Specification and Analysis of Information Systems

Lecture 3

OPM Interim

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System Structure

What is a Structure?

- Anything composed of **parts** **arranged** together in some way (http://www.Dictionary.com)

- **Construction** or framework of identifiable **elements** which gives form and **stability** (http://www.businessdictionary.com).

What is system structure?

- A set of system **elements** and the allowable **relationships** between them. (SEBok)
- A **physical** or **logical** **relationship** among data **elements** (ISO/IEC 2009, 1)
- System structure or **hierarchies** are system **representations** of a partitioning **relationship** where the system is **separated** into **smaller** more **manageable** entities (INCOSE SE Handbook).

What is system structure?

- Structure is a way of expressing the **relationships** between the system's entities and dealing with **complexity** of systems

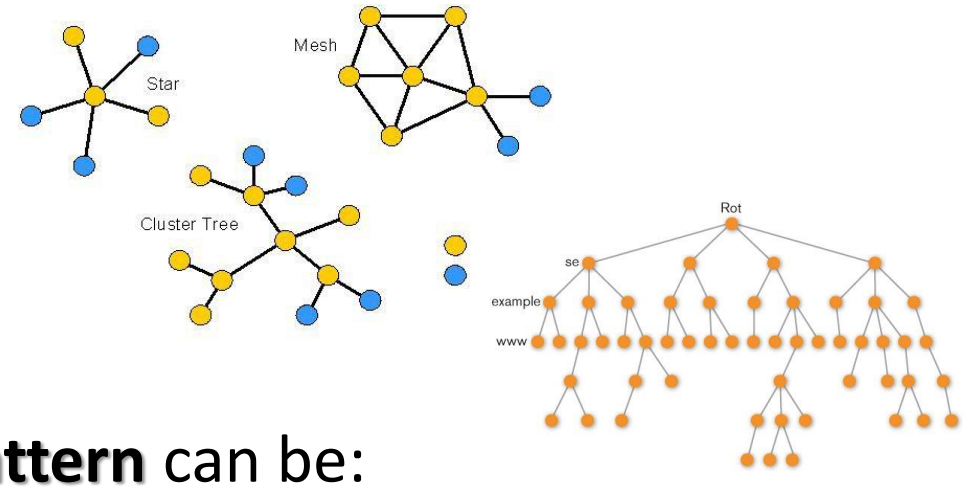
complex systems which have been organized into a structure are more understandable

- We express the system structure based on:

system structure patterns

Basic System Structure Patterns

- All the patterns consist of three simple **structure relation**:
  - One-to-One
  - One-to-Many
  - Many-to One



- Basic system **structure pattern** can be:
  - **Tree structure** based on hierarchy between elements
  - **Network structure** based on absence of hierarchy between elements(bus, star – hub and spokes, ring, network – mesh)

System Thinking- Relationship
Abstraction and Encapsulation

- **Whole and its parts**: Aggregation ↔ participation
- **Type and its features**: Exhibition ↔ characterization
- **Type and its subtypes**: Generalization ↔ specialization
- **Type and its realizations**: Classification ↔ instantiation

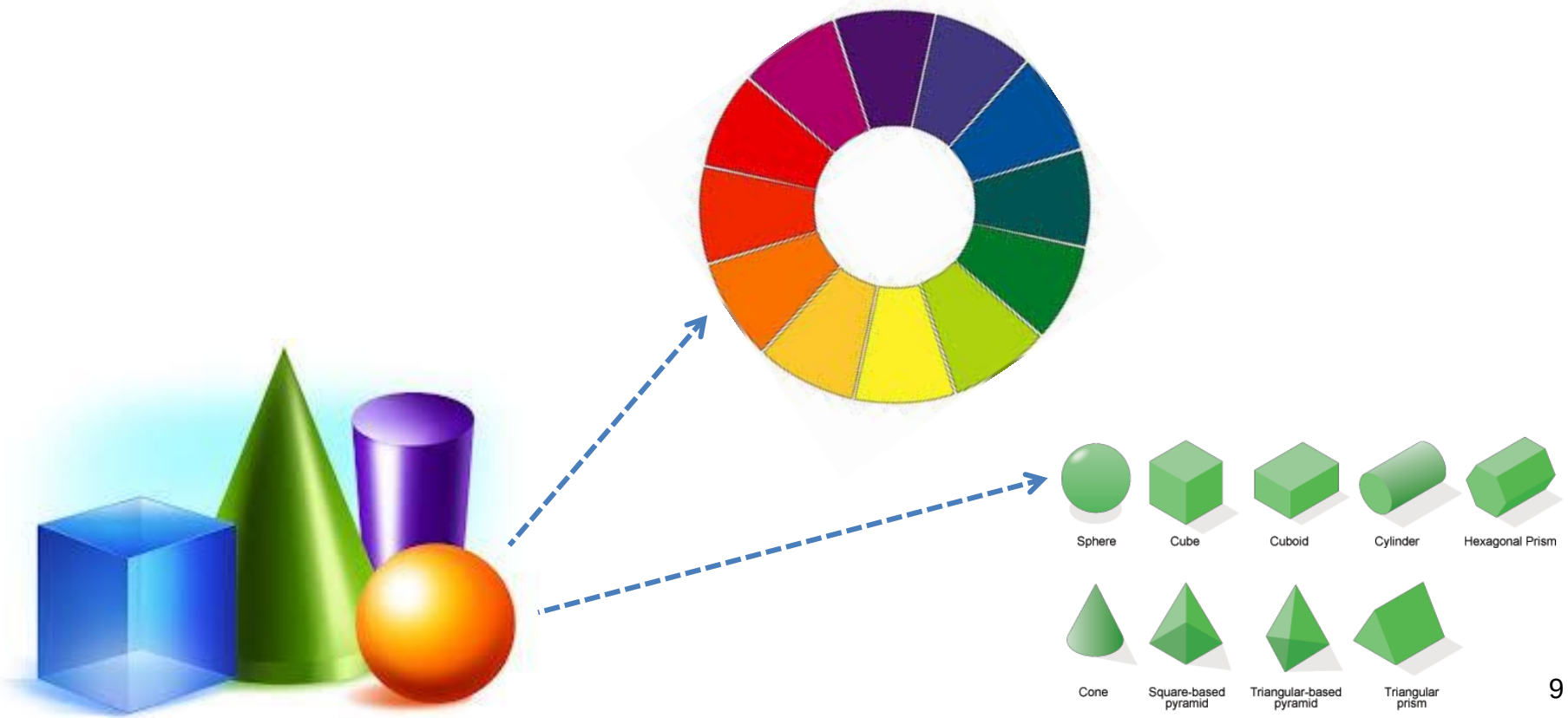
*features=attributes and operations

Whole ↔ Parts Relationship

- A whole-part relationship indicates that one entity is **composed of** one or more parts which are themselves instances of that or another entity.

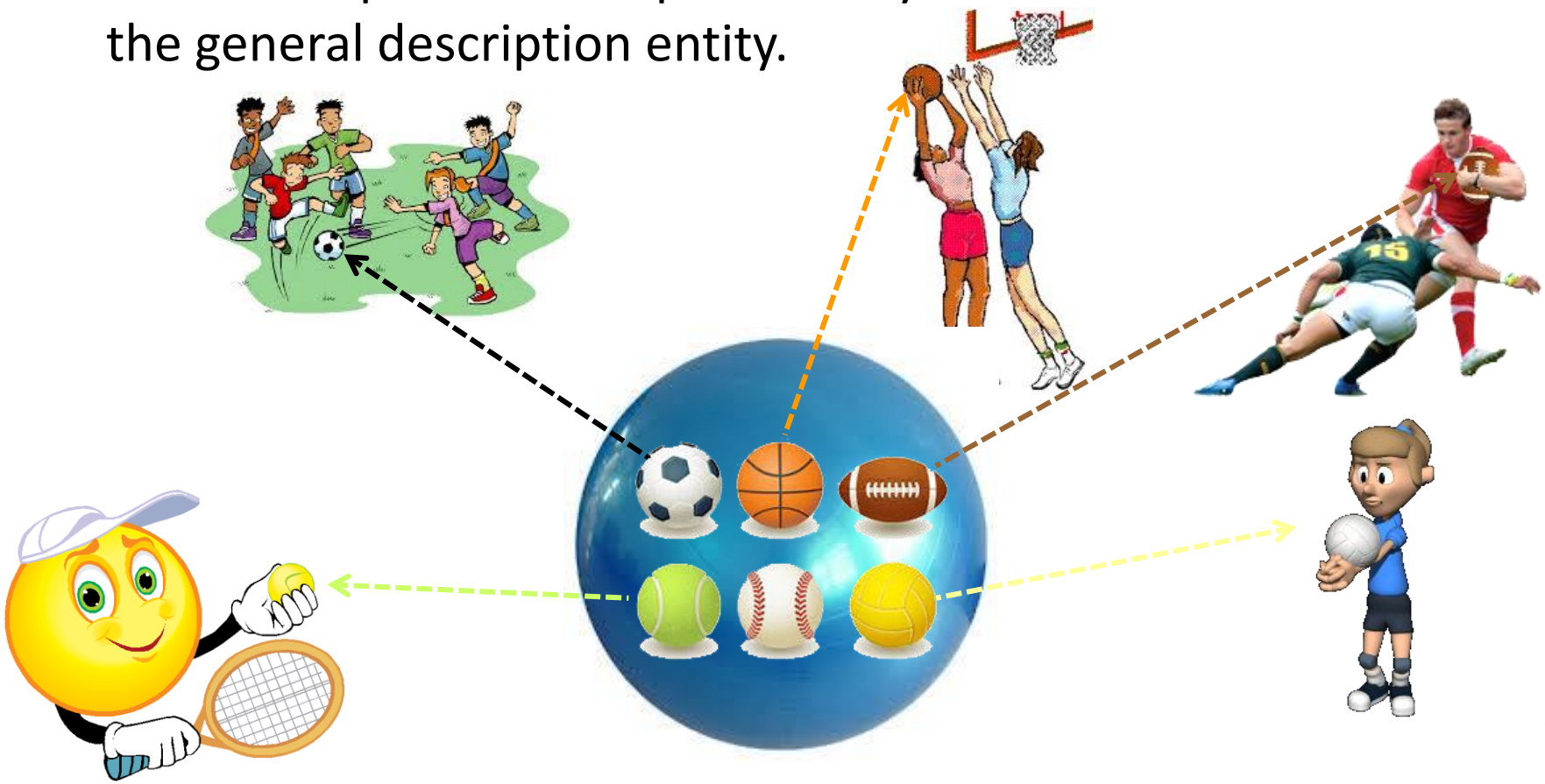
Type ↔ Attributes Relationship

- A type-attribute relationship indicates that one entity is **characterized by** the attribute entity.



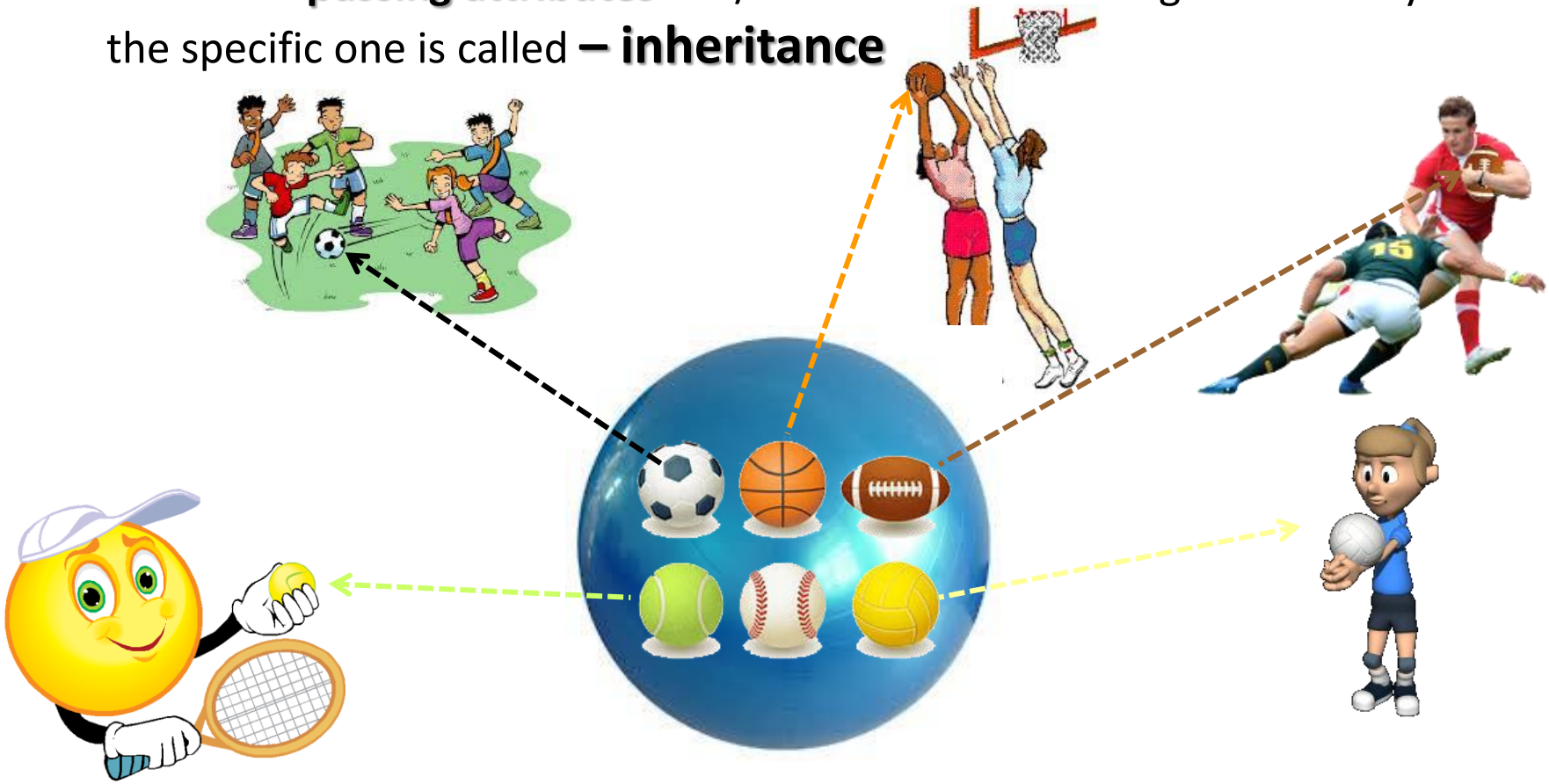
Type ↔ Subtypes Relationship

- A type-subtype relationship indicates A relation between a **more general** thing and a **more specific** thing.
- The more specific description entity **is builds on and extends** the general description entity.



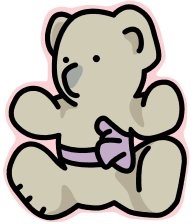
Type ↔ Subtypes Relationship cont.

- The **more specific** description is fully **consistent** with the **more general** one and may **contain additional information**.
- The act of **passing attributes** and/or behavior from the general entity to the specific one is called **– inheritance**

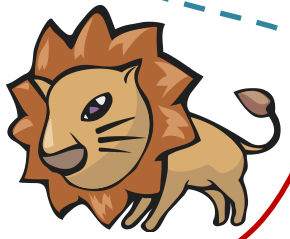


Type ↔ Subtypes Relationship cont.





