Accessing and Manipulating Life-Sciences Ontologies using Web Services

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SMI - Stanford University

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Context: Semantic needs for Life Sciences

- Huge ∃ corpus of distributed data and kn.
  - automate access
  - automate retrieval
  - automate processing
- Syntactic and semantic heterogeneity
  - explicit and formalized representation of kn.
- Applications need to cooperate
  - automate as much as possible

Context: Overlap with the SW approach

- Limitations are common with other domains
  - sharing D, sharing K, enhance interop.
- Web Technologies = promising approach
  - some are already mainstream
- ∃ efforts for representing and formalizing K
  - GO, OMIM, MGED, Galen, FMA
- However:
  - under exploited
  - not inter-connected

Hypothesis

- Life Sciences = interesting test case for a Semantic Web killer app
- Some of the outcome could be generalized to other domains

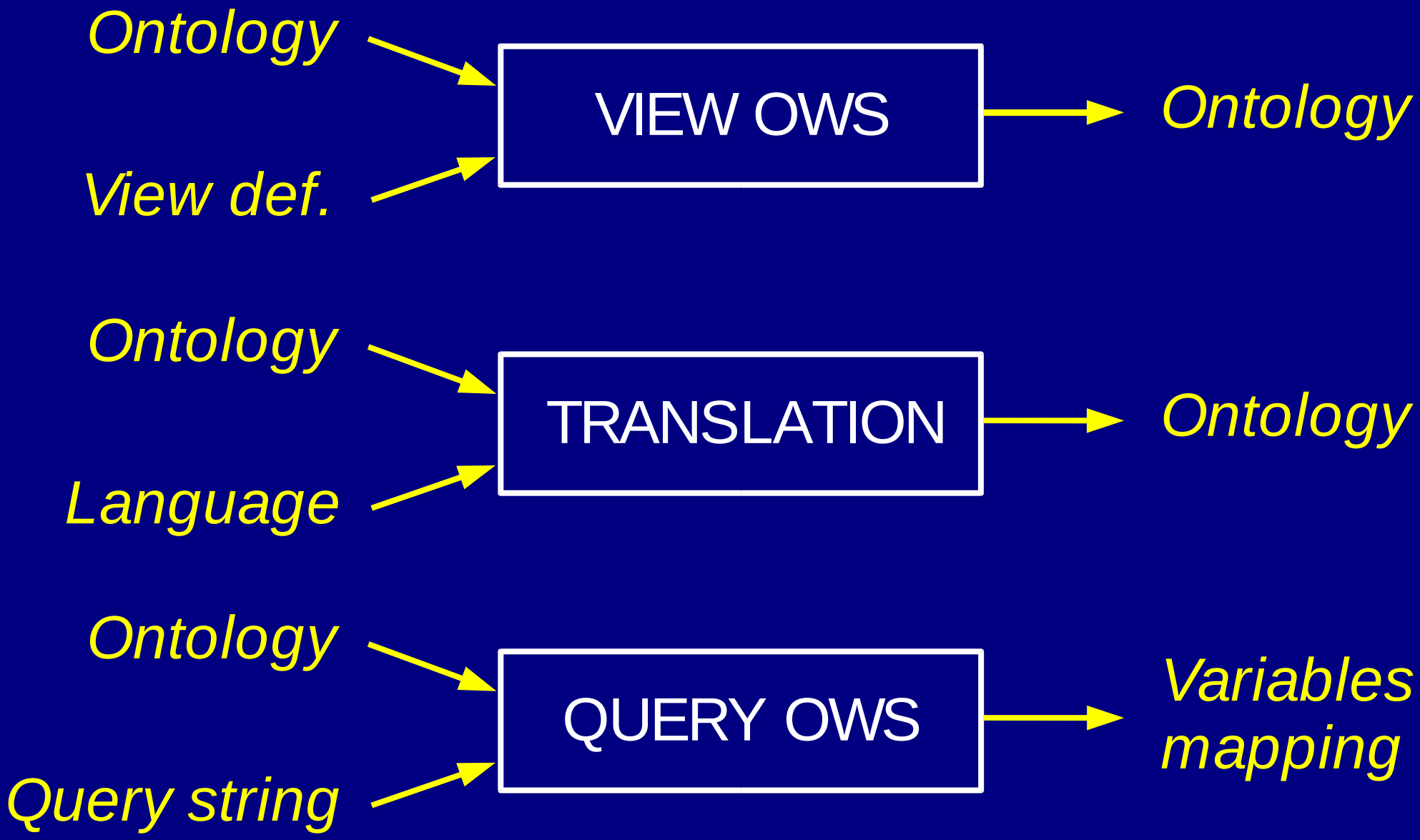
Objectives

- Identify ontology manipulation functions
  - application and domain-independant
- Implement them as Web Services: **OWS**
  - scenario of need for OWS in LS context
  - can be implemented with current technologies
- OWS are also necessary to SW framework
  - processing semantic descr. of regular WS
  - automatic retrieval, composition

OWS Categories

- Queries
- Views
- Translations
- Mapping
- Versioning
- Merging
- Reasoning

OWS Categories



OWS Implementation scenario

- Retrieve the clinical trials relevant to a patient with lung tumor
  - stage the patient's tumor
  - query to NCI clinical trials online DB

OWS Implementation scenario

Clinical Trial: Satraplatin for Locally Advanced Non-Small Cell Lung Cancer with Simultaneous Radiotherapy - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

CT http://clinicaltrials.gov/ct/show/NCT00093132?order=8

CT Clinical Trial: Satraplatin for Loc...

ClinicalTrials.gov

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Satraplatin for Locally Advanced Non-Small Cell Lung Cancer with Simultan

This study is currently recruiting patients.

Sponsored by:	GPC Biotech
Information provided by:	GPC Biotech

Purpose

PURPOSE: This trial is designed to compare the combination of the investigational oral cytotoxic drug, satraplatin, and radiatio
Cancer (NSCLC) with no prior chemotherapy or radiation therapy treatment. Please refer to the Eligibility Criteria below for ke

WHAT IS SATRAPLATIN: Satraplatin is an oral, investigational anticancer drug that is a member of the platinum-based class

Eligibility

Ages Eligible for Study: 18 Years and above, Genders Eligible for Study: Both

Criteria

Inclusion Criteria:

- Locally advanced or medically inoperable NSCLC (stage II or III)
- ECOG performance status score 0-2
- Adequate bone marrow, liver, and pulmonary functions
- Life expectancy > three months.

