CS : 7810 - Metadata Representation Languages

Group 3 : Antrea Christou, Erin Rogers, Sydney Woods

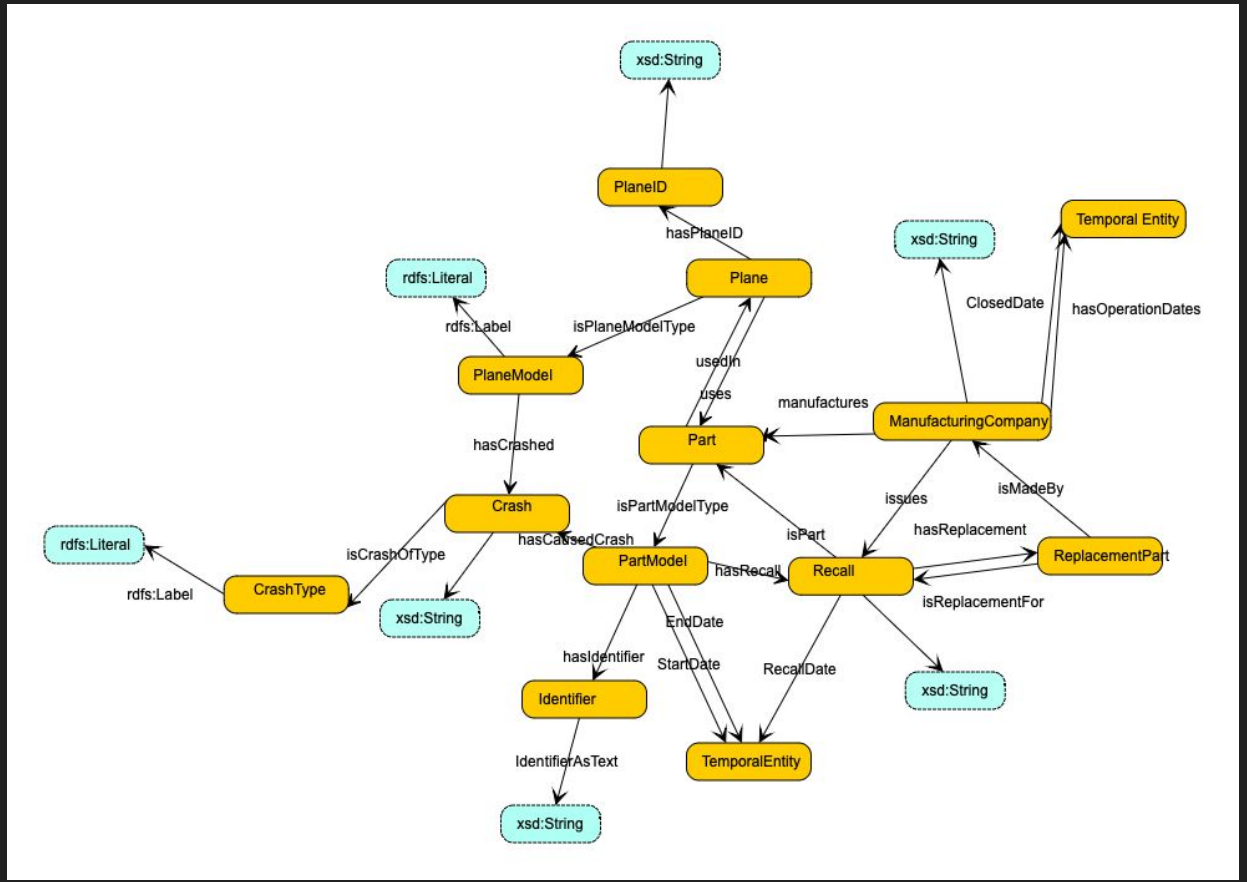
Our Graph :

- Our Knowledge Graph consists of information regarding airplanes of any kind.
- Our goal is to provide as much information as possible regarding any available airplane attribute.

Our Attributes :

- PlaneID : The unique tail number of each plane.
- Plane Model : The model of each plane.
- Crash Type : A Binary Representation of a Crash depending if it had any fatalities.
- Airworthiness Directive : A notice issued by the FAA for a part that needs to be checked at in order for it to be airworthy.
- Part : The name of a part of the plane.
- Manufacturing Company : The name of a Manufacturing Company making a specific part.

What we wanted



So what happened?

