Consider the following prefixes for all of the exam exercises if necessary!

@prefix ex: <http://example.org> .

@prefix owl: <http://www.w3.org/2002/07/owl#> .

@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .

@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .

@prefix s: <http://schema.org/> .

@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

Important tips:

- **No materials and tools are allowed (prints, books, cell phones, etc.). Not obeying the rules causes disqualification, i.e. FAILING the exam.**
- **The questions are arranged on separate paper sheets. Please enter your name matriculation number at the top of each sheet.**
- **Answer each open question right after the question text.**
- **Answer multiple-choice questions by ticking all boxes you consider to be correct. There can be more than one correct options!**
- **Keep your answers short, avoid long sentences, and mention only the key points!**
- **The number of points for each question is indicated.**
- **There are 90 points overall, corresponding to 90 minutes!**

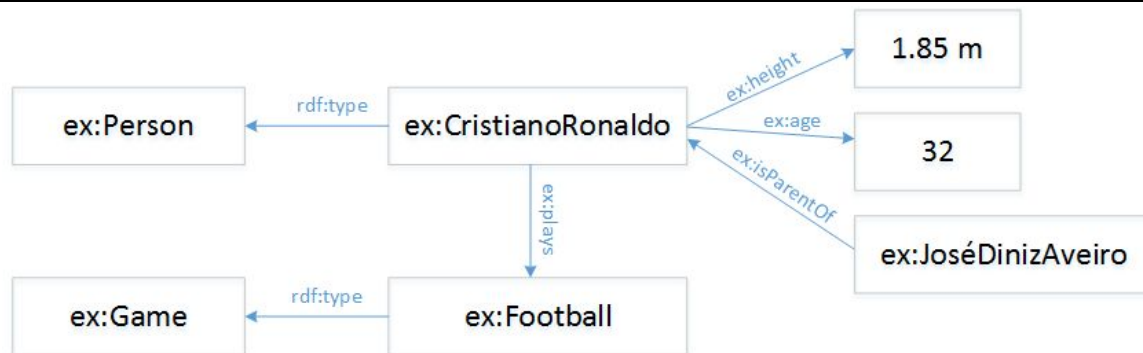| TaskNr	Pts	Skill
1	12	RDF(S) basic knowledge

Fig 1. Football RDF Graph

Based on the RDF graph in Fig 1. answer the following questions:

1) Write down (4 points) :

Number of Instances: . . . .

Number of Classes: . . . .

Number of Properties: . . . .

URIs of the classes: .. . .

2) Represent in Turtle syntax, the following RDF/RDFs statements (4 points):

José Diniz Aveiro is a person: . . . .

Cristiano Ronaldo plays for Real Madrid: . . . .

Cristiano Ronaldo plays as a forward : .. . .

ex:plays can take a person as subject and a game as an object. : .. . .

3) List two RDF serialization formats that can be used to add semantic metadata to existing HTML web documents (4 points).

. . . .

. . . .

TaskNr	Pts	Skill
2	12	RDF Serializations: RDFa, JSON-LD

Complete the RDFa and JSON-LD serializations of the following RDF graph:

@prefix s: <http://schema.org>.
@prefix dbp: <http://dbpedia.org/resource/> .

dbp:Ludwig_van_Beethoven a s:Person;
                  s:name "Ludwig van Beethoven"@en;
                  s:deathDate "1827-03-26"^^xsd:date;
                  s:birthPlace dbp:Bonn.

JSON-LD: (5.5 points)

{
 .... :
 {
   .... : "http://schema.org/name",
   .... : { .... : "http://schema.org/deathDate",
         .... : "http://www.w3.org/2001/XMLSchema#date" },
   .... : { ....: "http://schema.org/birthPlace",
         .... : .... }
 },
 .... : "http://dbpedia.org/resource/Ludwig_van_Beethoven",
 "@type": ....,
 "name": "Ludwig van Beethoven",
 "died": "1827-03-26",
 "birth place": "http://dbpedia.org/resource/Bonn"
}

RDFa: (6.5 points)

```
<div ........................="http://Schema.org"

        .............................. = "xsd: http://www.w3.org/2001/XMLSchema#

        ............................................................................"

        .......................... = "Person">

        <h1 .......................................................> Ludwig van Beethoven</h1>

        born in

        <span ............... ="birthPlace".........................="dbp:Bonn"......>

                Bonn, Germany

        </span>

        ( died

        <span ...........................................................................................

        ...............................................> March 26, 1827 </span> )

</div>
```

TaskNr	Pts	Skill
3	10	RDFS

Consider the following information:

Our solar system consists of different objects, including a star, planets and satellites. The planets in the solar system orbit around the star we know as **Sun**. These planets can be either regular planets (e.g., **Earth**) or dwarf planets (e.g., **Pluto**). Some planets have satellites, and these satellites can be natural satellites or artificial satellites. The **Moon** is an example of natural satellite and the **ISS** (International Space Station) is one of the most popular artificial satellites we currently have. Both Moon and ISS orbit around our Earth.