Exclusion Criteria:

- Prior malignancy
- Serious concurrent uncontrolled medical disorder.
- Uncontrolled or significant cardiovascular disease
- History of mastectomy
- Pregnant or breast-feeding patients are not eligible
- Prior radiotherapy to the primary tumor site or cytotoxic chemotherapy

Location and Contact Information

Faith E. Nathan, MD (GPC Biotech) 609-524-1048

Texas

Southwestern Medical Center, Dallas, Texas, 75390, United States; Recruiting
Benito Garcia 214-648-1631
Hak Choy, MD, Principal Investigator

TNM classification

- TNM:
  - T0 – T4: primary tumor
  - N0 – N3: metastasis in lymph nodes
  - M0 – M1: distant metastasis
  - Stage 0 - IV: derived from the TxNyMz score
- Requires:
  - Representation TxNyMz criteria + stages
  - Taxonomy of tumors + pathologies
  - Taxonomy + partonomy of anatomy

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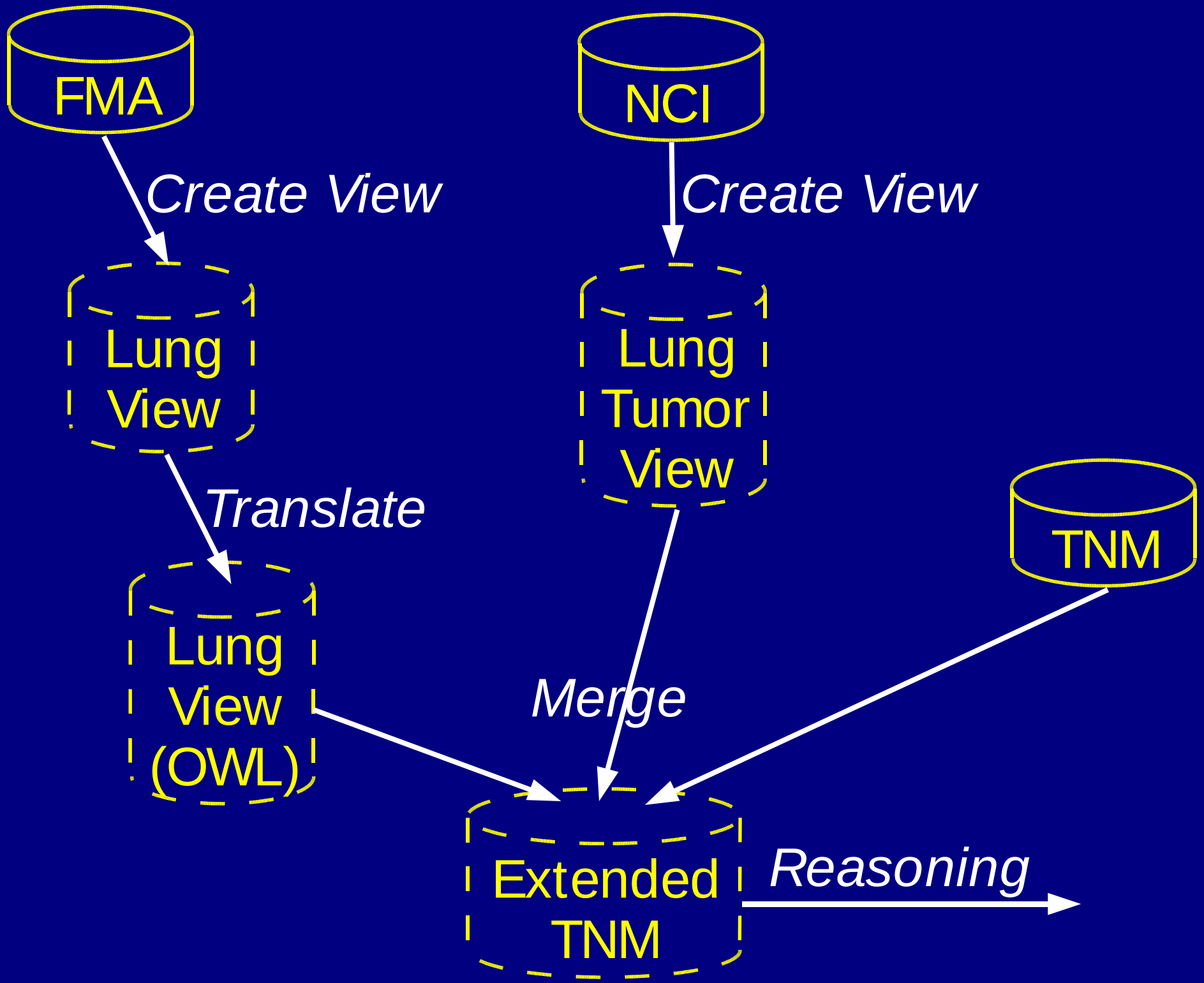
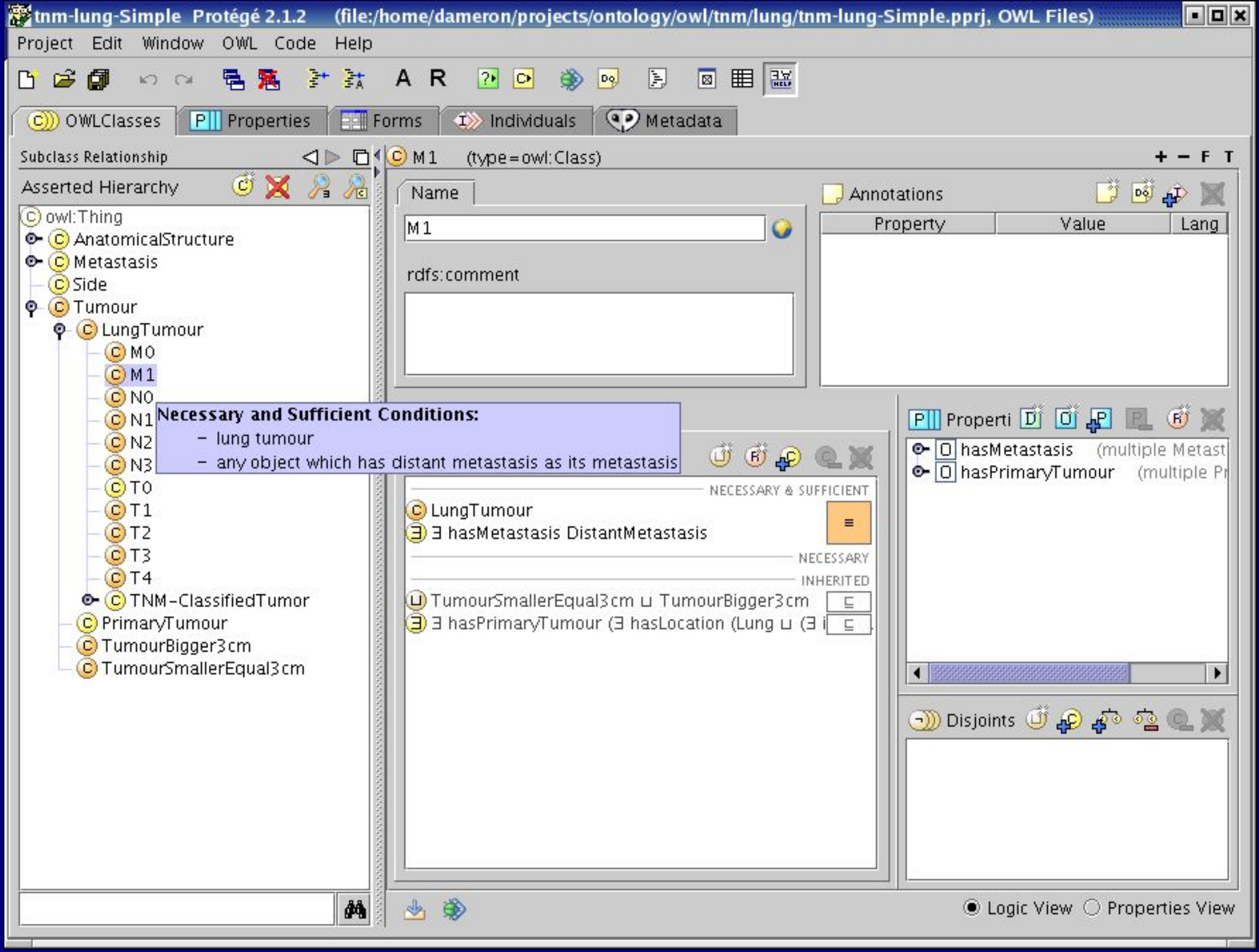
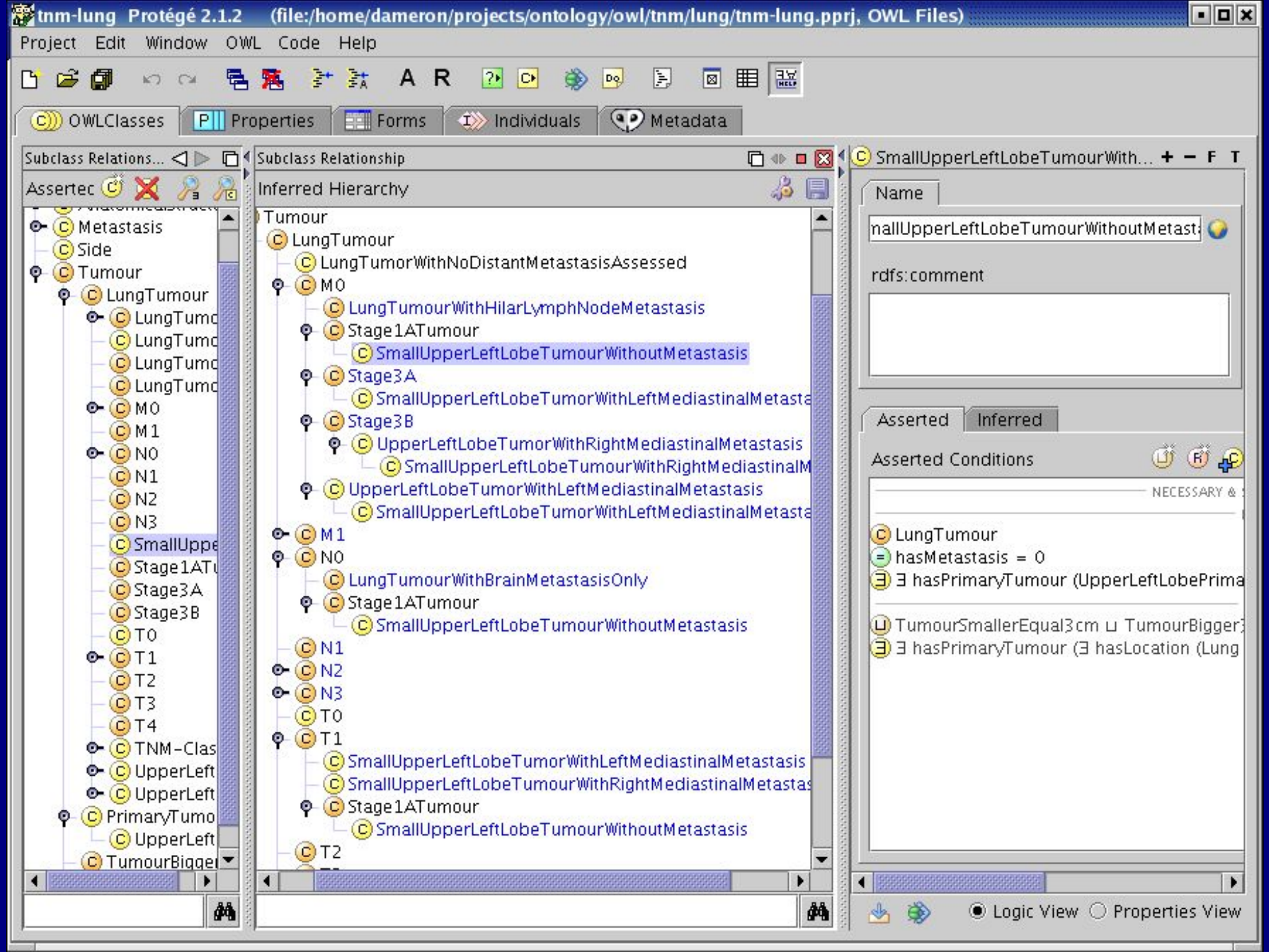