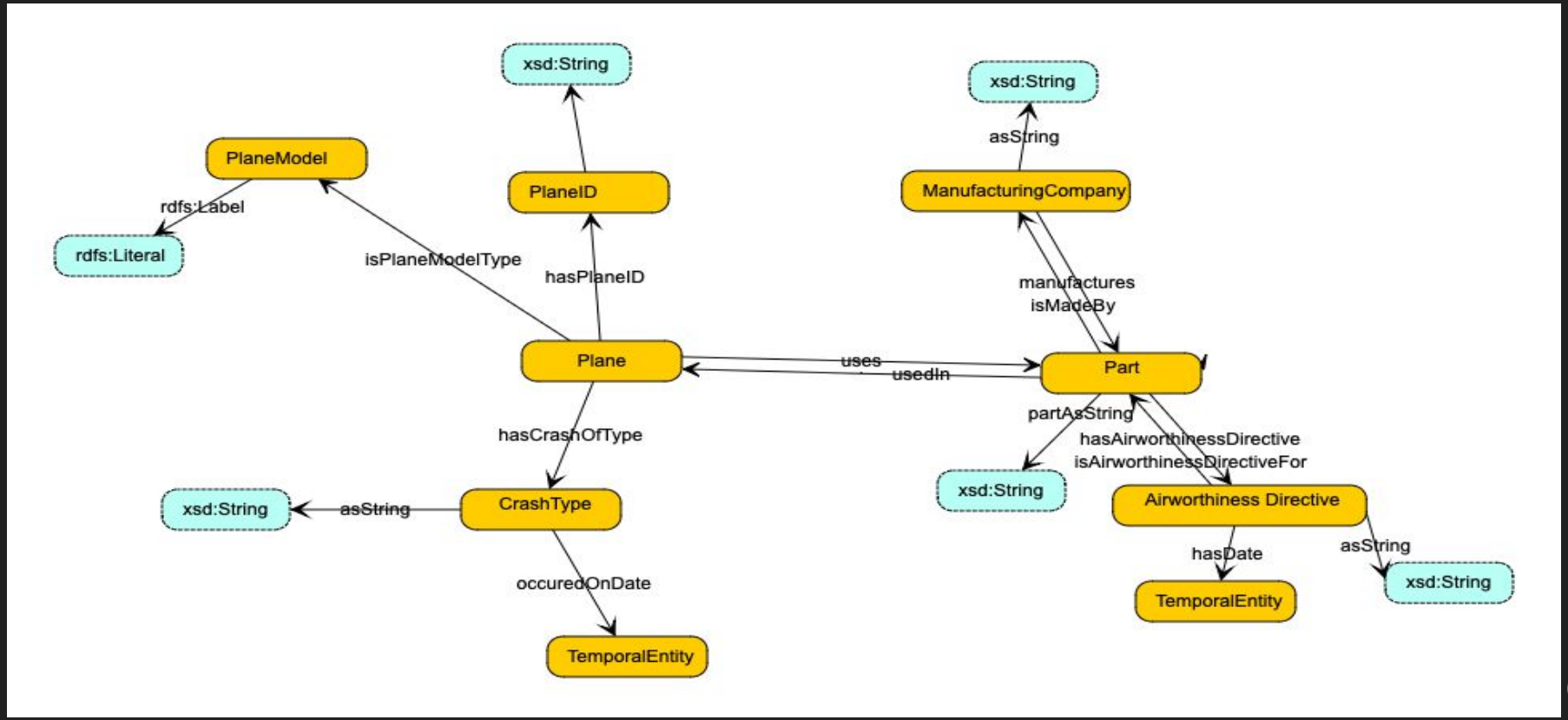
- FAA documentation is done via scanned copies of documents rather than data entered into datasets.

- Surprisingly little easily accessible comprehensive data on aircraft.

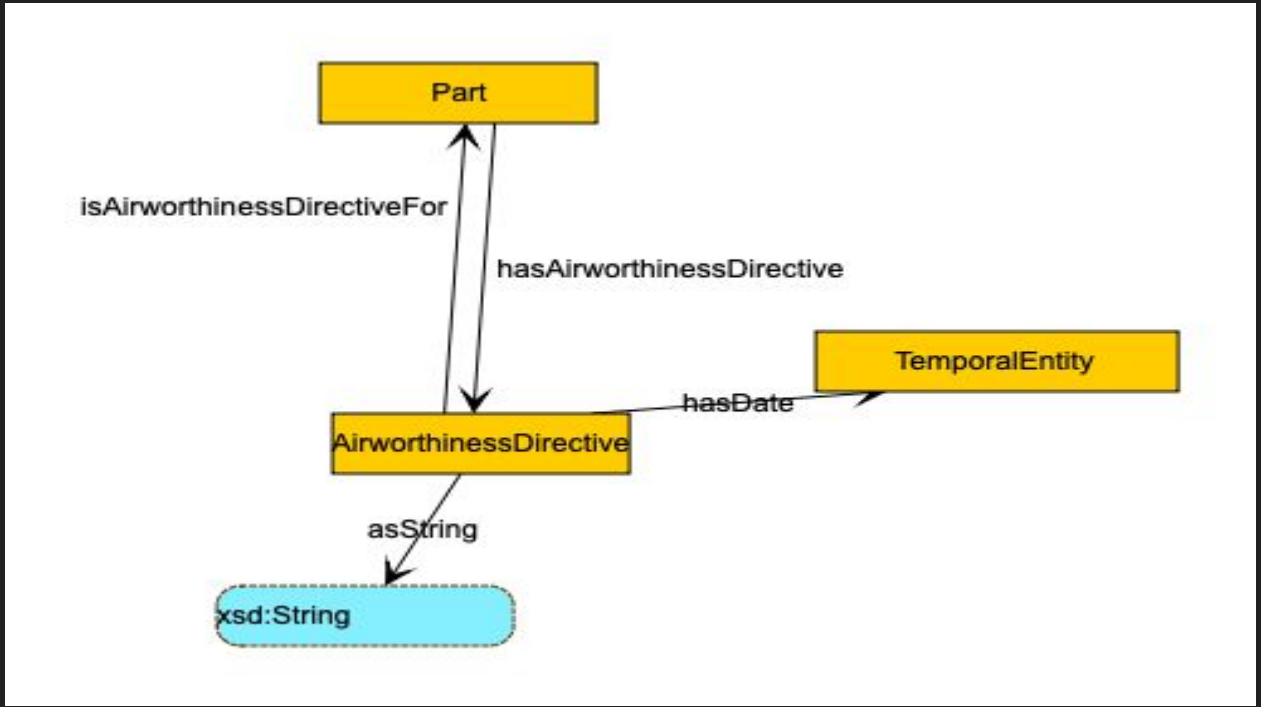
- Airworthiness Directive data was entered by hand from scanned documents, took too much time.

- Schema had to changed to accommodate missing data.