Type ↔ Realizations Relationship

- A type-realization relationship indicates that one entity is **the instance of** another entity.

Type ↔ Realizations Relationship

- Type is a template for a group of potentially existing things with the same set of attributes (structure) and operations (behavior)

Type: **Racecar**
Attribute: **Color**

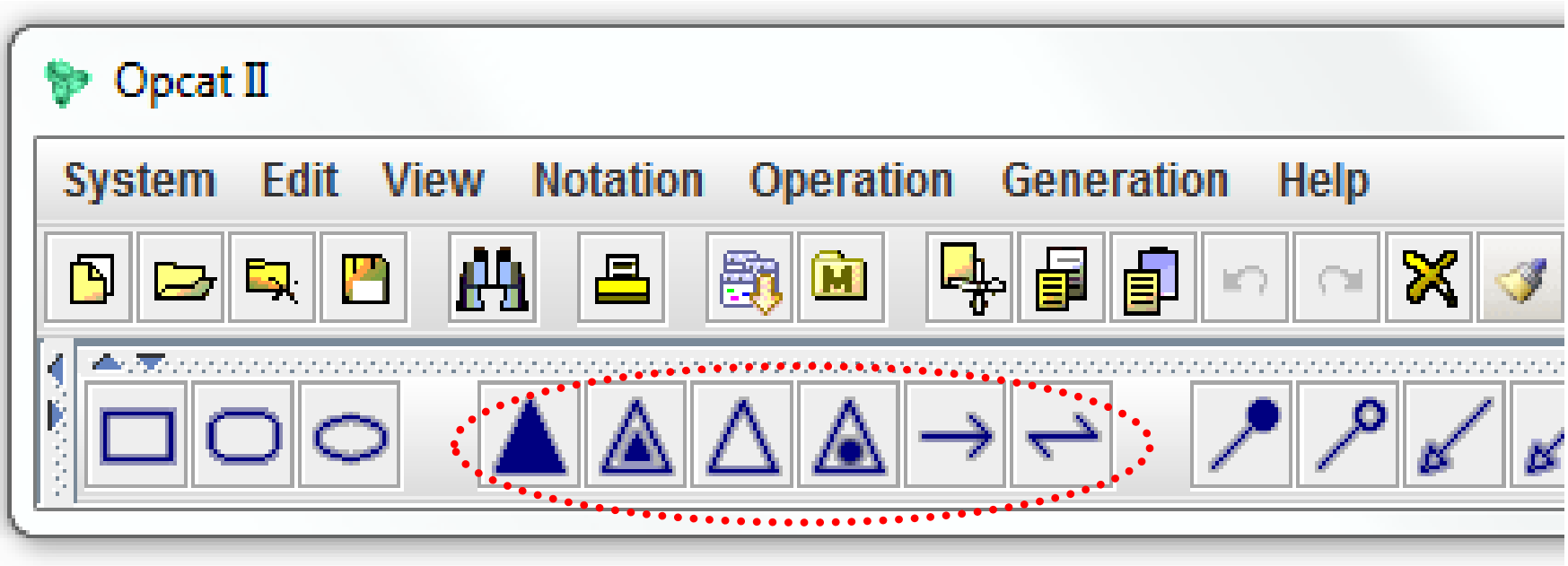
  - An instance – an actual identifiable entity belonging to a class, with its own set of attribute values

Type: **Racecar**
Attribute: **Color**
Attribute Value: **yellow**

System Structure With OPM

Fundamental Structural Relation

- Connection between two objects or two processes which denote structural relations.

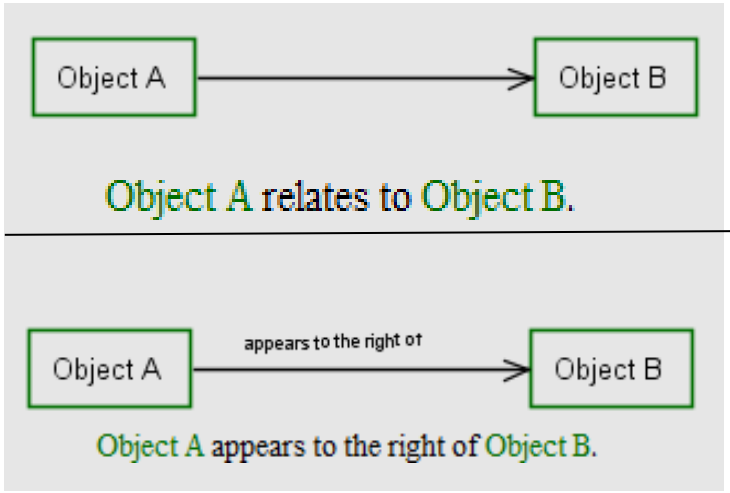


OPM – Structural Links

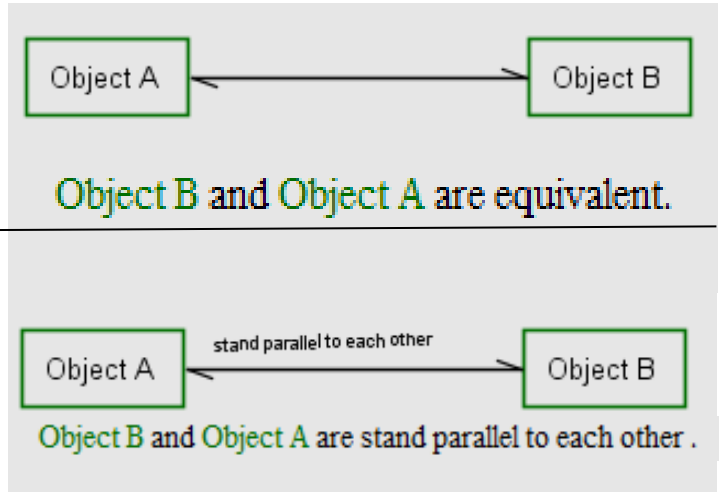
Unidirectional & Bidirectional Relation

- Unidirectional tagged structural relation
- Bidirectional tagged structural relation

Unidirectional



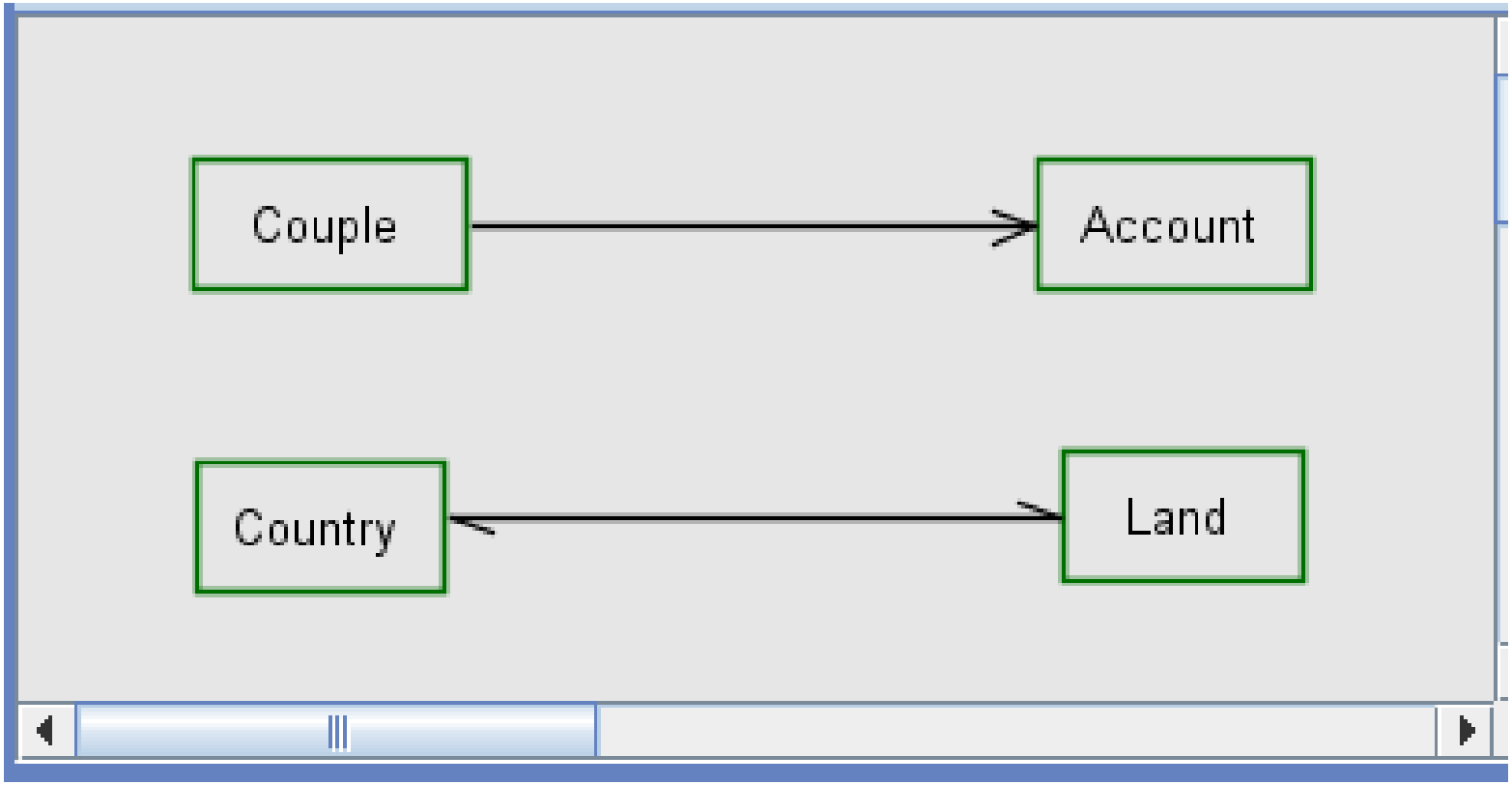
Bidirectional



tagged

OPM – Structural Links

Unidirectional & Bidirectional Relation One-to-One



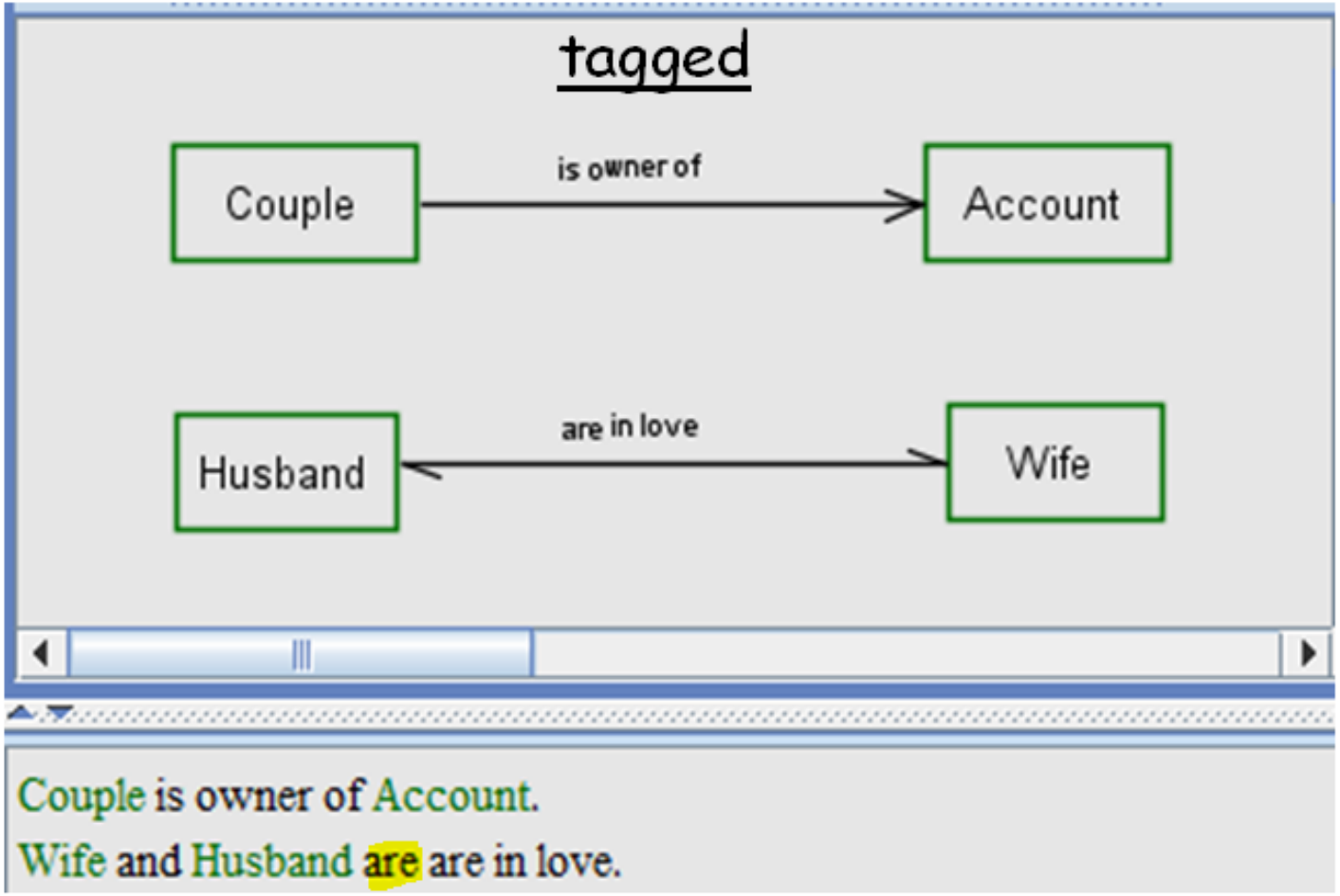
Couple relates to Account.

Land and Country are equivalent.

