Chinese in the Grammatical Framework

What There is and What You Can Do

Aarne Ranta

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digital Grammars
Language technology to rely on.

What is GF?

What can you do with GF?

What is there for Chinese?

What is special about Chinese?

What can you do?

How to get started?

What is GF?

The mission of GF is

- to formalize the grammars of the world
- to make them usable in computer applications

What is GF?

1 . Grammar formalism

Example: context-free grammars

```
S  ::= NP VP
VP ::= TV NP
TV ::= “love”
NP ::= “I”
NP ::= “you”
```

GF enables this but is more powerful.

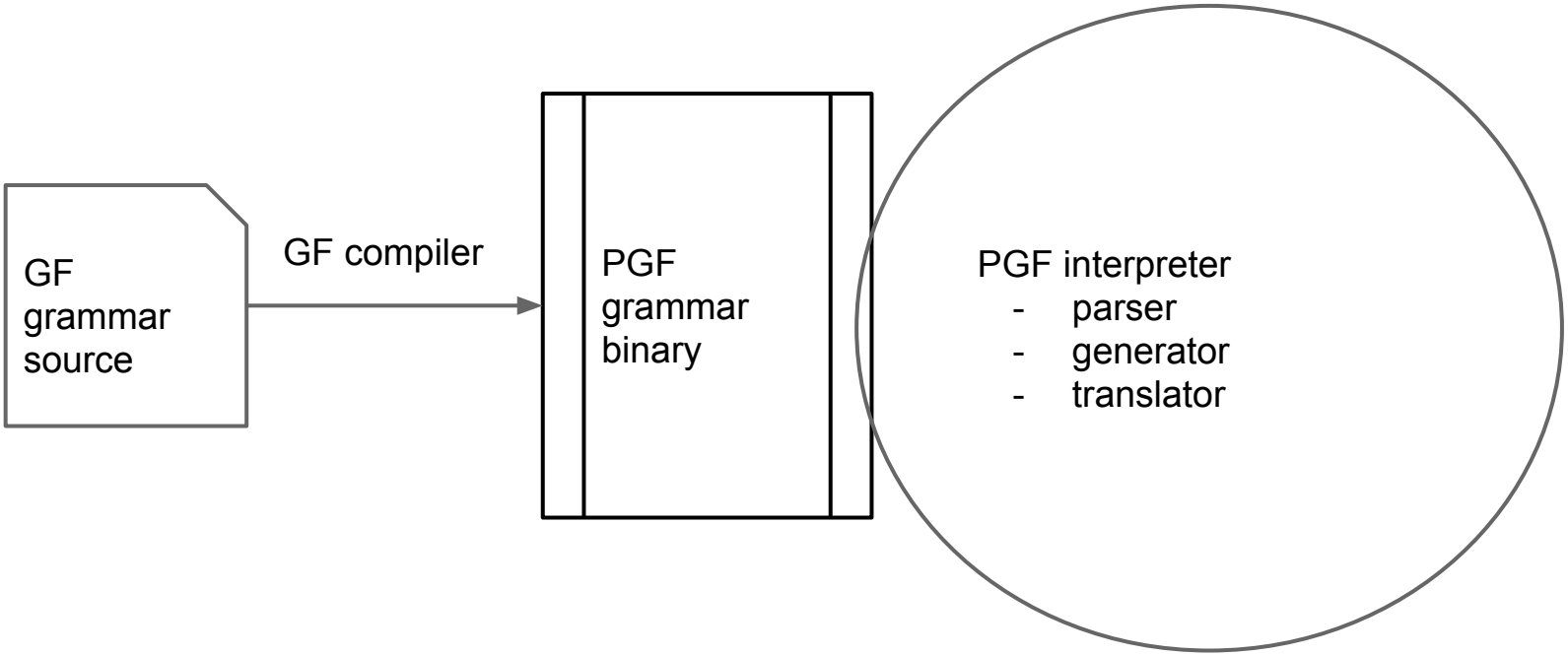
Programming language for writing grammars

```
abstract Foods = {

  flags startcat = Comment ;
  cat
    Comment ; Item ; Kind ; Quality ;
  fun
    Pred : Item -> Quality -> Comment ;
    This, That, These, Those : Kind -> Item ;
    Mod : Quality -> Kind -> Kind ;
    Wine, Cheese, Fish, Pizza : Kind ;
    Very : Quality -> Quality ;
    Fresh, Warm, Italian,
      Expensive, Delicious, Boring : Quality ;
}
```

```
concrete FoodsEng of Foods = {
  flags language = en_US;
  lincat
    Comment, Quality = {s : Str} ;
    Kind = {s : Number => Str} ;
    Item = {s : Str ; n : Number} ;
  lin
    Pred item quality =
      {s = item.s ++ copula ! item.n ++ quality.s} ;
    This  = det Sg "this" ;
    That  = det Sg "that" ;
    These = det Pl "these" ;
    Those = det Pl "those" ;
    Mod quality kind =
      {s = \\n => quality.s ++ kind.s ! n} ;
    Wine = regNoun "wine" ;
    Cheese = regNoun "cheese" ;
    Fish = noun "fish" "fish" ;
    Pizza = regNoun "pizza" ;
    Very a = {s = "very" ++ a.s} ;
    Fresh = adj "fresh" ;
    Warm = adj "warm" ;
    Italian = adj "Italian" ;
    Expensive = adj "expensive" ;
    Delicious = adj "delicious" ;
    Boring = adj "boring" ;
  param
    Number = Sg | Pl ;
  oper
    det : Number -> Str ->
      {s : Number => Str} -> {s : Str ; n : Number} =
        \n,det,noun -> {s = det ++ noun.s ! n ; n = n} ;
```

```
concrete FoodsChi of Foods = {


lincat
    Comment, Item = Str ;
    Kind = {s,c : Str} ;
    Quality = {s,p : Str} ;
lin
    Pred item quality = item ++ "是" ++ quality.s ++ quality.p
    This kind = "这" ++ kind.c ++ kind.s ;
    That kind = "那" ++ kind.c ++ kind.s ;
    These kind = "这" ++ "些" ++ kind.s ;
    Those kind = "那" ++ "些" ++ kind.s ;
    Mod quality kind = {
      s = quality.s ++ quality.p ++ kind.s ;
      c = kind.c
      } ;
    Wine  = geKind "酒" ;
    Pizza = geKind "比 萨 饼" ;
    Cheese  = geKind "奶 酪" ;
    Fish  = geKind "鱼" ;
```