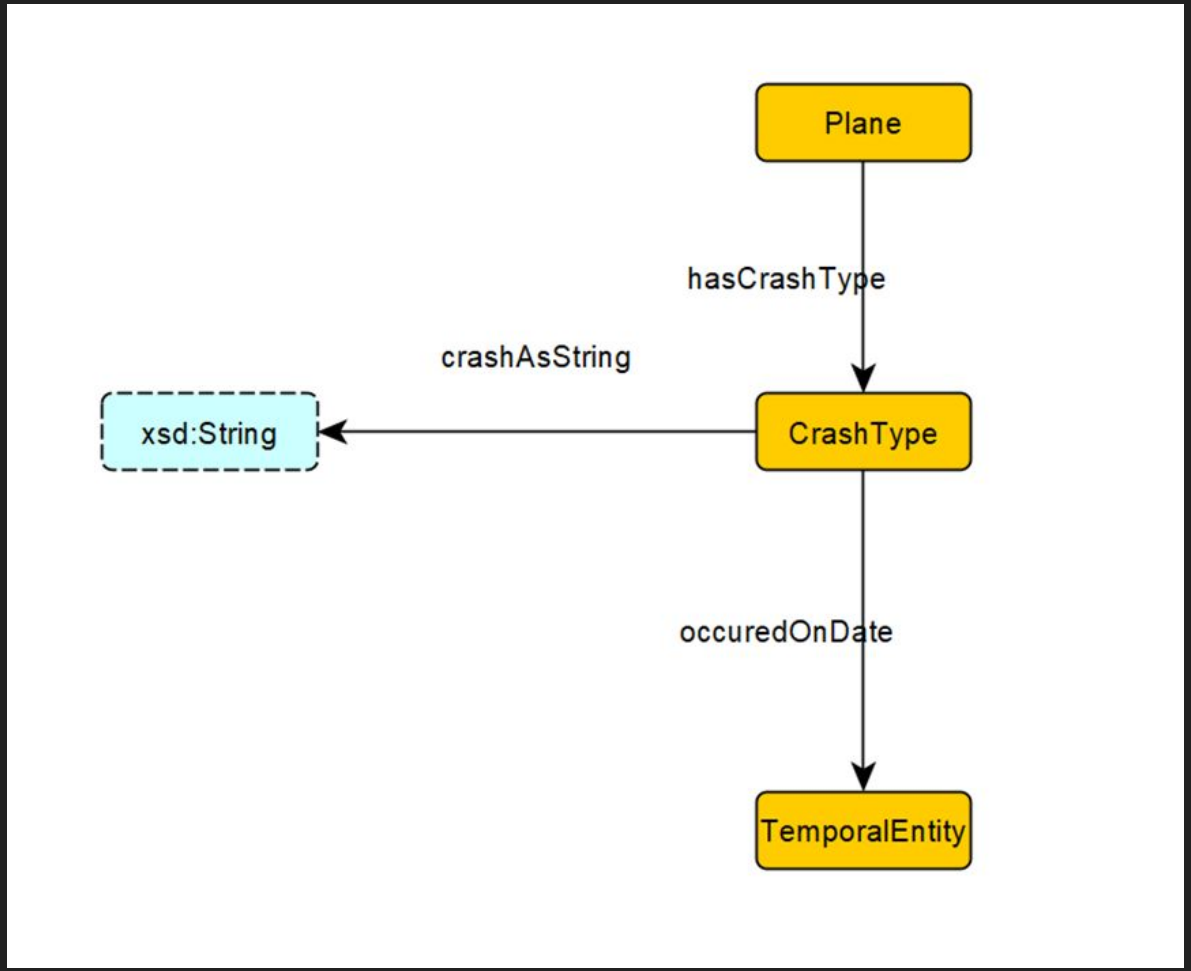
What we got


xsd:String
xsd:String
PlaneModel
PlaneID
ManufacturingCompany
asString
rdfs:Label
rdfs:Literal
isPlaneModelType
hasPlaneID
manufactures
isMadeBy
Plane
uses
usedIn
Part
partAsString
hasCrashOfType
hasAirworthinessDirective
isAirworthinessDirectiveFor
xsd:String
xsd:String
asString
CrashType
Airworthiness Directive
hasDate
asString
occuredOnDate
TemporalEntity
xsd:String
TemporalEntity