OPM – Structural Links

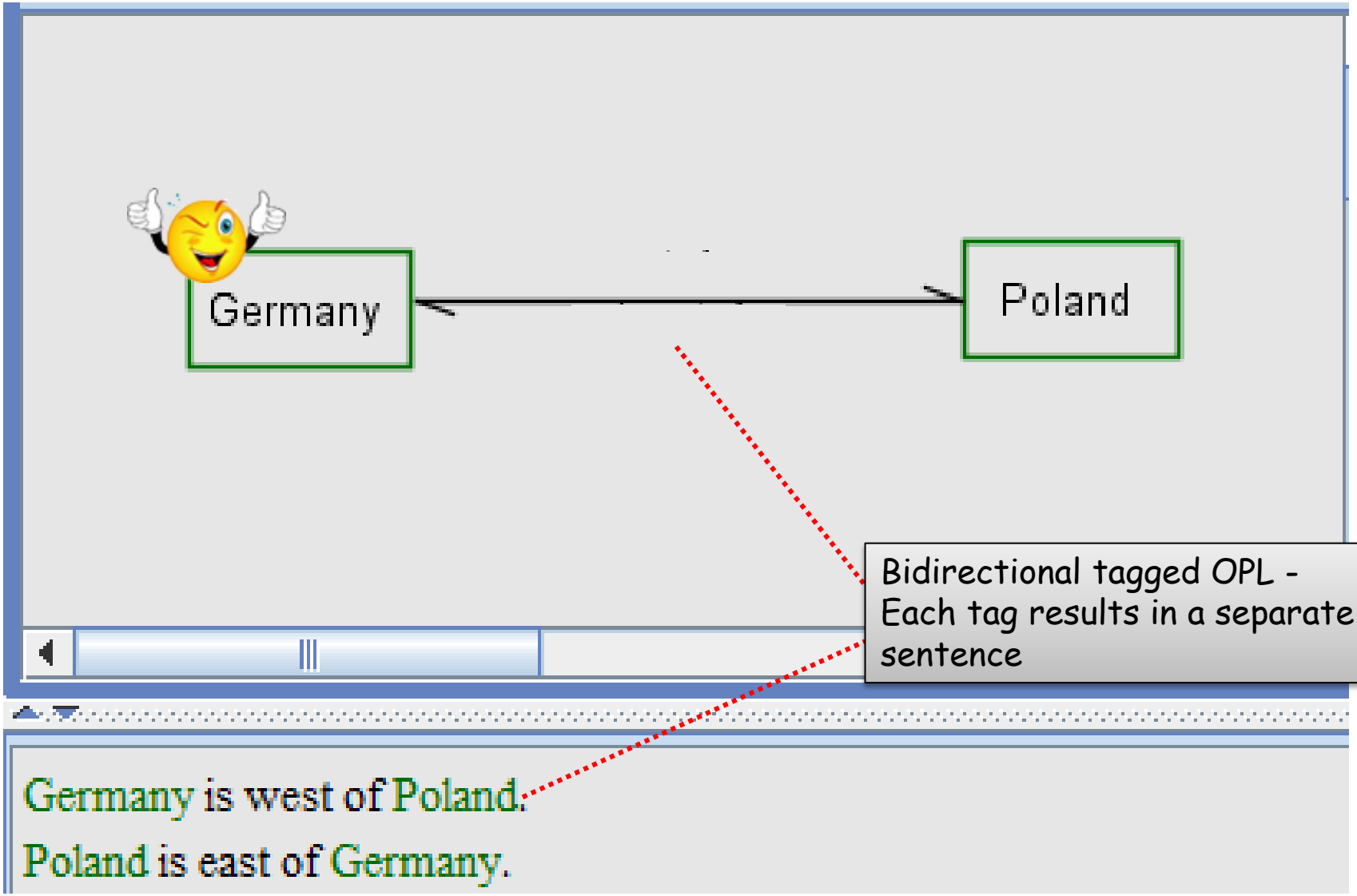
Unidirectional & Bidirectional Relation One-to-One

tagged



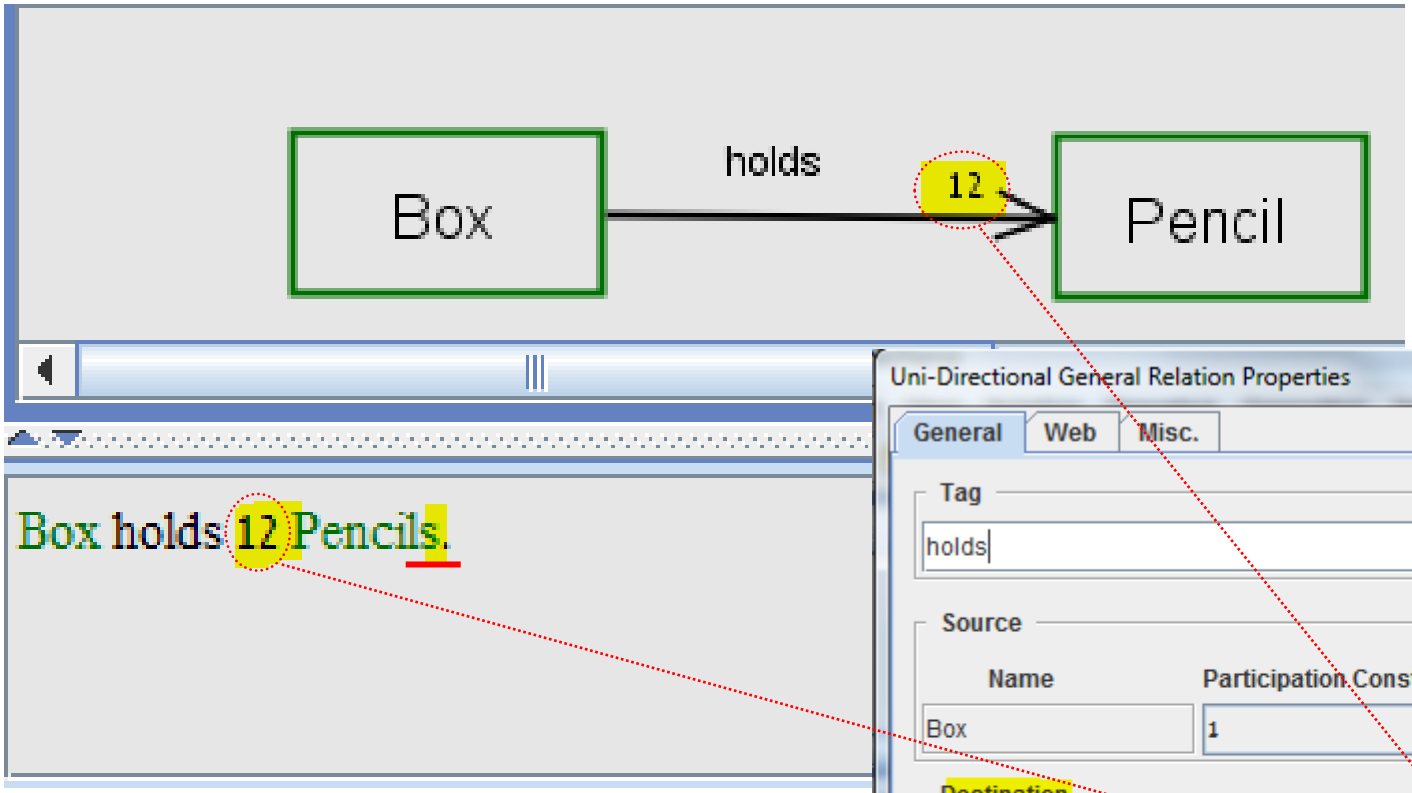
OPM – Structural Links

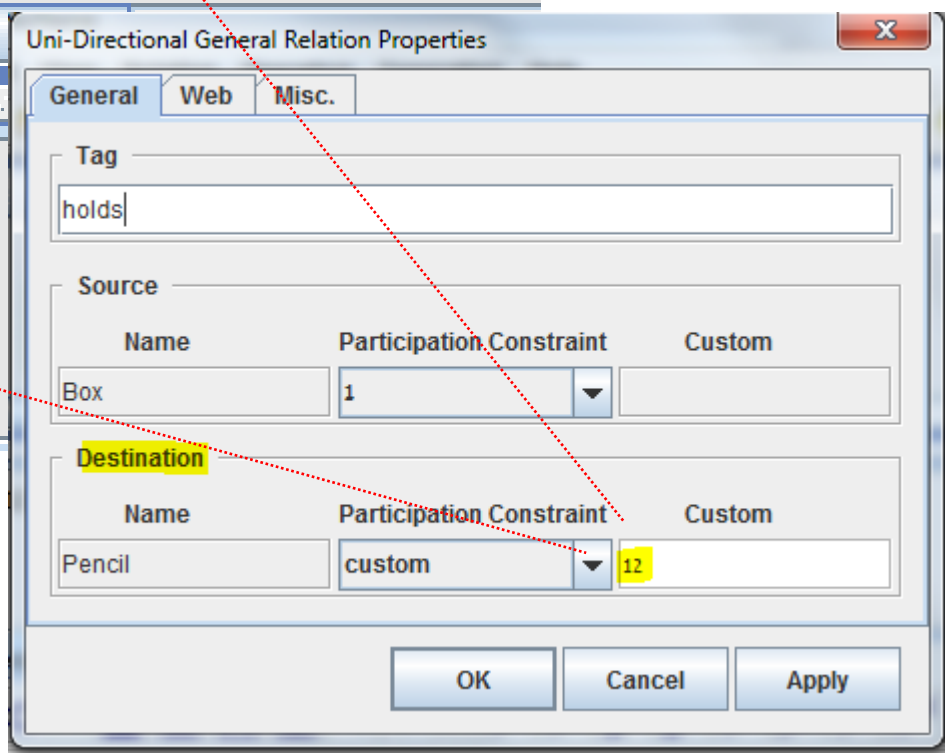
Unidirectional & Bidirectional Relation One-to-One



OPM – Structural Links

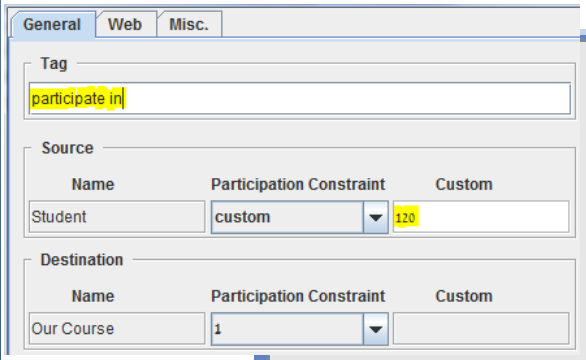
Unidirectional & Bidirectional Relation One-to-Many

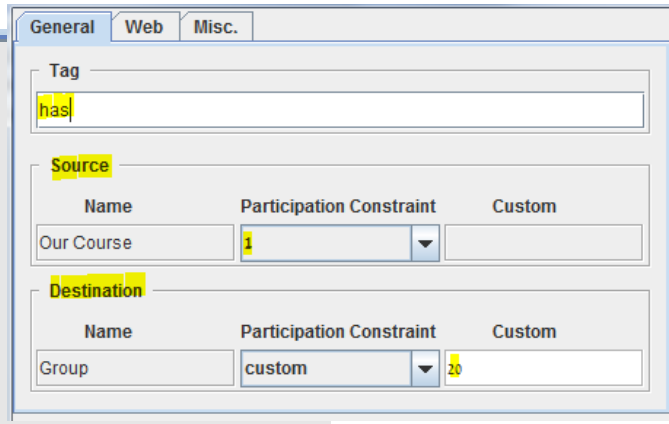




OPM – Structural Links

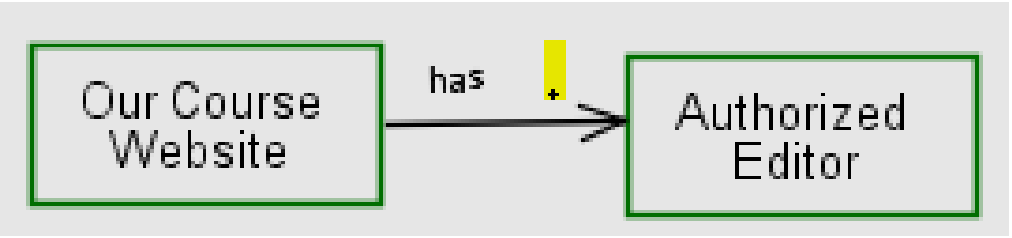
Unidirectional & Bidirectional Relation One-to-Many





Participation Constraints and Cardinality

Participation Constraint	1	many	custom: [q | q_{min} .. q_{max}]				
			q	q1..q2	0..1	0..m	1..m
OPD Symbol	(none)	m	q	q1..q2	?	*	+
OPL phrase		many	q	Q1 to q2	An optional	optional (+ plural)	at least one



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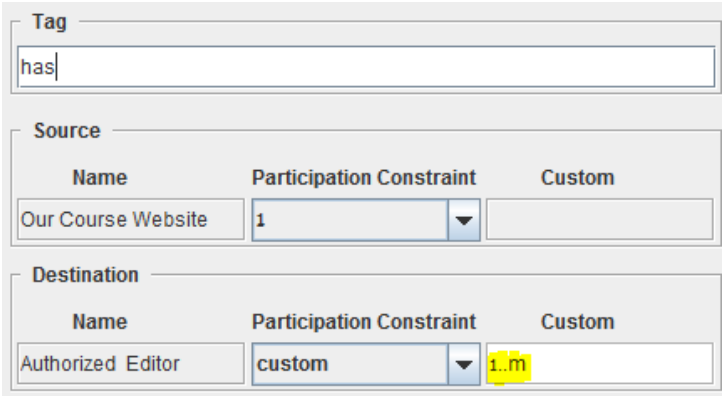
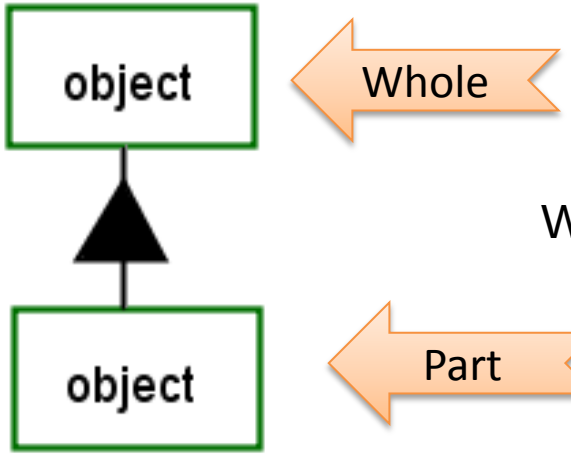
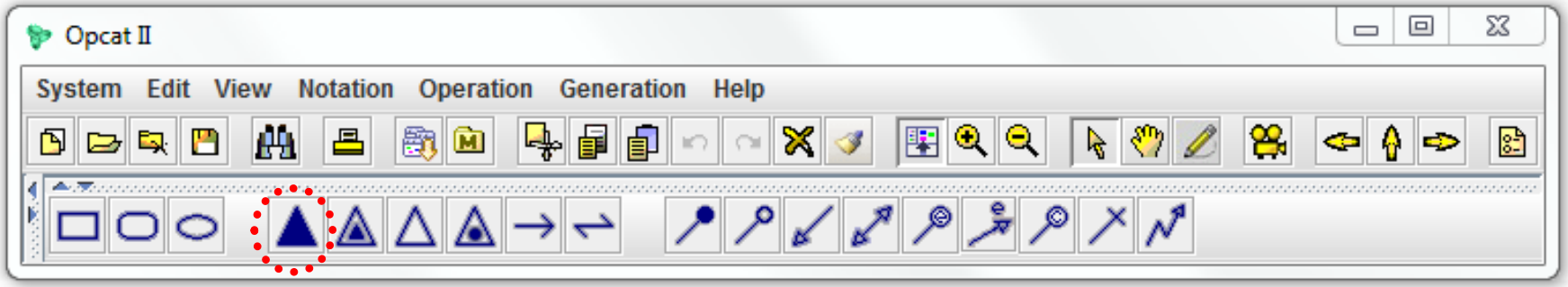


