Ibrahim Johar Farooqi - 23K-0074 - BAI-5A
Knowledge Representation and Reasoning
Assignment 2

Question 01

Purpose

To formally represent knowledge about wounds (types, causes, affected tissues, complications, healing stages, risk/severity, and treatments) so that the ontology can (a) classify wound instances, (b) infer likely complications and recommended treatments, and (c) support DL / SPARQL queries for diagnosis support and decision-making. This implementation follows Ontology 101 methodology and meets the assignment deliverables.

Scope

Covers clinical concepts related to acute and surgical wounds: open vs closed wounds and their subtypes (abrasions, lacerations, punctures, avulsions, contusions, hematomas, crush injuries), surgical wound classes (I–IV), causes, affected tissues, complications (infections and others), treatments (first aid, medical, surgical), healing stages, severity and risk levels, and representative individuals for testing. Intended for coursework demonstration, semantic querying, and basic decision support.

Intended users & use cases

- Medical students and instructors (learning & demonstration)
- Developers building clinical decision-support prototyping (triage heuristics)
- Knowledge engineers (testing OWL reasoning)
  Uses: classification, querying (DL/SPARQL), rule-like inference via OWL axioms, and example population for validation.

Language

- OWL 2 DL implemented in Protégé.
- Classes model domain concepts (Wound, Tissue, Treatment, etc.).
- Object properties model relationships (affectsTissue, hasCause, treatedBy).
- Data properties capture measurements (hasPainLevel, hasBleedingAmount).
- Non-trivial axioms used: disjointness, cardinality restrictions, property characteristics (functional, transitive, inverse).

Class Taxonomy

Thing
├── **Severity**
│   ├── Critical
│   ├── Severe
│   ├── Moderate
│   └── Mild
├── **BodyLocation**
│   ├── Leg
│   ├── Arm
│   ├── Torso
│   └── Head
├── **Cause**
│   ├── SurgicalProcedure
│   ├── BluntForce
│   ├── Fall
│   ├── Bullet
│   ├── Nail
│   └── SharpObject
├── **Complication**
│   ├── Cellulitis
│   ├── Hemorrhage
│   ├── **Infection**
│   │   ├── StaphylococcalInfection
│   │   └── GasGangrene
│   ├── NecrotizingFasciitis
│   ├── Scarring
│   └── Tetanus
├── **ExternalAgent**
├── **HealingProcess**
│   ├── Remodeling
│   ├── ScarFormation
│   ├── Epithelialization
│   ├── Proliferation

```
|   ├── Inflammation
|   └── Hemostasis
├── Risk_Factor
|   ├── HighRisk
|   ├── MediumRisk
|   └── LowRisk
├── SurgicalClassification
|   ├── ClassI
|   ├── ClassII
|   ├── ClassIII
|   └── ClassIV
├── Symptom
|   ├── Bleeding
|   ├── Fever
|   ├── Pain
|   ├── Pus
|   ├── Redness
|   ├── ShockSymptom
|   └── Swelling
├── Tissue
|   ├── BloodVessel
|   ├── Bone
|   ├── Joint
|   ├── Muscle
|   ├── Nerve
|   ├── Organ
|   ├── Skin
|   └── SubcutaneousFat
├── Treatment
|   ├── Antibiotics
|   ├── Debridement
|   ├── FirstAid
|   |   ├── ApplyingPressure
|   |   ├── Bandaging
```

```
| | └─ Cleaning
| ├─ Irrigation
| ├─ Packing
| ├─ PainMedication
| ├─ Surgery
| ├─ Suturing
| └─ TetanusShot
└─ Wound
    ├─ ChronicWound
    ├─ ClosedWound
    |   ├─ Contusion
    |   ├─ CrushingInjury
    |   ├─ Hematoma
    |   ├─ SpeainRelatedWound
    |   └─ WhiplashRelatedInjury
    ├─ OpenWound
    |   ├─ Abrasion
    |   ├─ Avulsion
    |   ├─ CrushWound
    |   ├─ GunshotWound
    |   ├─ Incision
    |   ├─ Laceration
    |   └─ PunctureWound
    └─ SurgicalWound
        ├─ DrainSiteWound
        └─ IncisionWound
```
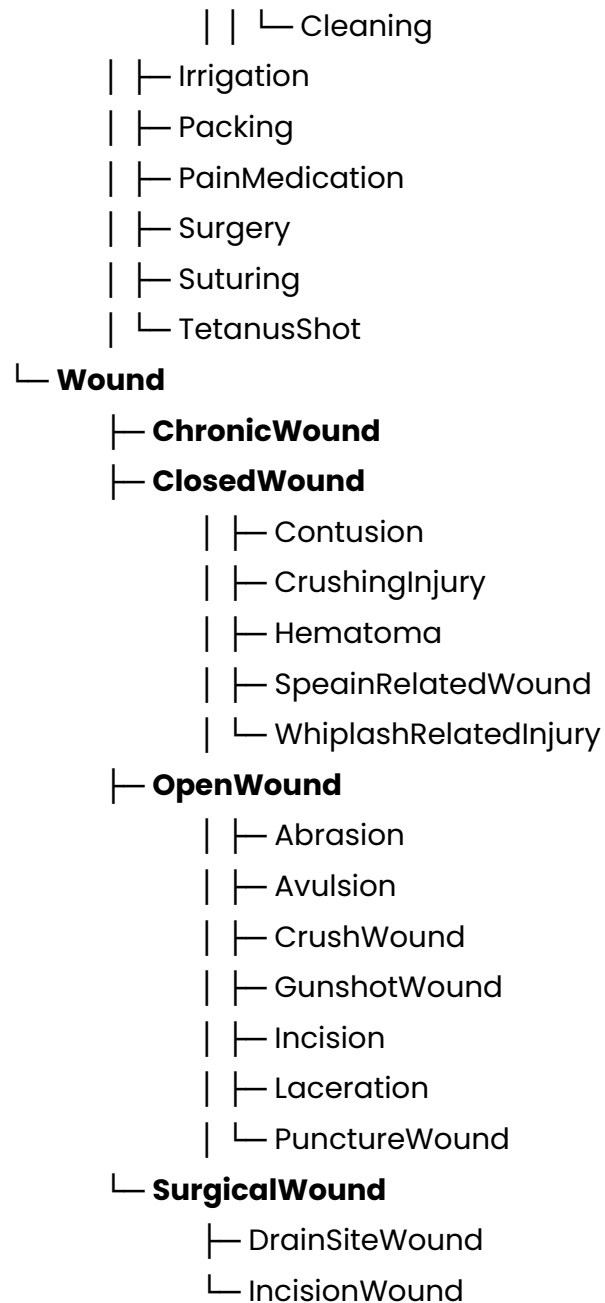
Object Properties

