

CS6852 - Theory and Application of Ontologies

Assignment 1 - Group 2

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April 2021

1 Introduction

For the assignment we have chosen "Government System" as our domain and designed ontology for the same. The ontology mainly concentrates on hierarchy of the government officials in India and various relations among them.

2 Concepts

Our ontology consists of the following concepts :

- **People**
 - Consists of all people in the domain universe
- **Voter**
 - Person satisfying certain cutoffs, and can vote in the elections.
- **GovernmentOfficials**
 - This consists of all various officials working in the government
- **PrimeMinister**
 - The person who has majority support in the Lok Sabha

- **LokSabha**
 - Lower House of the Central Government government
- **RajyaSabha**
 - Upper House of the Central Government
- **LokSabhaMPs**
 - Member of Parliament of the Lok Sabha, elected by the people
- **RajyaSabhaMPs**
 - Member of Parliament of the Rajya Sabha, elected by the legislative assemblies of the state
- **Speaker**
 - Speaker for either the Lok Sabha or the Rajya Sabha
- **President**
 - Head of state, elected indirectly by the state and central Parliament houses.
- **Vice-President**
 - Serves as the speaker in the Rajya Sabha, and is elected indirectly by the electoral college
- **CabinetMembers**
 - Key Lok Sabha MPs who head certain important ministries.
- **ChiefMinister**
 - The person who has the majority support in the state Vidhan Sabha
- **VidhanSabha**
 - State Legislative Assembly, the lower house in the State government
- **VidhanParishad**
 - State Legislative Council, the upper house in the State government

- **StateMemberofLegislative Council**
 - Member of the Vidhan Parishad
- **StateMemberofLegislative Assembly**
 - Member of the Vidhan Sabha
- **ParliamentaryHouses**
 - Concept that is the Union of all the parliamentary houses(State and Central)
- **Constituency**
 - Lok Sabha elections have 543 constituencies.

3 Roles

We define a set of Roles, which are binary relations between two concepts defined in the above section.

1. **reportsTo: GovernmentOfficials → GovernmentOfficials**
 - This role identifies which official reports to which official in the hierarchy.
2. **memberOf: GovernmentOfficials → ParliamentHouses**
 - This role is used to identify the house that a particular official belongs to.
3. **canVoteFor: People → GovernmentOfficials**
 - This role is used to identify which person can vote for which official.
4. **heads: GovernmentOfficials → ParliamentHouses**
 - This role is used to identify the heads of each parliament house.
5. **represents: GovernmentOfficials → Constituency**
 - This role is used to identify the constituency in which the particular official presides.

6. **supportsForPm: GovernmentOfficials \rightarrow GovernmentOfficials**

- This role is used to identify the support of government officials to other government officials as a candidate for PrimeMinister.
Example : $\text{supportsForPm}(A, B)$ would mean Government official A supports official B to be PrimeMinister.

7. **supportsForPresident: GovernmentOfficials \rightarrow GovernmentOfficials**

- This role is used to identify the support of government officials to other government officials as a candidate for President. Similar to above role 'supportsForPm'.

8. **hasId: People \rightarrow VoterId**

- This role is used to identify the voter ID of a particular person.

9. **votePersonMap: VoterId \rightarrow People**

- This role is the inverse of HasId, it identifies the person based on the voter ID.

10. **inConstituency: VoterId \rightarrow Constituency**

- This role is used to identify the constituency that a particular voter can vote in given their voter ID.

4 Axioms

With the help of the Roles and Primitive Concepts defined above, we introduce the following Compound Concepts and Subsumptions into the ontology: $\subseteq \sqcup \sqcap \sqsubseteq \equiv$

1. **LokSabhaMPs \sqsubseteq GovernmentOfficials**

- Every Lok Sabha MP is a Government Official.

2. **RajyaSabhaMPs \sqsubseteq GovernmentOfficials**

- Every Rajya Sabha MP is also a Government Official.

