

# ON COMPOSITIONALITY OF ISO 25964 HIERARCHICAL RELATIONS (BTG, BTP, BTI)

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and [emacs](#).

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# BTG, BTP, BTI

KOS have used different kinds of hierarchical relations for a long time:

Relation	Abbr	Name	Example
broaderGeneric	BTG	Genus/Species Relation	mineral BTG inorganic material (AAT)
			Iceland spar BTG calcite (AAT)
broaderPartitive	BTP	Part/Whole Relation	Tuscany BTP Italy (TGN)
broaderInstantial	BTI	Kind/Instance Relation	Rembrandt van Rijn BTI person (ULAN)
			<a href="#">SG Dynamo Dresden</a> BTI football clubs (GND)

# USE OF BTG, BTP, BTI IN THESAURI

Examples:

- Deutsche Nationalbibliothek: [Gemeinsame Normdatei Ontology](#)
  - `gndo:broaderTermInstantial` (see [Dynamo Dresden in Linked Data Service](#))
- Some vocabs in xTree ([vocnet.org](#)) by [digiCULT-Verbund eG](#)
- [FinnONTO SKOS Extensions](#) (Aalto University)
- [WordNet](#), with BTP distinctions: member vs part vs substance meronym/holonym
- [ISO 25964 Ontology](#): officially formalized (as "step" properties)
- Most recently, [Getty Vocabulary Program \(GVP\) LOD](#)
  - First industrial application of ISO 25964
  - Many examples in this presentation are from GVP

# DEFINITIONS IN ISO 25964

- BTG: amenable to logical all-and-some test
  - Children should all be a type, or kind of the parent
  - From the parent's point of view, it encompasses only some of any given child
  - Can be concluded it's comparable to `rdfs:subClassOf (isA)`: transitive
- BTP: part of entity/system belongs uniquely to particular possessing whole in any context
  - The part may not belong to more than one whole, and BTP has to be universally valid
  - **AAT Guidelines**: "Each child should be part of the parent and all ancestors above it" (transitive)
- BTI: individual instance to general class
  - Instances often represented by proper name (also called "classes of one")
  - Instances may not have further BTI nor BTG
  - But it may be further subdivided: use custom relationship

# GVP HIERARCHICAL RELATION COUNTS

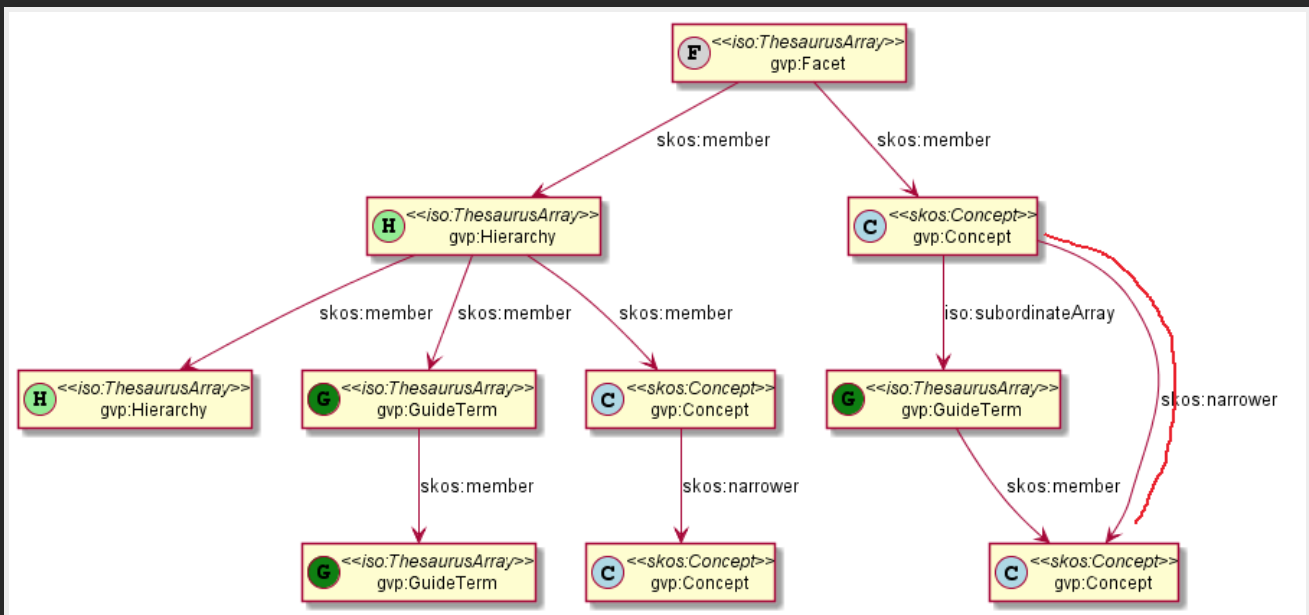
Row Labels	BTG	BTI	BTP	and Total
<b>AAT</b>	<b>43460</b>		<b>85</b>	<b>43545</b>
Concept	41271		8	41279
GuideTerm	2151		77	2228
Hierarchy	38			38
<b>TGN</b>	<b>1</b>	<b>1</b>	<b>1262619</b>	<b>1262621</b>
Administrative	1		1249042	1249043
Facet		1	75	76
GuideTerm			574	574
Physical			12928	12928
<b>ULAN</b>		<b>214261</b>	<b>17667</b>	<b>231928</b>
CorporateBody		554	545	1099
Facet		213695	17122	230817
GuideTerm		11		11
Person		1		1
<b>Grand Total</b>	<b>43461</b>	<b>214262</b>	<b>1280371</b>	<b>1538094</b>