GF grammar compiler and runtime interpreter



GF is more powerful then CFG

Expressive power

- PMCFG = Parallel Multiple Context-Free

Semantics

- Constructive Type Theory

Multilinguality

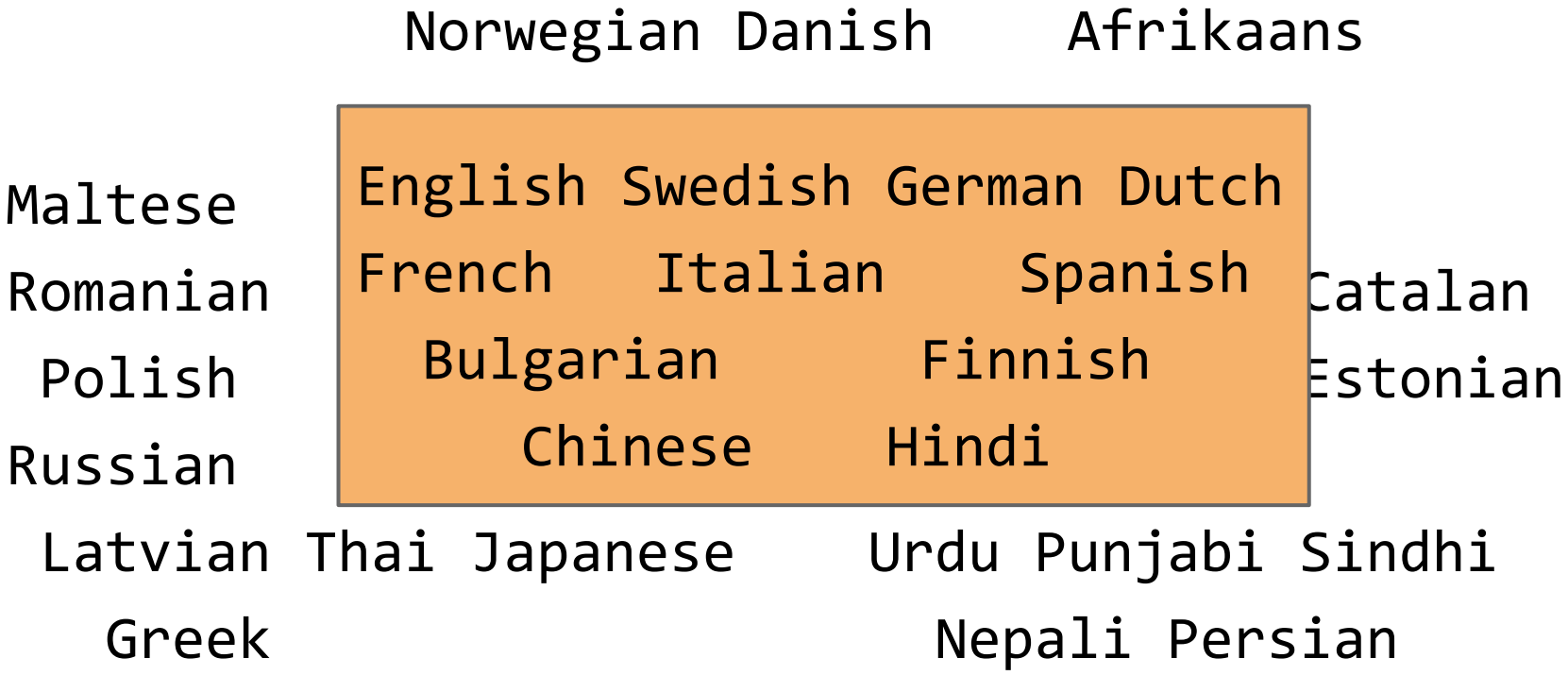
- shared rules and structures

Modularity, functional programming

What is GF?

