Medical Entity vocabulary extension proposal of schema.org

1. The goal:

To extend the medicalEntity vocabulary of schema.org.

2. Rationale:

MedicalEntity and subtypes vocabulary provided in schema.org are largely used by content publishers that wish to mark up health and medical content on the web. Like all schema.org schemas, the health and medical schema is intended to make it easier for people to find the right web pages by exposing structured information contained in web pages to search engines, and may also enable other applications that make use of the structure.

However, given the complexity of health and medical content, some classes and predicates were missing, or incompletely defined to achieve this indexing use. Today, most of health and medical web content are structured documents, based on clinical information models or HL7 standards (HL7 V3 RIM, CDA, C-CDA, FHIR etc.) and are integrating existing vocabularies and terminology (SNOMED, ICD, LOINC, ATC, RxNorm etc.).

Moreover, some case use scenarios go beyond this simple indexing: schema.org has been used in recent health APIs, as a pillar source of medical ontology/vocabulary for formalization of healthcare information, through RDF graphs which is a high contribution to the semantic web interoperability. To meet those challenges it was necessary to extend the MedicalEntity vocabulary and take this opportunity to refine some of existing concept (classes and predicates).

The intention here is neither to have a comprehensive medical ontology nor provide a clinical information model nor define or codify a new controlled medical vocabulary, but to provide a scalable, use-driven vocabulary schema, in-line with the schema.org philosophy.

3. Approach used:

In this design, none of existing concepts (classes and predicates) are renamed or deleted. There are only additions of new classes/predicates and extensions (definitions or domain and range) on the existing concepts. For granular classes the priority is given to use the schema.org vocabulary in clinical information models which use classes from existing vocabularies and terminology (SNOMED, ICD, LOINC, ATC, RxNorm etc.) so the new concepts are minimized. This is a scalable approach as schema.org can't include all those granular concepts.

Additional, staying in schema.org best practice and philosophy we avoided some discussions interfering with high-level schema.org design. Finally to refine existing concepts or for a better

integration of new concepts, there was hierarchy rebuild, like declaring existing schema classes/properties as subClass of or subPropertyOf.

4. High level overview of the principle changes

The proposal contains 3 types of changes:

1) Changes: only hierarchies (purpose: corrections of existing hierarchy or for integrating new proposed classes/predicates)
   a. Class : 18
   b. Predicates : 9
2) Deletions: 0
3) Additions/extension
   a. Class : 172 (Overview here)
   b. Predicates : 173 (Overview here)

A table showing all changes details is provided below, but in nutshell changes are:

Classes:

-Added AnatomicalOrgan and AnatomicalRegion classes under hierarchy of AnatomicalEntity class and related properties

-Extended subclass of AnatomicalSystem class and related properties

-Extended subclass of MedicalSignOrSymptom class and related properties

-Big extension in MedicalProcedure with a one change (actually additional declaration) of making the MedicalTherapy a subclass of TherapeuticProcedure class, itself a subclass of MedicalProcedure class. The PreventiveProcedure become a subclass of MedicalProcedure class as well.

-extending Person class with Patient class as subclass.

-making the Drug also a subclass in low level hierarchy of Substance (the new class).

- Extended subclass MedicalEnumeration (some of subclasses are the existing ones: see below table).

-New classes added.

Properties:

-adverseOutcome, location, provider, medicalSpeciality and procedure were extended with granular subproperties

-status was extended with 2 granular subproperties

-introduction of Snomed concepts use as domain/range objects (not always but where there was no clear similar schema.org existing class)
-new properties added.

Comparing the *existing* schema.rdfa file and the *proposed* schema.rdfa patch, there are in total 2578 insertions (+), 59 deletions (-), 25 fixes (changes in *subPropertyOf*/*subClassOf*/*rdfs:comment* in existing properties/classes) , 0 class/predicate rename and 0 class/predicate deletions.
We are aware that some improvement may be required even beyond official publication, but those will be minimal.

Table1. The changeLog details:

Current version	Proposal version	Rationale

:AnatomicalStructure
   subClassOf
      :MedicalEntity
	:AnatomicalStructure
	   subClassOf
	      : AnatomicalEntity
		AnatomicalEntity was suggested as parent of all anatomical related concepts what is more scalable if one day we need to extend anatomy vocabulary

: AnatomicalSystem
   subClassOf
      :MedicalEntity
	: AnatomicalSystem
	   subClassOf
	      : AnatomicalEntity
		cfr supra

: MedicalProcedure *rdfs:comment*	*rdfs:comment* Definition extended	The definition change to cover all medical related procedure

: MedicalTherapy
   subClassOf
      : MedicalEntity
	: MedicalTherapy
	   subClassOf
	      : TherapeuticProcedure
		TherapeuticProcedure was suggested as parent of all therapeutic concepts in scope of rebuilding *MedicalProcedure* entity (mainly to comply with medical terminologies: Snomed and HL7 standards)