Airworthiness Directive

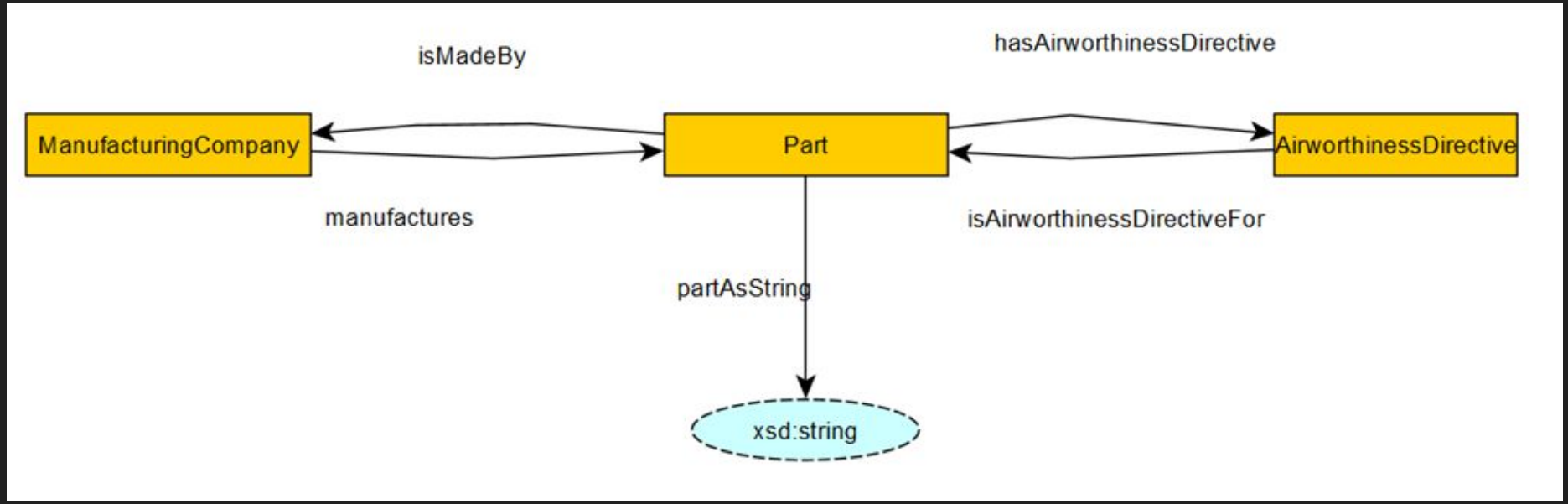


Crash Type

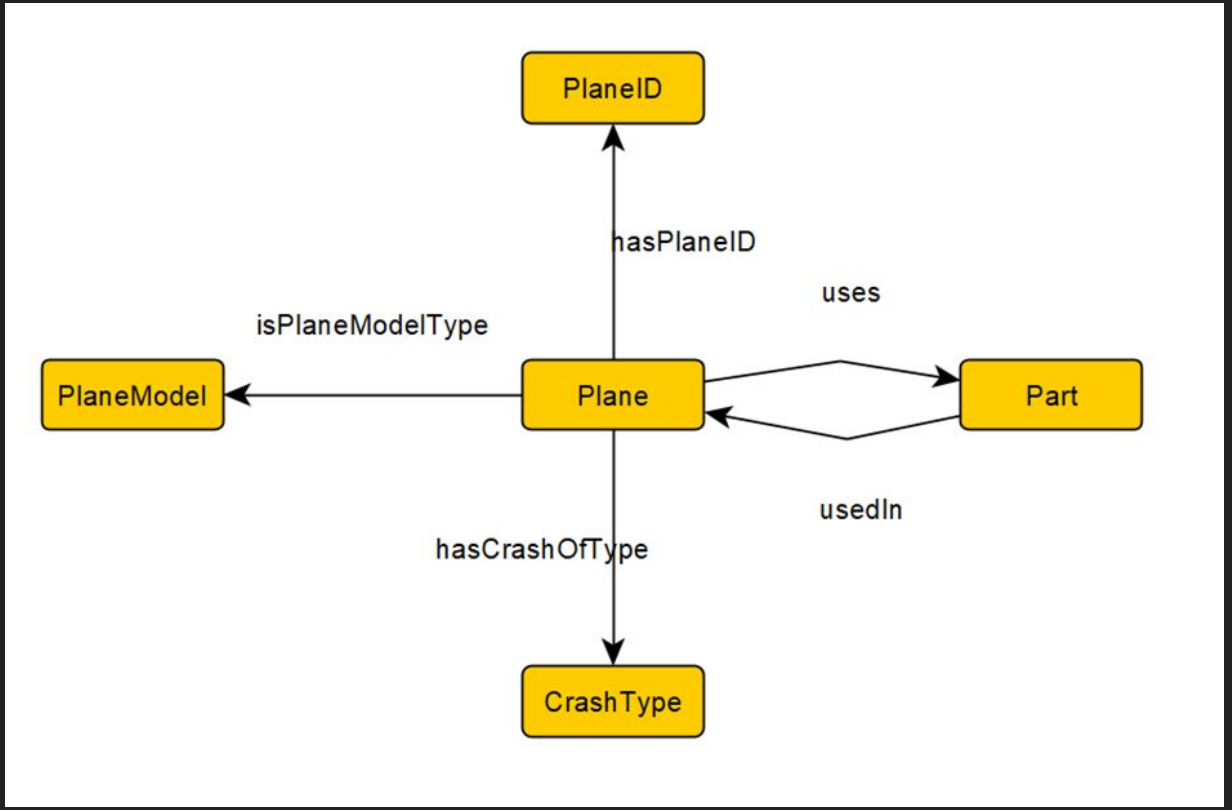

Plane
hasCrashType
crashAsString
xsd:String
CrashType
occuredOnDate
TemporalEntity

Manufacturing Company

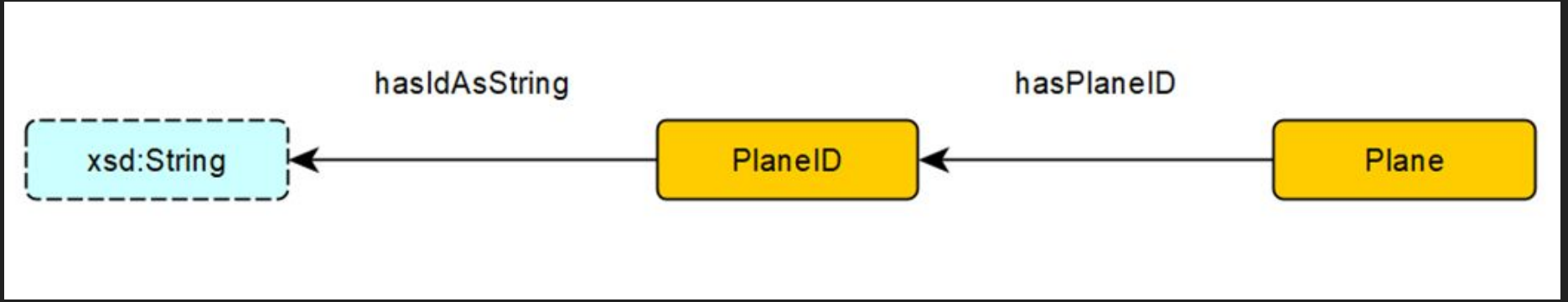
Part


isMadeBy
hasAirworthinessDirective
ManufacturingCompany
Part
AirworthinessDirective
manufactures
isAirworthinessDirectiveFor
partAsString
xsd:string

