Explainable AI for Irish grammatical error correction

9 April 2024

Grammatical error correction

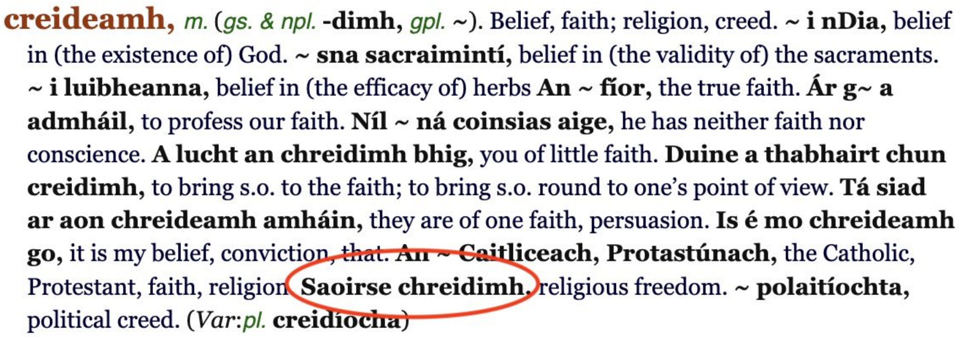
- Task takes a sentence as input, and outputs the sentence with errors corrected
- Easier problem: grammatical error *detection*
- Harder problem: Grammatical error detection/correction plus *explanations*
- Research is mostly on English; small datasets for maybe 20 languages total
- Exceptionally difficult task: F-scores in 50’s/60’s near SOTA for English
- Irish is easier! My old (2003) rule-based system scores comparably

Official Standard(s)

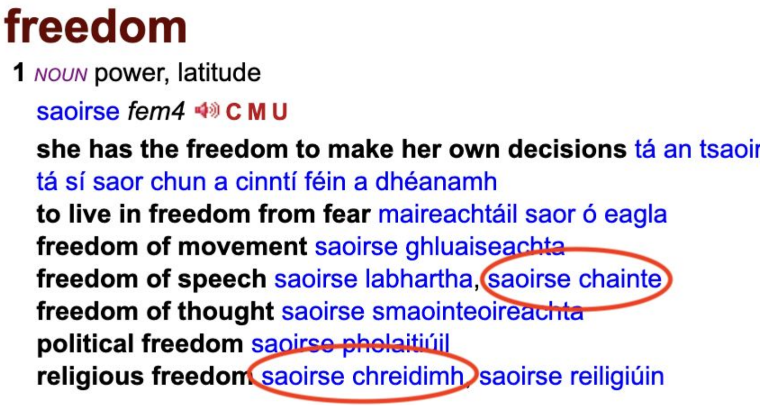
- First version published in 1958, revised in 2012 and then 2017
- Widely adopted, though rarely 100% outside of the most formal writing
- Not fully aligned with existing grammars, textbooks, and dictionaries
- Rules leave quite a bit up to interpretation
- Very little fully-reliable training data available

One problematic example (of dozens)

- “saoirse cainte” or “saoirse chainte”?
- 177M word corpus: “saoirse cainte” 687 times and “saoirse chainte” 28 times
- Similarly, “saoirse creidimh” or “saoirse chreidimh”?
- Same corpus: 85 times vs. 26 times



creideamh, *m.* (*gs. & npl.* **-dimh,** *gpl.* ~). Belief, faith; religion, creed. ~ **i nDia,** belief in (the existence of) God. ~ **sna sacraimintí,** belief in (the validity of) the sacraments. ~ **i luibheanna,** belief in (the efficacy of) herbs **An ~ fíor,** the true faith. **Ár g~ a admháil,** to profess our faith. **Níl ~ ná coinsias aige,** he has neither faith nor conscience. **A lucht an chreidimh bhig,** you of little faith. **Duine a thabhairt chun creidimh,** to bring s.o. to the faith; to bring s.o. round to one's point of view. **Tá siad ar aon chreideamh amháin,** they are of one faith, persuasion. **Is é mo chreideamh go,** it is my belief, conviction, that. **An ~ Caitliceach, Protastúnach,** the Catholic, Protestant, faith, religion. **Saoirse chreidimh,** religious freedom. ~ **polaitíochta,** political creed. (*Var*:*pl.* **creidíocha**)