hasRiskLevel — Domain: Wound → Range: Risk_Factor
Meaning: risk category for future complications.

requiresFirstAid — Domain: Wound → Range: FirstAid
Meaning: indicates that the wound requires first-aid steps.

hasSeverityLevel — Domain: Wound → Range: Severity (mark as Functional)
Meaning: current severity; only one severity per wound.

precedesStage — Domain: HealingProcess → Range: HealingProcess (inverse of followsStage)

followsStage — Domain: HealingProcess → Range: HealingProcess (mark as Transitive)
Meaning: sequencing of healing stages.

affectsTissue — Domain: Wound → Range: Tissue
Meaning: which tissue(s) are damaged.

causedByAgent — Domain: Wound → Range: ExternalAgent
Alternate cause/agent relation (use if modeling agents explicitly).

hasCause — Domain: Wound → Range: Cause
Meaning: cause/event that produced the wound.

hasClassification — Domain: SurgicalWound → Range: SurgicalClassification
Usage: set surgical wound classification individuals (ClassI..ClassIV).

hasComplication — Domain: Wound → Range: Complication
Meaning: complications associated or inferred for the wound.

hasSymptom — Domain: Wound → Range: Symptom
Note: property label as shown in your ontology (hasSymptoom). (See note about typo below.)

occursAt — Domain: Wound → Range: BodyLocation

treatedBy — Domain: Wound → Range: Treatment
Inverse of treatsWound.

treatsWound — Domain: Treatment → Range: Wound
Inverse of treatedBy.

Data Properties

hasHealingTime — Domain: Wound → Range: xsd:int (days)

hasTemperature — Domain: Infection or Wound → Range: xsd:float (°C)

hasBleedingAmount — Domain: Wound → Range: xsd:float (volume or relative)

hasPainLevel — Domain: Wound → Range: xsd:int (0–10 scale; optional data restriction minInclusive=0, maxInclusive=10)

hasBleedingLevel — Domain: Wound → Range: xsd:string (alternate/qualitative descriptor if used)

hasDepth — Domain: Wound → Range: xsd:float (cm)

hasLength — Domain: Wound → Range: xsd:float (cm)

hasLocationDescription — Domain: Wound → Range: xsd:string

hasRiskScore — Domain: Wound → Range: xsd:int (optional numeric risk score)

Non-trivial axioms

Disjointness (using Disjoint With):
- OpenWound DisjointWith ClosedWound.
- Abrasion, Laceration, PunctureWound, Avulsion are mutually disjoint.
- Surgical classification individuals (ClassI, ClassIV).

Cardinality restrictions/subclass axioms
- SurgicalWound SubClassOf (hasClassification exactly 1 SurgicalClassification)
  Justification: each surgical wound is assigned exactly one surgical class.

- PunctureWound SubClassOf (affectsTissue min 1 Tissue)

   Justification: punctures penetrate and affect at least one tissue.

Property characteristics (set in Object properties):

- **followsStage** → Transitive.
- **precedesStage** → InverseOf followsStage.
- **hasSeverityLevel** → Functional.
- **treatedBy** ↔ **treatsWound** → set as InverseOf each other.
- OpenWound SubClassOf (**hasComplication some Infection**) – (models infection risk for open wounds).

Individuals

1. **Lac1**

   Type: Laceration

   Assertions: hasCause → SharpObj1 (type: SharpObject)

   affectsTissue → Skin1 (type: Skin)

   treatedBy → Suturing1 (type: Suturing)

   hasPainLevel → "6" – xsd:int

2. **Punc1**

   Type: PunctureWound

   Assertions: hasCause → Nail1 (type: Nail)

   affectsTissue → Muscle1 (type: Muscle)

   hasComplication → Tetanus1 (type: Tetanus)

   hasBleedingAmount → "0.2"^^xsd:float

3. **Surg1**

   Type: SurgicalWound

   Assertions: hasClassification → ClassII_Inst (type: ClassII)

   treatedBy → Suturing2 (type: Suturing)

DL Queries

- **Query 1:** Which wounds require suturing?
   - Wound and (treatedBy some Suturing)
- **Query 2:** Which wounds have infection complications?
   - Wound and (hasComplication some Infection)
- **Query 3:** Which open wounds affect muscle tissue?
   - OpenWound and (affectsTissue some Muscle)

- **Query 4:** Which surgical wounds are Class II?
  - SurgicalWound and (hasClassification value ClassII_Inst)