FMA
NCI
Create View
Create View
Lung View
Lung Tumor View
Translate
TNM
Lung View (OWL)
Merge
Extended TNM
Reasoning


tnm-lung-Simple Protégé 2.1.2 (file:/home/dameron/projects/ontology/owl/tnm/lung/tnm-lung-Simple.pprj, OWL Files)
Project Edit Window OWL Code Help
OWLClasses Properties Forms Individuals Metadata
Subclass Relationship
Asserted Hierarchy
owl:Thing
AnatomicalStructure
Metastasis
Side
Tumour
LungTumour
M0
M1
N0
N1
N2
N3
T0
T1
T2
T3
T4
TNM-ClassifiedTumor
PrimaryTumour
TumourBigger3cm
TumourSmallerEqual3cm
M1 (type=owl:Class)
Name
M1
rdfs:comment
Annotations
Property
Value
Lang
Necessary and Sufficient Conditions:
- lung tumour
- any object which has distant metastasis as its metastasis
NECESSARY & SUFFICIENT
LungTumour
∃ hasMetastasis DistantMetastasis
NECESSARY
INHERITED
TumourSmallerEqual3cm ⊔ TumourBigger3cm
∃ hasPrimaryTumour (∃ hasLocation (Lung ⊔ (∃
Properti
hasMetastasis (multiple Metast
hasPrimaryTumour (multiple Pr
Disjoints
Logic View
Properties View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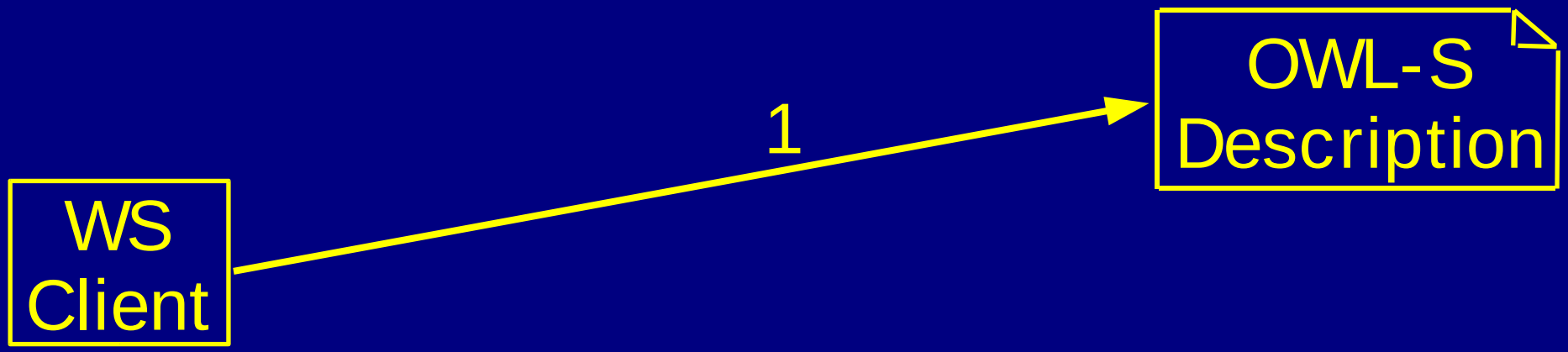
OWLClasses Properties Forms Individuals Metadata
Subclass Relations...
Assertec
Metastasis
Side
Tumour
LungTumour
M0
M1
N0
N1
N2
N3
Stage1ATu
Stage3A
Stage3B
T0
T1
T2
T3
T4
TNM-Clas
UpperLeft
UpperLeft
PrimaryTumo
UpperLeft
TumourBigge
Subclass Relationship
Inferred Hierarchy
Tumour
LungTumour
LungTumorWithNoDistantMetastasisAssessed
M0
LungTumourWithHilarLymphNodeMetastasis
Stage1ATumour
SmallUpperLeftLobeTumourWithoutMetastasis
Stage3A
SmallUpperLeftLobeTumorWithLeftMediastinalMetasta
Stage3B
UpperLeftLobeTumorWithRightMediastinalMetastasis
SmallUpperLeftLobeTumourWithRightMediastinalM
UpperLeftLobeTumorWithLeftMediastinalMetastasis
SmallUpperLeftLobeTumorWithLeftMediastinalMetasta
M1
N0
LungTumourWithBrainMetastasisOnly
Stage1ATumour
SmallUpperLeftLobeTumourWithoutMetastasis
N1
N2
N3
T0
T1
SmallUpperLeftLobeTumorWithLeftMediastinalMetastasis
SmallUpperLeftLobeTumourWithRightMediastinalMetastas
Stage1ATumour
SmallUpperLeftLobeTumourWithoutMetastasis
T2
SmallUpperLeftLobeTumourWith...
Name
nallUpperLeftLobeTumourWithoutMetast
rdfs:comment
Asserted Inferred
Asserted Conditions
NECESSARY &
LungTumour
hasMetastasis = 0
∃ hasPrimaryTumour (UpperLeftLobePrima
TumourSmallerEqual3cm ⊔ TumourBigger
∃ hasPrimaryTumour (∃ hasLocation (Lung
Logic View
Properties View

OWS for the Semantic Web

- Automating usage of WS
  - discovery
  - execution
  - composition
- Requires explicit description
  - syntactically valid communication: SOAP, WSDL
  - semantic aspect: **OWL-S**
- How do apps automatically access and process semantic descriptions ? **OWS**