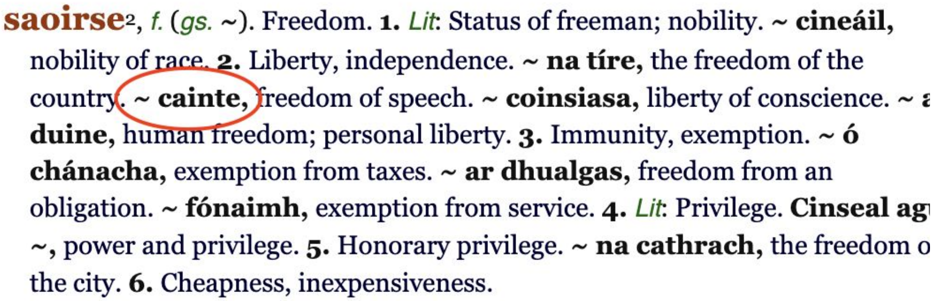


freedom

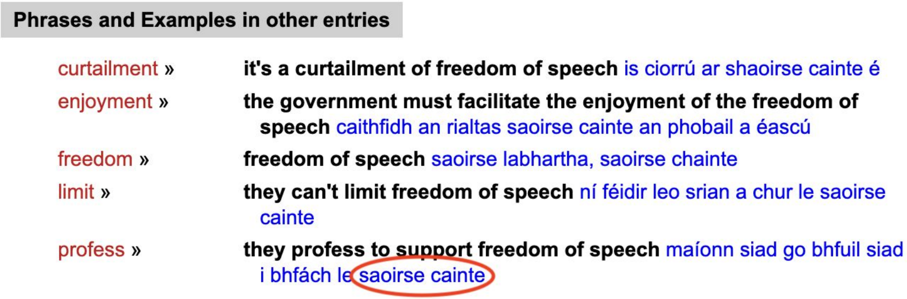
1 *NOUN* power, latitude

saoirse *fem4* C M U

she has the freedom to make her own decisions tá an tsaoir
tá sí saor chun a cinntí féin a dhéanamh
to live in freedom from fear maireachtáil saor ó eagla
freedom of movement saoirse ghluaiseachta
freedom of speech saoirse labhartha, saoirse chainte
freedom of thought saoirse smaointeoireachta
political freedom saoirse pholaitiúil
religious freedom saoirse chreidimh, saoirse reiligiúin