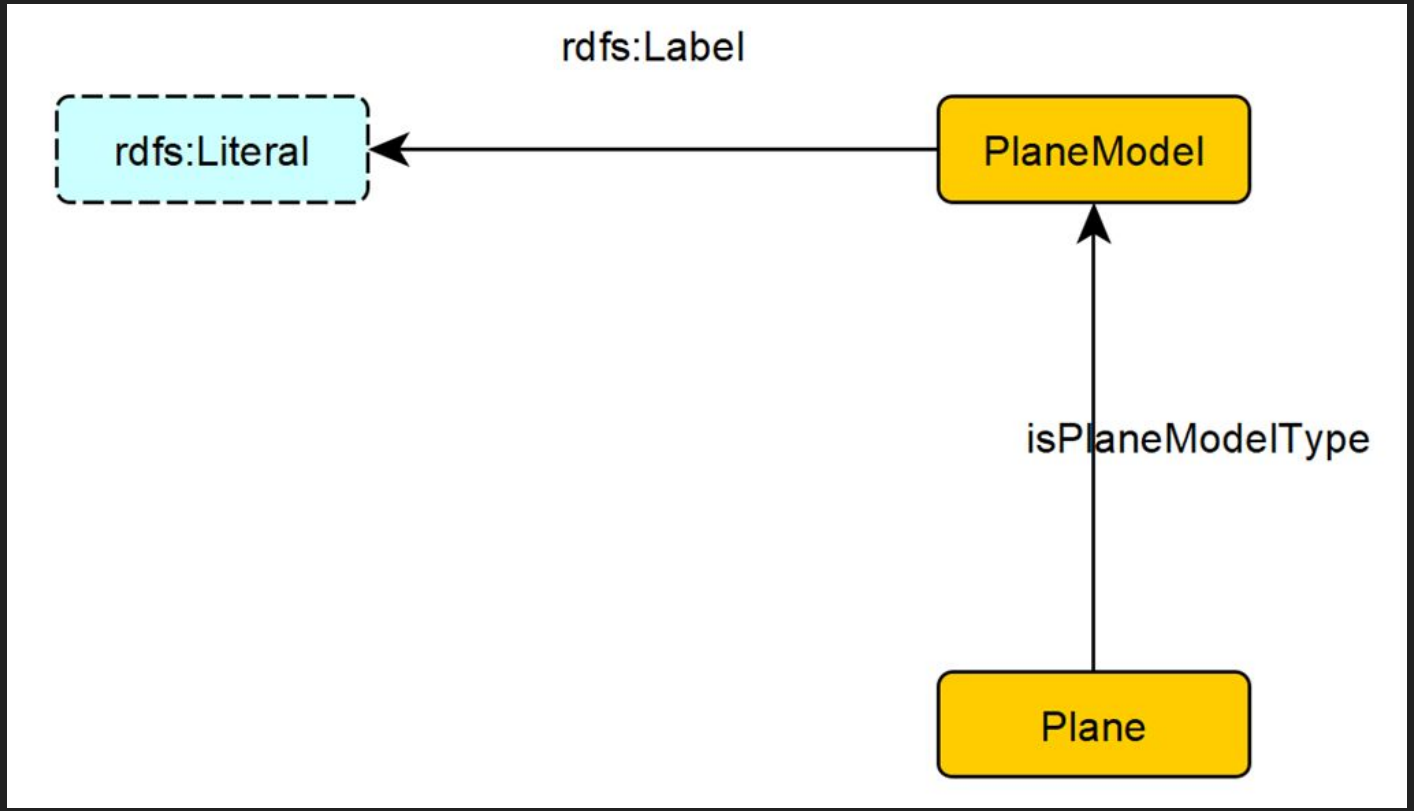
Plane


PlaneID
hasPlaneID
uses
isPlaneModelType
PlaneModel
Plane
Part
usedIn
hasCrashOfType
CrashType

Plane ID



Plane Model


rdfs:Label
rdfs:Literal
PlaneModel
isPlaneModelType
Plane

Axioms - Examples from our OWL File

PlaneModel ⊑ Plane

Every Plane Model is a Plane.

Plane ⊑ =1 isPlaneModelType.PlaneModel

Every Plane has exactly one isPlaneModelType relation filler of type Plane Model.