# GVP HIERARCHICAL RELATIONS

- AAT: most are BTG, but there is a variety of BTP:
  - (C) BTP (C): calendars of relics BTP cabinets of relics
  - (C) BTP (G): anvil components BTP <anvils and anvil accessories>
  - (G) BTP (C): <jewelry and accessory components> BTP jewelry
  - (G) BTP (G): <grinding and milling equipment components> BTP <grinding and milling equipment>
  - (C) BTP (H): building divisions BTP Single Built Works
- TGN: all are BTP
  - placeType: in the current TGN LOD (2.0) has no relation to BTI
  - May reconsider and make it subprop of BTI, see [TGN Place Type Relation](#) discussion paper
- ULAN: most are BTI, e.g. Rembrandt (ULAN) Persons facet (ULAN)
  - May consider more specific eg Rembrandt (I II ΔN) BTI

# GVP HIERARCHY STRUCTURE

- Subjects include (C)oncepts; but also: (F)acets, (H)ierarchies, (G)uide Terms
  - Not for indexing, only to structure. Implemented as `iso:ThesaurusArray`
  - G and C can be intermixed:  $F > H > (G|C)$





# SKOS/ISO VS GVP IMPEDANCE MISMATCH

- SKOS and ISO define **Standard Hierarchical Relations**
  - Only between Concepts
  - skos:broader, iso:broaderGeneric, etc
- We define custom **GVP Hierarchical Relations**
  - Connect the hierarchy uniformly
  - gvp:broader, gvp:broaderGeneric, etc
- We infer appropriate standard relations when they connect concepts directly
  - Notice the "thread-through" skos:narrower in the prev diagram

# PROBLEM STATEMENT

What are the appropriate combinations (compositions) of BTG, BTP, BTI?

- Matters with respect to appropriate closure for information retrieval
- It's a prerequisite for sensible search expansion
- Has not been systematically analyzed to date

# THE PROBLEM WITH BROADERTRANSITIVE

ISO 25964 formalized BTG, BTP, BTI as sub-properties of skos:broader

- skos:broader contributes unconditionally to skos:broaderTransitive  
(broaderGeneric|broaderPartitive|broaderInstantial) => broader => broaderTransitive
- **Ambiguities in representing thesauri using extended SKOS - examples from real life** (NKOS 2012):  
broaderTransitive should be established only for BTG and BTP, but not for BTI, nor mixed paths BTG+BTP
- skos:broaderTransitive may include semantically inappropriate statements
  - a place inherits all place types of its parents
  - eg: Sofia BTP Bulgaria BTI country => Sofia BTI country
- Lively discussion at SKOS mailing list **from Nov 2013** to April 2014

# THE TIME HAS COME!

We **have** to resolve this issue for GVP LOD representation:

- To infer appropriate thread-through standard relations
- Makes sense to represent TGN place types and ULAN actor roles as BTI
  - But skos:broaderTransitive causes confusion and bloat (100M=>400M statements)
- So we want to infer only appropriate compositions (see [BTG](#), [BTP](#), [BTI Inference](#))
  - BTGE, BTPE, BTIE (gvp:broaderGenericExtended, gvp:broaderPartitiveExtended, gvp:broaderInstantialExtended)
  - Their disjunction gvp:broaderExtended
  - (Also gvp:broaderPreferred and gvp:broaderPreferredExtended)

# BTG, BTP, BTI COMPOSITIONALITY

- Basic decision table.  $BT^*x$  means  $BT^*|BT^*E$

	BTGx	BTPx	BTIx
BTGx	BTGE	BTPE	no
BTPx	BTPE	BTPE	no
BTIx	BTIE	no	no

- $BTG \Rightarrow BTGE$ ,  $BTP \Rightarrow BTPE$ ,  $BTI \Rightarrow BTIE$ : basic inferences

## BTG, BTP, BTI COMPOSITIONALITY (2)

- BTG<sub>x</sub>/BTG<sub>x</sub>=>BTGE
  - If X is kind of Y and Y is kind of Z then X is kind of Z
  - Eg: racehorses BTG <horses by use or role> BTG Equus caballus => racehorses BTGE Equus caballus
- BTG<sub>x</sub>/BTP<sub>x</sub>=>BTPE
  - If X is kind of Y and Y is part of Z then X is part of Z (X can play the role of Y)
  - Eg: beak irons BTG anvil components BTP <anvils and anvil accessories => beak irons BTPE <anvils and anvil accessories>
- BTG<sub>x</sub>/BTI<sub>x</sub>=>n/a
  - A generic concept may not be hierarchically subordinate to an instance.
  - The understanding of instance, as described in ISO, excludes this composition