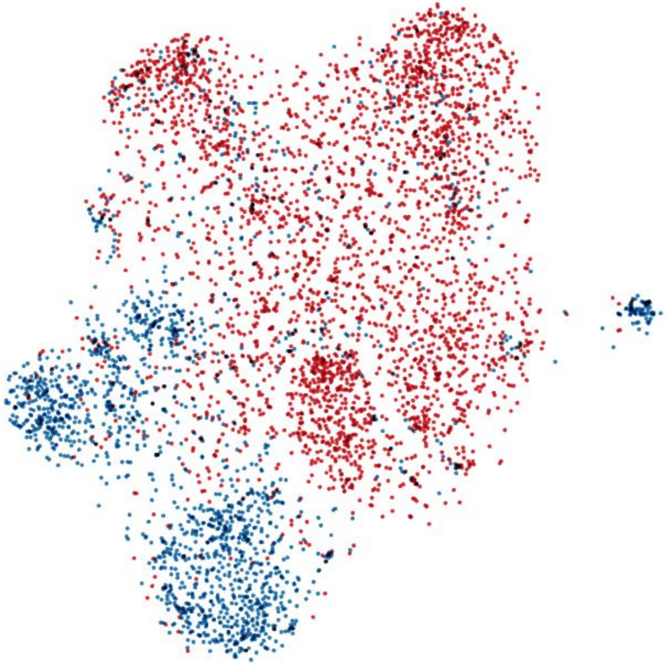
saoirse2, *f.* (*gs.* ~). Freedom. **1.** *Lit*: Status of freeman; nobility. ~ **cineáil,** nobility of race. **2.** Liberty, independence. ~ **na tíre,** the freedom of the country. ~ **cainte,** freedom of speech. ~ **coinsiasa,** liberty of conscience. ~ a **duine,** human freedom; personal liberty. **3.** Immunity, exemption. ~ **ó chánacha,** exemption from taxes. ~ **ar dhualgas,** freedom from an obligation. ~ **fónaimh,** exemption from service. **4.** *Lit*: Privilege. **Cinseal agu** ~**,** power and privilege. **5.** Honorary privilege. ~ **na cathrach,** the freedom o the city. **6.** Cheapness, inexpensiveness.



Phrases and Examples in other entries

curtailment »	**it's a curtailment of freedom of speech** is ciorrú ar shaoirse cainte é
enjoyment »	**the government must facilitate the enjoyment of the freedom of speech** caithfidh an rialtas saoirse cainte an phobail a éascú
freedom »	**freedom of speech** saoirse labhartha, saoirse chainte
limit »	**they can't limit freedom of speech** ní féidir leo srian a chur le saoirse cainte
profess »	**they profess to support freedom of speech** maíonn siad go bhfuil siad i bhfách le saoirse cainte

Unsupervised system (2019)



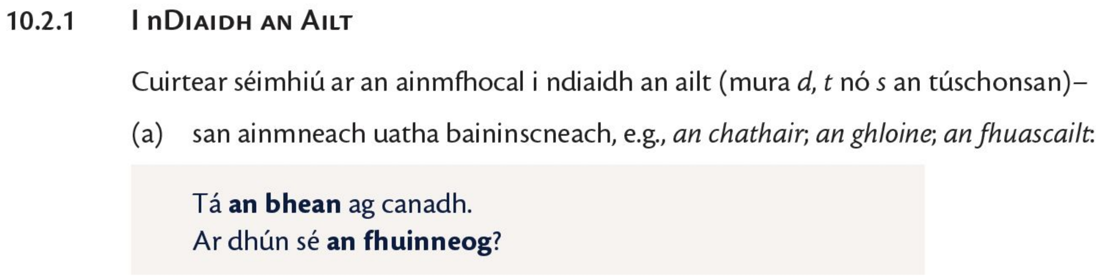
- Focused on predicting correct initial mutation
- Formulate as tagging problem with 5 tags
- LSTM layer(s), BiLSTM at character level
- Unlimited training data
- Achieves much higher accuracy than all previous approaches
- Character-based component learns gender and other relevant features
- Word-based component learns sometimes subtle contextual clues

Critique

- Learns mutations as used by the language community, “errors” included
- Makes some inexplicable mistakes; difficult to debug
- Easy things are easy for it; less effective on the cases humans find difficult
- **No explanations given**

How do we get the explanations back?

