The GF Ecosystem

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Sixth GF Summer School
Stellenbosch 3-14 December 2018
The mission of GF

Formalize the grammars of the world

and make them available for computer applications
The challenge

<table>
<thead>
<tr>
<th>grammars</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD in linguistics</td>
</tr>
<tr>
<td>5 years of work</td>
</tr>
<tr>
<td>limited coverage</td>
</tr>
<tr>
<td>brittle</td>
</tr>
<tr>
<td>obsolete</td>
</tr>
</tbody>
</table>
### The challenge

<table>
<thead>
<tr>
<th>statistics</th>
<th>grammars</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSc in computer science</td>
<td>PhD in linguistics</td>
</tr>
<tr>
<td>5 weeks of waiting</td>
<td>5 years of work</td>
</tr>
<tr>
<td>wide coverage</td>
<td>limited coverage</td>
</tr>
<tr>
<td>robust</td>
<td>brittle</td>
</tr>
<tr>
<td>state of the art</td>
<td>obsolete</td>
</tr>
</tbody>
</table>
programming language
http://www.grammaticalframework.org/

Grammatical Framework
A programming language for multilingual grammar applications

Get started
- Google Tech Talk
- GF Cloud ➔
- Tutorial

Learn more
- The GF Book
- Reference Manual
- Shell Reference
- Best Practices [PDF]

Develop
- Developers Guide
- PGF library API (Haskell runtime)
- PGF library API (C runtime)
- GF compiler API
- Text Editor Support

Contribute
- Mailing List
- Issue Tracker
- Authors
- Summer School

Download GF

RGL Synopsis

GF on GitHub
GF, a functional programming language

Inspirations:

- ALF
- Haskell, ML
- XFST
- compilers

Features

- multilingual
- reversible
- modular

```
lin
    UttS s = s ;
    UttQS s = s ;
    UttNP np = {s = np.s ! Acc} ;
    UttAdv adv = adv ;
    UttImpSg pol imp = {s = pol.s ++ imp.s ! pol.isTrue} ;
UseCl temp pol cl =
    let clt = cl.verb ! pol.isTrue ! temp.isPres
    in { s = pol.s ++ temp.s ++ --- needed for parsing
        clt.subj ++ -- she
        clt.fin ++ -- does
        negation pol.isTrue ++ -- not
        clt.inf ++ -- drink
        clt.compl ++ -- beer
    } ;
```

```
fun
    -- Phrase
    UttS : S -> Utt ;
    UttQS : QS -> Utt ;
    UttNP : NP -> Utt ;
    UttAdv : Adv -> Utt ;
    UttImpSg : Pol -> Imp -> Utt ;
```

```
-- Sentence
    UseCl : Temp -> Pol -> Cl ;
    UseQCl : Temp -> Pol -> QCl ;
    QuestCl : Cl -> QCl ;
    PredVP : NP -> VP -> Cl ;
    ImpVP : VP -> Imp ;
```

```
-- Verb
    UseV : V -> VP ;
    CompLV2 : V2 -> NP -> VP ;
```
Interlingual translation

Diagram showing interlingual translation connections to various languages:
- English
- Dutch
- Chinese
- Catalan
- Bulgarian
- Thai
- Swedish
- Spanish
- Japanese
- Italian
- Hindi
- French
- German

Central node labeled "Interlingua"
Linear scale-up
programming language

theory
Abstract syntax = Logical Framework = Type Theory
Concrete syntax = PMCFG
https://commons.wikimedia.org/wiki/Maps_of_the_world#/media/File:BlankMap-World-noborders.png
RGL = Resource Grammar Library