## BTG, BTP, BTI COMPOSITIONALITY (3)

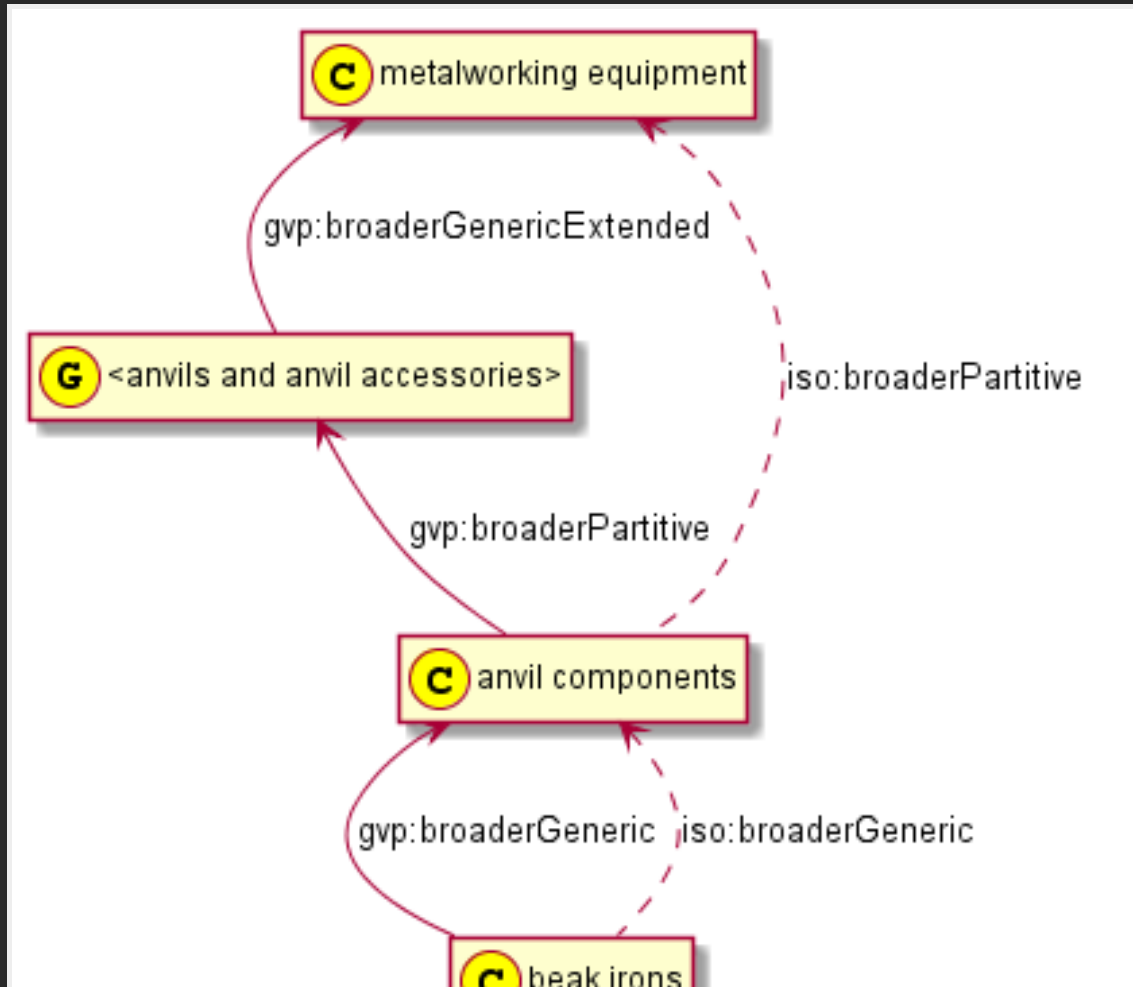
- $BTP_x/BTG_x \Rightarrow BTPE$ .
  - If X is part of Y and Y is kind of Z then X is part of Z (Z can play the role of Y)
  - Eg: anvil components BTP <anvils and anvil accessories>  
BTG <forging and metal-shaping tools>  $\Rightarrow$  anvil components BTPE <forging and metal-shaping tools>
- $BTP_x/BTP_x \Rightarrow BTPE$ 
  - If X is part of Y and Y is part of Z then X is part of Z
  - Eg: Sofia BTP Bulgaria, Bulgaria BTP Europe, so Sofia BTP Europe
  - But see mereological exceptions/imprecisions below!
- $BTP_x/BTI_x \Rightarrow \text{no}$ 
  - Counter-example: Sofia BTP Bulgaria BTI country. But Sofia is no country