OWS for assessing WS relevance



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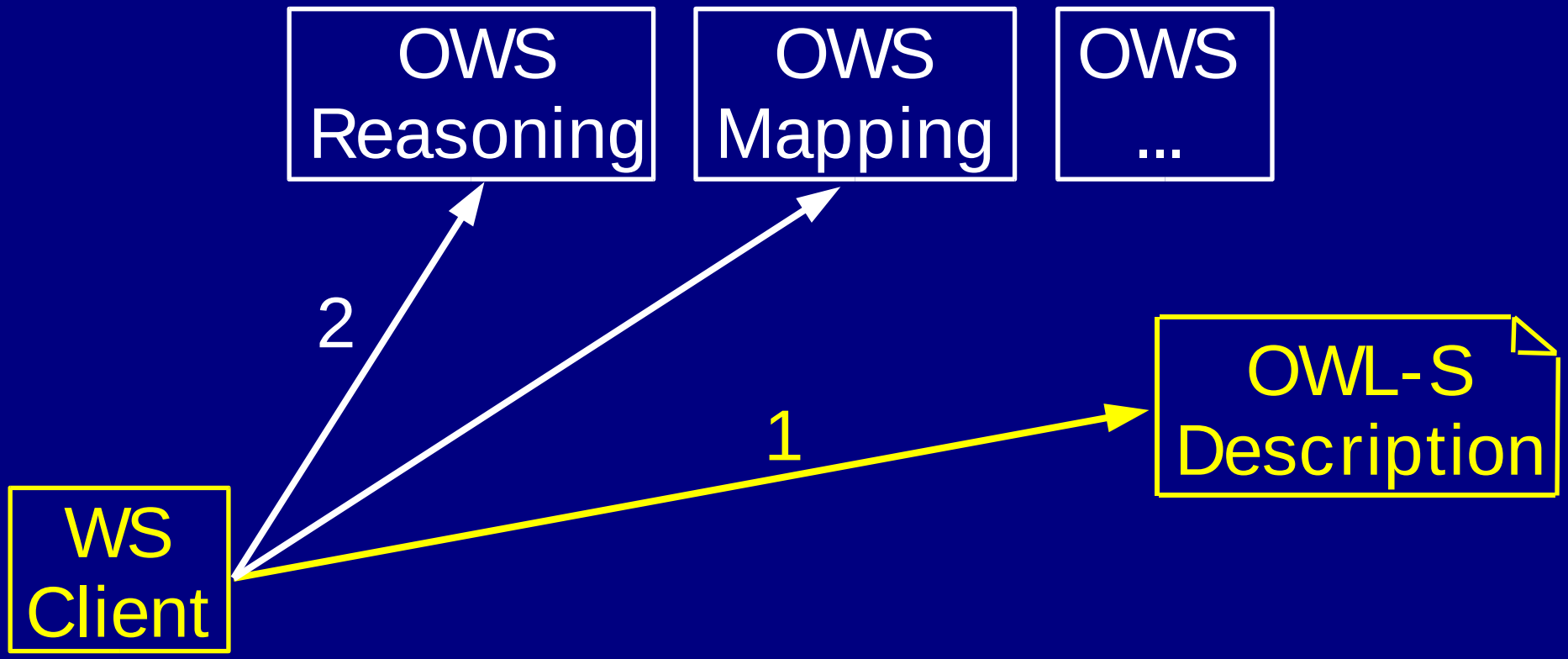