OPM – Structural Links

Aggregation-participation

A structural relation between the whole and its parts





OPM – Structural Links

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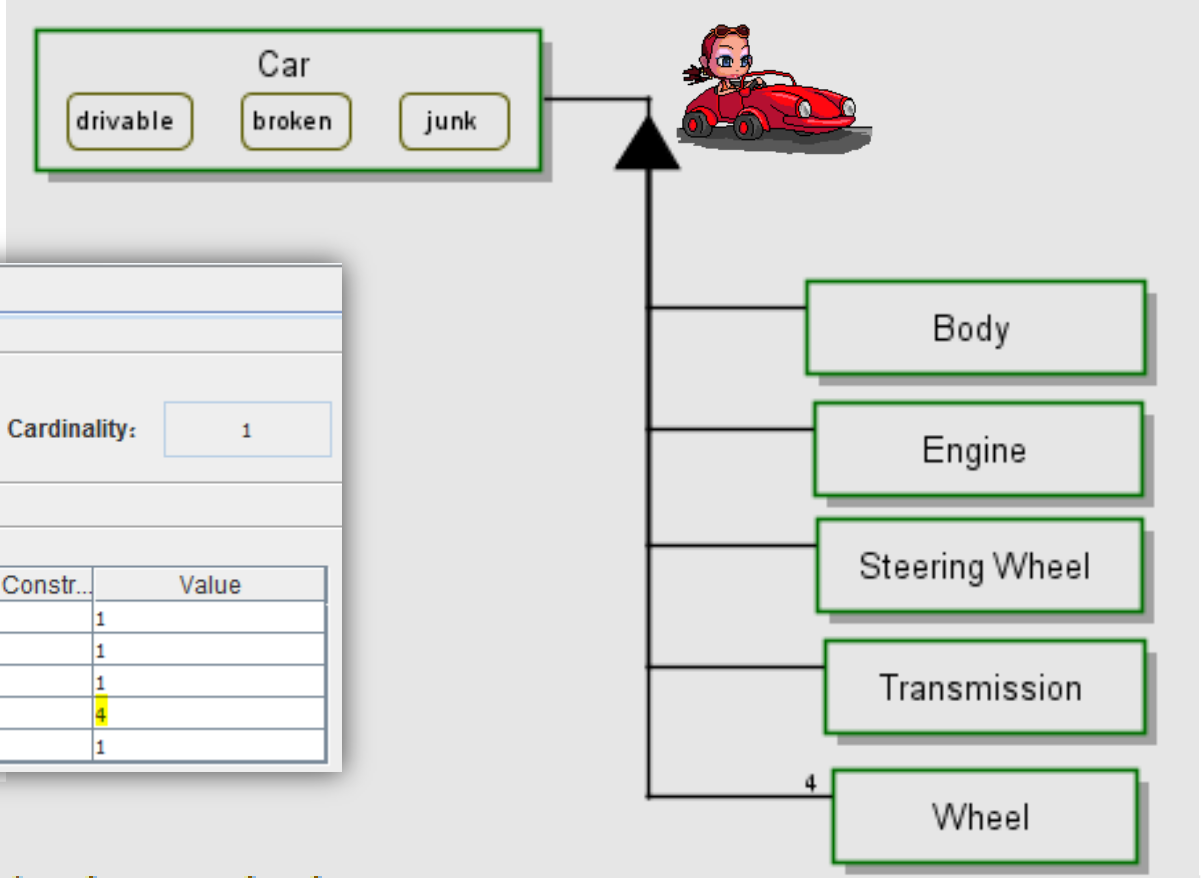


General | Misc.

Source

Name: Car Cardinality: 1

Destinations

Name	Participation Constr...	Value
Body	1	1
Engine	1	1
Transmission	1	1
Wheel	custom	4
Steering Wheel	1	1

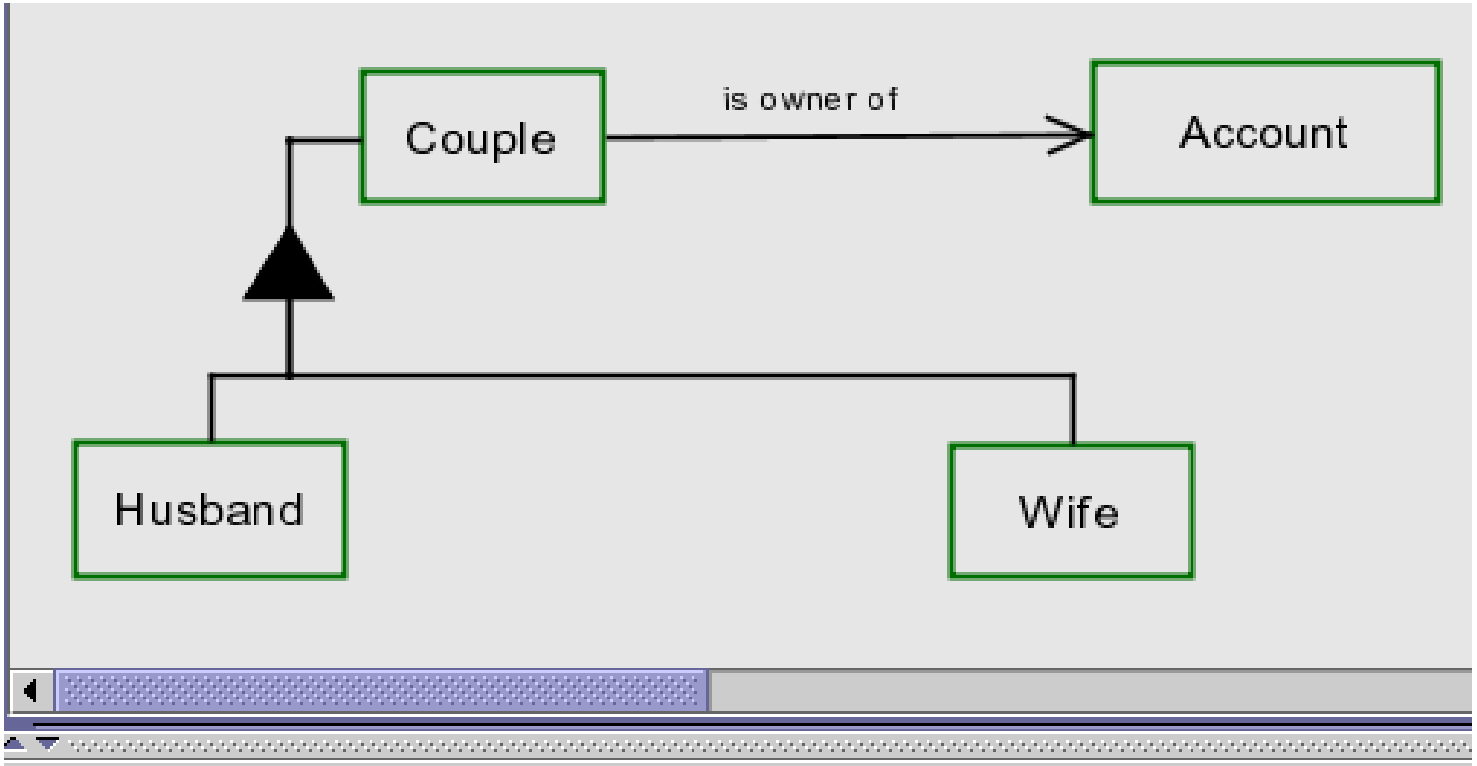
Car is physical.

Car can be drivable, broken, or junk.

Car consists of Body, Engine, Steering Wheel, Transmission, and 4 Wheels.

OPM – Structural Links

Aggregation-participation



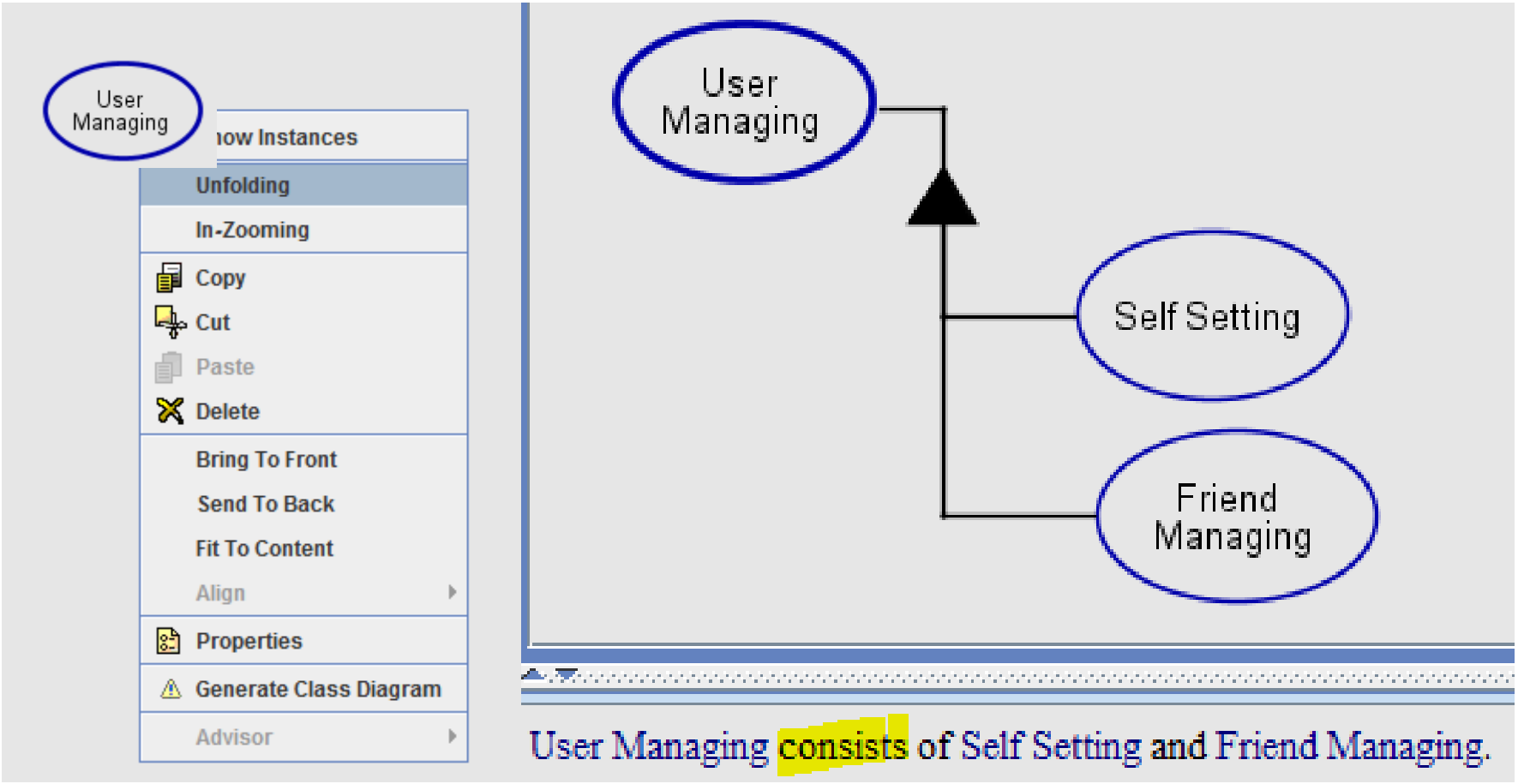
Couple consists of Husband and Wife.

Couple is owner of Account.

OPM – Structural Links

Aggregation-participation

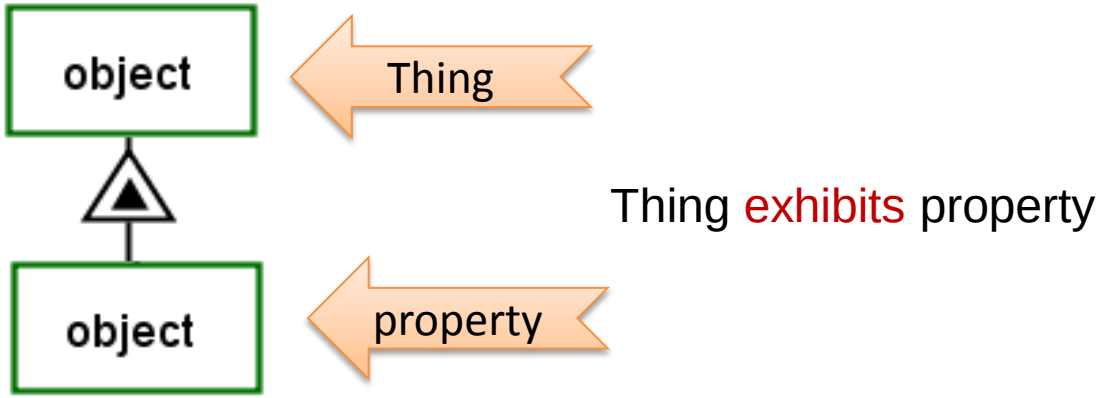
Asynchronous process consists of sub-processes