http://www.grammaticalframework.org/lib/doc/synopsis.html
languages

community

programming language

theory
https://groups.google.com/forum/#!forum/gf-dev
The GF Shell

```
Aarnes-MacBook-Pro:resource aarne$ gf

This is GF version 3.9.
Built on darwin/x86_64 with ghc-8.0, flags: interrupt server
License: see help -license.

Languages:
> i english/MiniLangEng.gf somali/MiniLangSom.gf portuguese/MiniLangPor.gf
- compiling abstract/MiniLang.gf... write file abstract/MiniLang.gfo
- compiling english/MiniLangEng.gf... write file english/MiniLangEng.gfo
- compiling somali/MiniLangSom.gf... write file somali/MiniLangSom.gfo
- compiling portuguese/MiniLangPor.gf... write file portuguese/MiniLangPor.gfo
linking ... OK

Languages: MiniLangEng MiniLangPor MiniLangSom
83 msec

MiniLang> gr -cat=S -tr | l
UseCl TAnt PNeg (PredVP (DetCN aPl_Det (UseN book_N)) (ComplV2 read_V2 (UsePron youPl_Pron)))

books have not read you
uns livros não leem vocês
buugag &+ ma ay idin akhriyaan
```
The GF Cloud

GF Cloud Service

Web Applications

- Minibar (word-completing translation tool)
- Syntax Editor (for building and manipulating abstract syntax trees)
- Translation Quiz
- GF online editor for simple multilingual grammars
- Simple Translation Tool (bilingual document editor)
- Wide Coverage Translation Demo

http://cloud.grammaticalframework.org/
APIs for embedded applications

<table>
<thead>
<tr>
<th>Haskell runtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>C runtime</td>
</tr>
<tr>
<td>- Java bindings</td>
</tr>
<tr>
<td>- Python bindings</td>
</tr>
<tr>
<td>- JavaScript bindings</td>
</tr>
</tbody>
</table>

Android

iOS

**Haskell runtime**

**C runtime**

- Java bindings
- Python bindings
- JavaScript bindings

**Android**

**iOS**

---

Before you use the Python binding you need to import the pgf module.

```python
>>> import pgf
```

Once you have the module imported, you can use the `dir` and `help` functions available in the object:

```python
>>> dir(pgf)
```

`help` is a little bit more advanced and it tries to produce more human readable documentation.

```python
>>> help(pgf)
```

A grammar is loaded by calling the method `readPGF`:

```python
>>> gr = pgf.readPGF("App12.pgf")
```

From the grammar you can query the set of available languages. It is accessible through `pgf.Concr` which represents the language. For example the following will print:

```python
>>> eng = gr.languages["AppEng"]
>>> print(eng)
<pgf.Concr object at 0x7f7d74a471d0>
```

**Parsing**

All language specific services are available as methods of the class `pgf.Concr`.

```python
>>> i = eng.parse("this is a small theatre")
```

This gives you an iterator which can enumerate all possible abstract trees.

```python
>>> p,e = i.next()
```
Controlled Natural Language translation

(a) Parsing English

(b) Linearizing into French

Conceptual authoring

http://www.phrasomatic.net/
Wide-coverage translation

http://cloud.grammaticalframework.org/wc.html
Multilingual concept analysis

9 results for "subject"