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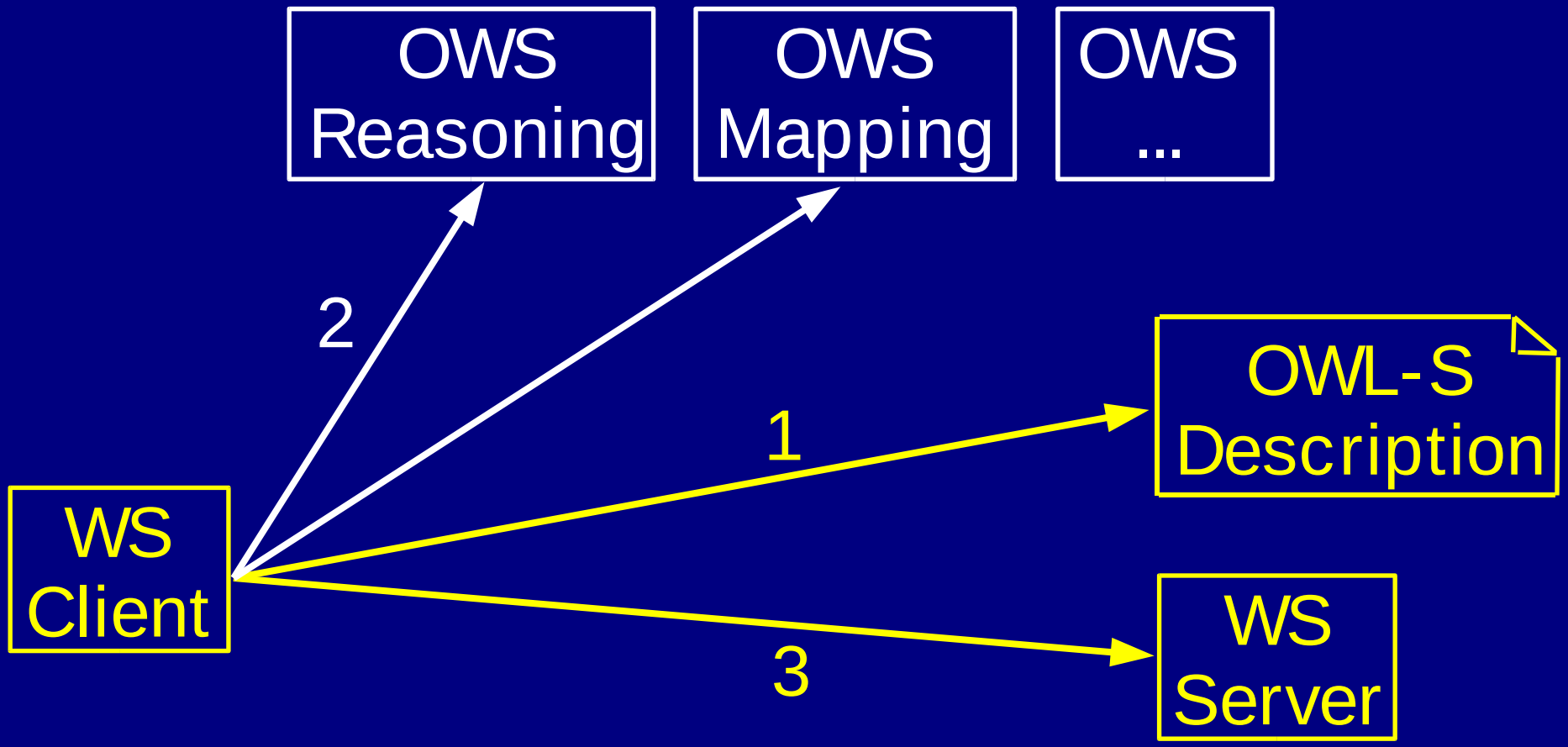
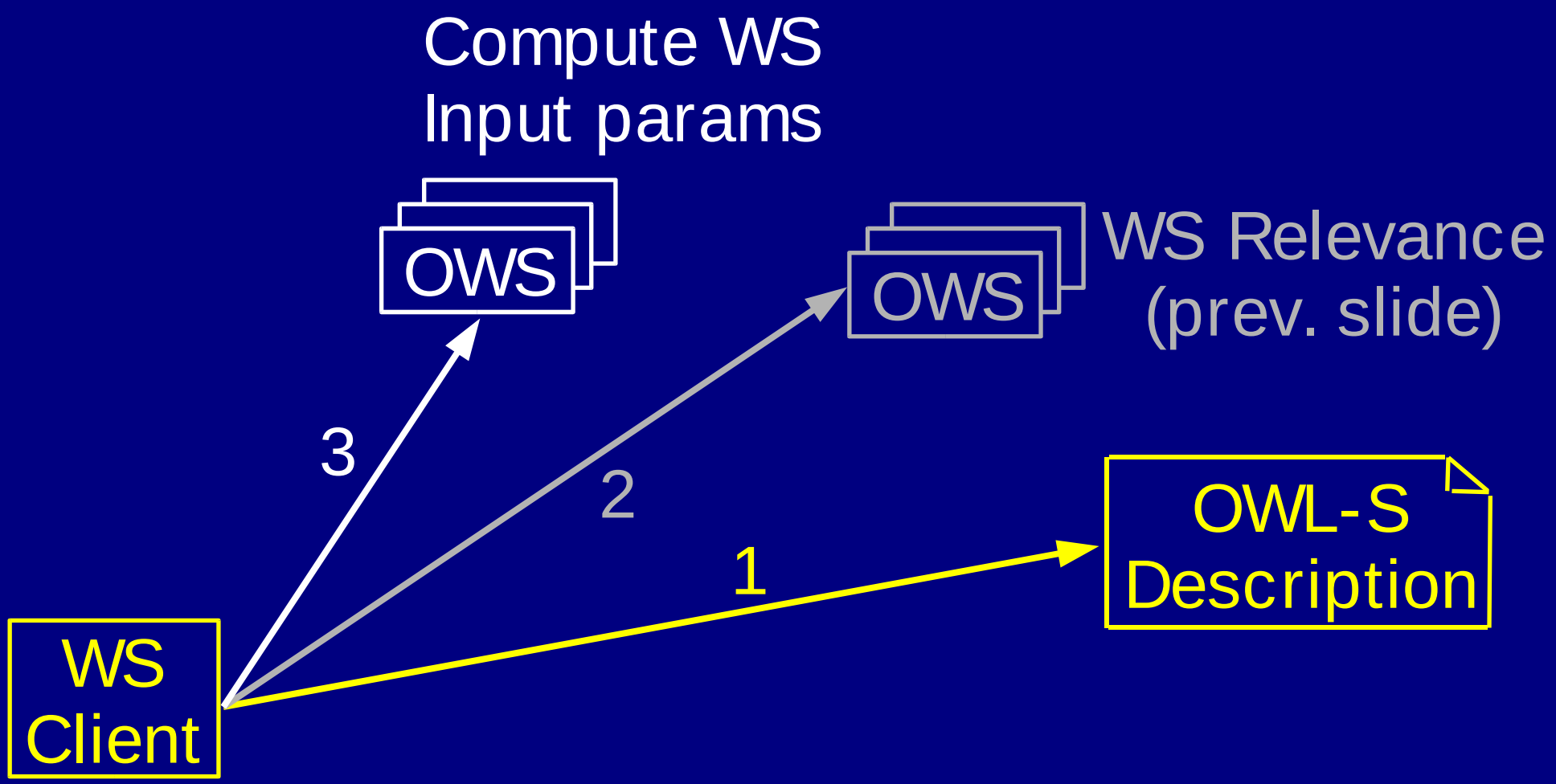