: Drug
   subClassOf
      :MedicalEntity
	rdfs:comment Definition extended
	
	: Drug
	   subClassOf
	      : PharmaceuticalSubstance
		PharmaceuticalSubstance was suggested as parent of all Pharmacological substance which extends the vocabulary

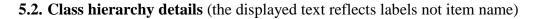|		

: DrugClass
    subClassOf
        : MedicalTherapy
	: DrugClass
	    subClassOf
	            : MedicalEnumeration
		Since the *MedicalTherapy* is defined as a medical procedure it cannot have a *DrugClass (defined here as* list item/concept*)*as children.

: MedicalEnumeration *rdfs:comment*	*rdfs:comment* Definition extended	This concept class seems to be the same as the medical observation defined with Snomed. The definition was updated to reflect its hierarchy content.

: MedicalCondition
    subClassOf
        :MedicalEntity
	: MedicalCondition
	    subClassOf
	            : ClinicalFinding
		ClinicalFinding was suggested as parent of all medical condoition (disorders) concepts what is in line with Snomed terminology.

:AnatomicalStructure
    subClassOf
        :MedicalEntity
	:AnatomicalStructure
	    subClassOf
	            : AnatomicalEntity
		AnatomicalEntity was suggested as parent of all anatomical related concepts what is more scalable if one day we need to extend anatomy vocabulary

: Patient
    subClassOf
        : MedicalAudience
	: Patient
	    subClassOf
	            : MedicalAudience
	
	: Patient
	    subClassOf
	            : Person	

: MedicalClinic
    subClassOf
        : MedicalOrganization
	: MedicalClinic
	    subClassOf
	            : MedicalOrganization
	
	: MedicalClinic
	    subClassOf
	            : HealthFacility
		HealthFacility was suggested as parent of all health related premises what is more covering other places like medical room, wards, etc.

: Ultrasound
    subClassOf
        : MedicalImagingTechnique
 	
: MedicalImagingTechnique
    subClassOf
        : MedicalEnumeration
	: Ultrasound
	    subClassOf
	        : MedicalImaging
		MedicalImaging is the most correct parent as it's defined here as a medical procedure.

: SurgicalProcedure *rdfs:comment*	*rdfs:comment* Definition updated	

: MedicalSignOrSymptom
    subClassOf
        :MedicalEntity
	: MedicalSignOrSymptom
	    subClassOf
	            : MedicalCondition
		Following the Snomed hierarchy.

: MedicalSignOrSymptom *rdfs:comment*	*rdfs:comment* Definition updated	
: MedicalSymptom *rdfs:comment*	*rdfs:comment* Definition updated	Disambiguation (vs MedicalSign)

: PhysicalExam
    subClassOf
        : MedicalEnumeration
 	
: MedicalSymptom
    rdfs:comment
	: PhysicalExam
	    subClassOf
	        : MedicalProcedure
	
	rdfs:comment Definition updated
		PhysicalExam is here defined as a procedure. So is fitting well in medical procedure hierarchy and not in enumeration.

: VitalSign
    subClassOf
        : PhysicalExam
	: VitalSign
	    subClassOf
	        : MedicalSign
		VitalSign is here defined as a sign. So is fitting well in medical sign hierarchy and not in physical exam (which is a medical procedure).

: PsychologicalTreatment
    subClassOf
        : MedicalTherapy
	: PsychologicalTreatment
	    subClassOf
	        : TherapeuticProcedure
		PsychologicalTreatment is is fitting well in *TherapeuticProcedure* hierarchy and not in *MedicalTherapy*.

: cause *rdfs:comment*	*rdfs:comment* Definition updated	
: comprisedOf *rdfs:comment*	*rdfs:comment* Definition updated	

: diagnosis
    :domainIncludes
	domainIncludes
	        Domain/range extended
	rdfs:comment Definition updated	

: clincalPharmacology	:clinicalPharmacology	Typo error fixing (in published version)
adverseOutcome, *location*, *provider*, *medicalSpeciality*, *procedure*,		extended with granular subproperties

