Learning How to Correct a Knowledge Base from the Edit History

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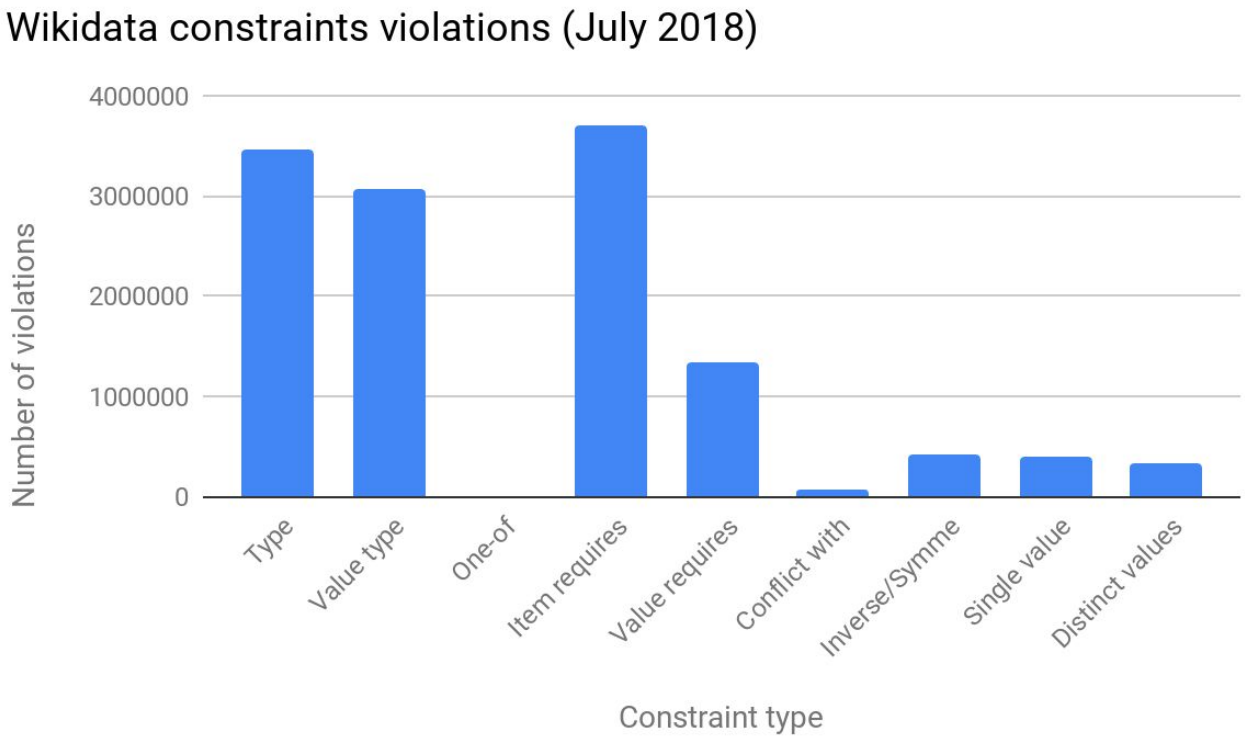
Knowledge bases are kind of messy



KB $\mathcal{K}$ with constraints

1. A-Box $\mathcal{A}$
2. T-Box $\mathcal{T}$
3. Constraints $\mathcal{C}$
   - consistency e.g. Γ: $\exists\, \text{gender}^{-} \sqsubseteq \{\ \text{male, female, nonbinary}\ \}$
   - completeness e.g. Γ: $\exists\, \text{birthPlace} \sqsubseteq \exists\, \text{birthDate}$

Constraints

$\mathcal{K} = (\mathcal{A}, \mathcal{T})$ satisfies a constraint $\Gamma \in \mathcal{C}$ if $\mathcal{I}_{\mathcal{K}} \models \Gamma$

where $\mathcal{I}_{\mathcal{K}}$ is the canonical model of $\mathcal{K}$

Example:

If $\mathcal{A}$ = {Zeus gender male} then $\mathcal{K}$ satisfies Γ_1: $\exists$ gender$^{-} \sqsubseteq$ { male, female, nonbinary }