<table>
<thead>
<tr>
<th>English</th>
<th>German</th>
<th>French</th>
<th>Italian</th>
<th>Spanish</th>
</tr>
</thead>
<tbody>
<tr>
<td>be subject to X</td>
<td>X unterliegen</td>
<td>être soumise à X</td>
<td>essere sottoposta a X</td>
<td>ser sujeta a X</td>
</tr>
<tr>
<td>be subject to X</td>
<td>X unterstehen</td>
<td>être placée sous les ordres de X</td>
<td>sottostare X</td>
<td>ser sujeta a X</td>
</tr>
<tr>
<td>be subject to X</td>
<td>X unterworfen sein</td>
<td>faire l' objet de X</td>
<td>essere soggiogata a X</td>
<td>ser sujeta a X</td>
</tr>
<tr>
<td>person subject to law</td>
<td>Rechtsunterworfen</td>
<td>justiciable</td>
<td>persona soggetta alla legge</td>
<td>persona sujeta al ley</td>
</tr>
<tr>
<td>subject</td>
<td>betroffen</td>
<td>concerné</td>
<td>soggetto</td>
<td>sujeto</td>
</tr>
<tr>
<td>subject</td>
<td>Gegenstand</td>
<td>sujet</td>
<td>soggetto</td>
<td>objeto</td>
</tr>
<tr>
<td>subject-matter</td>
<td>Gegenstand</td>
<td>objet</td>
<td>oggetto</td>
<td>objeto</td>
</tr>
<tr>
<td>subject to X</td>
<td>vorbehaltlich X</td>
<td>sous réserve de X</td>
<td>soggetto a X</td>
<td>siempre que se den X</td>
</tr>
<tr>
<td>subject to X</td>
<td>fallend unter X</td>
<td>soumis à X</td>
<td>soggetto a X</td>
<td>interesados a X</td>
</tr>
</tbody>
</table>

https://gdprlexicon.com
Natural Language Generation

UpdateOrderCommonChangeInProcessUnit

TSPartialOp

archTrackingData!?: optional ArchTrackingData

order!?: ORDER

archTrackingData!?: nil \Rightarrow wInProcessUnit' = wInProcessUnit
archTrackingData!?: \neq nil
\land (the archTrackingData!?).trackUnit = undefinedUnitId \Rightarrow
wInProcessUnit' = \{order!?:} \& wsInProcessUnit
archTrackingData!?: \neq nil
\land (the archTrackingData!?).trackUnit \neq undefinedUnitId \Rightarrow
wInProcessUnit' = wInProcessUnit \oplus
\{order!?: \mapsto (the archTrackingData!?).trackUnit \}

If the tracking data is not available, then the unit in process will not change.
If the tracking data is available, then

- if the track unit is undefined, then this order is removed from the set of orders in process.
- if the track unit is well-defined, then the order is related to the track unit in the set of orders in process.
Language learning

https://github.com/MUSTE-Project
3.6 Relative Clause

Below are examples of common rules building relative clauses in the GQA grammar. Words belonging to elements of relative clauses are in square brackets:

- who/that/which + verb phrase
  
  WhoVP_recl1 : VPChunk -> RelCl1
  
  Who are the people who [influenced the writers of Evenor]?

- whose + property + is/are + entity
  
  WhosePropIsX_recl1 : Property -> Entity -> RelCl1
  
  What is the city whose [mayor] is [Giorgos Kaminis]?

- whose + property + verb phrase
  
  WhosePropVP_recl1 : Property -> VPChunk -> RelCl1
  
  List the movies whose [director] are born in London.

- where + entity + verb phrase
  
  WhereXVP_recl1 : Entity -> VPChunk -> RelCl1
  
  Where was the battle fought where [2nd Foreign Infantry Regiment] [participated]?

3.7 Complex Entity

Some complex constructions can perform the grammatical functions of entities. The most important of them in the GQA grammar are:

- homogeneous simple entities connected with the conjunction and. They are built through the rule:
  
  EntityAndEntity : Entity -> Entity -> Entity;
  
  so that the corresponding branch of the tree for the question In which team did Dave Bing and Ron Reed started their basketball career? looks like:
  
  EntityAndEntity (twoWordEnt "Dave" "Bing") (twoWordEnt "Ron" "Reed")

- a property of an entity:
  
  PropOfEnt_to_Entity : Property -> Entity -> Entity
  
  What is the alma mater of the successor of F. A. Little, Jr.?
  
  PropOfEnt_to_Entity successor_0 (fourWordEnt "F." "A." "Little," "Jr."

- a simple entity followed by some property:
  
  EntProp_to_Entity : Entity -> Property -> Entity
  
  Name Ivanpah Solar power facility owner.
  
  EntProp_to_Entity (fourWordEnt "Ivanpah" "Solar" "power" "facility") owner_0.