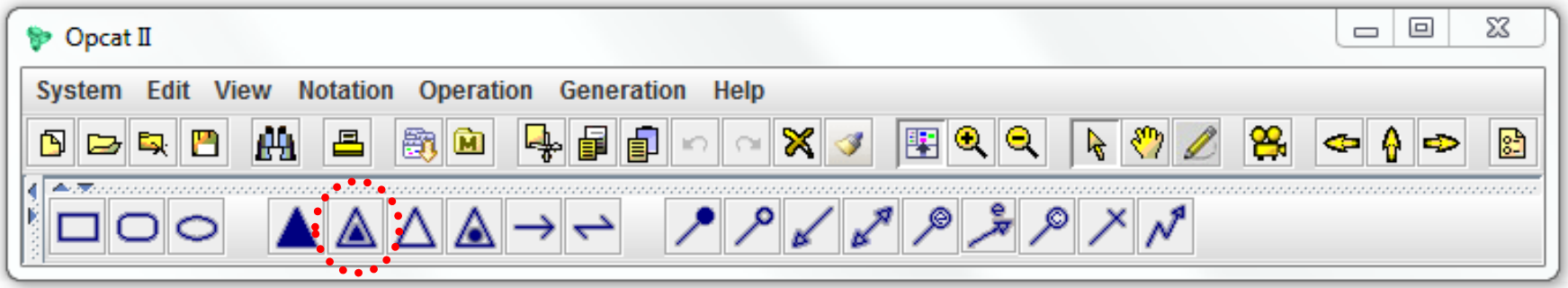


OPM – Structural Links

Exhibition-characterization

Thing exhibits, or is characterized by, another thing

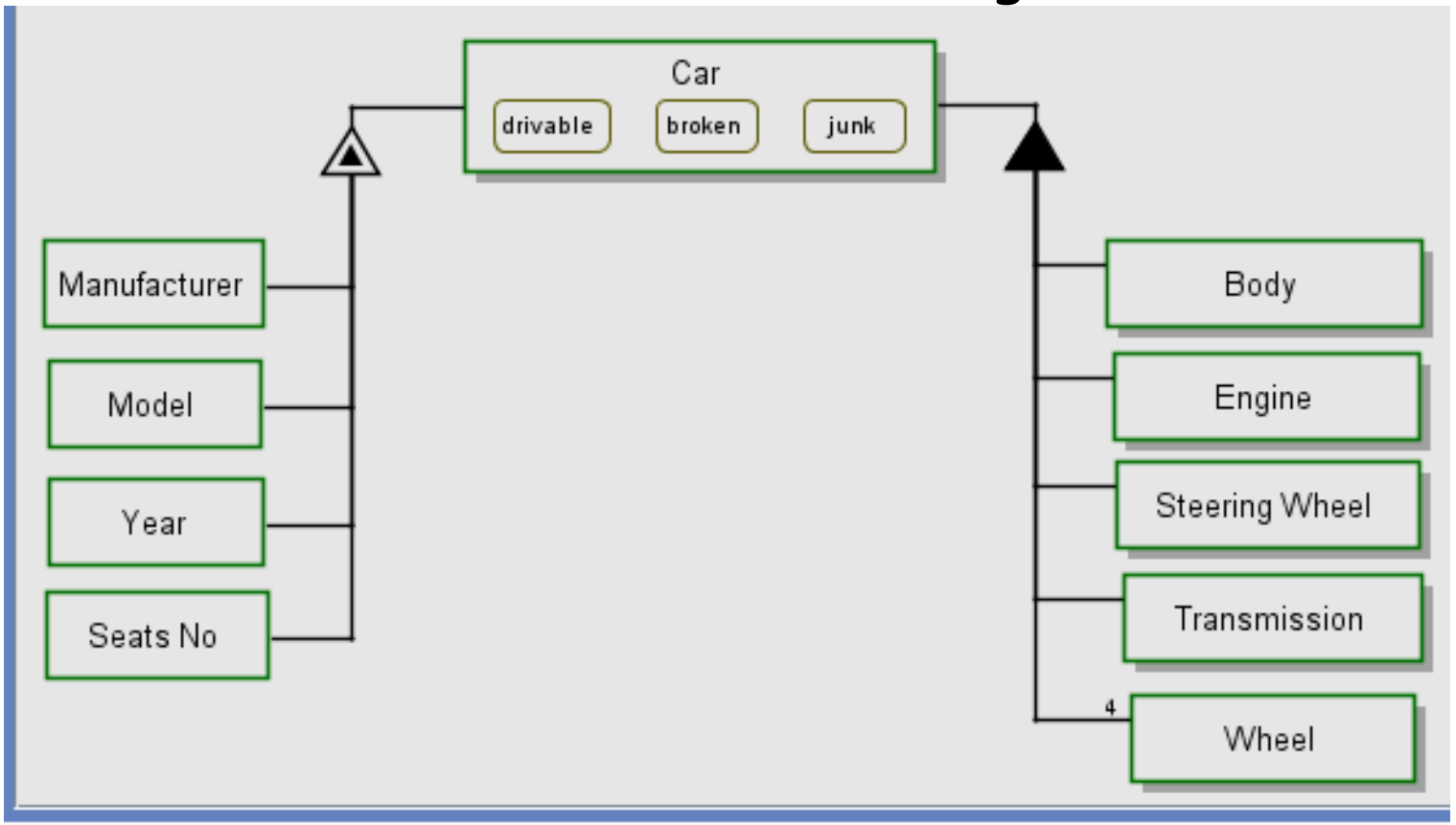




OPM – Structural Links

Exhibition-characterization

A structural relation between a thing and its features

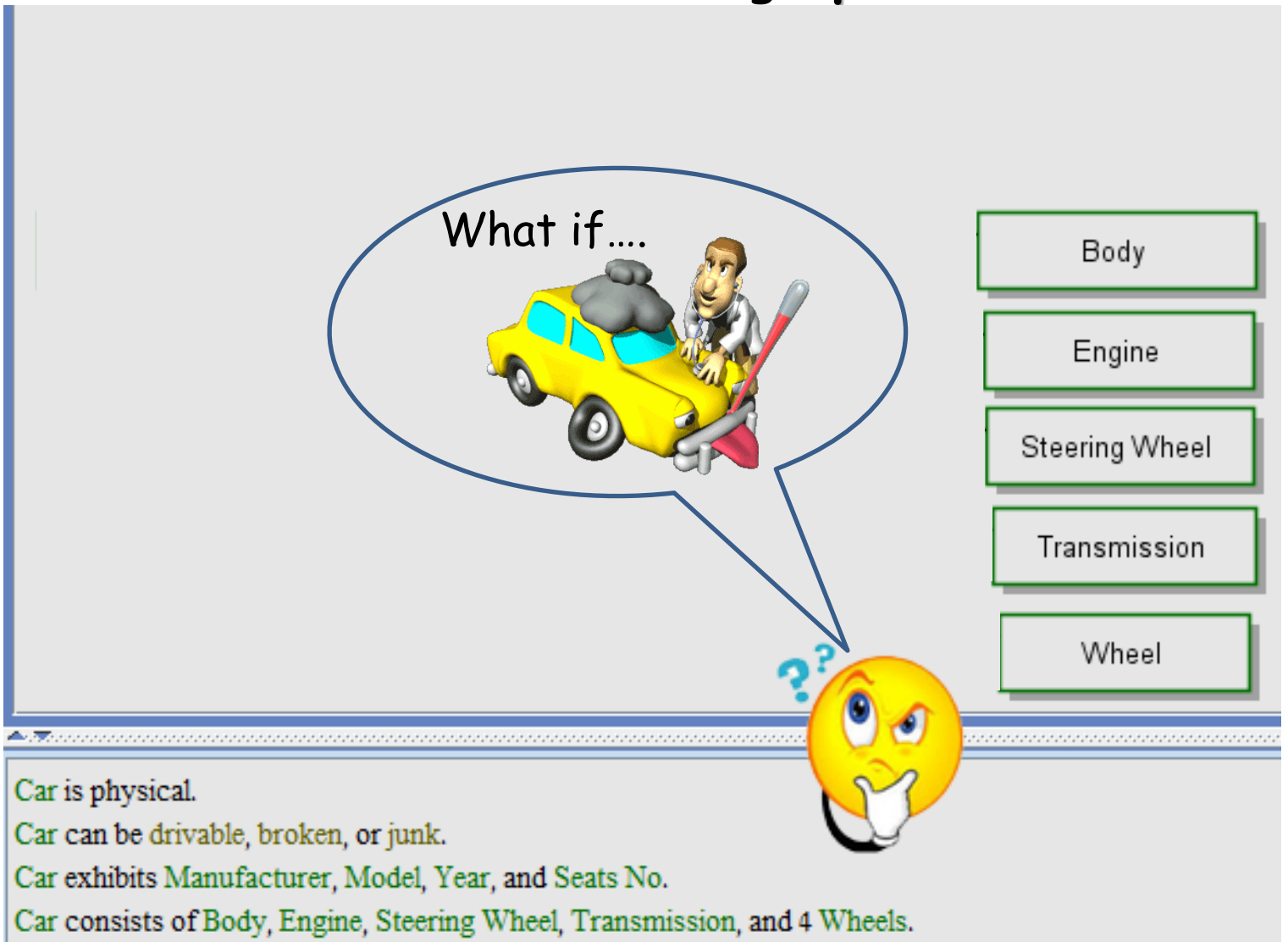


Car is physical.
Car can be drivable, broken, or junk.
Car exhibits Manufacturer, Model, Year, and Seats No.
Car consists of Body, Engine, Steering Wheel, Transmission, and 4 Wheels.

OPM – Structural Links

Exhibition-characterization

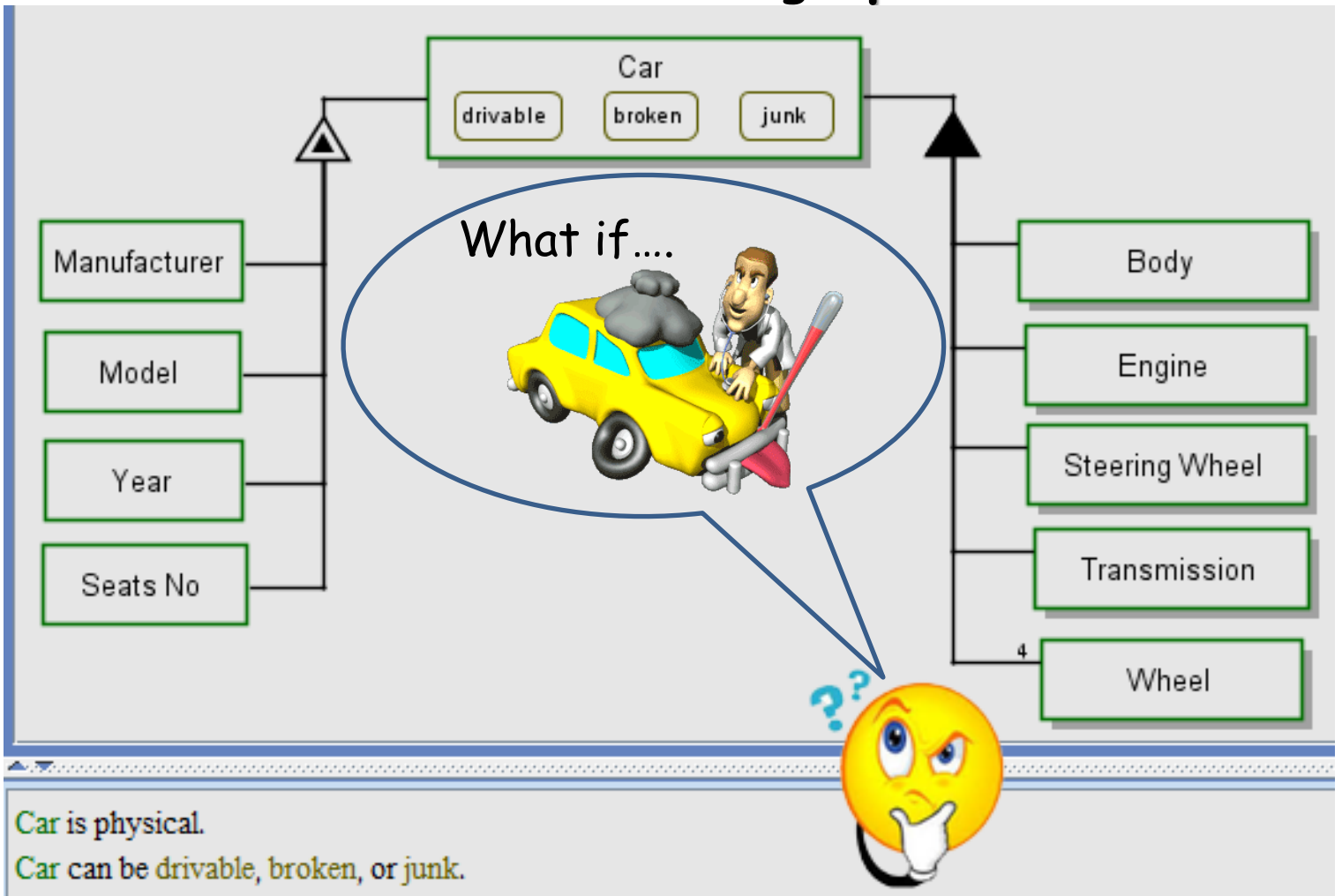
The **difference between** a thing's **part** and its **feature**



OPM – Structural Links

Exhibition-characterization

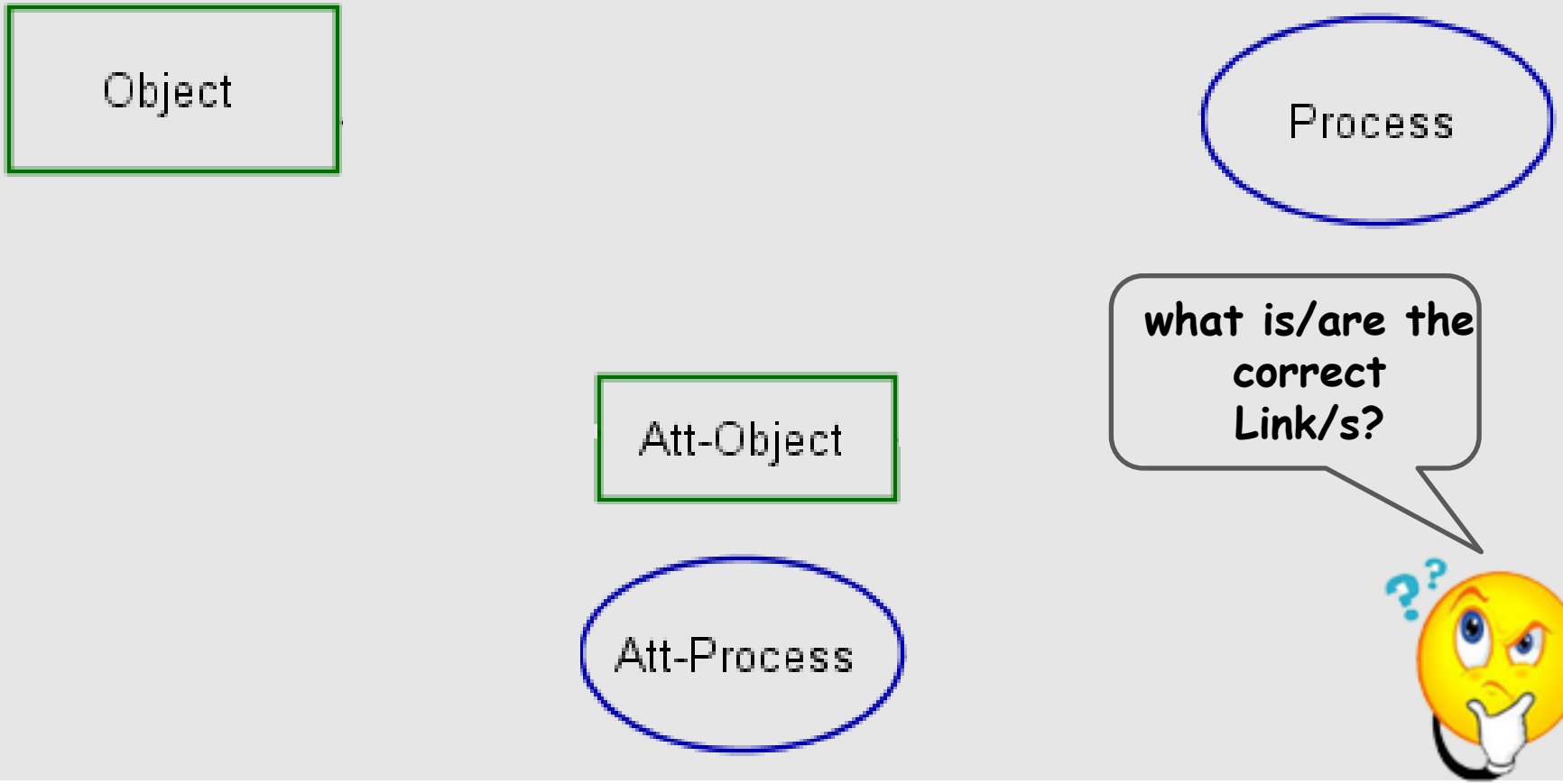
The **difference between** a thing's **part** and its **feature**