## BTG, BTP, BTI COMPOSITIONALITY (4)

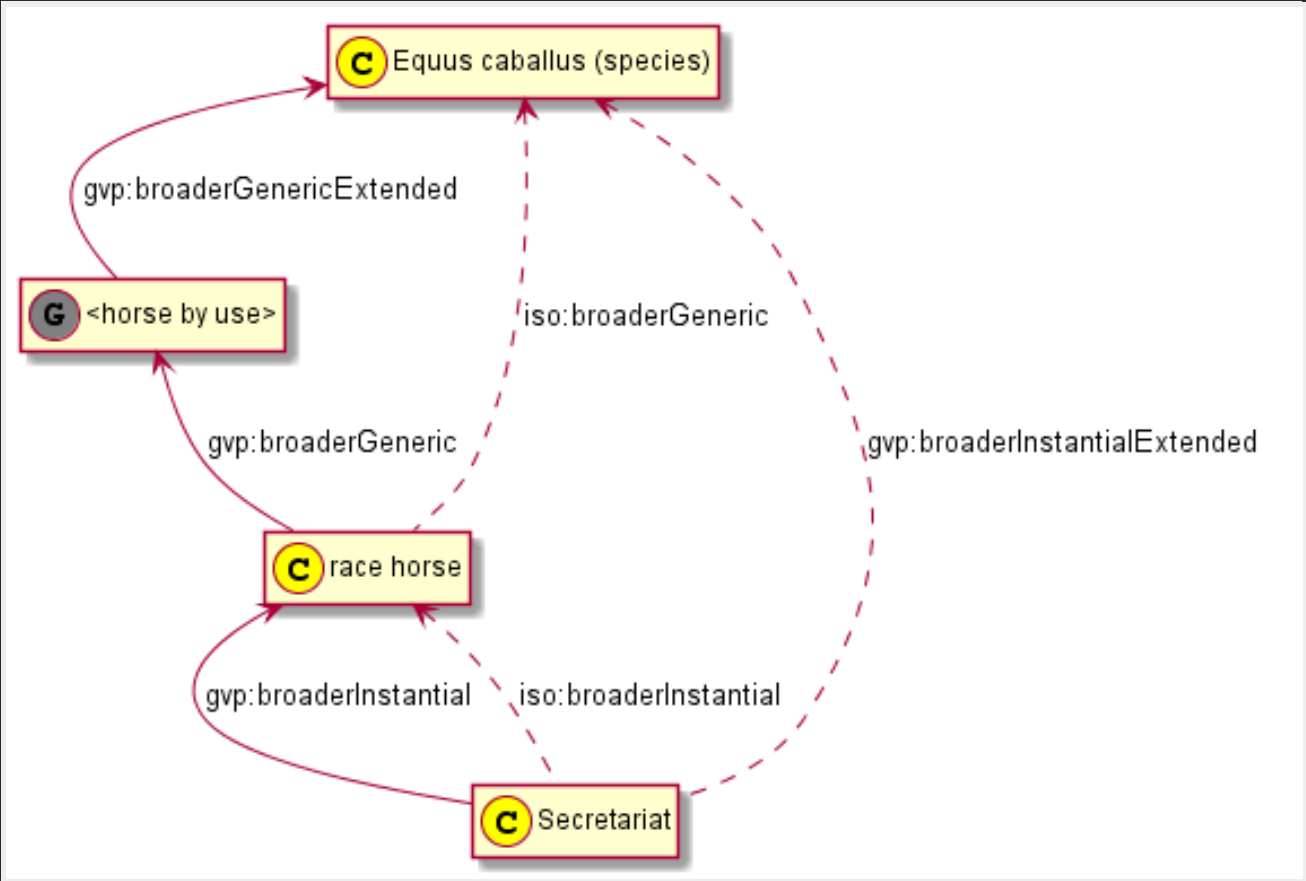
- BTIx/BTGx=>BTIE
  - If X is instance of Y and Y is kind of Z, then X is instance of Z (Z can play the role of Y)
  - Eg: Mt Athos BTI orthodox religious center BTG Christian religious center => Mt Athos BTIE Christian religious center
- BTIx/BTPx=>no
  - Counter-example: Statue of Liberty pedestal BTI pedestals BTP statues. That particular pedestal is neither BTI nor BTP statues in general
  - But see "beyond paths" below
- BTIx/BTIx=>n/a
  - An instance as a class of one cannot have instances
  - But see BTI Elaborations below