Constraints as rules

Constraints could be written as UCQ rules

Γ_1: $\exists$ gender^{-} $\sqsubseteq$ { male, female, nonbinary }

Γ_1(x): $\exists$ y gender(y,x) $\rightarrow$ x $\in$ { male, female, nonbinary }

Violations of $\Gamma(\vec{x})$ in $\mathcal{K}$

Minimal subset $\mathcal{V} \subseteq \mathcal{K}$ such that there exists $\vec{a}$ such that $\mathcal{V}$ violates $\Gamma(\vec{a})$ and $\mathcal{K}$ violates $\Gamma(\vec{a})$

Example:

If $\mathcal{A}$ = {gender(Zeus, male), gender(Hera, woman)} then $\mathcal{V}$ ={gender(Hera, woman)} is a violation of Γ_1: $\exists\, \text{gender}^- \sqsubseteq \{\text{ male, female, nonbinary }\}$

Atomic modifications

- Insertion: +{ s2 p2 o2 }
- Deletion: - { s1 p1 o1 }
- Modification: - { s1 p1 o1 } +{ s2 p2 o2 }

Example:

- {Hera gender woman} +{Hera gender female}

Solution of a violation $\mathcal{V}$ of $\Gamma(\vec{a})$ in $\mathcal{K}$

It is an atomic modification $(\mathcal{M}^+, \mathcal{M}^-)$ such that there exists $\mathcal{K}' \subseteq \mathcal{K}$ such that $(\mathcal{V} \cup \mathcal{K}' \cup \mathcal{M}^+) \setminus \mathcal{M}^-$ satisfies $\Gamma(\vec{a})$.

Example:

- {Hera gender woman} +{Hera gender female} is a solution of

$\mathcal{V}$ ={gender(Hera, woman)}

Γ_1: $\exists$ gender$^-$ $\sqsubseteq$ { male, female, nonbinary }

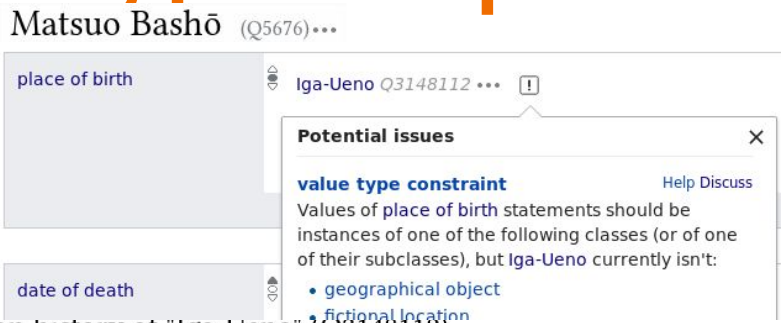
Good solution

We want to make the KB
close to the real world

The edit history of the KB is
a provider of good solutions

The KB edit history provides past corrections

Before:

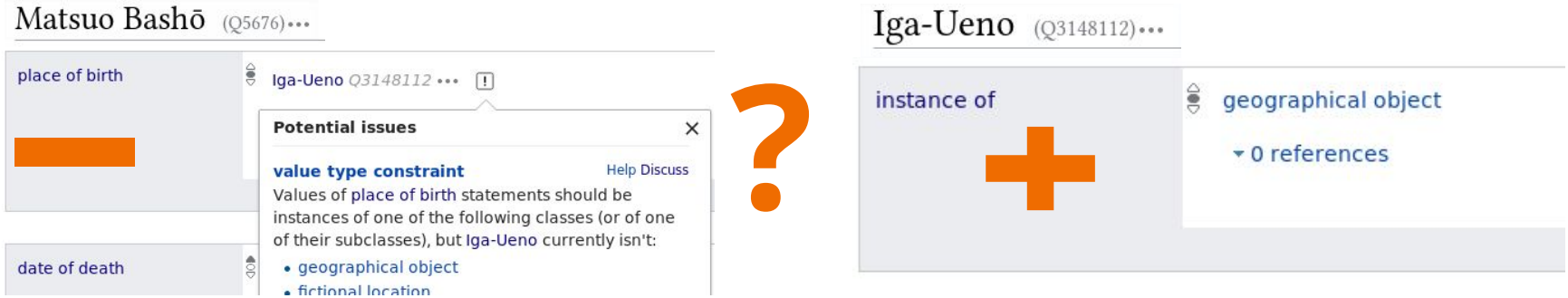


Edit:

After:

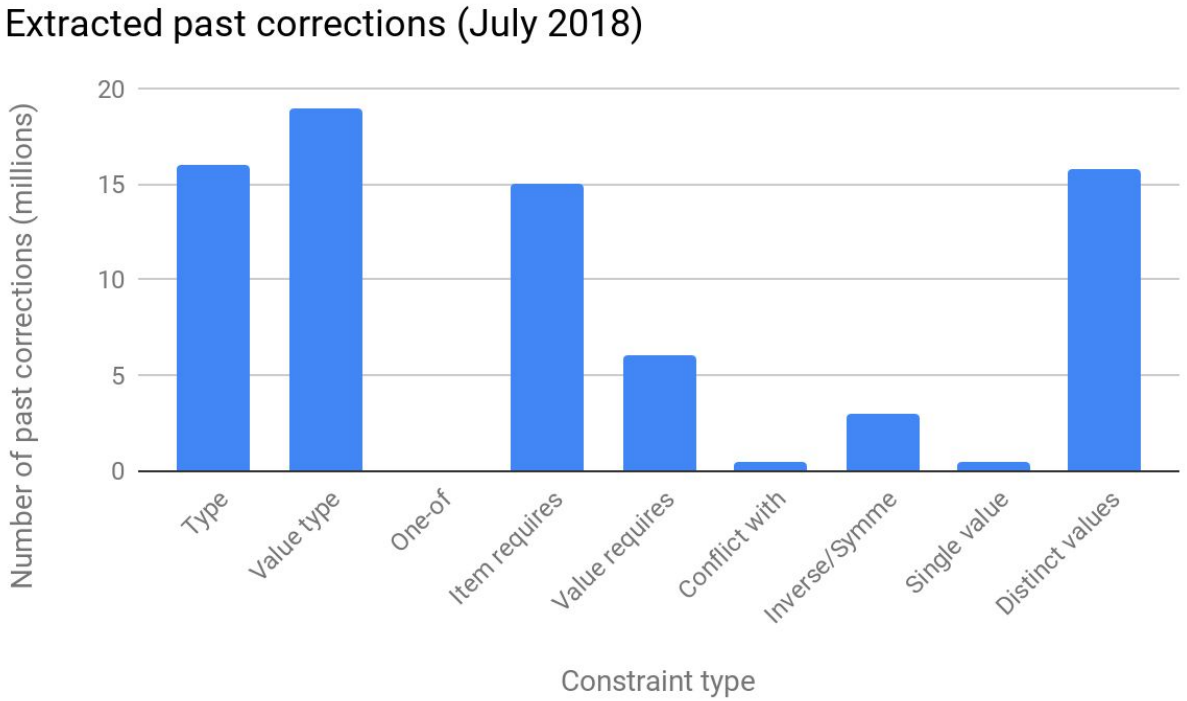
Extracting past corrections

- Solving a violation, two options:



- We look for such edits and check if they correct a violation

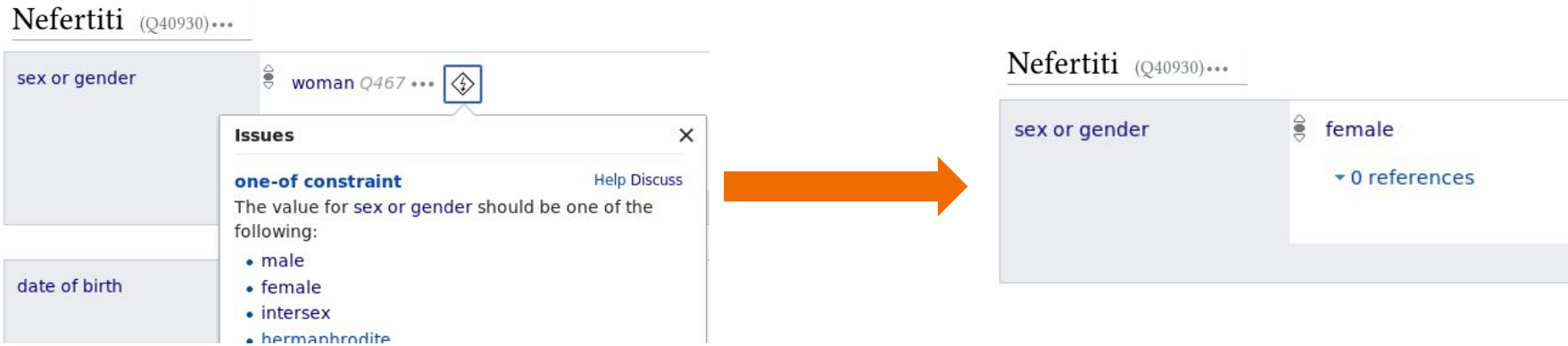
Applied on Wikidata



rev 1223445: placeOfBirth-valueType-violation(wd:MatsuoBashō, wd:Iga-Ueno)
→ +{ wd:Iga-Ueno wdt:type wd:geoObject }

rev 2334569: gender-oneOf-violation(wd:Nefertiti, wd:woman)
→ - { wd:Nefertiti wdt:gender wd:woman } +{ wd:Nefertiti wdt:gender wd:female }

There are patterns for finding the good solutions



$[\Gamma_1(?s, wd:woman)]: \rightarrow$ - { ?s wdt:gender wd:woman }

+{ ?s wdt:gender wd:female }

Why rules?

- Explainable
- Works well with new entities

Mining correction rules

- Start from the past corrections
- Generalize using the KB state at the correction

Using **AMIE** (slightly modified)
and standard confidence

Wikidata evaluation

178k rules mined on 80% of the past corrections

Some top rules:
Single Value:
[gender-singleValue-violation(?s, wd:maleOrganism)] ?s wdt:sportsTeam ?t
→ - { ?s wdt:gender wd:maleOrganism }
One-of :
[mannerOfDeath-oneOf-violation(?s wd:trafficAccident)]
→ - { ?s wdt:mannerOfDeath wd:trafficAccident }
+ { ?s wdt:causeOfDeath wd:trafficAccident }

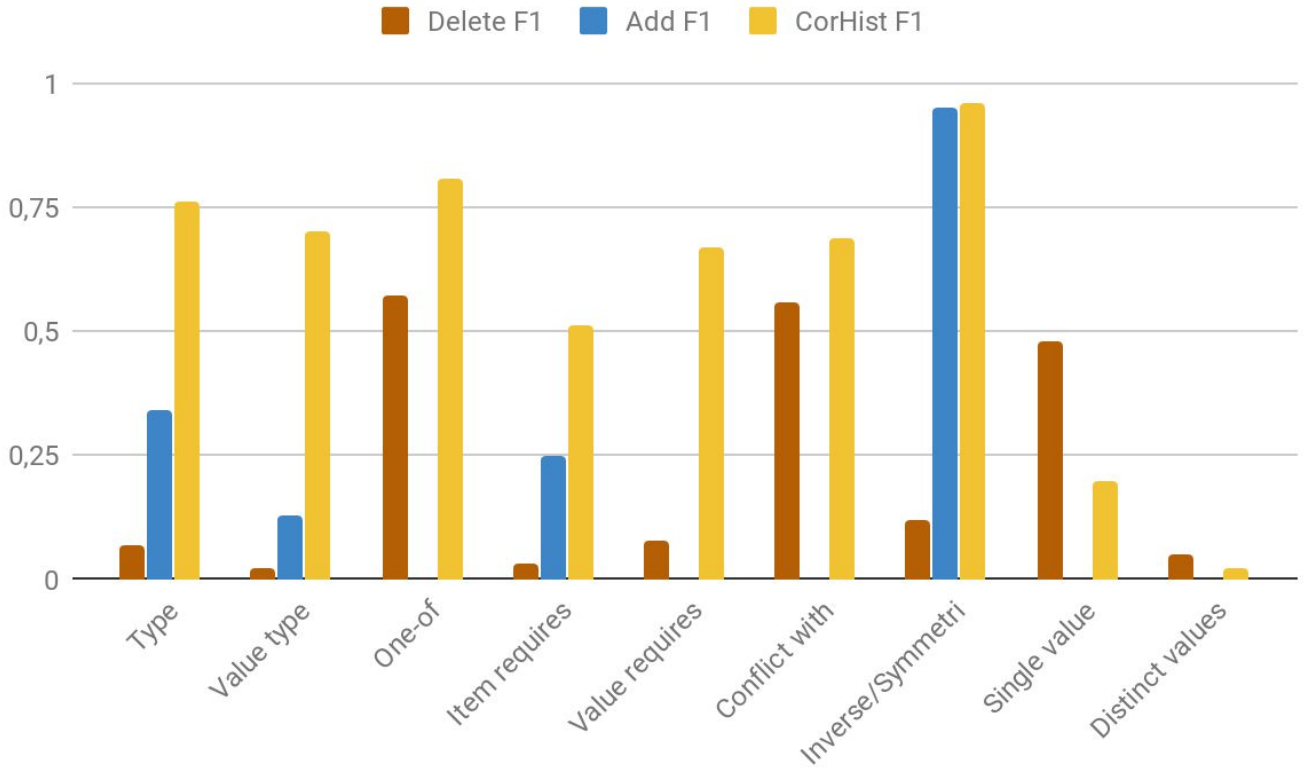
Evaluation on the past corrections (on Wikidata)