3. **Parliament \equiv LokSabha \sqcup RajyaSabha**

- Parliament is composed of both Lok Sabha and the Rajya Sabha

4. **CabinetMembers** \sqsubseteq **LokSabhaMPs** \sqcup **RajyaSabhaMPs**
 - Every Cabinet Member is either a Lok Sabha MP or a Rajya Sabha MP.
5. **CabinetMembers** $\sqsubseteq \exists$ **reportsto.PrimeMinister**
 - Every Cabinet minister reports to the Prime Minister.
6. **LokSabhaMPs** $\sqsubseteq \exists$ **memberOf. LokSabha** $\sqcap \exists$ **canVoteFor. President** $\sqcap \exists$ **canVoteFor. Vice-President** $\sqcap \exists$ **canVoteFor. {om birla}**
 - Every Lok Sabha MP is a member of Lok Sabha and can vote for the President and the Vice President and Om Birla.
7. **RajyaSabhaMPs** $\sqsubseteq \exists$ **memberOf. RajyaSabha** $\sqcap \exists$ **canVoteFor. President** $\sqcap \exists$ **canVoteFor. Vice-President**
 - Every Rajya Sabha MP is a member of Rajya Sabha and can vote for the President and the Vice President .
8. **StateMemberofLegislativeCouncil** \sqsubseteq **memberOf. VidhanParishad**
 - Every State Member of Legislative Council is a member of Vidhan Parishad.
9. **StateMemberofLegislativeAssembly** $\sqsubseteq \exists$ **memberOf. VidhanSabha** $\sqcap \exists$ **canVoteFor. President** $\sqcap \exists$ **canVoteFor. ChiefMinister** $\sqcap \exists$ **canVoteFor. Vice-President**
 - Every State Member of Legislative Assembly is a member of Vidhan Sabha and can vote for the President and the Vice President and Chief Minister.
10. **Speaker** \equiv **{om birla}** \sqcup **Vice-president**
 - Speaker is either Om Birla or the Vice President
11. **Vice-president** \equiv **Speaker** $\sqcap \exists$ **memberOf. RajyaSabha**
 - Vice President is that Speaker who is also a member of Rajya Sabha
12. **PrimeMinister** $\equiv \exists$ (**memberOf. LokSabha** \sqcup **memberOf. RajyaSabha**) $\sqcap \exists$ **heads. Cabinet**

- Prime Minister is either a member of Lok Sabha or a member of Rajya Sabha and head of the Cabinet.
13. **PrimeMinister** $\sqsubseteq \geq 272 \text{ supportsForPm}^- . (\text{RajyaSabhaMPs} \sqcup \text{LokSabhaMPs})$
- Prime Minister should have a support count of atleast 272 from members of Lok Sabha Rajya Sabha combined.
14. **ChiefMinister** $\sqsubseteq \text{StateMemberofLegislativeAssembly} \sqcap \exists \text{ memberOf. VidhanSabha}$
- Chief Minister is a state member of legislative assembly and a member of vidhan Sabha.
15. **President** $\equiv \text{heads.Parliament}$
- President is the head of the Parliament.
16. **President** $\sqsubseteq \geq 390 \text{ supportsForPresident}^- . \text{GovernmentOfficials}$
- President should have the support of atleast 390 of all the Government Officials.
17. **Voter** $\equiv \text{People} \sqcap (=1 \text{ hasId.VoterId}) \sqcap (=1 \text{ votePerson-Map.Person})$
- Voter is a person with a unique Voter-ID i.e Voter has 1 Voter-ID and every Voter-ID corresponds to 1 person
18. **Trans(reportsTo)**
- ReportsTo is a transitive relation
19. **ParliamentHouses** $\equiv \text{LokSabha} \sqcup \text{RajyaSabha} \sqcup \text{VidhanSabha} \sqcup \text{VidhanParishad}$
- A Parliament House is either LokSabha or RajyaSabha or VidhanSabha or VidhanParishad
20. **LokSabhaMPs** $\sqsubseteq \neg \text{RajyaSabhaMPs}$