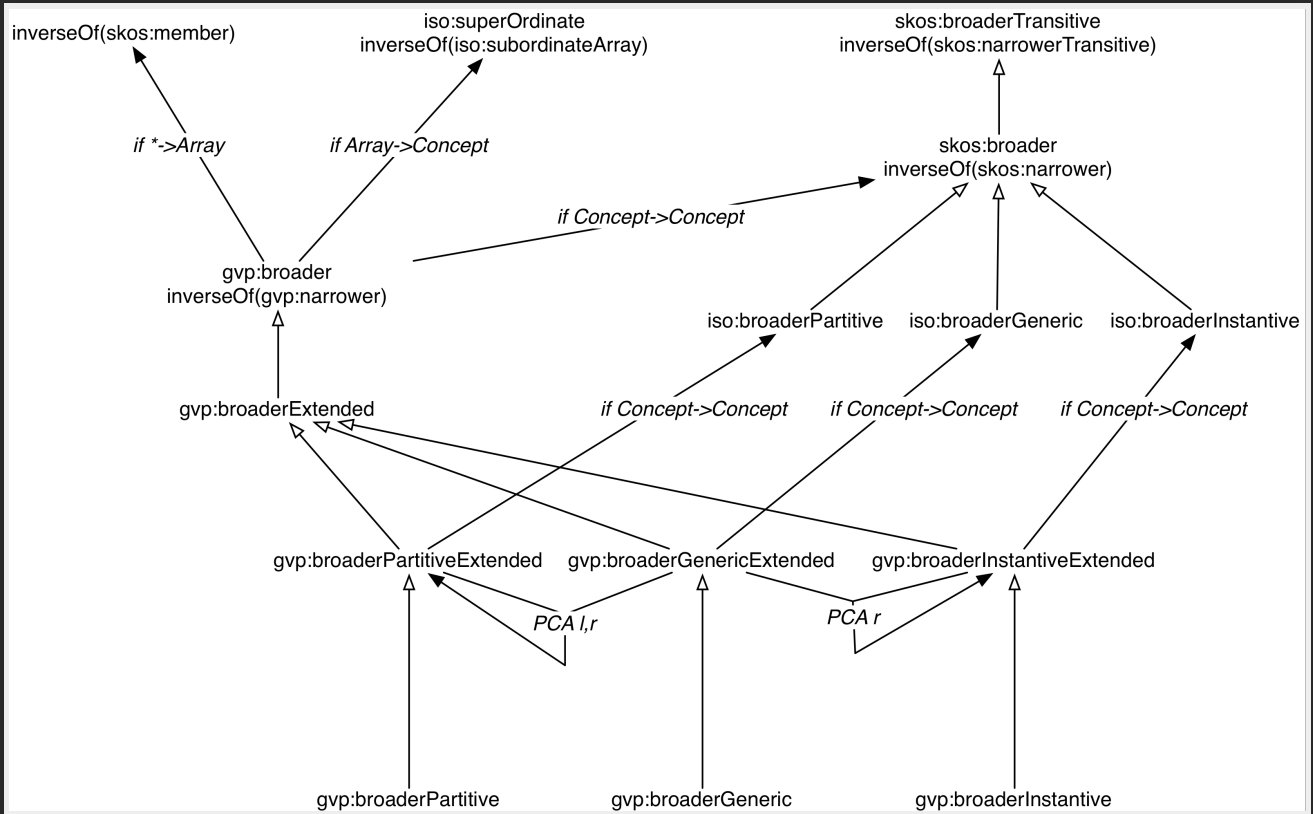
# USAGE: INFERRING ISO RELATIONS



# INFERRING ISO RELATIONS



# INFERENCE DEPENDENCIES



(A bit simplified, see [GVP Hierarchical Relations Inference](#))

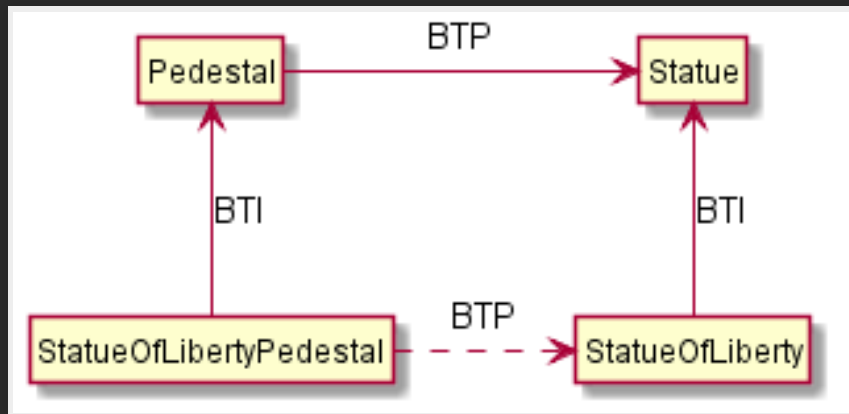
## USAGE 2: QUERY EXPANSION IN INFORMATION RETRIEVAL

The main purpose of a proper broader relation is to enable query expansion in information retrieval, eg:

- Sofia BTP Bulgaria BTP Europe => Sofia BTPE Europe
  - Enables a search for places in Europe to also find Sofia
- Mt Athos BTI orthodox religious centers BTG Christian religious centers BTG religious centers => Mt Athos BTIE religious centers
  - Enables a search for religious centers to also find Mt Athos