- 178k rules mined on 80% of the past corrections
- Apply the rules on the other 20% known corrections
- Compute precision and recall
- Baselines
  - Remove the violation
  - Add the missing triple (if possible)

Wikidata evaluation: Some results

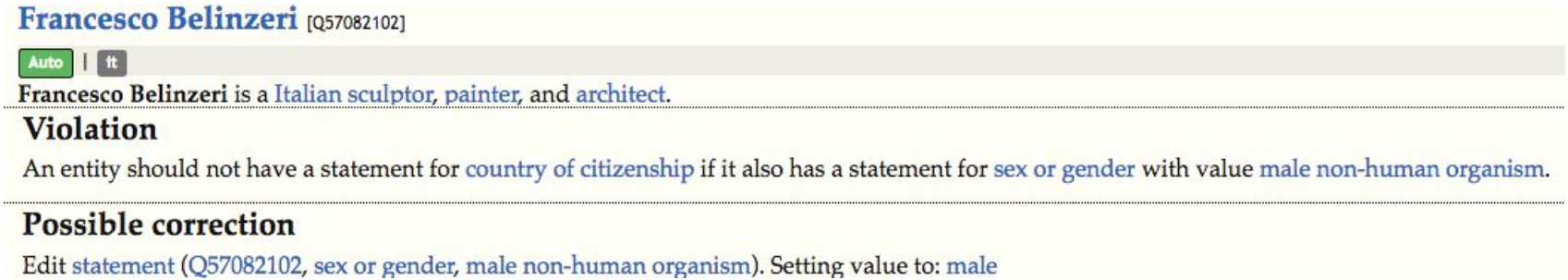
Micro averages

$$F1 = \frac{2 \times precision \times recall}{precision + recall}$$



User evaluation: suggest corrections to Wikidata

- Experiment on three months
- 47 participants
- 50k suggested corrections



User evaluation results

- Inverse/Symmetric: 22k actions, 92% approval
- Value requires statement and Conflicts with: 1k actions each, 80% approval
- Others: between 30 et 700 actions, approval between 20% and 50%

Biased by what has been done (or not) by bots

  - Some huge easy completions
  - Mostly hard stuff remains

Contribution

- Introduction and formalization of the problem of learning corrections from a KB history

- A competitive rule mining approach

Future work

- Interesting problems
  - *There are two birth places*
  - *A birth date is missing*

- Applications
  - Suggest edits
  - Fight vandalism

Thank you!

Paper: https://thomas.pellissier-tanon.fr/papers/2019-WWW-corhist.pdf

Game: https://tools.wmflabs.org/wikidata-game/distributed/#game=43

Dataset: https://doi.org/10.6084/m9.figshare.7712720

Code: https://github.com/Tpt/corhist

Wikidata History SPARQL endpoint: https://wdhqs.wmflabs.org