Materialization - Code Pointer

- After loading our datasets we followed the given example code to add our data to our graph.
- Example of code for Part Model and PartID :

```
crash_data = pd.read_csv("Crashes.csv")
# Binary for crashtype : returns 1 if there is one or more fatalities in the cra
crash_data['Fatalities'].mask(crash_data['Fatalities'] >=1 ,'1', inplace=True)
planeID=pd.read_csv("planeID.csv")
# Loop through the rows and create a new instance for each record
for index, row in crash_data.iterrows():
    plane_model = row["PlaneModel"]
    fatalities = row["Fatalities"]
    date=row["Date"]


    plane_uri = URIRef(f"{name_space}lod/resource/Plane{index}")
    g.add(( plane_uri, a, pfs["grair"]["Plane"]))
    g.add(( plane_uri, isPlaneModelType, Literal(plane_model)))
    crash_uri = URIRef(f"{name_space}lod/resource/CrashType{index}")
    g.add(( crash_uri, a, pfs["grair"]["CrashType"]))

    g.add((crash_uri, isCrashOfType, Literal(fatalities)))
    g.add((crash_uri, occuredOnDate, Literal(date)))

for index, row in planeID.iterrows():
    planeID=row["PlaneID"]
    plane_uri = URIRef(f"{name_space}lod/resource/Plane{index}")



    g.add((plane_uri, hasPlaneID, Literal(planeID)))
    g.add((plane_uri, a, pfs["grair"]["Plane"]))
```

Materialization - Examples of our output

```
@prefix grair: <https://group3/GenericOntology/Airplanes> .
@prefix kwgr: <http://stko-kwg.geog.ucsb.edu/lod/resource/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

kwgr:CrashType0 a grair:CrashType ;
    grair:isCrashOfType "1" ;
    grair:occuredOnDate "09/17/1908" .
```

Materilization - Examples of our output

```
@prefix grair: <https://group3/GenericOntology/Airplanes> .
@prefix kwgr: <http://stko-kwg.geog.ucsb.edu/lod/resource/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

kwgr:Plane4501 a grair:Plane ;
    grair:hasPlaneID "10WA" ;
    grair:isPlaneModelType "Piper PA-32" .
```

Materilization - Examples of our output

```
@prefix grair: <https://group3/GenericOntology/Airplanes> .
@prefix kwgr: <http://stko-kwg.geog.ucsb.edu/lod/resource/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
kwgr:AirworthinessDirective0 a grair:AirworthinessDirective ;
    grair:directiveAsString "2022-25-51" ;
    grair:hasDate "11/22/22" ;
    grair:isAirworthinessDirectiveFor kwgr:Part0 .
```

Materilization - Examples of our output

```
@prefix grair: <https://group3/GenericOntology/Airplanes> .
@prefix kwgr: <http://stko-kwg.geog.ucsb.edu/lod/resource/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
kwgr:ManufacuringCompany60 a grair:ManufacturingCompany ;
    grair:asString "Airbus SAS" ;
    grair:manufactures kwgr:Part60 .
```

Materilization - Examples of our output

```
@prefix grair: <https://group3/GenericOntology/Airplanes> .
@prefix kwgr: <http://stko-kwg.geog.ucsb.edu/lod/resource/> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
kwgr:Part99 a grair:Part ;
    grair:hasAirworthinessDirective kwgr:AirworthinessDirective99 ;
    grair:isMadeBy kwgr:ManufacuringCompany99 ;
    grair:partAsString "Wing Attach Angles" .
```

Live Jena Fuseki - sparql queries demonstration

All plane IDs along with their corresponding models :

```
PREFIX grair:<https://group3/GenericOntology/Airplanes>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX kwgr: <http://stko-kwg.geog.ucsb.edu/lod/resource/>



SELECT  ?planeId ?planeModel
WHERE {

  ?plane rdf:type grair:Plane .
  ?plane grair:hasPlaneID ?planeId .
  ?plane grair:isPlaneModelType ?planeModel .
}
```

Example sparql output :

	planeId	planeModel
1	1	Wright Flyer III
2	100	Dirigible
3	1000J	Super Zeppelin (airship)
4	10051	Junkers F-13
5	101TM	Douglas DC-3
6	101TQ	Lockheed 18 Lodestar
7	101TR	Avro 685 York I
8	101TT	Lockheed 18 Lodestar
9	101TV	FIAT G-212CP
10	101TW	Douglas DC-3
11	101TX	Douglas DC-3
12	101U	Douglas C-47B
13	101UA	Curtiss C-46D-5-CU
14	101UD	Lockheed 749-79-33 Constellation
15	10053	Breguet 14

All the parts along with their manufacturing company and airworthiness directive :

```
PREFIX grair:<https://group3/GenericOntology/Airplanes>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX kwgr: <http://stko-kwg.geog.ucsb.edu/lod/resource/>

SELECT ?part ?partString ?company ?companyString ?directive ?directiveString WHERE {
  ?part a grair:Part ;
        grair:partAsString ?partString ;
        grair:isMadeBy ?company ;
        grair:hasAirworthinessDirective ?directive .
  ?company a grair:ManufacturingCompany ;
           grair:asString ?companyString .
  ?directive a grair:AirworthinessDirective ;
             grair:directiveAsString ?directiveString .
}
```