- a class with a relative clause:
  
  Class_to_Entity : ClassChunk -> RelCl1 -> Entity
Dialogue systems

Digital Grammars provides multilingual machine translation that is specialised, explainable and dependable.

https://www.digitalgrammars.com/
Text robots for e-commerce. Product descriptions, category pages and personalised marketing.

https://www.textual.se/
Talkamatic develops conversational interfaces integrating voice, chat-bots, GUI, or any other sensory system or IoT input and output.

Our TDM™ system delivers advanced natural dialogue with multiple language support. We can take dialogue interfaces far beyond any other commercially available system.

TDM can be integrated into currently available systems such as Amazon Alexa, Google Assistant, Microsoft Cortana etc. to enable faster and and more cost effective development of conversational interfaces and digital assistants.

Our development is led by Staffan Larsson, Professor in Computational Linguistics at the University of Gothenburg, ensuring us to stay in the forefront of research in any area related to dialogue based human-computer interaction.

We can help you either you are completely new to the area or already have realized the limits of other solutions on the market and appreciate the challenge in creating a well functioning dialogue between humans and computers. Our consultancy services include development for any existing platform in speech or chat, as well as strategic services, research, and development.

http://www.talkamatic.se/
Create conversational agents for dialogues that matter. Build for any use case or channel with the Mercury.ai end-to-end enterprise-grade chatbot platform. Connect to your data, your people and your third party services. In the cloud or on-premises. Measure and analyze your agents performance and your customers voice. Compliant to European standards. Build and iterate maintainable bots with our user friendly Conversation Creator. Unit test in dev - A/B test in live. Get the user right with the Mercury.ai hybrid Natural Language Understanding component. Quick and precise.

Build bots instead of Apps and utilize contextual knowledge over complete dialogues.

Use conversational AI to power your customer support

Enhance your products with conversational interfaces

https://www.mercury.ai/#services
https://galois.com/ technology for systems where failure is unacceptable

https://www.lingsoft.fi full-service language management company

https://www.ontotext.com/ semantic technology developer

https://www.altran.com/ world leader in engineering solutions and R&D

https://signatu.com/ support digital businesses in a legal, transparent and secure manner

http://www.lexcogitans.com/ help lawyers analyze complex legal logic
Precision vs. coverage

- **GF**
  - Precision: 100%
  - Coverage: 100

- **Google, Bing, etc.**
  - Precision: 20%
  - Coverage: 1,000,000 concepts
Producer vs. consumer

- **Precision** (BLEU)
  - 100%
  - 20%

- **Coverage**
  - Producer tasks
  - Consumer tasks
  - 1,000,000 concepts
Business vs. research

- Precision (BLEU)
  - 100%
  - 20%

- Coverage
  - 100
  - 1,000
  - 1,000,000 concepts

- Business
- Research
Graceful degradation

![Graph showing graceful degradation with H-BLEU on the y-axis and coverage on the x-axis, with precision values of 95, 75, 50, 35, and 25.]
GF + black box machine learning

neural parsing

interlingua tree

grammar-based generation

Mitt
mamma
inte
svensk

学习翻译规则
Data augmentation with grammar

neural translation

This looks good.

Das sieht gut aus.