- Want to keep it as a tagging problem but with an enhanced set of tags
- Augment each tag with a section of the official standard that “explains” it
- *Tá an bhean/***S+10.2.1** *ag canadh*
- *Tá an doineann/***N+10.2.1.e1** *ag maolú*
- Just need to produce millions of training examples, somehow :/



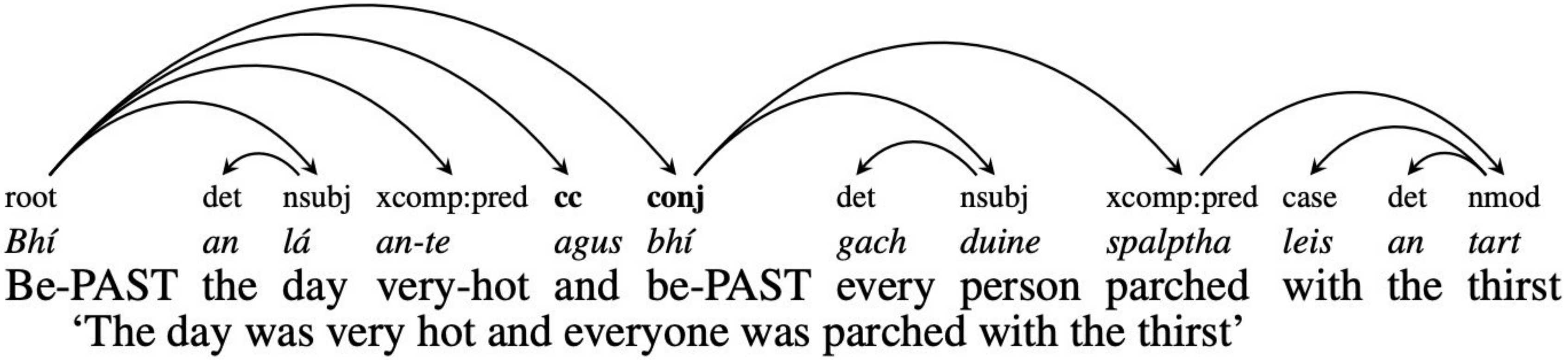
10.2.1 I nDiaidh an Ailt

Cuirtear séimhiú ar an ainmfhocal i ndiaidh an ailt (mura *d, t* nó *s* an túschonsan)–

(a) san ainmneach uatha baininscneach, e.g., *an chathair*; *an ghloine*; *an fhuascailt*:

Tá **an bhean** ag canadh.
Ar dhún sé **an fhuinneog**?

Universal Dependencies



root det nsubj xcomp:pred **cc** **conj** det nsubj xcomp:pred case det nmod

Bhí an lá an-te agus bhí gach duine spalptha leis an tart

Be-PAST the day very-hot and be-PAST every person parched with the thirst

‘The day was very hot and everyone was parched with the thirst’

Figure 4 in *Lynn, Teresa and Foster, Jennifer (2016) Universal dependencies for Irish. In: Second Celtic Language Technology Workshop. (CLTW 2016), 4 July 2016, Paris, France.*