2 . Collection of grammars

Resource Grammar Library (RGL)




Partial coverage
Full coverage

What is a grammar

- morphology
- syntax
- semantics

Morphology: *love* in English

inf	*love*
3p sg pres	*loves*
past	*loved*
past part	*loved*
pres part	*loving*

Morphology: *love* in Swedish

	active	**passive**
infinitive	*älska*	*älskas*
present	*älskar*	*älskas*
past	*älskade*	*älskades*
supine	*älskat*	*älskats*
imperative	*älska*	-
	nominative	**genitive**
past participle	*älskad, älskat, älskade*	*älskads, älskats, älskades*
present participle	*älskande*	*älskandes*

Morphology: *love* in French

Infin : aimer
Pres Indic Sg P1 : aime
Pres Indic Sg P2 : aimes
Pres Indic Sg P3 : aime
Pres Indic Pl P1 : aimons
Pres Indic Pl P2 : aimez
Pres Indic Pl P3 : aiment
Pres Conjunct Sg P1 : aime
Pres Conjunct Sg P2 : aimes
Pres Conjunct Sg P3 : aime
Pres Conjunct Pl P1 : aimions
Pres Conjunct Pl P2 : aimiez
Pres Conjunct Pl P3 : aiment
Imperf Indic Sg P1 : aimais
Imperf Indic Sg P2 : aimais
Imperf Indic Sg P3 : aimait
Imperf Indic Pl P1 : aimions
Imperf Indic Pl P2 : aimiez
Imperf Indic Pl P3 : aimaient

Imperf Conjunct Sg P1 : aimasse
Imperf Conjunct Sg P2 : aimasses
Imperf Conjunct Sg P3 : aimât
Imperf Conjunct Pl P1 : aimassions
Imperf Conjunct Pl P2 : aimassiezza
Imperf Conjunct Pl P3 : aimassent
Passe Sg P1 : aimai
Passe Sg P2 : aimas
Passe Sg P3 : aima
Passe Pl P1 : aimâmes
Passe Pl P2 : aimâtes
Passe Pl P3 : aimèrent
Fut Sg P1 : aimerai
Fut Sg P2 : aimeras
Fut Sg P3 : aimera
Fut Pl P1 : aimerons
Fut Pl P2 : aimerez
Fut Pl P3 : aimeront

Condit Sg P1 : aimerais
Condit Sg P2 : aimerais
Condit Sg P3 : aimerait
Condit Pl P1 : aimerions
Condit Pl P2 : aimeriez
Condit Pl P3 : aimeraient
Imper Sg P2 : aime
Imper Pl P1 : aimons
Imper Pl P2 : aimez
Part Masc Sg : aimé
Part Masc Pl : aimés
Part Fem Sg : aimée
Part Fem Pl : aimées
Ger : aimant