	part	partString	company	companyString	directive	directiveString
1	<http://stko-kwg.geog.uc...	Autoflight	<http://stko-kwg.geog.ucsb.edu/lod/...	2022-25-51	<http://stko-kwg.geog.ucsb.edu/lo...	2022-25-51
2	<http://stko-kwg.geog.uc...	Autoflight	<http://stko-kwg.geog.ucsb.edu/lod/...	Airbus	<http://stko-kwg.geog.ucsb.edu/lo...	2022-25-51
3	<http://stko-kwg.geog.uc...	Autoflight	<http://stko-kwg.geog.ucsb.edu/lod/...	2022-25-51	<http://stko-kwg.geog.ucsb.edu/lo...	2022-25-51
4	<http://stko-kwg.geog.uc...	Autoflight	<http://stko-kwg.geog.ucsb.edu/lod/...	Airbus	<http://stko-kwg.geog.ucsb.edu/lo...	2022-25-51
5	<http://stko-kwg.geog.uc...	CF34-8C and CF34...	<http://stko-kwg.geog.ucsb.edu/lod/...	2021-23-51	<http://stko-kwg.geog.ucsb.edu/lo...	2021-23-51
6	<http://stko-kwg.geog.uc...	CF34-8C and CF34...	<http://stko-kwg.geog.ucsb.edu/lod/...	General Electric ...	<http://stko-kwg.geog.ucsb.edu/lo...	2021-23-51
7	<http://stko-kwg.geog.uc...	Wing Attach Angles	<http://stko-kwg.geog.ucsb.edu/lod/...	2005-12-51	<http://stko-kwg.geog.ucsb.edu/lo...	2005-12-51
8	<http://stko-kwg.geog.uc...	Wing Attach Angles	<http://stko-kwg.geog.ucsb.edu/lod/...	The Boeing Com...	<http://stko-kwg.geog.ucsb.edu/lo...	2005-12-51
9	<http://stko-kwg.geog.uc...	Wing Attach Angles	<http://stko-kwg.geog.ucsb.edu/lod/...	2005-12-51	<http://stko-kwg.geog.ucsb.edu/lo...	2005-12-51
10	<http://stko-kwg.geog.uc...	Wing Attach Angles	<http://stko-kwg.geog.ucsb.edu/lod/...	The Boeing Com...	<http://stko-kwg.geog.ucsb.edu/lo...	2005-12-51
11	<http://stko-kwg.geog.uc...	Wing Attach Angles	<http://stko-kwg.geog.ucsb.edu/lod/...	2005-12-51	<http://stko-kwg.geog.ucsb.edu/lo...	2005-12-51
12	<http://stko-kwg.geog.uc...	Wing Attach Angles	<http://stko-kwg.geog.ucsb.edu/lod/...	The Boeing Com...	<http://stko-kwg.geog.ucsb.edu/lo...	2005-12-51
13	<http://stko-kwg.geog.uc...	Wing Attach Angles	<http://stko-kwg.geog.ucsb.edu/lod/...	2005-12-51	<http://stko-kwg.geog.ucsb.edu/lo...	2005-12-51
14	<http://stko-kwg.geog.uc...	Wing Attach Angles	<http://stko-kwg.geog.ucsb.edu/lod/...	The Boeing Com...	<http://stko-kwg.geog.ucsb.edu/lo...	2005-12-51
15	<http://stko-kwg.geog.uc...	Wing Attach Angles	<http://stko-kwg.geog.ucsb.edu/lod/...	2005-12-51	<http://stko-kwg.geog.ucsb.edu/lo...	2005-12-51
16	<http://stko-kwg.geog.uc...	Wing Attach Angles	<http://stko-kwg.geog.ucsb.edu/lod/...	The Boeing Com...	<http://stko-kwg.geog.ucsb.edu/lo...	2005-12-51
17	<http://stko-kwg.geog.uc...	Wing Attach Angles	<http://stko-kwg.geog.ucsb.edu/lod/...	2005-12-51	<http://stko-kwg.geog.ucsb.edu/lo...	2005-12-51
18	<http://stko-kwg.geog.uc...	Wing Attach Angles	<http://stko-kwg.geog.ucsb.edu/lod/...	The Boeing Com...	<http://stko-kwg.geog.ucsb.edu/lo...	2005-12-51
19	<http://stko-kwg.geog.uc...	Flight Controls	<http://stko-kwg.geog.ucsb.edu/lod/...	2005-05-53	<http://stko-kwg.geog.ucsb.edu/lo...	2005-05-53

All Parts made by a specific company :

```
PREFIX grair:<https://group3/GenericOntology/Airplanes>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX kwgr: <http://stko-kwg.geog.ucsb.edu/lod/resource/>
SELECT ?part ?partString ?company ?companyString
WHERE {
  ?part a grair:Part ;
        grair:partAsString ?partString ;
        grair:isMadeBy ?company ;
        grair:hasAirworthinessDirective ?directive .
  ?company a grair:ManufacturingCompany ;
           grair:asString ?"Airbus SAS"  .

}
```

In this example, all parts made by "Airbus SAS"

	part	partString	company	companyString
1	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part5...	Taperlok Fasteners	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany5...	
2	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part5...	Taperlok Fasteners	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany5...	
3	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part5...	Taperlok Fasteners	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany5...	
4	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part5...	Taperlok Fasteners	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany5...	
5	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part5...	Taperlok Fasteners	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany5...	
6	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part5...	Angle of Attack Prob...	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany5...	
7	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part5...	Angle of Attack Prob...	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany5...	
8	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part5...	Angle of Attack Prob...	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany5...	
9	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part5...	Angle of Attack Prob...	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany5...	
10	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part6...	Angle of Attack Prob...	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany6...	
11	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part6...	Angle of Attack Prob...	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany6...	
12	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part6...	Angle of Attack Prob...	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany6...	
13	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part6...	Angle of Attack Prob...	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany6...	
14	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part6...	Angle of Attack Prob...	<http://stko-kwg.geog.ucsb.edu...	
15	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part6...	Angle of Attack Prob...	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany6...	
16	<http://stko-kwg.geog.ucsb.edu/lod/resource/Part6...	Angle of Attack Prob...	<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany6...	