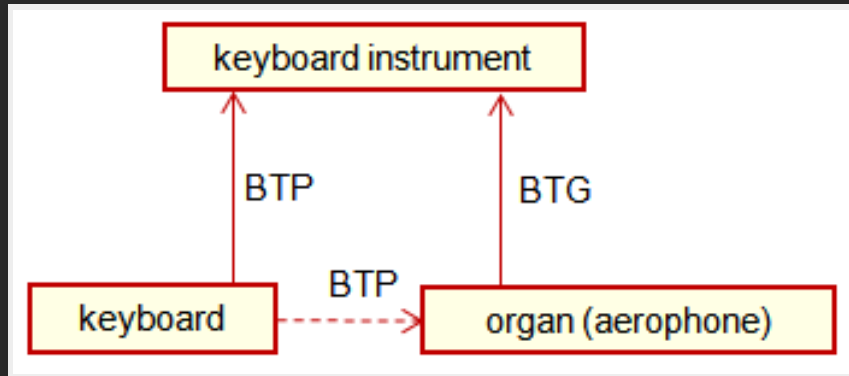
# USAGE 3: BEYOND CHAIN INFERENCES

If X necessary BTP Y and Z BTI X and T BTI Y then Z BTP T



# USAGE 3: BEYOND CHAIN INFERENCES

If X necessary BTP Y and Z BTG Y then X BTP Z



# USAGE 4: QUALITY CHECKING

<p>Objects Facet</p> <ul style="list-style-type: none"><li>.... Components (Hierarchy Name) (G)</li><li>..... components (objects) (G)</li><li>..... &lt;components by specific context&gt; (G)</li><li>..... sound device components (G)</li><li>..... keyboard instrument components (G) <b>right</b></li><li>..... &lt;swells and swell components&gt; (G)</li><li>..... swell components (G)</li><li>..... swell boxes (G)</li></ul>	<p>Objects Facet</p> <ul style="list-style-type: none"><li>.... Components (Hierarchy Name) (G)</li><li>..... components (objects) (G)</li><li>..... &lt;components by specific context&gt; (G)</li><li>..... sound device components (G)</li><li>..... aerophone components (G)</li><li>..... organ components (G) <b>right</b></li><li>..... swell boxes (G)</li></ul> <p>Objects Facet</p> <ul style="list-style-type: none"><li>.... Furnishings and Equipment (Hierarchy Name) (G)</li><li>..... Sound Devices (Hierarchy Name) (G)</li><li>..... sound devices (equipment) (G)</li><li>..... &lt;sound devices by acoustical characteristics&gt; (G)</li><li>..... aerophones (G)</li><li>..... organs (aerophones) (G) <b>wrong</b></li><li>..... swell boxes (G)</li></ul>
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- "swell boxes" BTG "organ components" BTP "organs (aerophones)" => BTPE
- "swell boxes" BTG "organs (aerophones)" is asserted in error
- Can catch it if we declare BTGE & BTPE as owl:disjointProperty
- But is this true in all cases?

# BTP IMPRECIATIONS

- Mixing partial vs full inclusion; and physical vs administrative: Netherlands Antilles BTP Netherlands BTP Europe ??

**Hierarchical Position:**

-  World (facet)
-  ... North and Central America (continent) (P)
-  ..... Netherlands Antilles (former nation/state/empire) (P)

**Additional Parents:**

-  World (facet)
-  ... Europe (continent) (P)
-  ..... Netherlands (nation) (P)
-  ..... Netherlands Antilles (former nation/state/empire) (P)

**Place Types:**

former nation/state/empire ( <b>preferred</b> , C)	
dependent state (H)	..... Dutch since 17th cen., autonomous since 1954; Aruba seceded in 1986
colony (H)	..... of The Netherlands, until 1954
primary political unit (H)	

- was until 1954: is in TGN with historic date qualification
- sample query: [Places Outside Bounding Box \(Overseas Possessions\)](#)



# BTP IMPRECISIONS (2)

- Mixing Partial vs full inclusion:  
Istanbul BTP Turkey BTP Asia



How about Istanbul BTP Europe? It does straddle the Bosphorus strait:



## BTP IMPRECISIONS (3)

- Mixing member vs substance meronym:  
chicken feet BTP chicken BTP chicken soup ??
- Mixing intrinsic vs extrinsic BTP; and categories (person vs group):  
Mick Jagger's BTP Mick Jagger BTP The Rolling Stones ??

Mereology is a complex topic spanning: philosophy, mathematical logic, theoretical computer science, physics, Sheaf, Topos, or Category Theory, object-oriented programming.