Morphology: *love* in Finnish

Inf Inf1 : rakastaa
Inf Inf3Iness : rakastamassa
Inf Inf3Elat : rakastamasta
Inf Inf3Illat : rakastamaan
Inf Inf3Adess : rakastamalla
Inf Inf3Abess : rakastamatta
Inf InfPresPart : rakastavan
Inf InfPresPartAgr : rakastava
Presn Sg P1 : rakastan
Presn Sg P2 : rakastat
Presn Sg P3 : rakastaa
Presn Pl P1 : rakastamme
Presn Pl P2 : rakastatte
Presn Pl P3 : rakastavat
Impf Sg P1 : rakastin
Impf Sg P2 : rakastit
Impf Sg P3 : rakasti
Impf Pl P1 : rakastimme
Impf Pl P2 : rakastitte
Impf Pl P3 : rakastivat
Condit Sg P1 : rakastaisin
Condit Sg P2 : rakastaisit
Condit Sg P3 : rakastaisi
Condit Pl P1 : rakastaisimme
Condit Pl P2 : rakastaisitte
Condit Pl P3 : rakastaisivat
Imper Sg : rakasta
Imper Pl : rakastakaa
ImperP3 Sg : rakastakoon
ImperP3 Pl : rakastakoot
s ImperP1Pl : rakastakaamme
s ImpNegPl : rakastako
PassPresn True : rakastetaan
PassPresn False : rakasteta
PassImpf True : rakastettiin
PassImpf False : rakastettu
PassCondit True : rakastettaisiin
PassCondit False : rakastettaisi
PastPartAct Sg Nom : rakastanut
PastPartAct Sg Gen : rakastaneen
PastPartAct Sg Part : rakastanutta
PastPartAct Sg Transl : rakastaneeksi
PastPartAct Sg Ess : rakastaneena
PastPartAct Sg Iness : rakastaneessa
PastPartAct Sg Elat : rakastaneesta
PastPartAct Sg Illat : rakastaneeseen
PastPartAct Sg Adess : rakastaneella
PastPartAct Sg Ablat : rakastaneelta
PastPartAct Sg Allat : rakastaneelle
PastPartAct Sg Abess : rakastaneetta
PastPartAct Pl Nom : rakastaneet
PastPartAct Pl Gen : rakastaneiden
PastPartAct Pl Part : rakastaneita
PastPartAct Pl Transl : rakastaneiksi
PastPartAct Pl Ess : rakastaneina
PastPartAct Pl Iness : rakastaneissa
PastPartAct Pl Elat : rakastaneista
PastPartAct Pl Illat : rakastaneisiin
PastPartAct Pl Adess : rakastaneilla
PastPartAct Pl Ablat : rakastaneilta
PastPartAct Pl Allat : rakastaneille
PastPartAct Pl Abess : rakastaneitta
PastPartAct NComit : rakastaneine
PastPartAct NInstruct : rakastanein
PastPartAct NPossNom Sg : rakastanee
PastPartAct NPossNom Pl : rakastanee
PastPartAct NPossGen Sg : rakastanee
PastPartAct NPossGen Pl : rakastaneide
PastPartAct NPossTransl Sg : rakastaneekse
PastPartAct NPossTransl Pl : rakastaneikse
PastPartAct NPossIllat Sg : rakastaneesee
PastPartAct NPossIllat Pl : rakastaneisii
PastPartAct NCompound : rakastanut
PastPartAct AAdv : rakastaneesti
PastPartPas Sg Nom : rakastettu
PastPartPas Sg Gen : rakastetun
PastPartPas Sg Part : rakastettua
PastPartPas Sg Transl : rakastetuksi
PastPartPas Sg Ess : rakastettuna
PastPartPas Sg Iness : rakastetussa
PastPartPas Sg Elat : rakastetusta
PastPartPas Sg Illat : rakastettuun
PastPartPas Sg Adess : rakastetulla
PastPartPas Sg Ablat : rakastetulta
PastPartPas Sg Allat : rakastetulle
PastPartPas Sg Abess : rakastetutta
PastPartPas Pl Nom : rakastetut
PastPartPas Pl Gen : rakastettujen
PastPartPas Pl Part : rakastettuja
PastPartPas Pl Transl : rakastetuiksi
PastPartPas Pl Ess : rakastettuina
PastPartPas Pl Iness : rakastetuissa
PastPartPas Pl Elat : rakastetuista
PastPartPas Pl Illat : rakastettuihin
PastPartPas Pl Adess : rakastetuilla
PastPartPas Pl Ablat : rakastetuilta
PastPartPas Pl Allat : rakastetuille
PastPartPas Pl Abess : rakastetuitta
PastPartPasAN NComit : rakastettuine
PastPartPasAN NInstruct : rakastetuin
PastPartPasAN NPossNom Sg : rakastettu
PastPartPasAN NPossNom Pl : rakastettu
PastPartPasAN NPossGen Sg : rakastettu
PastPartPasAN NPossGen Pl : rakastettuje
PastPartPasAN NPossTransl Sg : rakastetukse
PastPartPasAN NPossTransl Pl : rakastetuikse
PastPartPasAN NPossIllat Sg : rakastettuu
PastPartPasAN NPossIllat Pl : rakastettuihi
PastPartPasAN NCompound : rakastettu
PastPartPass AAdv : rakastetusti