OWS for semantic interoperability



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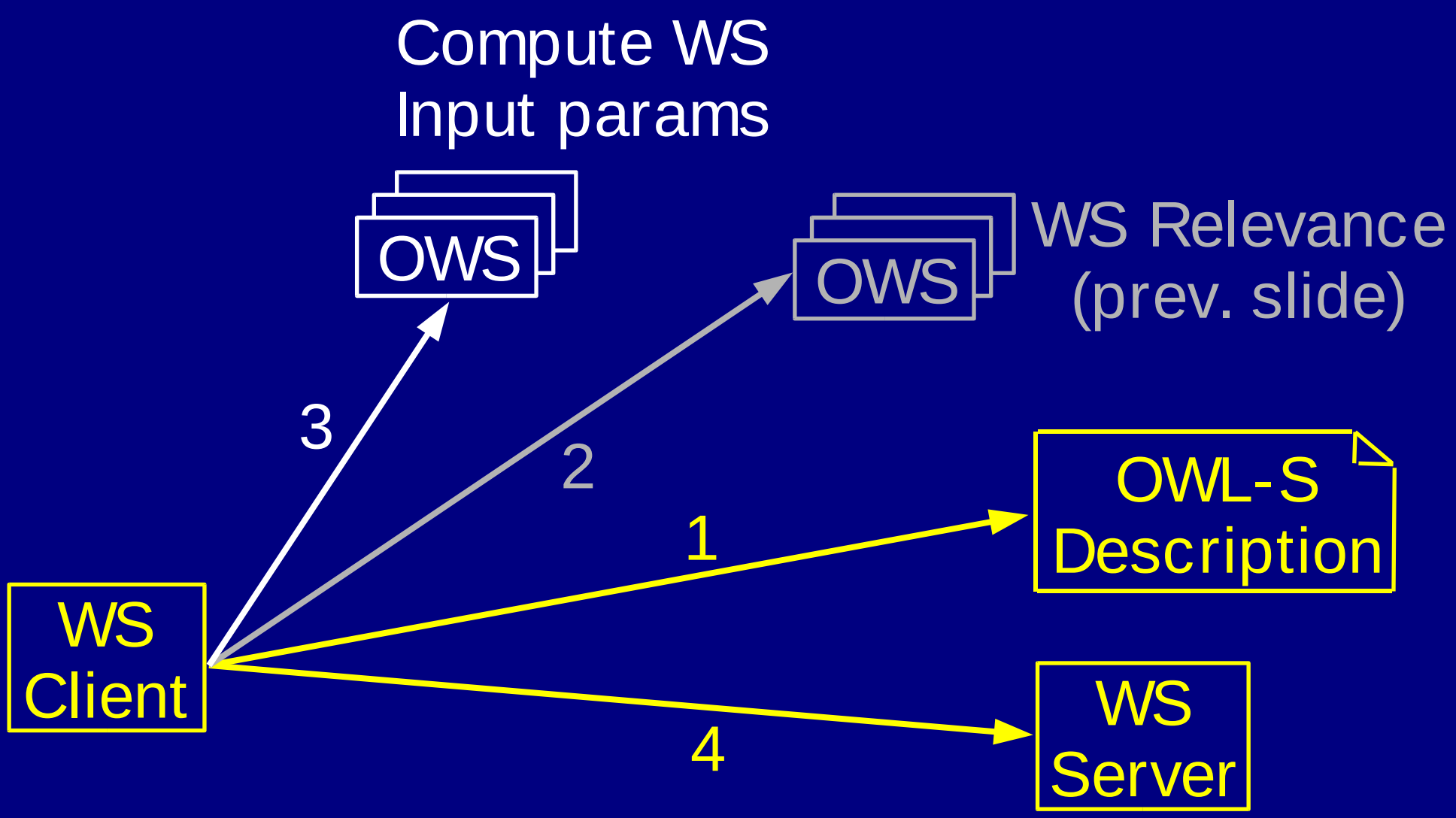

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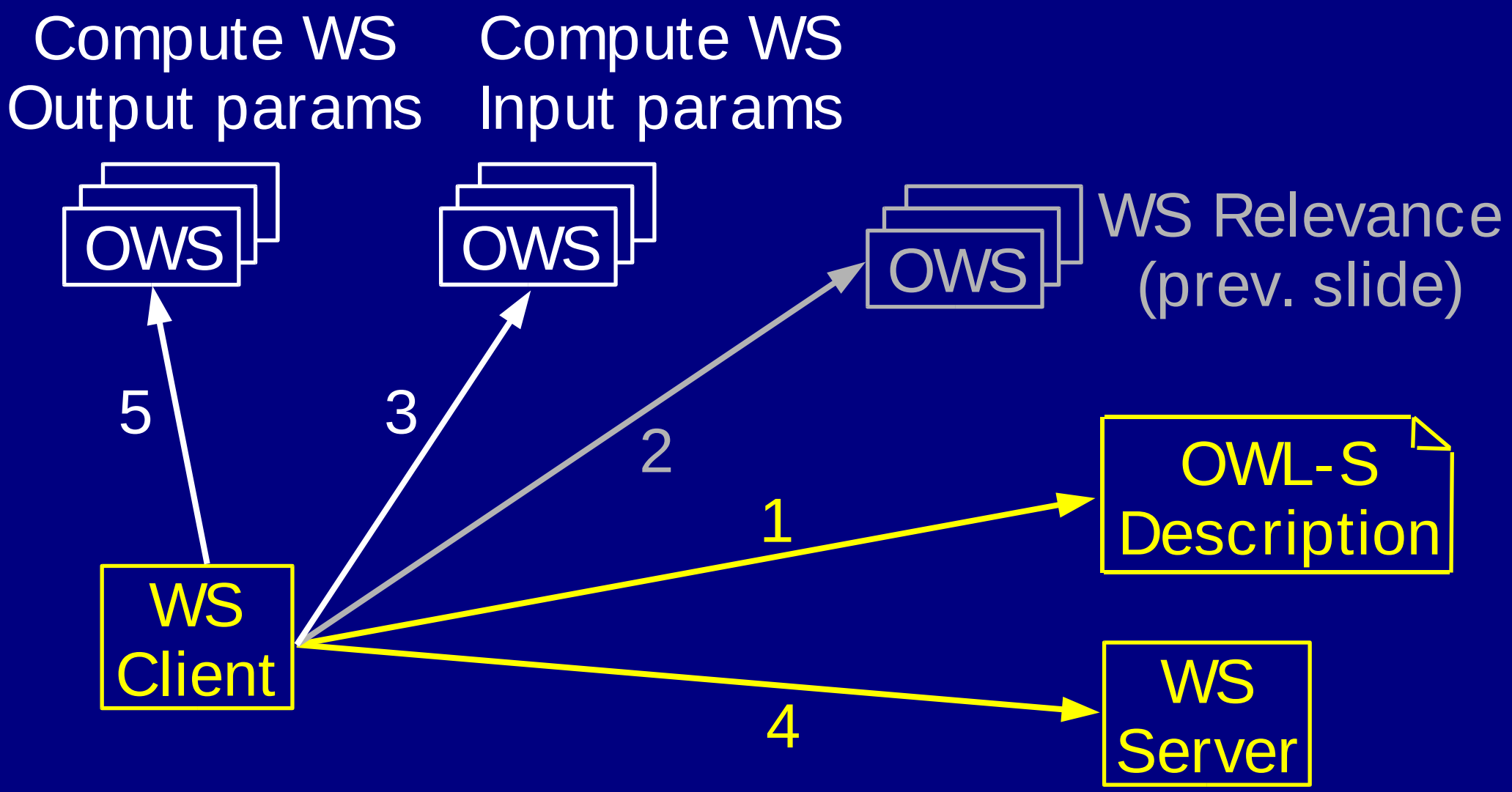
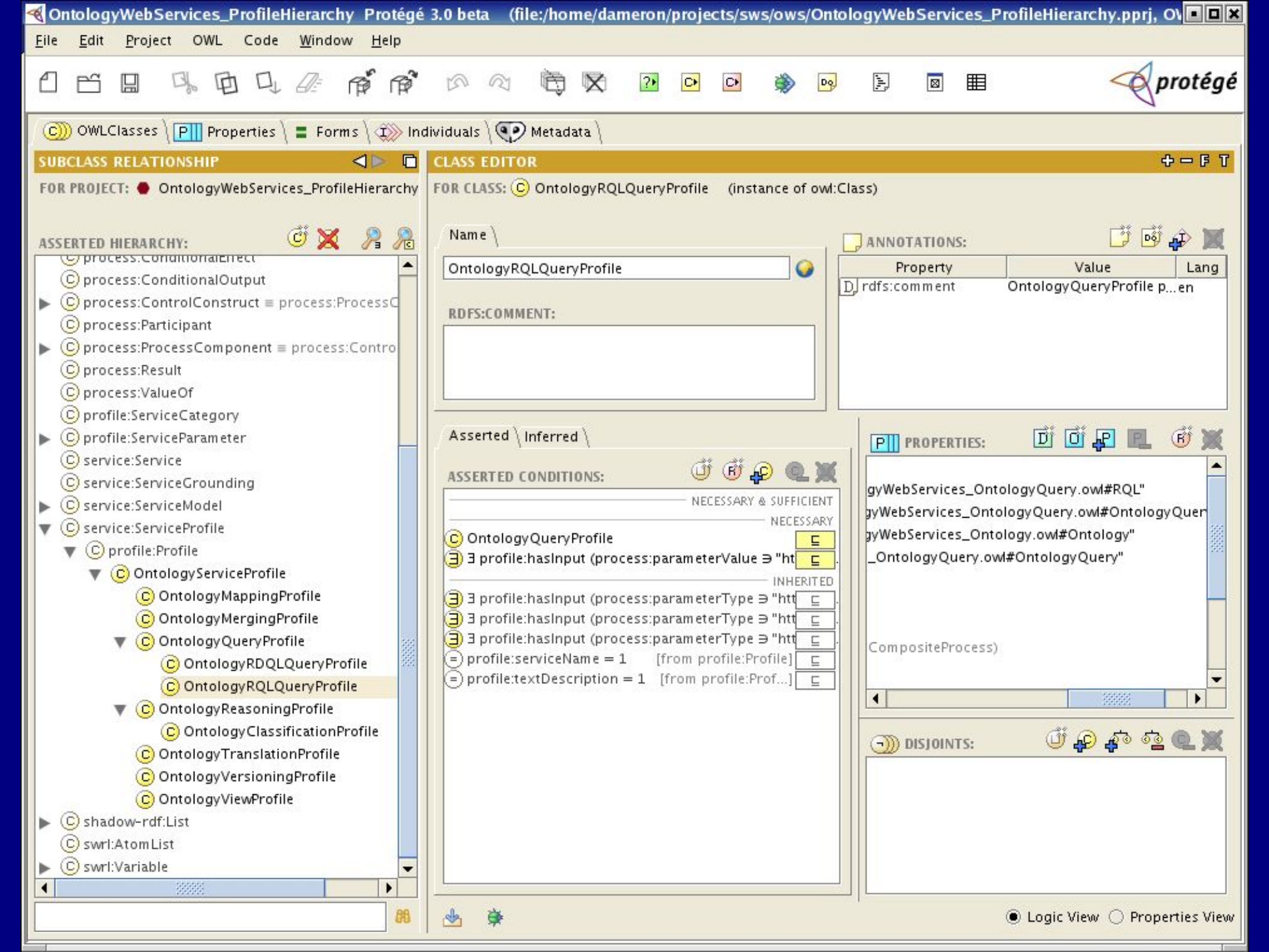