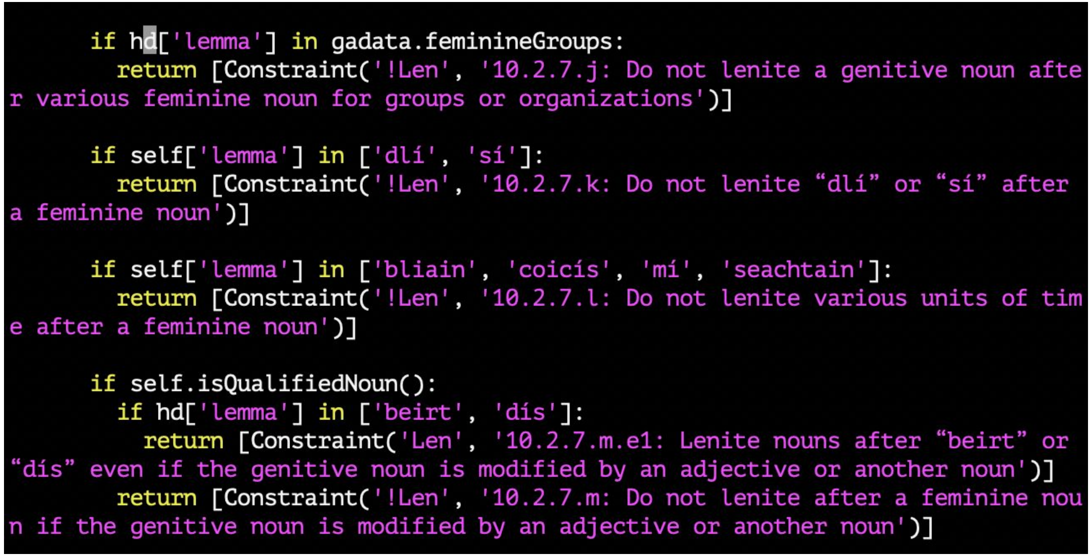
CoNLL-U format (with features)

```
# sent_id = 465
# text = Bhí sí naoi mbliana agus leathchéad.
1       Bhí          bí           VERB     Form=Len|Mood=Ind|Tense=Past               0     root
2       sí           sí           PRON     Gender=Fem|Number=Sing|Person=3            1     nsubj
3       naoi         naoi         NUM      NumType=Card                               4     nummod
4       mbliana      bliain       NOUN     Case=NomAcc|Form=Ecl|Gender=...            1     xcomp:pred
5       agus         agus         CCONJ    _                                          6     cc
6       leathchéad   leathchéad   NOUN     Case=NomAcc|Gender=Masc|Number=Sing        4     conj
7       .            .            PUNCT    _                                          1     punct
```

Feature Prediction

- I developed a suite a QA tools for checking the Irish treebank(s) in 2021
- https://github.com/kscanne/grammatach
- Implements constraints on feature values based on dependency relations
- Refactored this code to parallel the rules in the standard to the extent possible

An Caighdeán Leictreonach

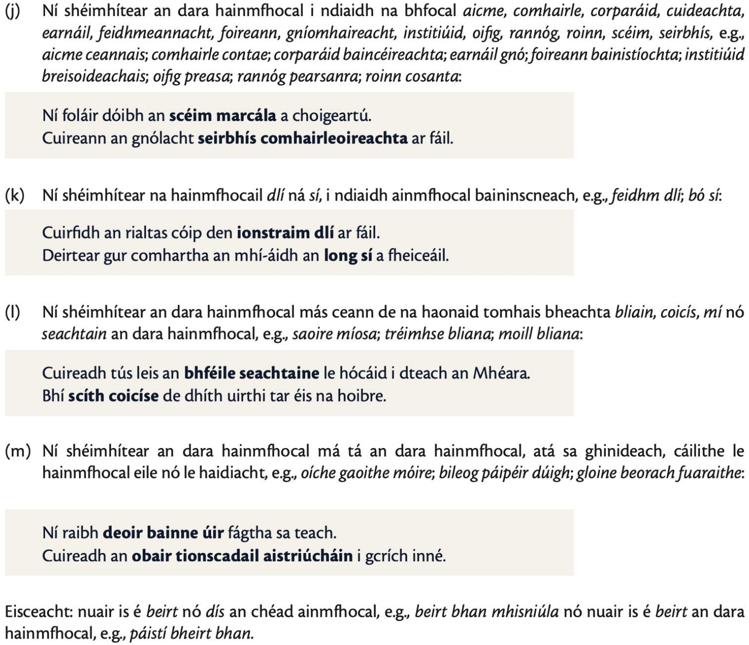


```
      if hd['lemma'] in gadata.feminineGroups:
        return [Constraint('!Len', '10.2.7.j: Do not lenite a genitive noun afte
r various feminine noun for groups or organizations')]

      if self['lemma'] in ['dlí', 'sí']:
        return [Constraint('!Len', '10.2.7.k: Do not lenite “dlí” or “sí” after
a feminine noun')]

      if self['lemma'] in ['bliain', 'coicís', 'mí', 'seachtain']:
        return [Constraint('!Len', '10.2.7.l: Do not lenite various units of tim
e after a feminine noun')]

      if self.isQualifiedNoun():
        if hd['lemma'] in ['beirt', 'dís']:
          return [Constraint('Len', '10.2.7.m.e1: Lenite nouns after “beirt” or
“dís” even if the genitive noun is modified by an adjective or another noun')]
        return [Constraint('!Len', '10.2.7.m: Do not lenite after a feminine nou
n if the genitive noun is modified by an adjective or another noun')]
```