Morphology: *love* in Latin

```
Perf Ind Sg P1 : amavi
Perf Ind Sg P2 : amavisti
Perf Ind Sg P3 : amavit
Perf Ind Pl P1 : amavimus
Perf Ind Pl P2 : amavistis
Perf Ind Pl P3 : amaverunt
Perf Conj Sg P1 : amaverim
Perf Conj Sg P2 : amaveris
Perf Conj Sg P3 : amaverit
Perf Conj Pl P1 : amaverimus
Perf Conj Pl P2 : amaveritis
Perf Conj Pl P3 : amaverint
Plusq Ind Sg P1 : amaveram
Plusq Ind Sg P2 : amaveras
Plusq Ind Sg P3 : amaverat
Plusq Ind Pl P1 : amaveramus
Plusq Ind Pl P2 : amaveratis
Plusq Ind Pl P3 : amaverant
Plusq Conj Sg P1 : amavissem
Plusq Conj Sg P2 : amavisses
Plusq Conj Sg P3 : amavisset
Plusq Conj Pl P1 : amavissemus
Plusq Conj Pl P2 : amavissetis
Plusq Conj Pl P3 : amavissent
Fut Sg P1 : amavero
Fut Sg P2 : amaveris
Fut Sg P3 : amaverit
Fut Pl P1 : amaverimus
Fut Pl P2 : amaveritis
Fut Pl P3 : amaverint
Pres Ind Sg P1 : amo
Pres Ind Sg P2 : amas
Pres Ind Sg P3 : amat
Pres Ind Pl P1 : amamus
Pres Ind Pl P2 : amatis
Pres Ind Pl P3 : amant
Pres Conj Sg P1 : amem
Pres Conj Sg P2 : ames
Pres Conj Sg P3 : amet
Pres Conj Pl P1 : amemus
Pres Conj Pl P2 : ametis
Pres Conj Pl P3 : ament
```

```
Perf Ind Sg P2 : amavisti
Perf Ind Sg P3 : amavit
Perf Ind Pl P1 : amavimus
Perf Ind Pl P2 : amavistis
Perf Ind Pl P3 : amaverunt
Perf Conj Sg P1 : amaverim
Perf Conj Sg P2 : amaveris
Perf Conj Sg P3 : amaverit
Perf Conj Pl P1 : amaverimus
Perf Conj Pl P2 : amaveritis
Perf Conj Pl P3 : amaverint
Plusq Ind Sg P1 : amaveram
Plusq Ind Sg P2 : amaveras
Plusq Ind Sg P3 : amaverat
Plusq Ind Pl P1 : amaveramus
Plusq Ind Pl P2 : amaveratis
Plusq Ind Pl P3 : amaverant
Plusq Conj Sg P1 : amavissem
Plusq Conj Sg P2 : amavisses
Plusq Conj Sg P3 : amavisset
Plusq Conj Pl P1 : amavissemus
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Fut Sg P1 : amavero
Fut Sg P2 : amaveris
Fut Sg P3 : amaverit
Fut Pl P1 : amaverimus
Fut Pl P2 : amaveritis
Fut Pl P3 : amaverint
Pres Ind Sg P1 : amo
Pres Ind Sg P2 : amas
Pres Ind Sg P3 : amat
Pres Ind Pl P1 : amamus
Pres Ind Pl P2 : amatis
Pres Ind Pl P3 : amant
Pres Conj Sg P1 : amem
Pres Conj Sg P2 : ames
Pres Conj Sg P3 : amet
Pres Conj Pl P1 : amemus
Pres Conj Pl P2 : ametis
Pres Conj Pl P3 : ament
Impf Ind Sg P1 : amabam
```

```
Perf Ind Sg P3 : amavit
Perf Ind Pl P1 : amavimus
Perf Ind Pl P2 : amavistis
Perf Ind Pl P3 : amaverunt
Perf Conj Sg P1 : amaverim
Perf Conj Sg P2 : amaveris
Perf Conj Sg P3 : amaverit
Perf Conj Pl P1 : amaverimus
Perf Conj Pl P2 : amaveritis
Perf Conj Pl P3 : amaverint
Plusq Ind Sg P1 : amaveram
Plusq Ind Sg P2 : amaveras
Plusq Ind Sg P3 : amaverat
Plusq Ind Pl P1 : amaveramus
Plusq Ind Pl P2 : amaveratis
Plusq Ind Pl P3 : amaverant
Plusq Conj Sg P1 : amavissem
Plusq Conj Sg P2 : amavisses
Plusq Conj Sg P3 : amavisset
Plusq Conj Pl P1 : amavissemus
Plusq Conj Pl P2 : amavissetis
Plusq Conj Pl P3 : amavissent
Fut Sg P1 : amavero
Fut Sg P2 : amaveris
Fut Sg P3 : amaverit
Fut Pl P1 : amaverimus
Fut Pl P2 : amaveritis
Fut Pl P3 : amaverint
Pres Ind Sg P1 : amo
Pres Ind Sg P2 : amas
Pres Ind Sg P3 : amat
Pres Ind Pl P1 : amamus
Pres Ind Pl P2 : amatis
Pres Ind Pl P3 : amant
Pres Conj Sg P1 : amem
Pres Conj Sg P2 : ames
Pres Conj Sg P3 : amet
Pres Conj Pl P1 : amemus
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Pres Conj Pl P3 : ament
Impf Ind Sg P1 : amabam
Impf Ind Sg P2 : amabas
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Perf Ind Pl P1 : amavimus
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Fut Pl P2 : amaveritis
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Pres Ind Sg P3 : amat
Pres Ind Pl P1 : amamus
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Pres Conj Pl P1 : amemus
Pres Conj Pl P2 : ametis
Pres Conj Pl P3 : ament
Impf Ind Sg P1 : amabam
Impf Ind Sg P2 : amabas
Impf Ind Sg P3 : amabat
Impf Ind Pl P1 : amabamus
Impf Ind Pl P2 : amabatis
```
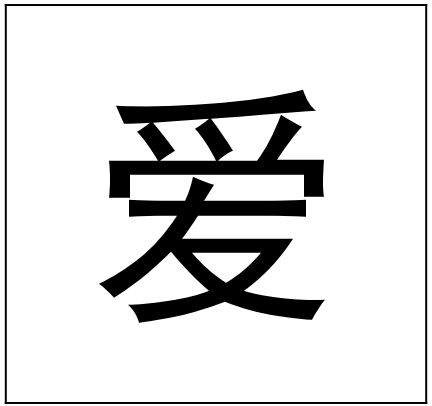

