oceans"],
     "nw_level1": ["Mountains > Ko olau Range", "Oceans > Pacific"],
     "nw_level2": ["Mountains > Ko olau Range > Diamond Head (Le ahi)", "Oceans > Pacific >
     Mamala Bay"]
   }
}
```