(j) Ní shéimhítear an dara hainmfhocal i ndiaidh na bhfocal *aicme, comhairle, corparáid, cuideachta, earnáil, feidhmeannacht, foireann, gníomhaireacht, institiúid, oifig, rannóg, roinn, scéim, seirbhís,* e.g., *aicme ceannais; comhairle contae; corparáid baincéireachta; earnáil gnó; foireann bainistíochta; institiúid breisoideachais; oifig preasa; rannóg pearsanra; roinn cosanta*:

Ní foláir dóibh an **scéim marcála** a choigeartú.
Cuireann an gnólacht **seirbhís comhairleoireachta** ar fáil.

(k) Ní shéimhítear na hainmfhocail *dlí* ná *sí*, i ndiaidh ainmfhocal baininscneach, e.g., *feidhm dlí; bó sí*:

Cuirfidh an rialtas cóip den **ionstraim dlí** ar fáil.
Deirtear gur comhartha an mhí-áidh an **long sí** a fheiceáil.

(l) Ní shéimhítear an dara hainmfhocal más ceann de na haonaid tomhais bheachta *bliain, coicís, mí* nó *seachtain* an dara hainmfhocal, e.g., *saoire míosa; tréimhse bliana; moill bliana*:

Cuireadh tús leis an **bhféile seachtaine** le hócáid i dteach an Mhéara.
Bhí **scíth coicíse** de dhíth uirthi tar éis na hoibre.

(m) Ní shéimhítear an dara hainmfhocal má tá an dara hainmfhocal, atá sa ghinideach, cáilithe le hainmfhocal eile nó le haidiacht, e.g., *oíche gaoithe móire; bileog páipéir dúigh; gloine beorach fuaraithe*:

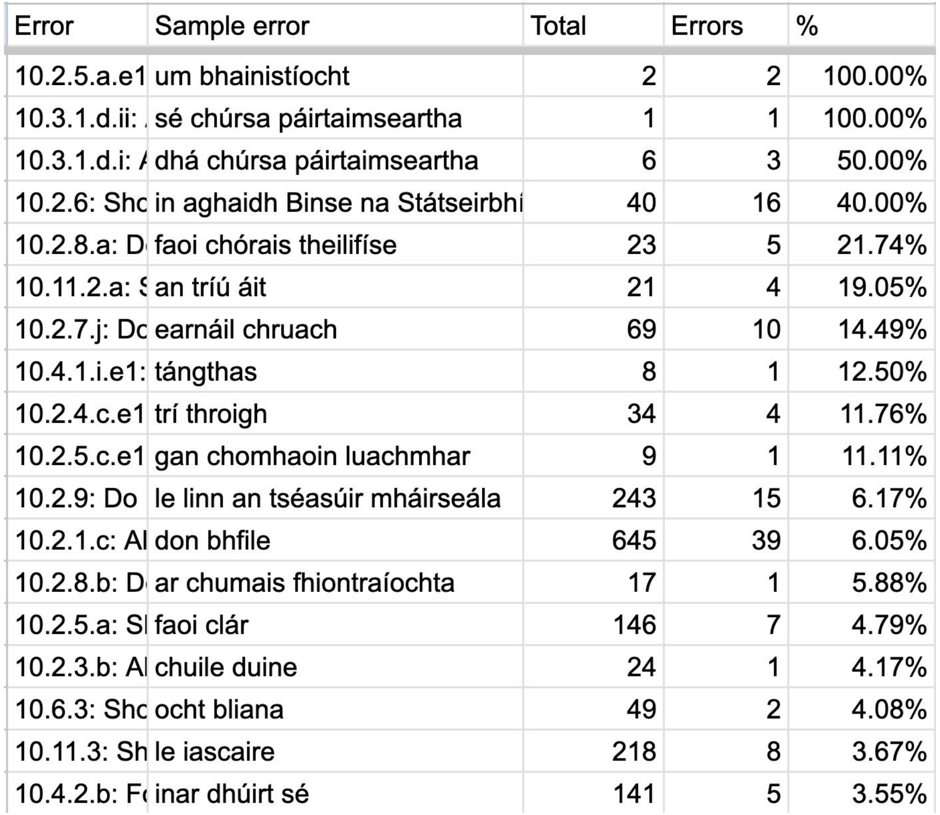
Ní raibh **deoir bainne úir** fágtha sa teach.
Cuireadh an **obair tionscadail aistriúcháin** i gcrích inné.