<http://stko-kwg.geog.ucsb.edu/lod/resource/ManufacuringCompany63>

Most common Plane Models :

```
PREFIX grair:<https://group3/GenericOntology/Airplanes>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX kwgr: <http://stko-kwg.geog.ucsb.edu/lod/resource/>
SELECT ?planeModel (COUNT(?planeModel) AS ?count)
WHERE {
  ?plane grair:isPlaneModelType ?planeModel .
}
GROUP BY ?planeModel
ORDER BY DESC(?count)
LIMIT 10
```

	planeModel	count
1	Douglas DC-3	"334"^^<http://www.w3.org/2001/XMLSchema#integer>
2	de Havilland Canada DHC-6 Twin Otter 300	"81"^^<http://www.w3.org/2001/XMLSchema#integer>
3	Douglas C-47A	"74"^^<http://www.w3.org/2001/XMLSchema#integer>
4	Douglas C-47	"62"^^<http://www.w3.org/2001/XMLSchema#integer>
5	Douglas DC-4	"40"^^<http://www.w3.org/2001/XMLSchema#integer>
6	Yakovlev YAK-40	"37"^^<http://www.w3.org/2001/XMLSchema#integer>
7	Antonov AN-26	"36"^^<http://www.w3.org/2001/XMLSchema#integer>
8	Junkers JU-52/3m	"32"^^<http://www.w3.org/2001/XMLSchema#integer>
9	Douglas C-47B	"29"^^<http://www.w3.org/2001/XMLSchema#integer>
10	De Havilland DH-4	"28"^^<http://www.w3.org/2001/XMLSchema#integer>

The year with the most crashes of type 1 :

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX kwgr: <http://stko-kwg.geog.ucsb.edu/lod/resource/>
SELECT ?year (COUNT(?crash) AS ?count)
WHERE {
  ?crash a grair:CrashType ;
         grair:isCrashOfType "1" ;
         grair:occuredOnDate ?date .
  BIND(SUBSTR(?date, 7, 4) AS ?year)
}
GROUP BY ?year
ORDER BY DESC(?count)
LIMIT 1
```

	year	count
1	1972	"103"^^<http://www.w3.org/2001/XMLSchema#integer>

The number of parts each company makes :

```
PREFIX grair:<https://group3/GenericOntology/Airplanes>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX kwgr: <http://stko-kwg.geog.ucsb.edu/lod/resource/>
SELECT ?partString ?companyString (COUNT(?part) AS ?count)
WHERE {
  ?part a grair:Part ;
        grair:partAsString ?partString ;
        grair:isMadeBy ?company .

  ?company a grair:ManufacturingCompany ;
           grair:asString ?companyString .

  ?company grair:manufactures ?part .
}
GROUP BY ?partString ?companyString
ORDER BY DESC(?count)
```

	partString	companyString	count
1	CF34-8C and CF34-8E Turbofan Engines	General Electric Company	"13"^^<http://www.w3.org/2001/XMLSchema#integer>
2	Aft Rudder Control Rods	Embraer S.A.	"12"^^<http://www.w3.org/2001/XMLSchema#integer>
3	Angle of Attack Probes	Airbus SAS	"11"^^<http://www.w3.org/2001/XMLSchema#integer>
4	737 Pneumatic Motor	The Boeing Company	"9"^^<http://www.w3.org/2001/XMLSchema#integer>
5	Wing Attach Angles	The Boeing Company	"9"^^<http://www.w3.org/2001/XMLSchema#integer>
6	V2522-A5 Turbofan Engine	International Aero Engines AG	"7"^^<http://www.w3.org/2001/XMLSchema#integer>
7	PW4074 Turbofan Engine	Pratt & Whitney Division	"7"^^<http://www.w3.org/2001/XMLSchema#integer>
8	Taperlok Fasteners	Airbus SAS	"5"^^<http://www.w3.org/2001/XMLSchema#integer>
9	Fuel Pump	The Boeing Company	"5"^^<http://www.w3.org/2001/XMLSchema#integer>
10	Principle Wing Structure	Aero Union Corporation	"4"^^<http://www.w3.org/2001/XMLSchema#integer>
11	Flight Controls	Cessna Aircraft	"4"^^<http://www.w3.org/2001/XMLSchema#integer>
12	Wing Structure	Embraer S.A.	"4"^^<http://www.w3.org/2001/XMLSchema#integer>
13	Bob-weight Interconnect Link	Hawker Textron Aviation Inc	"3"^^<http://www.w3.org/2001/XMLSchema#integer>
14	Elevator Control System	Hawker Textron Aviation Inc	"3"^^<http://www.w3.org/2001/XMLSchema#integer>
15	Foreward Spar Fasteners	Hawker Textron Aviation Inc	"3"^^<http://www.w3.org/2001/XMLSchema#integer>
16	Lower Rear Bathtub Fitting	Hawker Textron Aviation Inc	"3"^^<http://www.w3.org/2001/XMLSchema#integer>
17	Rear Spar Fasteners	Hawker Textron Aviation Inc	"3"^^<http://www.w3.org/2001/XMLSchema#integer>
18	Rear Wing Lower Spar Caps	Hawker Textron Aviation Inc	"3"^^<http://www.w3.org/2001/XMLSchema#integer>
19	Operational Program Software	The Boeing Company	"3"^^<http://www.w3.org/2001/XMLSchema#integer>
20	TSO-C172 Cargo Restraint Straps	The Boeing Company	"3"^^<http://www.w3.org/2001/XMLSchema#integer>
21	Lower Wing Panel	328 Support Services GmbH	"2"^^<http://www.w3.org/2001/XMLSchema#integer>

Retrospective

Antrea Christou

I was surprised from the lack of easily accessible information regarding airplanes.

Erin Rogers

Given the amount of paper documentation done for aircraft, it was shocking to find how little had been digitized.

Also, I learned the Boeing 737 is an objectively garbage airplane.

Sydney Woods

It was obvious that the department of transportation is a mess, but I did not realize how much of a mess exists in data for the FAA.