parsing

grammar-based generation
programming language

companies

applications

languages

community

theory

research

interfaces to other formats

tools
<table>
<thead>
<tr>
<th>Function</th>
<th>Signature</th>
<th>Tokens</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>deliver_2_V</td>
<td>V</td>
<td>-- 01440941-v</td>
<td>[unchecked, post] bring to a conclusion</td>
</tr>
<tr>
<td>deliver_4_V</td>
<td>V</td>
<td>-- 02556841-v</td>
<td>[unchecked] free from harm or injury</td>
</tr>
<tr>
<td>deliver_8_V</td>
<td>V</td>
<td>-- 02557299-v</td>
<td>[unchecked, religion] save from harm or injury</td>
</tr>
<tr>
<td>deliver_1_V2</td>
<td>V2</td>
<td>-- 00991634-v</td>
<td>[unchecked] deliver (a speech, a message, a lecture)</td>
</tr>
<tr>
<td>deliver_3_V2</td>
<td>V2</td>
<td>-- 02298282-v</td>
<td>[unchecked] to surrender something</td>
</tr>
<tr>
<td>deliver_4_V2</td>
<td>V2</td>
<td>-- 02556841-v</td>
<td>[unchecked] free from harm or injury</td>
</tr>
<tr>
<td>deliver_5_V2</td>
<td>V2</td>
<td>-- 02509014-v</td>
<td>[unchecked] hand over to the authority</td>
</tr>
<tr>
<td>deliver_6_V2</td>
<td>V2</td>
<td>-- 01064275-v</td>
<td>[unchecked, law] pass down; &quot;disperse&quot;</td>
</tr>
<tr>
<td>deliver_7_V2</td>
<td>V2</td>
<td>-- 00991901-v</td>
<td>[unchecked] utter (an exclamation)</td>
</tr>
<tr>
<td>deliver_8_V2</td>
<td>V2</td>
<td>-- 02557299-v</td>
<td>[unchecked, religion] save from harm or injury</td>
</tr>
<tr>
<td>deliver_9_V2</td>
<td>V2</td>
<td>-- 02363326-v</td>
<td>[unchecked] carry out or perform</td>
</tr>
<tr>
<td>deliver_10_V2</td>
<td>V2</td>
<td>-- 02240011-v</td>
<td>[unchecked] relinquish possession</td>
</tr>
<tr>
<td>deliver_11_V2</td>
<td>V2</td>
<td>-- 01511711-v</td>
<td>[unchecked] throw or hurl from one place to another</td>
</tr>
<tr>
<td>deliver_12_V2</td>
<td>V2</td>
<td>-- 00056644-v</td>
<td>[unchecked, animals, biology]</td>
</tr>
<tr>
<td>deliverable_A</td>
<td>A</td>
<td>-- 02721174-a</td>
<td>[unchecked] suitable for or relevant to</td>
</tr>
<tr>
<td>deliverable_N</td>
<td>N</td>
<td>-- 03178402-n</td>
<td>[unchecked] something that can be delivered</td>
</tr>
<tr>
<td>deliverance_N</td>
<td>N</td>
<td>-- 00094303-n</td>
<td>[unchecked] recovery or preservation</td>
</tr>
<tr>
<td>deliverer_1_N</td>
<td>N</td>
<td>-- 11103646-n</td>
<td>[unchecked, religion] a teacher</td>
</tr>
<tr>
<td>deliverer_2_N</td>
<td>N</td>
<td>-- 10573233-n</td>
<td>[unchecked, person] a person who delivers something</td>
</tr>
<tr>
<td>deliverer_3_N</td>
<td>N</td>
<td>-- 10020810-n</td>
<td>[unchecked, commerce, person]</td>
</tr>
<tr>
<td>deliverer_4_N</td>
<td>N</td>
<td>-- 10020651-n</td>
<td>[unchecked, economy] a person who delivers something</td>
</tr>
<tr>
<td>delivery_1_N</td>
<td>N</td>
<td>-- 00318033-n</td>
<td>[unchecked, commerce] the act of delivering something</td>
</tr>
<tr>
<td>delivery_2_N</td>
<td>N</td>
<td>-- 07335222-n</td>
<td>[unchecked] the event of giving something to someone</td>
</tr>
<tr>
<td>delivery_3_N</td>
<td>N</td>
<td>-- 07085523-n</td>
<td>[unchecked, art, linguistics]</td>
</tr>
<tr>
<td>delivery_4_N</td>
<td>N</td>
<td>-- 01110658-n</td>
<td>[unchecked, economy] the volume of something delivered</td>
</tr>
<tr>
<td>delivery_5_N</td>
<td>N</td>
<td>-- 00107092-n</td>
<td>[unchecked, baseball] the act of delivering a ball</td>
</tr>
<tr>
<td>delivery_6_N</td>
<td>N</td>
<td>-- 00094303-n</td>
<td>[unchecked] recovery or preservation</td>
</tr>
<tr>
<td>delivery_7_N</td>
<td>N</td>
<td>-- 00043279-n</td>
<td>[unchecked, anatomy, medicine]</td>
</tr>
</tbody>
</table>