- Lok Sabha MPs are not Rajya Sabha MPs
- 21. **President** $\sqsubseteq \neg (\text{Lok Sabha MPs} \sqcup \text{Rajya Sabha MPs} \sqcup \text{Speaker})$
 - President is not a Lok Sabha MP, Rajya Sabha MP, or a speaker
- 22. **Vice-President** $\sqsubseteq \neg (\text{Lok Sabha MPs} \sqcup \text{Rajya Sabha MPs})$
 - Vice President is neither a Lok Sabha MP nor a Rajya Sabha MP
- 23. **(Chief Minister \sqcup State Member of Legislative Council \sqcup State Member of Legislative Assembly)** $\sqsubseteq \neg (\text{Lok Sabha MPs} \sqcup \text{Rajya Sabha MPs})$
 - Chief Minister, State Member of Legislative Council, State Member of Legislative Assembly are not Lok Sabha MPs or Rajya Sabha MPs
- 24. **Cabinet Members** $\sqsubseteq \neg (\text{President} \sqcup \text{Vice-President} \sqcup \text{Prime Minister})$
 - Cabinet Members cannot be a President, Vice President or a Prime Minister
- 25. **Speaker** $\sqsubseteq \neg (\text{President} \sqcup \text{Prime Minister} \sqcup \text{State Member of Legislative Council} \sqcup \text{State Member of Legislative Assembly})$
 - Speaker cannot be a President, Prime Minister or State Member of Legislative Council or a State Member of Legislative Assembly
- 26. **Lok Sabha** $\sqsubseteq \neg (\text{Rajya Sabha} \sqcup \text{Vidhan Sabha} \sqcup \text{Vidhan Parishad})$
 - Lok Sabha is not Rajya Sabha or Vidhan Sabha or a Vidhan Parishad
- 27. **Vidhan Sabha** $\sqsubseteq \neg (\text{Vidhan Parishad} \sqcup \text{Lok Sabha} \sqcup \text{Rajya Sabha})$
 - Vidhan Sabha is not Vidhan Parishad or Lok Sabha or Rajya Sabha

28. **StateMemberofLegislativeCouncil** $\sqsubseteq \neg$ (**StateMemberofLegislativeAssembly** \sqcup **RajyaSabhaMPs** \sqcup **LokSabhaMPs**)
 - A State Member of Legislative Council is not State Member of Legislative Assembly, Rajya Sabha MP or a Lok Sabha MP
29. **StateMemberofLegislativeAssembly** $\sqsubseteq \neg$ (**StateMemberofLegislativeCouncil** \sqcup **RajyasabhaMPs** \sqcup **LokSabhaMPs**)
 - A State Member of Legislative Assembly is not State Member of Legislative Council, Rajya Sabha MP or a Lok Sabha MP
30. **ParliamentHouses** $\sqsubseteq \neg$ **People**
 - Parliament Houses are not People
31. **GovernmentOfficials** \sqsubseteq **People**
 - Government Officials are People

5 ALC-Tbox

We put together all the GCIs into the TBox as given below:

1. **LokSabhaMPs** \sqsubseteq **GovernmentOfficials**
2. **RajyaSabhaMPs** \sqsubseteq **GovernmentOfficials**
3. **Parliament** \equiv **LokSabha** \sqcup **RajyaSabha**
4. **CabinetMembers** \sqsubseteq **LokSabhaMPs** \sqcup **RajyaSabhaMPs**
5. **CabinetMembers** $\sqsubseteq \exists$ reportsto. **PrimeMinister**
6. **LokSabhaMPs** $\sqsubseteq \exists$ memberOf. **LokSabha** $\sqcap \exists$ canVoteFor. **President** $\sqcap \exists$ canVoteFor. **Vice-President** $\sqcap \exists$ canVoteFor. {om birla}
7. **RajyaSabhaMPs** $\sqsubseteq \exists$ memberOf. **RajyaSabha** $\sqcap \exists$ canVoteFor. **President** $\sqcap \exists$ canVoteFor. **Vice-President**
8. **StateMemberofLegislativeCouncil** \sqsubseteq memberOf. **VidhanParishad**