Eisceacht: nuair is é *beirt* nó *dís* an chéad ainmfhocal, e.g., *beirt bhan mhisniúla* nó nuair is é *beirt* an dara hainmfhocal, e.g., *páistí bheirt bhan.*

Applications

- Improves the Irish treebank, thereby improving parsers/taggers trained on it
- Can be applied to *output* of these parsers/taggers to again resolve problems
- Allows corpus-based survey of adherence to standard, rule-by-rule
- Gives us a tool to generate synthetic training examples for our task

Corpus-level survey of errors



Error	Sample error	Total	Errors	%
10.2.5.a.e1	um bhainistíocht	2	2	100.00%
10.3.1.d.ii: A	sé chúrsa páirtaimseartha	1	1	100.00%
10.3.1.d.i: A	dhá chúrsa páirtaimseartha	6	3	50.00%
10.2.6: Sho	in aghaidh Binse na Státseirbhí	40	16	40.00%
10.2.8.a: D	faoi chórais theilifíse	23	5	21.74%
10.11.2.a: S	an tríú áit	21	4	19.05%
10.2.7.j: Do	earnáil chruach	69	10	14.49%
10.4.1.i.e1:	tángthas	8	1	12.50%
10.2.4.c.e1	trí throigh	34	4	11.76%
10.2.5.c.e1	gan chomhaoin luachmhar	9	1	11.11%
10.2.9: Do	le linn an tséasúir mháirseála	243	15	6.17%
10.2.1.c: Al	don bhfile	645	39	6.05%
10.2.8.b: D	ar chumais fhiontraíochta	17	1	5.88%
10.2.5.a: Sl	faoi clár	146	7	4.79%
10.2.3.b: Al	chuile duine	24	1	4.17%
10.6.3: Sho	ocht bliana	49	2	4.08%
10.11.3: Sh	le iascaire	218	8	3.67%
10.4.2.b: Fo	inar dhúirt sé	141	5	3.55%

Synthetic training data

- Produce dependency parses for sentences in a large corpus
- Ignore tokens with incorrect features according to QA scripts
- (Mix of incorrect parses and corpus examples not compliant with standard)
- Each remaining token is attached to one or more constraints
- Intentionally violate those constraints by changing the mutation and add tag:
    - Correct sentence: *Tá an bhean ag canadh*
    - Constraint on “bhean” requires the S tag with reference 10.2.1
    - Can violate this two ways: *Tá an bean/S+10.2.1 ag canadh*
      Tá an mbean/S+10.2.1 ag canadh

Benefits and future directions

- Neatly handles the issue of non-standard texts in training
- Can oversample rare mutation contexts that the previous model failed on
- Works with any of the UD features (errors in agreement verb tense, etc.)
- Approach should apply neatly to the 4 other Celtic languages with treebanks

Thank you! / Go raibh maith agaibh!

- https://cadhan.com/
- https://github.com/kscanne/