Morphology: *love* in Chinese



Syntax: S+V+O in Chinese

subject	verb	object
我	爱	她
I	*love*	*her*
她	爱	我
she	*loves*	*me*

Syntax: S+V+O in English

subject(nom)	verb(agr(subject))	object(acc)
I	*love*	*her*
she	*loves*	*me*

Syntax: S+V+O in French

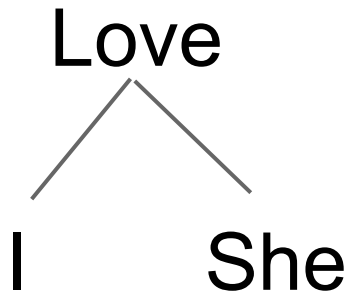
with certain pronoun objects:

subject(nom)	**object(acc)**	**verb(agr(subject))**	
je	*l'*	*aime*	"I love her"
elle	*m'*	*aime*	"she loves me"

with other kinds of objects:

subject(nom)	**verb(agr(subject))**	**object(acc)**	
j'	*aime*	*ma femme*	"I love my wife"

Semantics: an abstract object



abstract syntax tree

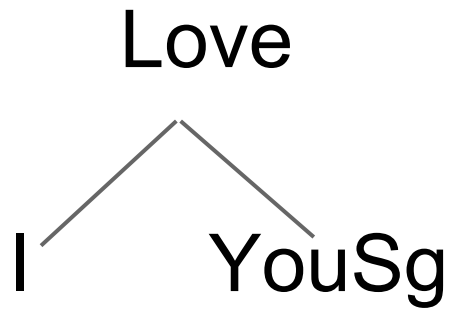
This expresses the meaning shared by different languages.