9. $\text{StateMemberofLegislativeAssembly} \sqsubseteq \exists \text{ memberOf. VidhanSabha} \sqcap \exists \text{ canVoteFor. President} \sqcap \exists \text{ canVoteFor. ChiefMinister} \sqcap \exists \text{ canVoteFor. Vice-President}$
10. $\text{Speaker} \equiv \{\text{om birla}\} \sqcup \text{Vice-President}$
11. $\text{Vice-President} \equiv \text{Speaker} \sqcap \exists \text{ memberOf. RajyaSabha}$
12. $\text{PrimeMinister} \equiv \exists (\text{memberOf. LokSabha} \sqcup \text{memberOf. RajyaSabha}) \sqcap \exists \text{ heads. Cabinet}$
13. $\text{PrimeMinister} \sqsubseteq \geq 272 \text{ supportsForPm}^{\neg} . (\text{RajyaSabhaMPs} \sqcup \text{LokSabhaMPs})$
14. $\text{ChiefMinister} \sqsubseteq \text{StateMemberofLegislativeAssembly} \sqcap \exists \text{ memberOf. VidhanSabha}$
15. $\text{President} \equiv \text{heads.Parliament}$
16. $\text{President} \sqsubseteq \geq 390 \text{ supportsForPresident}^{\neg} . \text{GovernmentOfficials}$
17. $\text{Voter} \equiv \text{People} \sqcap (=1 \text{ hasId.VoterId}) \sqcap (=1 \text{ votePersonMap.Person})$
18. $\text{Trans}(\text{reportsTo})$
19. $\text{Parliament Houses} \equiv \text{LokSabha} \sqcup \text{RajyaSabha} \sqcup \text{VidhanSabha} \sqcup \text{VidhanParishad}$
20. $\text{LokSabhaMPs} \sqsubseteq \neg \text{RajyaSabhaMPs}$
21. $\text{President} \sqsubseteq \neg (\text{LokSabhaMPs} \sqcup \text{RajyaSabhaMPs} \sqcup \text{Speaker})$
22. $\text{Vice-President} \sqsubseteq \neg (\text{LokSabhaMPs} \sqcup \text{RajyaSabhaMPs})$
23. $(\text{ChiefMinister} \sqcup \text{StateMemberofLegislativeCouncil} \sqcup \text{StateMemberofLegislativeAssembly}) \sqsubseteq \neg (\text{LokSabhaMPs} \sqcup \text{RajyaSabhaMPs})$
24. $\text{Cabinet Members} \sqsubseteq \neg (\text{President} \sqcup \text{Vice-President} \sqcup \text{PrimeMinister})$
25. $\text{Speaker} \sqsubseteq \neg (\text{President} \sqcup \text{PrimeMinister} \sqcup \text{StateMemberofLegislativeCouncil} \sqcup \text{StateMemberofLegislativeAssembly})$
26. $\text{LokSabha} \sqsubseteq \neg (\text{RajyaSabha} \sqcup \text{VidhanSabha} \sqcup \text{VidhanParishad})$
27. $\text{VidhanSabha} \sqsubseteq \neg (\text{VidhanParishad} \sqcup \text{LokSabha} \sqcup \text{RajyaSabha})$

- 28. $\text{StateMemberofLegislativeCouncil} \sqsubseteq \neg (\text{StateMemberofLegislativeAssembly} \sqcup \text{RajyaSabhaMPs} \sqcup \text{LokSabhaMPs})$
- 29. $\text{StateMemberofLegislativeAssembly} \sqsubseteq \neg (\text{StateMemberofLegislativeCouncil} \sqcup \text{RajyaSabhaMPs} \sqcup \text{LokSabhaMPs})$
- 30. $\text{ParliamentHouses} \sqsubseteq \neg \text{People}$
- 31. $\text{GovernmentOfficials} \sqsubseteq \text{People}$

6 Conclusion

Government system of various countries can be systemed in similar manner. The ontology design can further be expanded to include political parties, civil servants like IAS, IPS etc