[https://github.com/GrammaticalFramework/gf-wordnet](https://github.com/GrammaticalFramework/gf-wordnet)
<table>
<thead>
<tr>
<th>Verb</th>
<th>Voice</th>
<th>Arguments</th>
<th>Freq.</th>
<th>Verb</th>
<th>Voice</th>
<th>Arguments</th>
<th>Freq.</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2</td>
<td>Act</td>
<td>NP_{doj} NP_{msubj}</td>
<td>277</td>
<td>V</td>
<td>Act</td>
<td>Adv NP_{msubj}</td>
<td>155</td>
</tr>
<tr>
<td>V2</td>
<td>Pass</td>
<td>NP_{msubjpass}</td>
<td>84</td>
<td>V3</td>
<td>Act</td>
<td>NP_{doj} NP_{msubj}</td>
<td>2</td>
</tr>
<tr>
<td>V2</td>
<td>Act</td>
<td>Adv NP_{doj} NP_{msubj}</td>
<td>80</td>
<td>VQ</td>
<td>Act</td>
<td>QS</td>
<td>2</td>
</tr>
<tr>
<td>V</td>
<td>Act</td>
<td>NP_{msubj}</td>
<td>78</td>
<td>VS</td>
<td>Act</td>
<td>Adv NP_{msubj} S</td>
<td>2</td>
</tr>
<tr>
<td>V2</td>
<td>Pass</td>
<td>Adv NP_{msubjpass}</td>
<td>34</td>
<td>V2</td>
<td>Pass</td>
<td>Adv NP_{doj} NP_{msubjpass}</td>
<td>2</td>
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<tr>
<td>VS</td>
<td>Act</td>
<td>NP_{msubj} S</td>
<td>29</td>
<td>V2</td>
<td>Pass</td>
<td>NP_{doj}</td>
<td>2</td>
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<tr>
<td>VV</td>
<td>Act</td>
<td>NP_{msubj} VP</td>
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<td>V2</td>
<td>Pass</td>
<td>NP_{msubjpass}</td>
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<td>V2</td>
<td>Act</td>
<td>NP_{doj}</td>
<td>17</td>
<td>V2S</td>
<td>Act</td>
<td>NP_{doj} NP_{msubj} S</td>
<td>1</td>
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<td>V</td>
<td>Act</td>
<td>Adv Adv NP_{msubj}</td>
<td>16</td>
<td>V2S</td>
<td>Act</td>
<td>NP_{doj} S</td>
<td>1</td>
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<td>VQ</td>
<td>Act</td>
<td>NP_{msubj} QS</td>
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<td>Act</td>
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<td>V2</td>
<td>Act</td>
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<td>VS</td>
<td>Act</td>
<td>S</td>
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<td>Adv</td>
<td>8</td>
<td>VV</td>
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<td>VP</td>
<td>1</td>
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<tr>
<td>V2V</td>
<td>Act</td>
<td>NP_{doj} NP_{msubj} VP</td>
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<td>V2</td>
<td>Pass</td>
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<tr>
<td>VS</td>
<td>Pass</td>
<td>NP_{msubjpass} S</td>
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<td>V5</td>
<td>Pass</td>
<td>NP_{msubjpass} S</td>
<td>1</td>
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</tbody>
</table>

Table 8 Syntactic valence patterns underlying the shared semantico-syntactic patterns. The order of arguments (FEs) is not taken into account.

