Problem: Conflicting Data

Large language models (LLMs) often struggle with conflicting data

- **Legal data**
  - similar cases may decide differently
  - different statutes may conflict
- **Medical data**
  - similar medical applications may produces different results in different studies
- **Fact-Checking**
  - different sources may conflict

Solution I: Integrating with CBR

Case-based reasoning (CBR) is a traditional approach to resolve conflicting cases

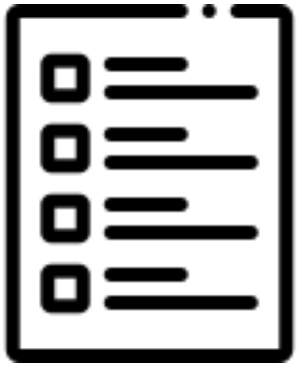
- **analogical reasoning**: why a case is similar to one but distinguish from another ?
- **non-monotonic reasoning**: why an additional factor might oppose the decision ?
- **preferential reasoning**: how a priority of the cases can help handling a new decision ?

ongoing research: Studying LLM abilities of analogical reasoning based on Ashley (2009)

Ashley, K. D. (2009). Ontological requirements for analogical, teleological, and hypothetical legal reasoning. In *Proceedings of the 12th ICAIL* (pp. 1-10).

Solution II: Integrating with Inductive Learning

Inductive Learning is a logical approach to resolve conflicting statutes e.g., Li et al (2013)



Visa Regulations	University Policy
$\mathcal{G}(\mathcal{X},\mathcal{E})$: $\langle \emptyset, \texttt{applyStudentVisa(Student)} \rangle \rightarrow$ {intStudentApplyVisa(Student)} $\mathcal{C}^{\uparrow}(\mathcal{X},\mathcal{E})$: $\langle \{\texttt{person(Student, overseas)}\}, \texttt{acceptOffer(Student)} \rangle \rightarrow$ {obl(applyStudentVisa(Student), arrival(Student), illegalImmigrant(Student)), pow(intStudentApplyVisa(Student)), perm(intStudentApplyVisa(Student))} $\langle \{\texttt{person(Student, overseas)}\}, \texttt{intStudentApplyVisa(Student)} \rangle \rightarrow$ {studentVisa(Student, tier4), perm(work(Student, twenty))} $\mathcal{C}^{\downarrow}(\mathcal{X},\mathcal{E}) = \emptyset$	$\mathcal{G}(\mathcal{X},\mathcal{E})$: $\langle \emptyset, \texttt{applyToStudy(Student, Nationality)} \rangle \rightarrow$ {intApplication(Student)} $\mathcal{C}^{\uparrow}(\mathcal{X},\mathcal{E})$: $\langle \emptyset, \texttt{intApplication(Student)} \rangle \rightarrow$ {obl(sendOfferLetter(Student), startofTerm, invalidOffer)} $\langle \{\texttt{person(Student, Nationality)}\}, \texttt{intApplication(Student)} \rangle \rightarrow$ {offer(Student, Nationality)} $\langle \emptyset, \texttt{sendOfferLetter(Student)} \rangle \rightarrow$ {sendOfferLetter(Student)} $\langle \{\texttt{offer(Student, Nationality)}\}, \texttt{acceptOffer(Student)} \rangle \rightarrow$ {offerConfirmed(Student, Nationality), perm(askStudentShip(Student))} $\langle \{\texttt{availability, askStudentShip(Student)}\}, \texttt{intComp(Promissor, Promisee, ContractID, AgreedFine)} \rangle \rightarrow$ {obl(work(Student, thirty), endOfStudy, withdrawStudentship), perm(work(Student, thirty))} $\mathcal{C}^{\downarrow}(\mathcal{X},\mathcal{E}) = \emptyset$

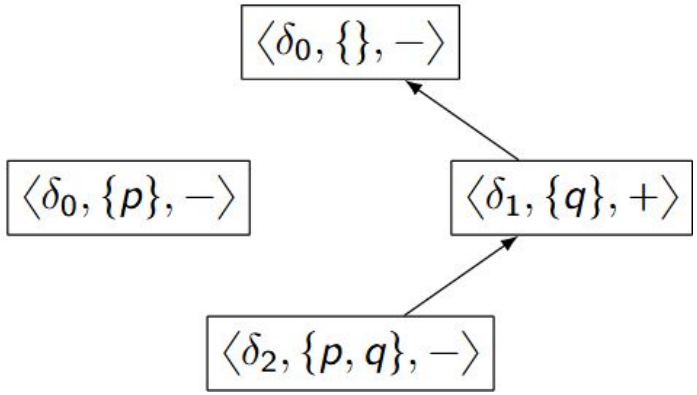
- **logical structure of statutes**: can we represent statutes logically ?
- **ongoing research**: investigating whether LLMs can understand and interpret statutes into logical structures

Li, T., Balke, T., De Vos, M., Padget, J., & Satoh, K. (2013,). A model-based approach to the automatic revision of secondary legislation. In *Proceedings of the fourteenth ICAIL* (pp. 202-206).

Solution III: Integrating with Argumentation

Argumentation framework (Dung 1995) is commonly used in explaining conflicts

$$\delta_0 = \langle \{p \to \neg r\}, \{q \to r\}, \{\neg r\} \rangle$$
$$\delta_1 = \langle \{p \to \neg r\}, \{q \to r\}, \{\} \rangle$$
$$\delta_2 = \langle \{p \to \neg r\}, \{\}, \{\neg r\} \rangle$$
$$\delta_3 = \langle \{p \to \neg r\}, \{\}, \{\} \rangle$$
$$\delta_4 = \langle \{\}, \{q \to r\}, \{\neg r\} \rangle$$
$$\delta_5 = \langle \{\}, \{q \to r\}, \{\} \rangle$$
$$\delta_6 = \langle \{\}, \{\}, \{\neg r\} \rangle$$
$$\delta_7 = \langle \{\}, \{\}, \{\} \rangle$$



- **graphical structures**: how can we define arguments and attacks ?
- **ongoing research**: investigating integration of argumentation framework with LLMs to explain certain types of conflicts

Dung, P. M. (1995). On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games. *Artificial intelligence*, 77(2), 321-357.

Fungwacharakorn, W., Tsushima, K., Hosobe, H., Takeda, H., & Satoh, K. (2024). An Argumentative Approach for Explaining Preemption in Soft-Constraint Based Norms. In *the International Workshop on AI Value Engineering and AI Compliance Mechanisms*. (VECOMP 2024)