5. Current overview of the hierarchy

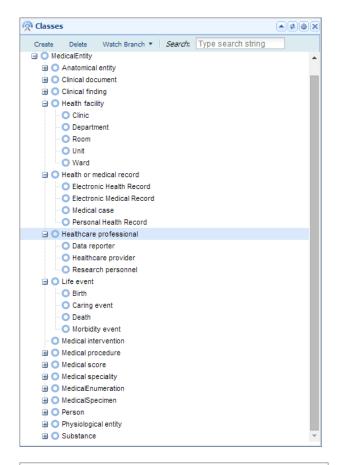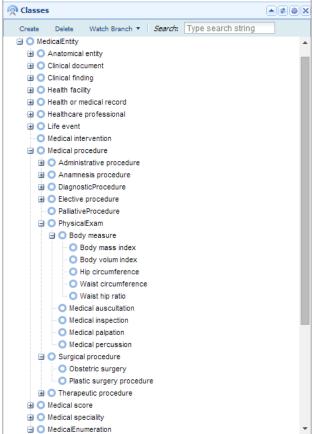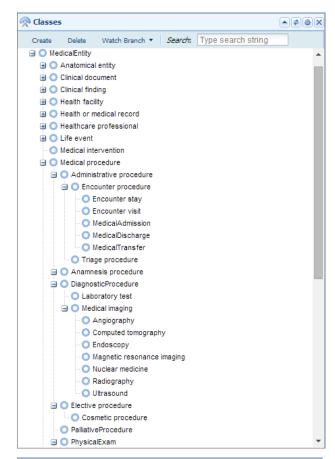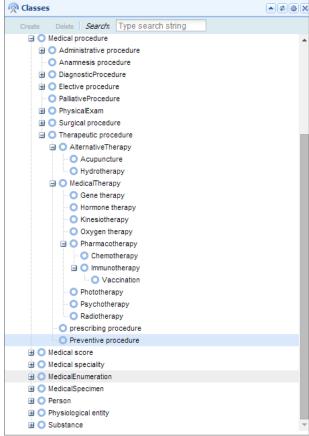### 5.1. Class hierarchy overview (Can be seen in full here)

5.2. Class hierarchy details (the displayed text reflects labels not item name)

Top-left window — Classes:
- MedicalEntity
  - Anatomical entity
  - Clinical document
  - Clinical finding
  - Health facility
    - Clinic
    - Department
    - Room
    - Unit
    - Ward
  - Health or medical record
    - Electronic Health Record
    - Electronic Medical Record
    - Medical case
    - Personal Health Record
  - Healthcare professional
    - Data reporter
    - Healthcare provider
    - Research personnel
  - Life event
    - Birth
    - Caring event
    - Death
    - Morbidity event
  - Medical intervention
  - Medical procedure
  - Medical score
  - Medical speciality
  - MedicalEnumeration
  - MedicalSpecimen
  - Person
  - Physiological entity
  - Substance

Top-right window — Classes:
- MedicalEntity
  - Anatomical entity
  - Clinical document
  - Clinical finding
  - Health facility
  - Health or medical record
  - Healthcare professional
  - Life event
  - Medical intervention
  - Medical procedure
    - Administrative procedure
      - Encounter procedure
        - Encounter stay
        - Encounter visit
        - MedicalAdmission
        - MedicalDischarge
        - MedicalTransfer
      - Triage procedure
    - Anamnesis procedure
    - DiagnosticProcedure
      - Laboratory test
      - Medical imaging
        - Angiography
        - Computed tomography
        - Endoscopy
        - Magnetic resonance imaging
        - Nuclear medicine
        - Radiography
        - Ultrasound
    - Elective procedure
      - Cosmetic procedure
    - PalliativeProcedure
    - PhysicalExam

Bottom-left window — Classes:
- MedicalEntity
  - Anatomical entity
  - Clinical document
  - Clinical finding
  - Health facility
  - Health or medical record
  - Healthcare professional
  - Life event
  - Medical intervention
  - Medical procedure
    - Administrative procedure
    - Anamnesis procedure
    - DiagnosticProcedure
    - Elective procedure
    - PalliativeProcedure
    - PhysicalExam
      - Body measure
        - Body mass index
        - Body volum index
        - Hip circumference
        - Waist circumference
        - Waist hip ratio
      - Medical auscultation
      - Medical inspection
      - Medical palpation
      - Medical percussion
    - Surgical procedure
      - Obstetric surgery
      - Plastic surgery procedure
    - Therapeutic procedure
  - Medical score
  - Medical speciality
  - MedicalEnumeration

Bottom-right window — Classes:
- Medical procedure
  - Administrative procedure
  - Anamnesis procedure
  - DiagnosticProcedure
  - Elective procedure
  - PalliativeProcedure
  - PhysicalExam
  - Surgical procedure
  - Therapeutic procedure
    - AlternativeTherapy
      - Acupuncture
      - Hydrotherapy
    - MedicalTherapy
      - Gene therapy
      - Hormone therapy
      - Kinesiotherapy
      - Oxygen therapy
      - Pharmacotherapy
        - Chemotherapy
        - Immunotherapy
          - Vaccination
      - Phototherapy
      - Psychotherapy
      - Radiotherapy
    - prescribing procedure
    - Preventive procedure
- Medical score
- Medical speciality
- MedicalEnumeration
- MedicalSpecimen
- Person
- Physiological entity
- Substance