The remaining less than 7% of the shared frame functions represent the use of other verb types – VS, VQ, V2V, V3 and V2S – for which the respective RGL constructors are applied:

-mkVP : VS → S → VP
[|I|Cognizer/NP do |REMEMBER|V5 [we did a few gigs]|Content/S

-mkVP : VQ → QS → VP
[he|Cognizer/NP |RECOGNIZED|V5 [where he was]|Phenomenon/QS

-mkVP : V2V → NP → VP → VP
[you|Speaker/NP specifically |REQUEST|V2V |me|Addressee/NP [to do so]|Message/VP

-mkVP : V3 → NP → NP → VP
[you|Agent/NP |DENIED|V3 [her]|Protagonist/NP [any life of her own]|State_of_affairs/NP

-mkVP : V2S → NP → S → VP
[he|Speaker/NP |PERSUADED|V2S [himself]|Addressee/NP [that they helped]|Content/S

Abstract Meaning Representations (AMR)

RIGOTRIO at SemEval-2017 Task 9: Combining Machine Learning and Grammar Engineering for AMR Parsing and Generation

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http://aclweb.org/anthology/S17-2159
Universal Dependencies (UD)

UD treebank data augmentation
Xerox LEXC

Lexicon> pg -lexc -lang=Swa

Multichar_Symbols
+SG +(VPast +g11_10 +AN +P3) +g11_6 +g11 +g9_10 +g7_8
VFut +Pl +Super1 +AA +(AF +IN) +Compar +Posit +(VImper

LEXICON Root
enemy_N+SG:adui #

swell_V+(VPast+SG+g11_10+AN+P3):alifura #
swell_V+(VPast+SG+g11_6+AN+P3):alifura #
swell_V+(VPast+SG+g11+AN+P3):alifura #
swell_V+(VPast+SG+g9_10+AN+P3):alifura #
swell_V+(VPast+SG+g7_8+AN+P3):alifura #
swell_V+(VPast+SG+g6+AN+P3):alifura #
swell_V+(VPast+SG+g5a_6+AN+P3):alifura #
swell_V+(VPast+SG+g5_6+AN+P3):alifura #
swell_V+(VPast+SG+g3_4+AN+P3):alifura #
swell_V+(VPast+SG+g1_2+IN+P3):alifura #
swell_V+(VPast+SG+g1_2+IN+P2):alifura #
swell_V+(VPast+SG+g1_2+IN+P1):alifura #
come_V+(VPast+SG+g11_10+AN+P3):alikuja #
come_V+(VPast+SG+g11_6+AN+P3):alikuja #
come_V+(VPast+SG+g11+AN+P3):alikuja #
come_V+(VPast+SG+g9_10+AN+P3):alikuja #
come_V+(VPast+SG+g7_8+AN+P3):alikuja #
come_V+(VPast+SG+g6+AN+P3):alikuja #
come_V+(VPast+SG+g5a_6+AN+P3):alikuja #
come_V+(VPast+SG+g5_6+AN+P3):alikuja #

Speech recognition formats
Grammatical Framework

Grammatical Framework (GF) is a special-purpose functional language for defining grammars. It uses a Logical Framework (LF) for a description of abstract syntax, and adds to this a notation for defining concrete syntax. GF grammars themselves are purely declarative ...

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- Source: [http://www.grammaticalframework.org/lib/src/romanian](http://www.grammaticalframework.org/lib/src/romanian) (Ramona Enache)

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- Publications

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Gothenburg, Sweden, 2009

Barcelona, Catalonia, 2011

Frauenchiemsee, Bavaria, 2013

Marsalforn, Gozo, Malta, 2015

Riga, Latvia, 2017
Sixth GF Summer School 2018

Stellenbosch, South Africa
3rd–14th December 2018
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