Given these classes:

```
ex:Planet
ex:DwarfPlanet
ex:RegularPlanet
ex:Star
ex:Satellite
```

And the following properties:

```
ex:isOrbitingAround
ex:isSatelliteOf
ex:isNaturalSatelliteOf
ex:isArtificialSatelliteOf
```

Complete the missing Turtle snippets below!

   I.   The hierarchy of classes (1 point per each correct answer)

```
ex:_____        rdfs:subClassOf      ex:_____ .
ex:_____        rdfs:subClassOf      ex:_____ .
```

   II.   The hierarchy of properties (1 point per each correct answer)

```
ex:_____        rdfs:subPropertyOf   ex:_____ .
ex:_____        rdfs:subPropertyOf   ex:_____ .
```

III. Domain and range of a property (1 point; 0.5 point each correct answer)

```
ex:isSatelliteOf          rdfs:range        ex:_____;
                          rdfs:domain       ex:_____.
```

IV. Instances of the classes   (Bold-marked nouns in the text are the instances) (2.5 points; 0.5 point for each correct answer)

```
ex:_____        rdf:type        ex:_____.
ex:_____        rdf:type        ex:_____.
ex:_____        rdf:type        ex:_____.
ex:_____        rdf:type        ex:_____.
ex:_____        rdf:type        ex:_____.
```

V. Properties of instances and relationships between instances. (score: 2.5 points; 0.5 point each correct answer)

```
ex:Moon        ex:_____        ex:Earth.
ex:ISS         ex:_____        ex:Earth.
ex:Earth       ex:_____        ex:Sun.
ex:Moon        ex:_____        ex:Earth.
ex:ISS         ex:_____        ex:Earth.
```

TaskNr	Pts	Skill
4	10	Logical Inference with RDF(S)

Given the following RDF(s) graph:

@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix aa: <http://www.example.com/2017/comp-ns#> .

aa:Microsoft	aa:acquires	aa:LinkedIn
aa:Microsoft	rdf:produces	aa:Kinect
aa:Siemens	aa:postsJob	aa:LinkedIn
aa:Microsoft	rdf:type	aa:TechCompany
aa:Siemens	rdf:type	aa:ElectronicsCompany
aa:LinkedIn	rdf:type	aa:ProfessionalSocialNetwork
aa:ProfessionalSocialNetwork	rdfs:subClassOf	aa:SocialNetwork
aa:TechCompany	rdfs:subClassOf	aa:Company
aa:ElectronicsCompany	rdfs:subClassOf	aa:Company
aa:postsJob	rdfs:subPropertyOf	aa:uses
aa:postsJob	rdfs:domain	aa:ElectronicsCompany
aa:postsJob	rdfs:range	aa:ProfessionalSocialNetwork
aa:uses	rdfs:range	aa:SocialNetwork
aa:produces	rdfs:domain	aa:TechCompany
aa:produces	rdfs:range	aa:Technology

Select the triples that can be entailed from the list of options below. Put the letter 'T' if it is a correct entailment or 'F' otherwise (1.25 points for each correct answer):

a. aa:postsJob   rdfs:range   aa:SocialNetwork

b. aa:postsJob   rdfs:domain   aa:Company

c. aa:TechCompany   aa:postsJob   aa:ProfessionalSocialNetwrk

d. aa:LinkedIn   rdf:type   aa:TechCompany

e. aa:Company   rdf:type   rdfs:Resource

f. aa:Microsoft   rdf:type   aa:ElectronicsCompany

g. aa:Kinect   rdf:type   aa:Technology

h. aa:Microsoft   rdf:type   aa:Company

TaskNr	Pts	Skill
5	10	OWL Modelling

5.1 If we want to infer that ex:Jessie and ex:Jessica are the same person from the following triples (1 point - only 1 correct answer) :

ex:John ex:hasMother ex:Jessie.

ex:John ex:hasMother ex:Jessica.

which feature(s) of an OWL property should be declared for ex:hasID?

1. **Irreflexive property**
2. **Symmetric property**
3. **Transitive property**
4. **Functional property**
5. **Inverse functional property**

5.2 What do the following statements in OWL Manchester Syntax express (3 points - any wrong answer will cancel a correct one) ?

DatatypeProperty: ex:hasMetric

Annotations:
    rdfs:comment "A metric related to a process"@en,
    rdfs:label "has Metric"@en

Range:
    xsd:decimal

Domain:
    ex:Process

1. *Annotations* **is a subclass of** *DatatypeProperty***.**
2. *DatatypeProperty* **is a type of** *ex:hasMetric***.**
3. **The subject of a triple with the** *ex:hasMetric* **property is of type** *Process***.**
4. *ex:hasMetric is a property.*
5. *ex:hasMetric* **is a** *DatatypeProperty***.**
6. **The subject of a triple with the** *hasMetric* **property must be a decimal number.**

5.3 Which of the following OWL knowledge bases will become logically inconsistent once we add the following statements to it? For each option, in order to be considered a complete correct answer (1.5 points), please argue why the knowledge base becomes inconsistent or remains consistent (6 points - each correct answer counts 1.5 points).

ex:EmployeeA ex:hasSkill ex:Skill_1.
ex:EmployeeA ex:leads ex:DepartmentX.