- [Wikipedia article](#)
- [Introduction to part-whole relations: mereology, conceptual modelling and mathematical aspects](#) (Maria Keet, 2006)

# BTI ELABORATIONS

- **Metaclasses** in OOP and **Punning** in OWL allow classes of classes, and use them profitably
- **ISO**: instance may have parts/subdivisions, recommends custom relation BTX (eg BTS=subdivision).  
Eg "BMW E87" BTS "BMW 1 Series" BTI "Automobiles"
- **Biological classification**: concepts belong to different levels (taxonomic ranks).  
Eg Secretariat (ULAN <named animal>) BTI racehorses BTG Equus caballus BTI species

# BTI IN TAXONOMIC RELATIONS

**H** Taxonomy ranks (en) (ID: equ00004)

- domain (taxonomy rank) (en) (ID: equ00005) [G] **Secretariat is not instance of domain or any other taxonomic rank**
- Eukaryota (domain) (en) (ID: equ00015) [I]
- Animalia (kingdom) (en) (ID: equ00016) [G]
- Chordata (phylum) (de) (ID: equ00017) [G]
- Vertebrata (subphylum) (de) (ID: equ00018) [G]
- Mammalia (class) (en) (ID: equ00019) [G]
- Perissodactyla (order) (en) (ID: equ00020) [G]
- Equidae (family) (en) (ID: equ00021) [G]
- Equus (genus) (en) (ID: equ00022) [G]
- Equus caballus (species) (en) (ID: equ00023) [G]
- N** (horses by use or role) (en) (ID: equ00025)
- racehorses (en) (ID: equ00003)
- Secretariat (en) (ID: equ00002) [I] **Secretariat instance of all these taxonomic entities**
- Thoroughbreds (breed) (en) (ID: equ00024) [G]
- Secretariat (en) (ID: equ00002) [I]

- kingdom (taxonomy rank) (en) (ID: equ00006) [G]
- phylum (taxonomy rank) (en) (ID: equ00007) [G]
- subphylum (taxonomy rank) (en) (ID: equ00008) [G]
- class (taxonomy rank) (en) (ID: equ00009) [G]
- order (taxonomy rank) (en) (ID: equ00010)
- family (taxonomy rank) (en) (ID: equ00011)
- genus (taxonomy rank) (en) (ID: equ00012)
- species (taxonomy rank) (en) (ID: equ00013)
- individual (en) (ID: equ00014)
- Secretariat (en) (ID: equ00002) [I] **Secretariat is an instance of individual, but that's not a taxonomic rank 😞**

# DO INDIVIDUALS BELONG IN A THESAURUS?

- TGN gave up placeType<BTI for now, because of non-sensical broaderTransitive
- If you exclude BTI then broaderExtended coincides with broaderTransitive:  $BTG^* \mid (BTG \mid BTP)^* = (BTG \mid BTP)^*$
- Some CRM SIG members: "Individuals don't belong to a thesaurus. Mixing individuals and generics is logically inconsistent"
- Eg in Getty LOD: [tgn:7009977](#) London is gvp:adminplaceconcept, gvp:subject, skos:concept
  - Separate node [tgn:7009977-place](#) is schema:Place, wgs:SpatialThing
  - Such [Concept vs Place Duality](#) is respected by VIAF, UK BL, FR BnF, SE KB; but not US LoC, DE DNB

## DO INDIVIDUALS BELONG IN A THESAURUS? (2)

We think yes: main role of a thesaurus is a list of fixed values (concepts, people, etc)

- Eg GND mixes 10M things: materials, subjects, football clubs, deities, ghosts
- Eg British Museum LOD: [London England](#) is `ecrm:E53_Place`, `skos:Concept` (but latter may be removed)
- Eg LoC MARC Relators: [Author](#) is `skos:Concept`, `rdf:Property`, `owl:ObjectProperty` !

# THANKS FOR YOUR TIME!

- [Draft paper](#) (some months old, these ideas are still evolving)
- Research conducted as part of GVP LOD publication:  
<http://vocab.getty.edu>
  - See [CIDOC 2014 presentation](#)
  - See doc (100 pages!): <http://vocab.getty.edu/doc>
- The financial support of the J. Paul Getty Trust is gratefully acknowledged