OPM – Structural Links

Exhibition-characterization

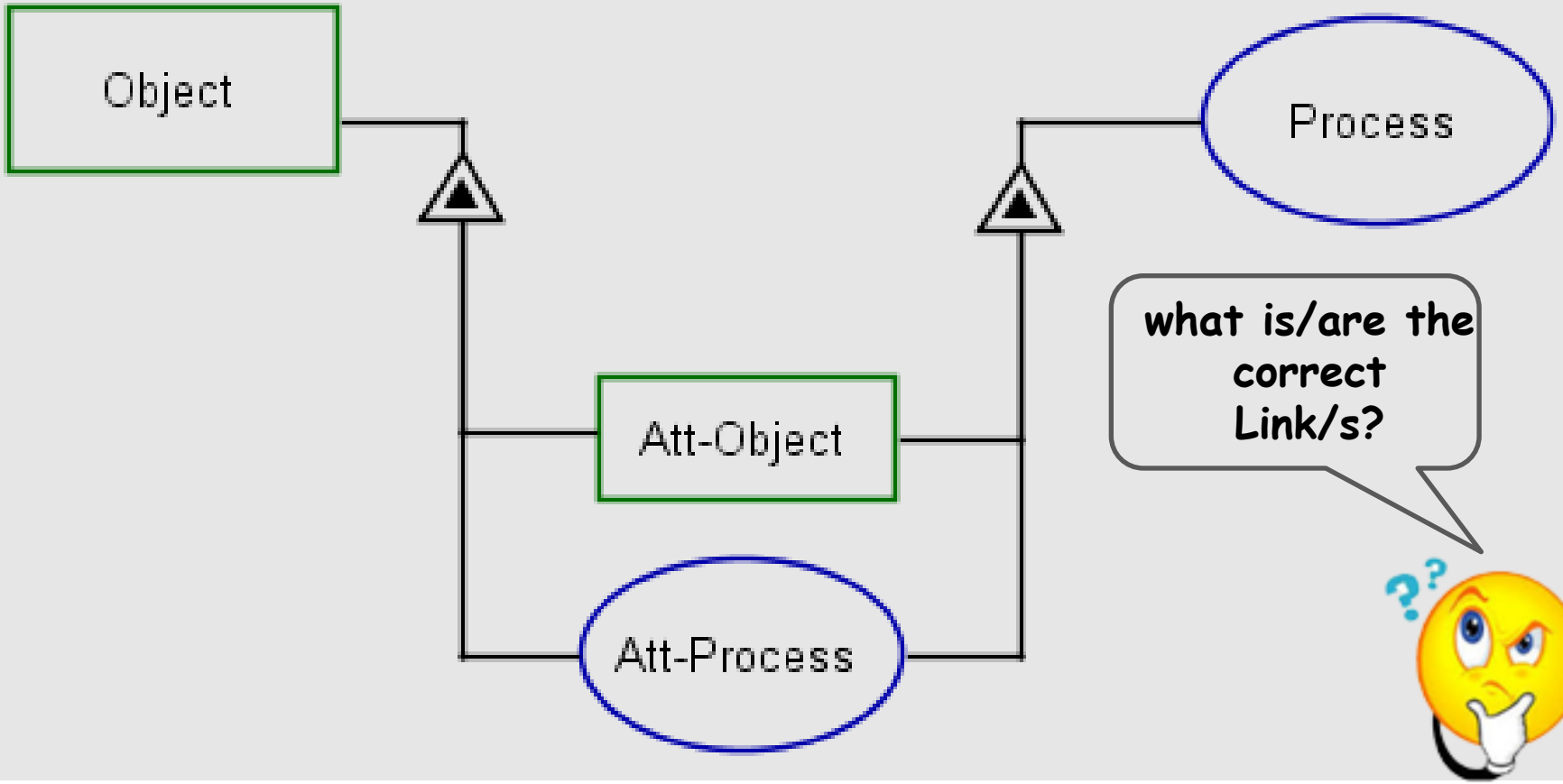
A structural relation between a thing and its features



OPM – Structural Links

Exhibition-characterization

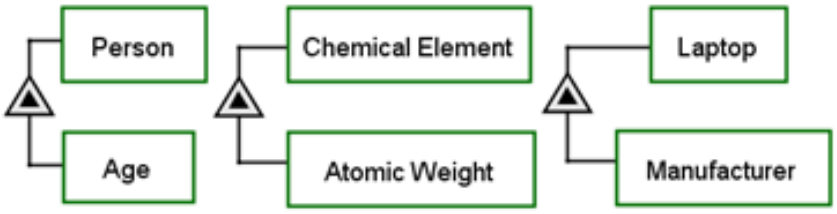
A structural relation between a thing and its features



OPM – Structural Links

Exhibition-characterization

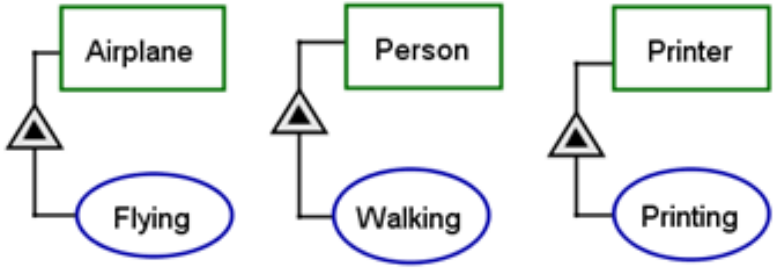
Structural relation **examples** between an object and its features



Person exhibits **Age.**

Chemical Element exhibits **Atomic Weight.**

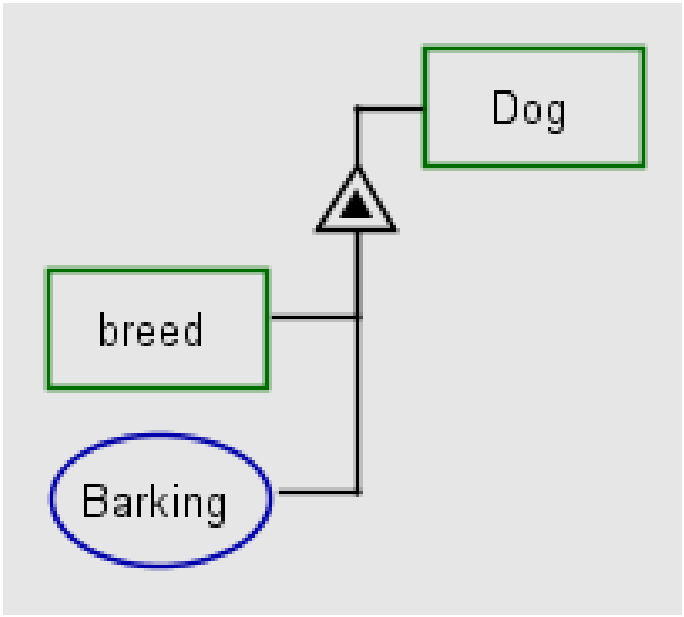
Laptop exhibits **Manufacturer.**



Airplane exhibits **Flying.**

Person exhibits **Walking.**

Printer exhibits **Printing.**

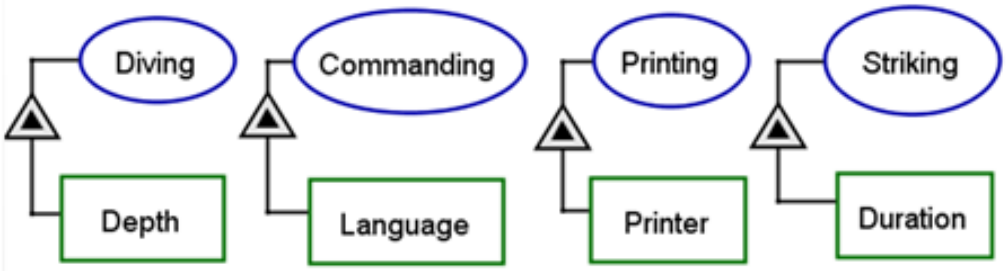


Dog exhibits breed, as well as Barking.

OPM – Structural Links

Exhibition-characterization

Structural relation **examples** between a process and its features

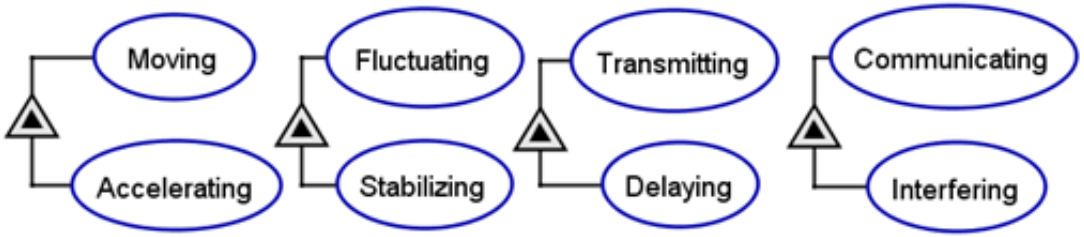


Diving exhibits **Depth.**

Commanding exhibits **Language.**

Printing exhibits **Printer.**

Striking exhibits **Duration.**

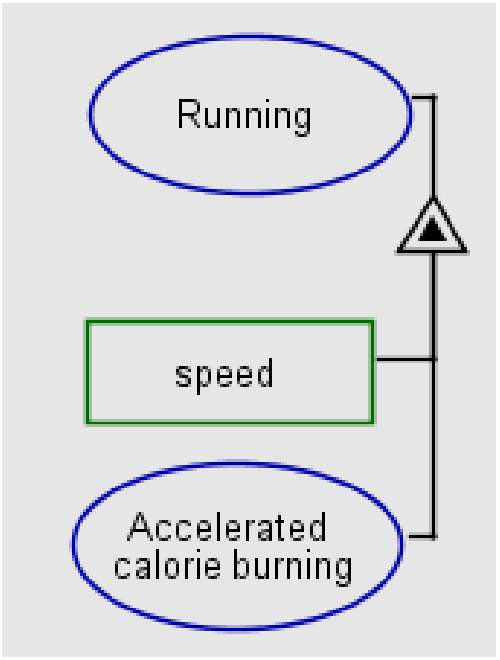


Moving exhibits **Accelerating.**

Fluctuating exhibits **Stabilizing.**

Transmitting exhibits **Delaying.**

Communicating exhibits **Interfering.**

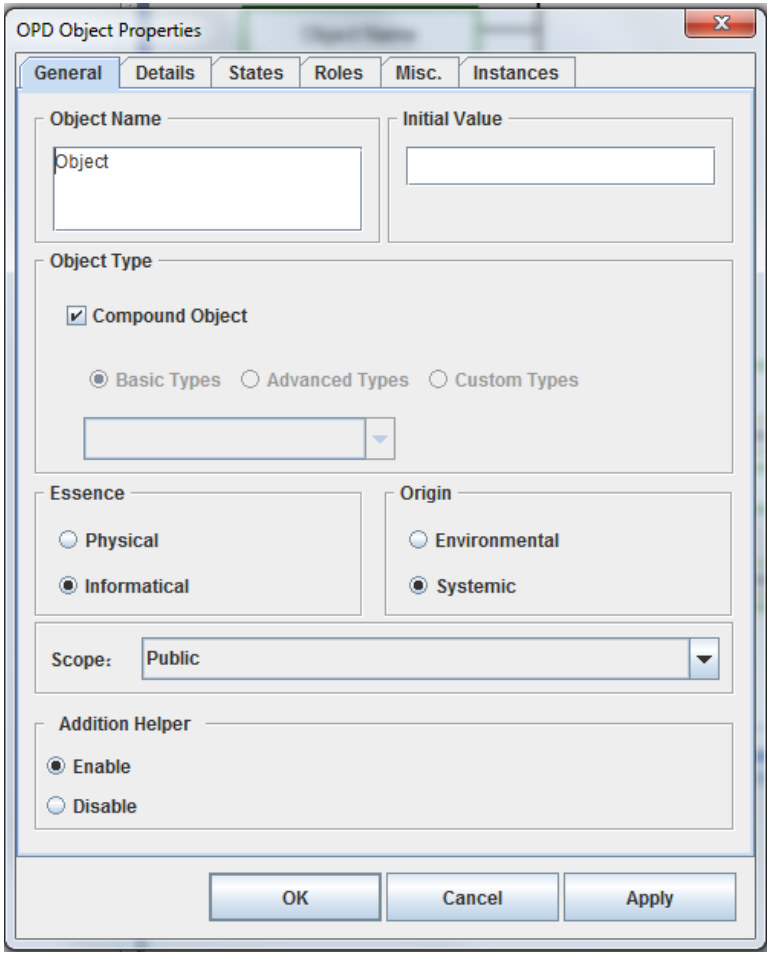


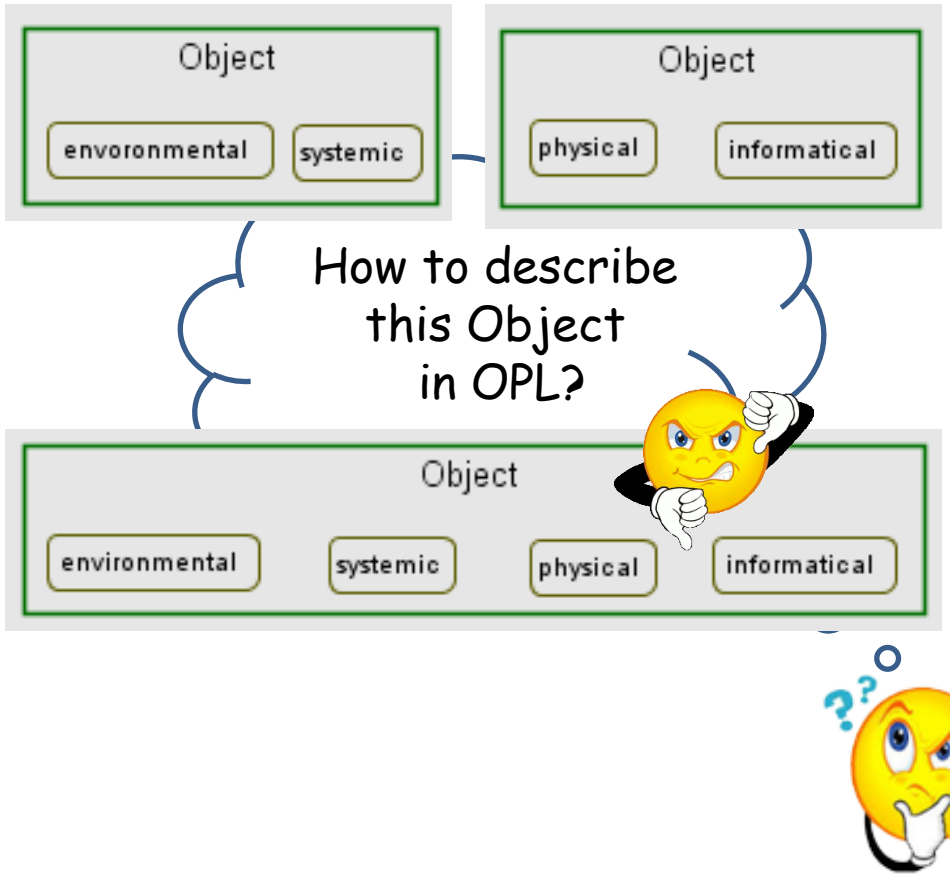
Running **exhibits** Accelerated calorie burning, as well as speed.