1. *ex:EmployeeA a ex:Employee;*
   ex:worksIn ex:DepartmentX.
   ex:EmployeeB a ex:Employee.
   ex:EmployeeB ex:leads ex:DepartmentX.
   ex:EmployeeA owl:differentFrom ex:EmployeeB.
   ex:leads a owl:InverseFunctionalProperty.

2. *ex:EmployeeA a ex:Employee;*
   ex:worksIn ex:DepartmentX.
   ex:EmployeeA ex:hasSkill ex:Skill_2.
   ex:hasSkill a owl:InverseFunctionalProperty.
   ex:EmployeeB ex:leads ex:DepartmentX.

3. *ex:leads a owl:FunctionalProperty,*
   owl:ObjectProperty .
   ex:hasSkill a owl:FunctionalProperty,
   owl:ObjectProperty .
   ex:EmployeeA a ex:Employee.
   ex:worksIn ex:DepartmentX.
   ex:Employee owl:disjointWith ex:Employer.

4. *ex:DepartmentX owl:differentFrom ex:DepartmentZ.*
   ex:EmployeeB ex:leads ex:DepartmentZ.
   ex:EmployeeA owl:differentFrom ex:EmployeeB.
   ex:EmployeeA ex:hasSkill ex:Skill_2.

TaskNr	Pts	Skill
6	12	SPARQL queries

Consider the following RDF graph with information about Clinical Trials:

@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix lct: <http://data.linkedct.org/vocab/resource/> .
@prefix lcte: <http://data.linkedct.org/vocab/resource/eligibility/> .

lct:1   a   lct:trial .
lct:1   rdfs:label   "NCT00001162" .
lct:1   lct:eligibility   lcte:32 .
lct:1   lct:enrollment   "200" .
lct:1   lct:firstreceived_date   "November 3, 1999" .
lct:1   lct:lastchanged_date   "August 31, 2016" .
lct:1   lct:overall_status   "Recruiting" .
lct:1   lct:start_date   "May 1977" .
lct:1   lct:completion_date   "August 2007" .
lct:1   lct:study_type   "Observational" .
lct:1   lct:trial_location_countries   lct:country/united-states .

lct:2   a   lct:trial .
lct:2   rdfs:label   "NCT00148915" .
lct:2   lct:eligibility   lcte:61 .
lct:2   lct:enrollment   "98" .
lct:2   lct:firstreceived_date   "September 6, 2005" .
lct:2   lct:lastchanged_date   "July 20, 2015" .
lct:2   lct:overall_status   "Completed" .
lct:2   lct:start_date   "August 2005" .
lct:2   lct:study_type   "Interventional" .
lct:2   lct:trial_location_countries   lct:country/united-states .

lct:3   a   lct:trial .
lct:3   rdfs:label   "NCT00923221" .
lct:3   lct:eligibility   lcte:161 .
lct:3   lct:enrollment   "1000" .
lct:3   lct:firstreceived_date   "June 17, 2009" .
lct:3   lct:lastchanged_date   "December 10, 2014" .
lct:3   lct:overall_status   "Recruiting" .
lct:3   lct:start_date   "February 2007" .
lct:3   lct:study_type   "Observational" .

| lct:3 | lct:trial_location_countries | lct:country/united-states, lct:country/russian-federation . |

lcte:61	rdfs:label	"61f0ea6809bcf11ed2d4daa6e2ef53d5" .
lcte:61	lct:eligibility_gender	"Female" .
lcte:61	lct:eligibility_healthy_volunteers	"No" .
lcte:61	lct:eligibility_minimum_age	"55" .
lcte:61	lct:eligibility_maximum_age	"80" .

lcte:32	rdfs:label	"61f12a3ff16b3c38827642644421ca5a" .
lcte:32	lct:eligibility_gender	"Both" .
lcte:32	lct:eligibility_healthy_volunteers	"No" .
lcte:32	lct:eligibility_minimum_age	"18" .
lcte:32	lct:eligibility_maximum_age	"N/A" .

lcte:161	rdfs:label	"61f2e58b54a9949a59955d2be0d9328a" .
lcte:161	lct:eligibility_gender	"Female" .
lcte:161	lct:eligibility_healthy_volunteers	"No" .
lcte:161	lct:eligibility_minimum_age	"18" .
lcte:161	lct:eligibility_maximum_age	"N/A" .

Write SPARQL queries to retrieve the following information:

a) A list of clinical trials with start and, if available, completion date whose study type is "Observational", sorted by enrollment. (3 points)
b) A list of clinical trials whose location country is either "Russian Federation" or "United States" with eligibility minimum age greater than 20. (4 points)
c) Label of clinical trials with studies located in at least 2 countries and ratio of eligibility age (i.e., minimum age/maximum age). (5 points)

11

EXTRA PAGE TO USE IN CASE OF NEED

EXTRA PAGE TO USE IN CASE OF NEED