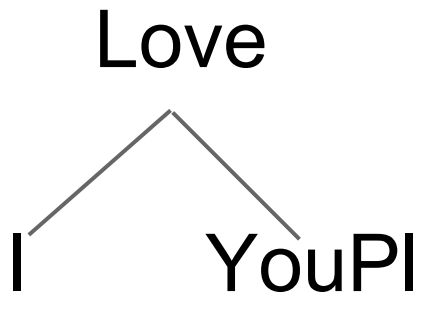
Ambiguity: one string, many trees

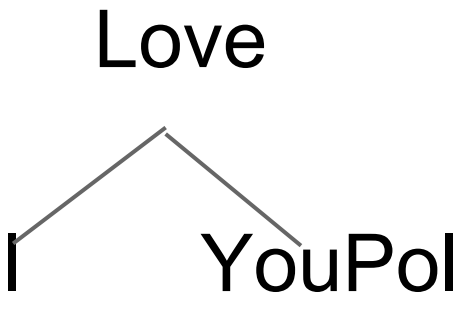
I love you

Ambiguity: one string, many trees

I love you







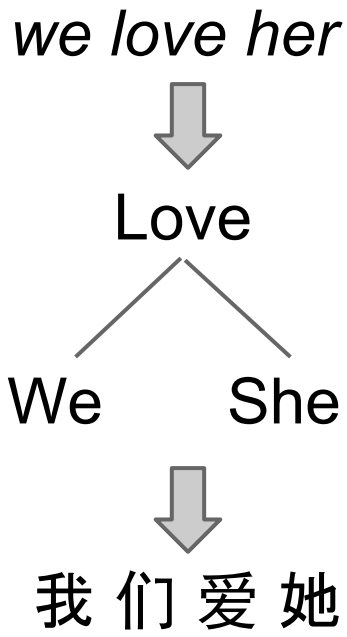
我 爱 你　　我 爱 你 们　　我 爱 您

Using grammars: translation

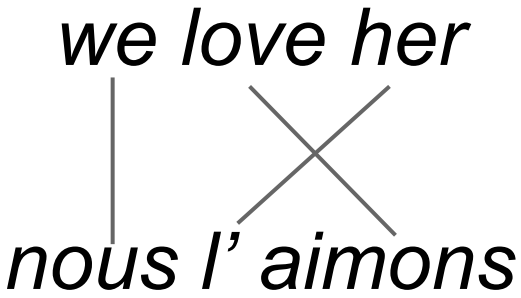
1. Analyse source language

2. Build abstract syntax tree

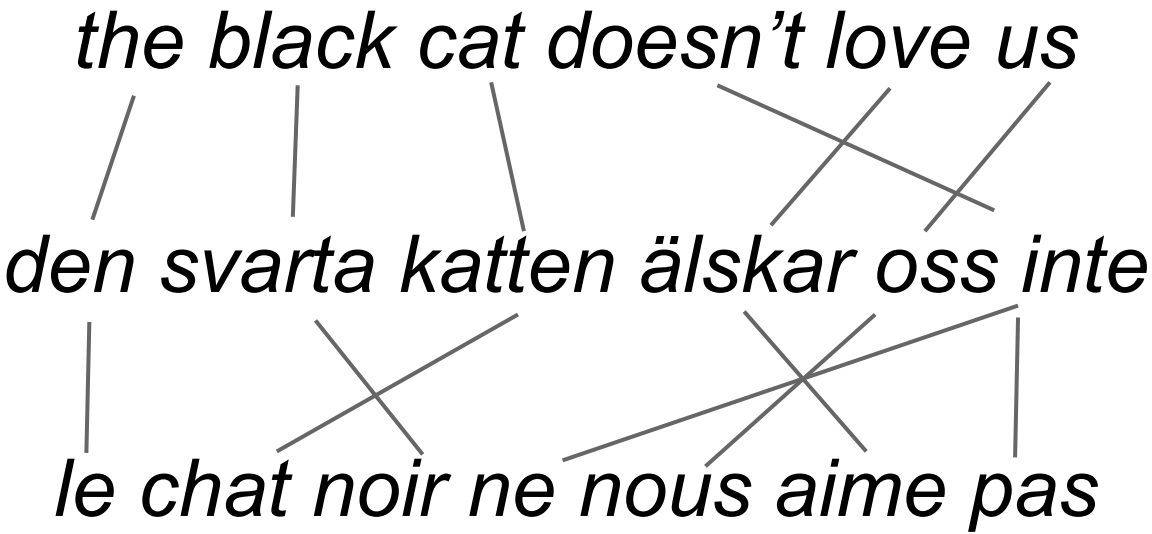
3. Generate target language



Word alignment



Word alignment can be complex



What is GF?

3 . Open-source software

Community

Started in 1998 at Xerox Research, Grenoble

Now 100+ developers around the world

Beijing University of Language and Culture

Shanghai Jiao Tong University

Sun Yat-Sen University, Guangzhou

Distribution

Home page

http://www.grammaticalframework.org/

GitHub

https://github.com/GrammaticalFramework/GF/

Licenses

Compiler: GPL

Libraries + Runtime: LGPL/BSD

Permits commercial binary-only products

- companies in Sweden, Finland, Bulgaria, The Netherlands, USA

What can you do with GF?

What can you do with GF?