OPM – Structural Links

Exhibition-characterization

Object's features and Object's states

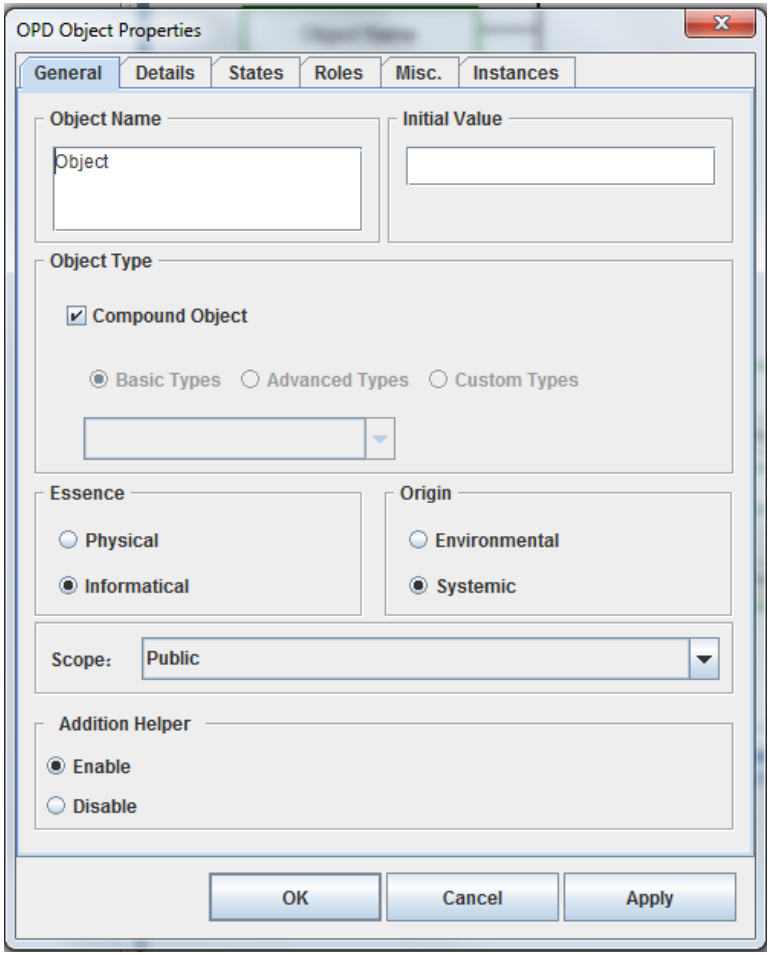


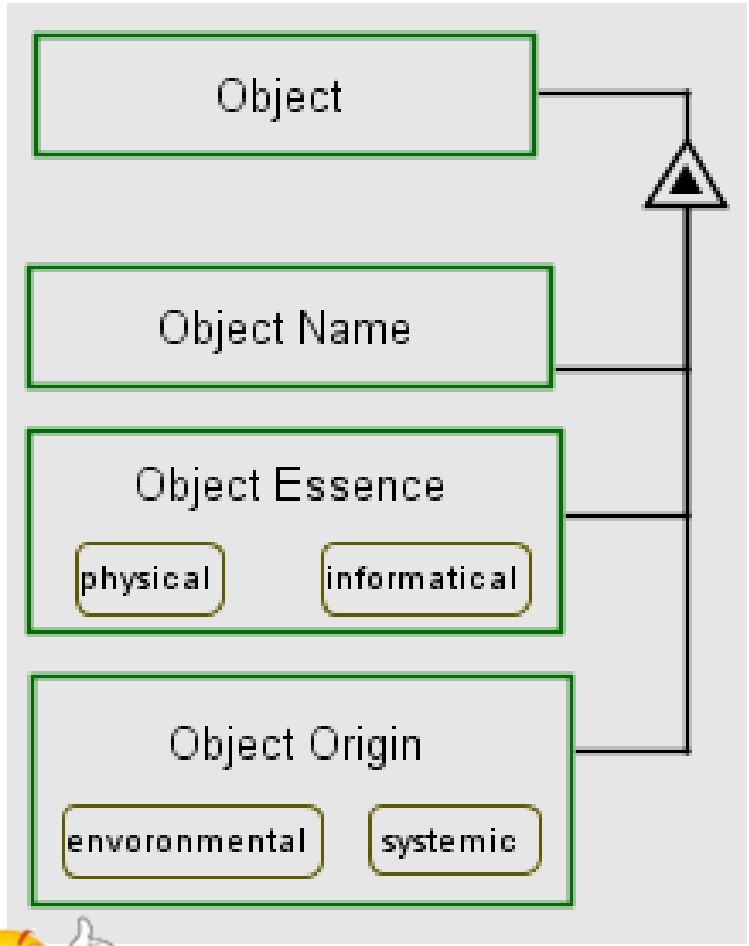


OPM – Structural Links

Exhibition-characterization

Object's features and Object's states



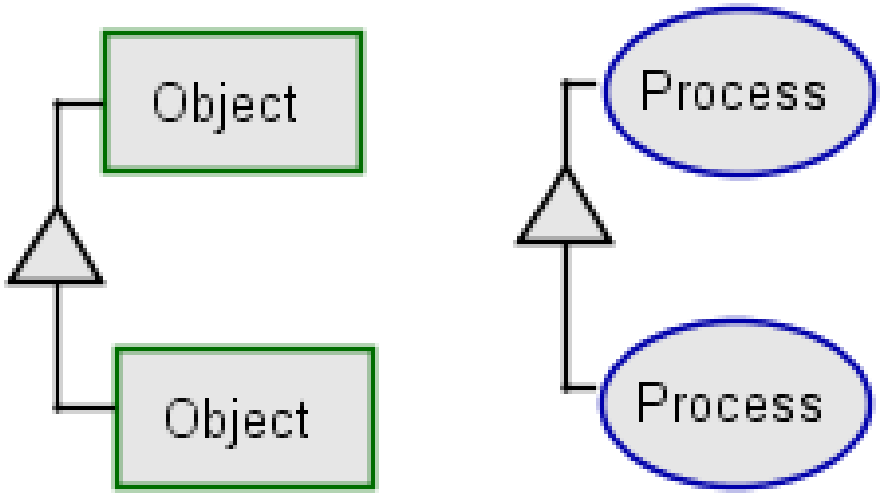


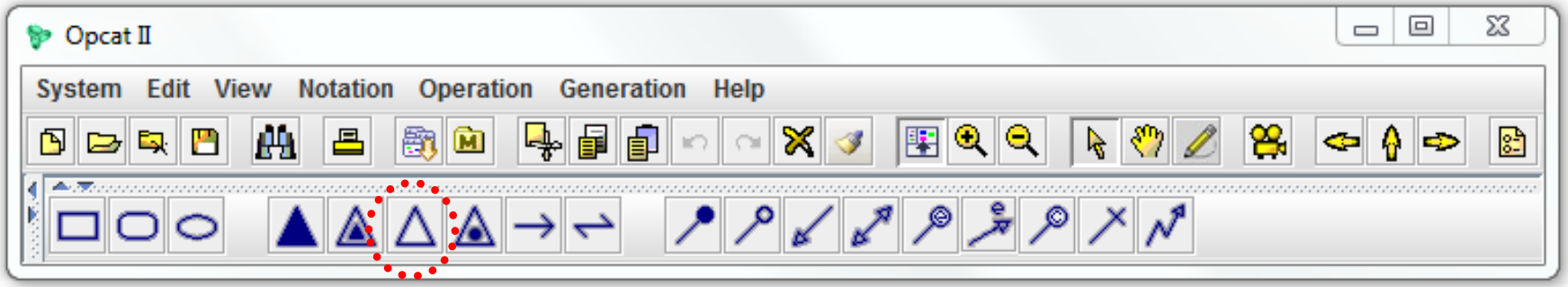
OPM – Structural Links

Generalization-specialization

Specializations of the general - Inheritance

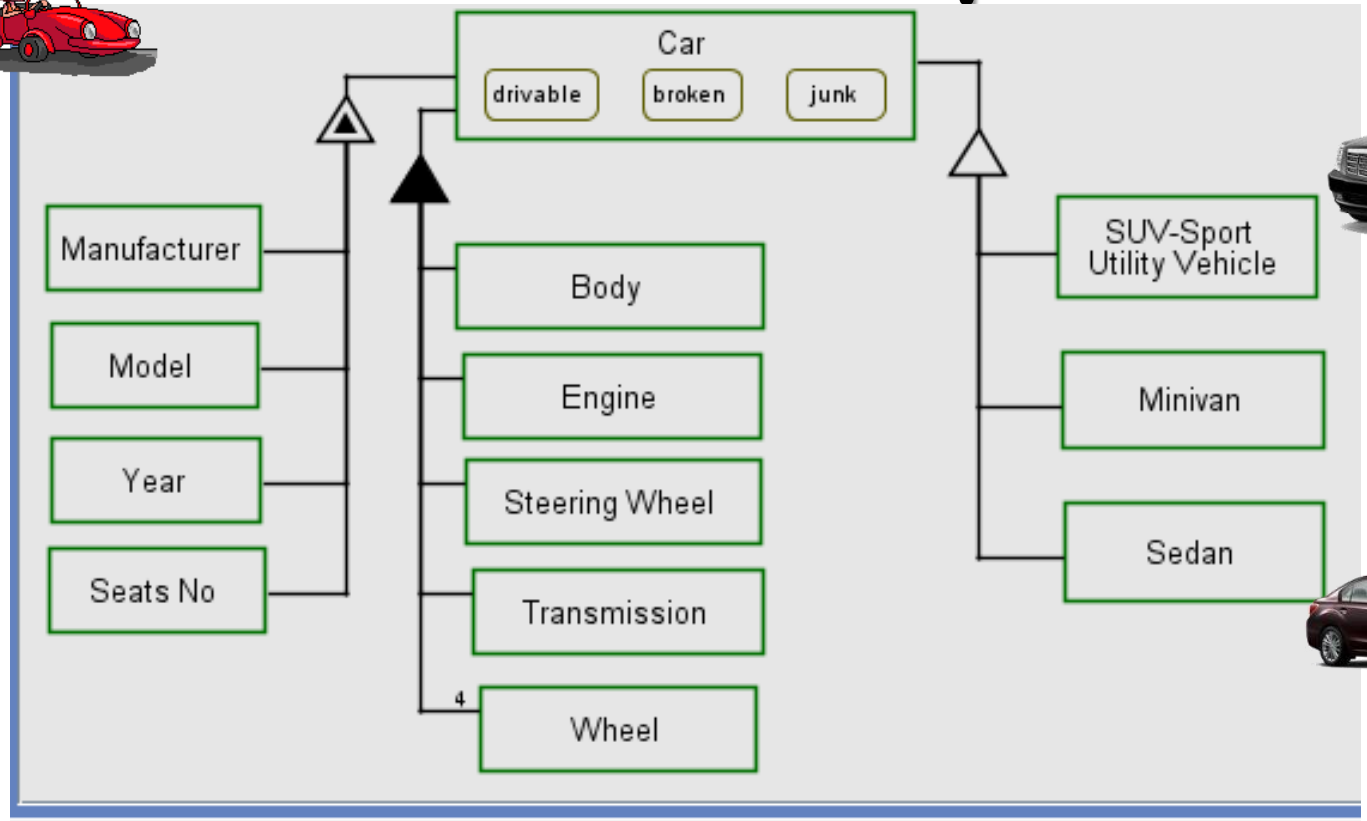
A structural relation between a thing and its specializations





OPM – Structural Links

Generalization-specialization

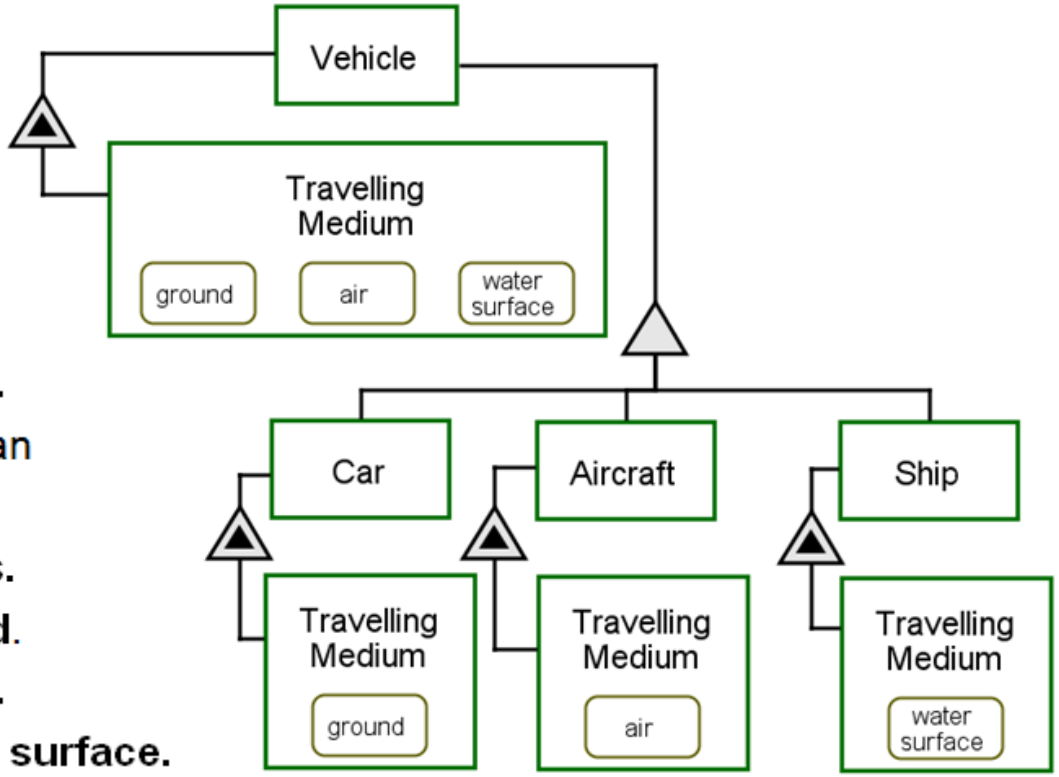


Car can be drivable, broken, or junk.
Car exhibits Manufacturer, Model, Year, and Seats No.
Car consists of Body, Engine, Steering Wheel, Transmission, and 4 Wheels.
SUV-Sport Utility Vehicle is a Car.
Minivan is a Car.
Sedan is a Car.