Conclusion

- Life Sciences: priviledged domain
  - ∃ ontologies
  - ∃ application needs
  - commercial opportunities
- Use of OWS for linking isolated resources
- OWS also play a role in the SW development


OntologyWebServices_ProfileHierarchy Protégé 3.0 beta (file:/home/dameron/projects/sws/ows/OntologyWebServices_ProfileHierarchy.pprj, OWL
File Edit Project OWL Code Window Help
protégé
OWLClasses Properties Forms Individuals Metadata
SUBCLASS RELATIONSHIP
FOR PROJECT: OntologyWebServices_ProfileHierarchy
ASSERTED HIERARCHY:
process:ConditionalOutput
process:ControlConstruct ≡ process:ProcessC
process:Participant
process:ProcessComponent ≡ process:Contro
process:Result
process:ValueOf
profile:ServiceCategory
profile:ServiceParameter
service:Service
service:ServiceGrounding
service:ServiceModel
service:ServiceProfile
profile:Profile
OntologyServiceProfile
OntologyMappingProfile
OntologyMergingProfile
OntologyQueryProfile
OntologyRDQLQueryProfile
OntologyRQLQueryProfile
OntologyReasoningProfile
OntologyClassificationProfile
OntologyTranslationProfile
OntologyVersioningProfile
OntologyViewProfile
shadow-rdf:List
swrl:AtomList
swrl:Variable
CLASS EDITOR
FOR CLASS: OntologyRQLQueryProfile (instance of owl:Class)
Name
OntologyRQLQueryProfile
RDFS:COMMENT:
ANNOTATIONS:
Property
Value
Lang
rdfs:comment
OntologyQueryProfile p...
en
Asserted
Inferred
ASSERTED CONDITIONS:
NECESSARY & SUFFICIENT
NECESSARY
OntologyQueryProfile
∃ profile:hasInput (process:parameterValue ∋ "ht
INHERITED
∃ profile:hasInput (process:parameterType ∋ "htt
∃ profile:hasInput (process:parameterType ∋ "htt
∃ profile:hasInput (process:parameterType ∋ "htt
profile:serviceName = 1 [from profile:Profile]
profile:textDescription = 1 [from profile:Prof...]
PROPERTIES:
gyWebServices_OntologyQuery.owl#RQL"
gyWebServices_OntologyQuery.owl#OntologyQuer
gyWebServices_Ontology.owl#Ontology"
_OntologyQuery.owl#OntologyQuery"
CompositeProcess)
DISJOINTS:
Logic View
Properties View