OPM – Structural Links

Generalization-specialization

A subset of the possible values of an inherited attribute may restrict the specialization

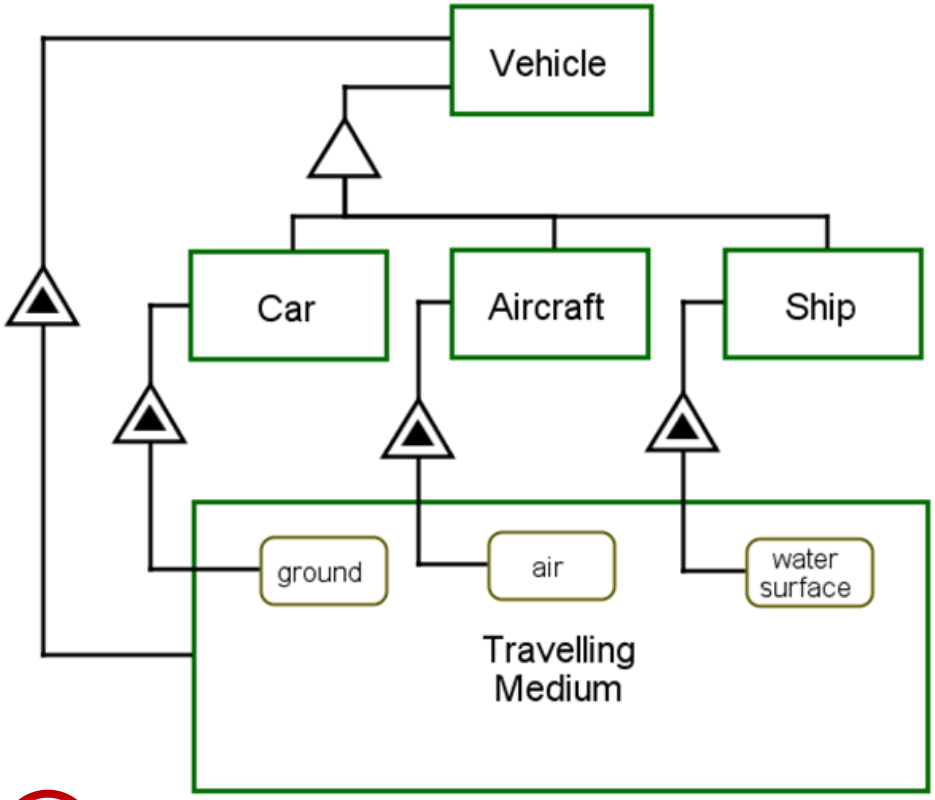


Vehicle exhibits **Travelling Medium.**
Travelling Medium of Vehicle can be ground, air, and water surface.
Car, Aircraft, and Ship are Vehicles.
Travelling Medium of Car is ground.
Travelling Medium of Aircraft is air.
Travelling Medium of Ship is water surface.

OPM – Structural Links

Generalization-specialization

A subset of the possible values of an inherited attribute may restrict the specialization



Vehicle exhibits **Travelling Medium**.
Travelling Medium of **Vehicle** can be **ground**, **air**, and **water surface**.
Car, **Aircraft**, and **Ship** are **Vehicles**.
Car exhibits **ground Travelling Medium**.
Aircraft exhibits **air Travelling Medium**.
Ship exhibits **water surface Travelling Medium**.

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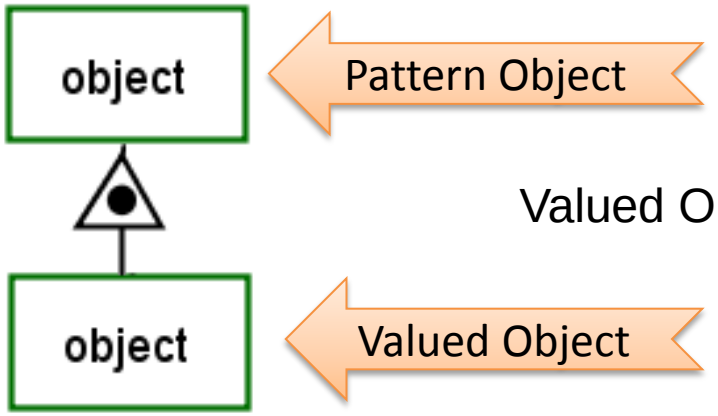
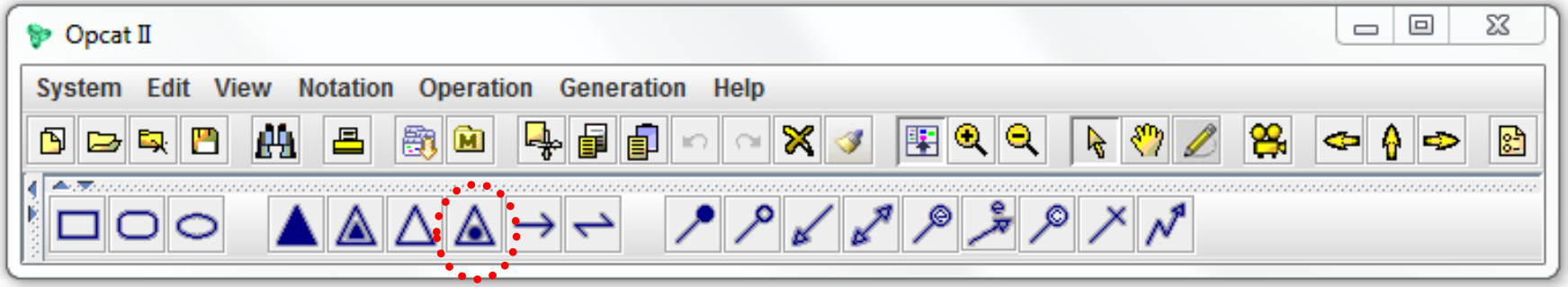
OPM – Structural Links

Classification-instantiation

a pattern for a thing, connect destination thing, which is valued instance of the source thing's pattern



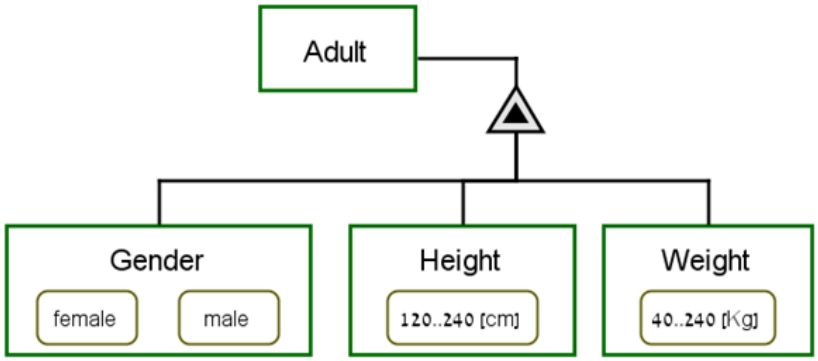
Valued Object is an instance of a Pattern Object

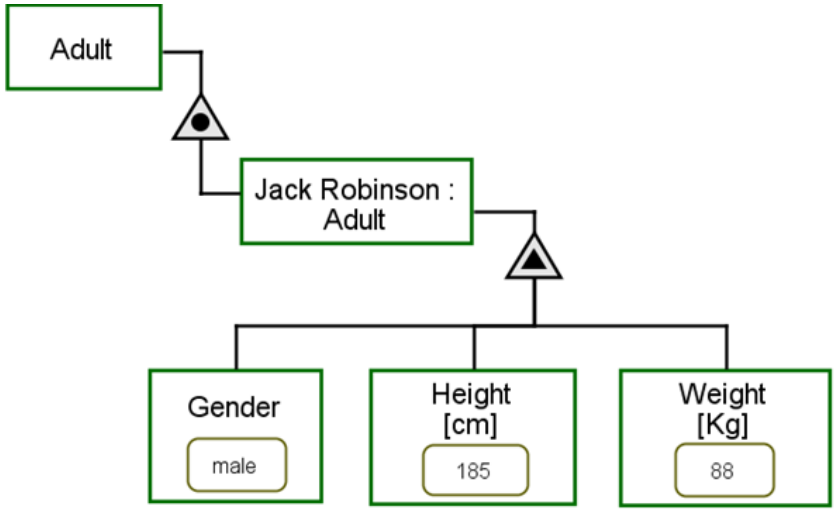


OPM – Structural Links

Classification-instantiation

a pattern for a thing, connect destination thing, which is valued instance of the source thing's pattern





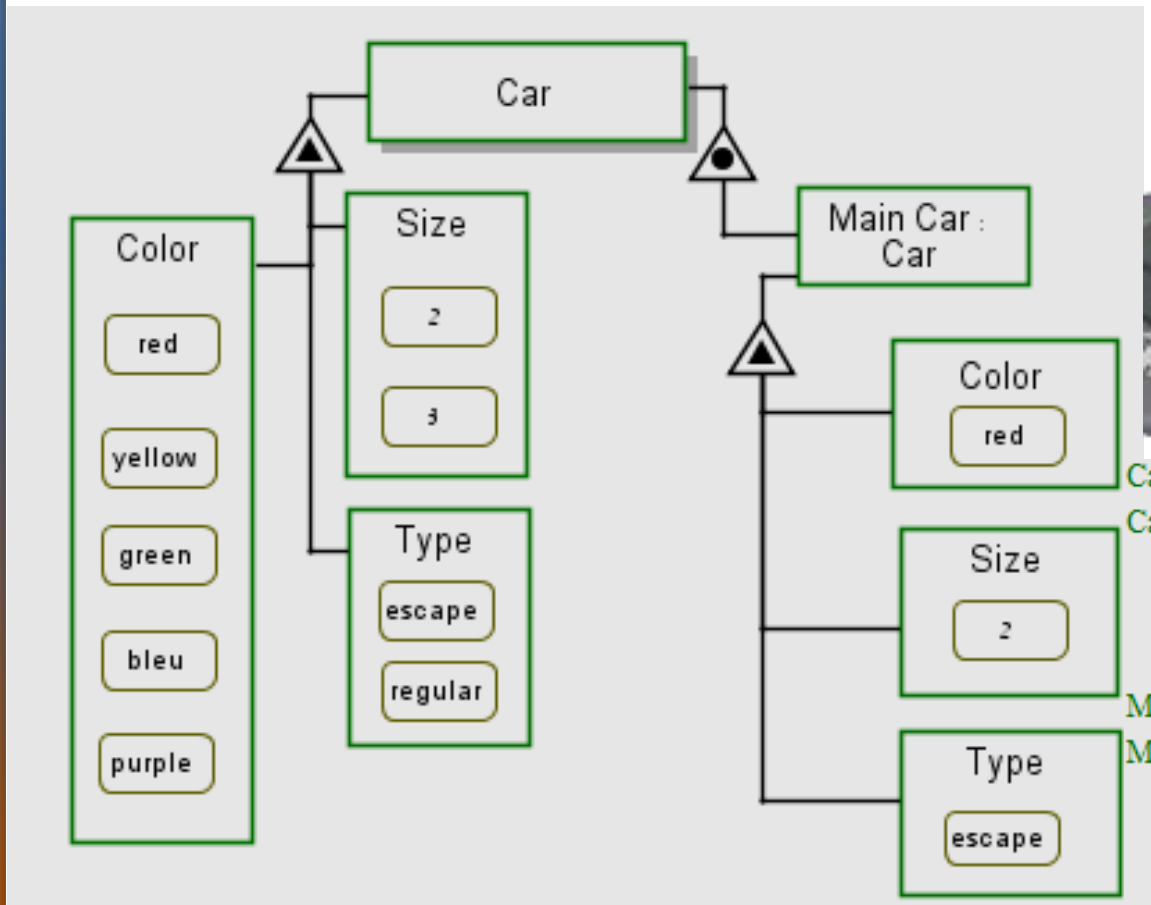
Adult exhibits **Gender**, **Height**, and **Weight**.
Gender of **Adult** can be **female** or **male**.
Height of **Adult** range is **120** through **240** **[cm]**.
Weight of **Adult** range is **40** through **240** **[Kg]**.

Jack Robinson is an instance of **Adult**.
Gender of **Jack Robinson** is **male**.
Height of **Jack Robinson** is **185** **[cm]**.
Weight of **Jack Robinson** is **88** **[Kg]**.

OPM – Structural Links

Classification-instantiation

a pattern for a thing, connect destination thing, which is valued instance of the source thing's pattern

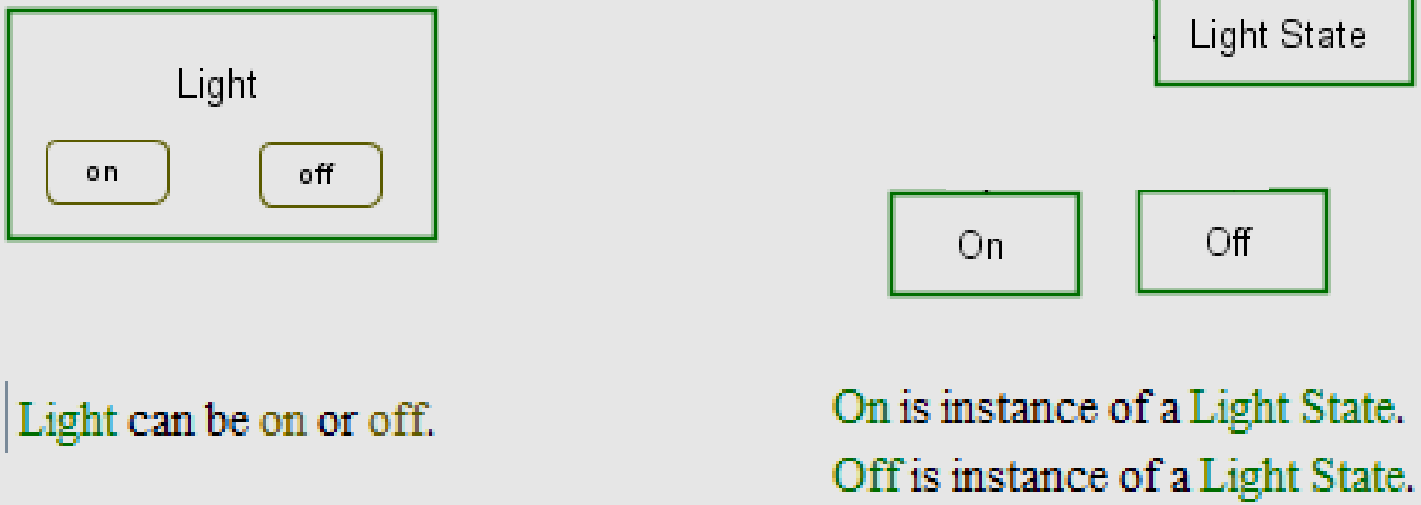


Car is physical.
Car exhibits Color, Size, and Type.
Color can be yellow, red, green, bleu, or purple.
Size can be 2 or 3.
Type can be escape or regular.
Main Car is instance of a Car.
Main Car exhibits Color, Size, and Type.
Color is red.
Size is 2.
Type is escape.

OPM – Structural Links

Classification-instantiation

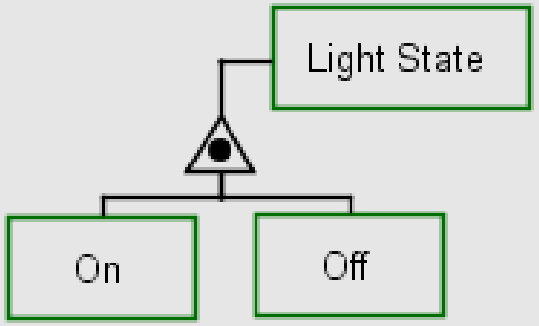
Instantiation – a thing which is a valued instance of the source thing's pattern



OPM – Structural Links

Classification-instantiation

Instantiation – a thing which is a valued instance of the source thing's pattern



Light can be on or off.

On is instance of a Light State.

Off is instance of a Light State.

An **enumeration** is a collection of items that is a complete, ordered listing of all of the items in that collection. As **states** each one describes a possible object state. As **objects** each one is a thing which is valued instance of the source thing's pattern.

Facebook Object Unfolding Example