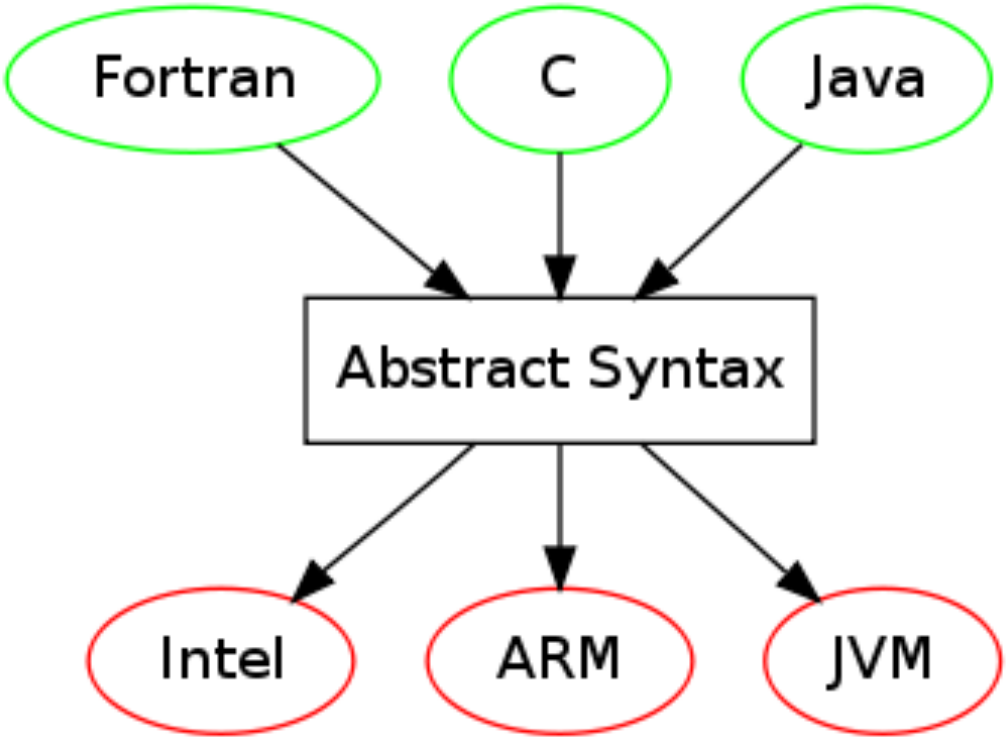
1. Multilingual grammars

Multilingual grammars

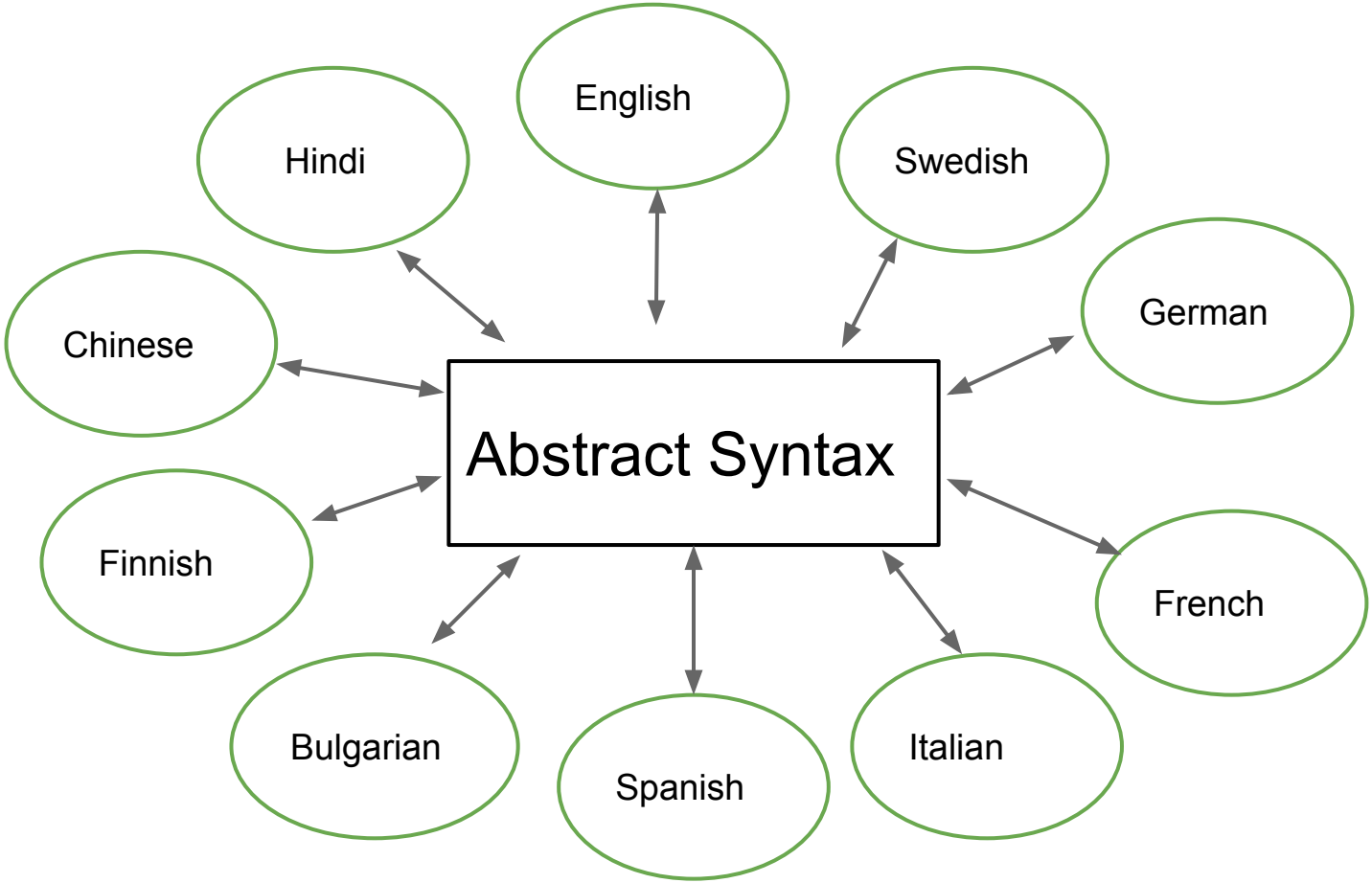
Abstract syntax: shared tree structure

Concrete syntax: language-specific structure

Idea from GCC: multi-source multi-target compiler



GF: multi-source multi-target compiler**-decompiler**



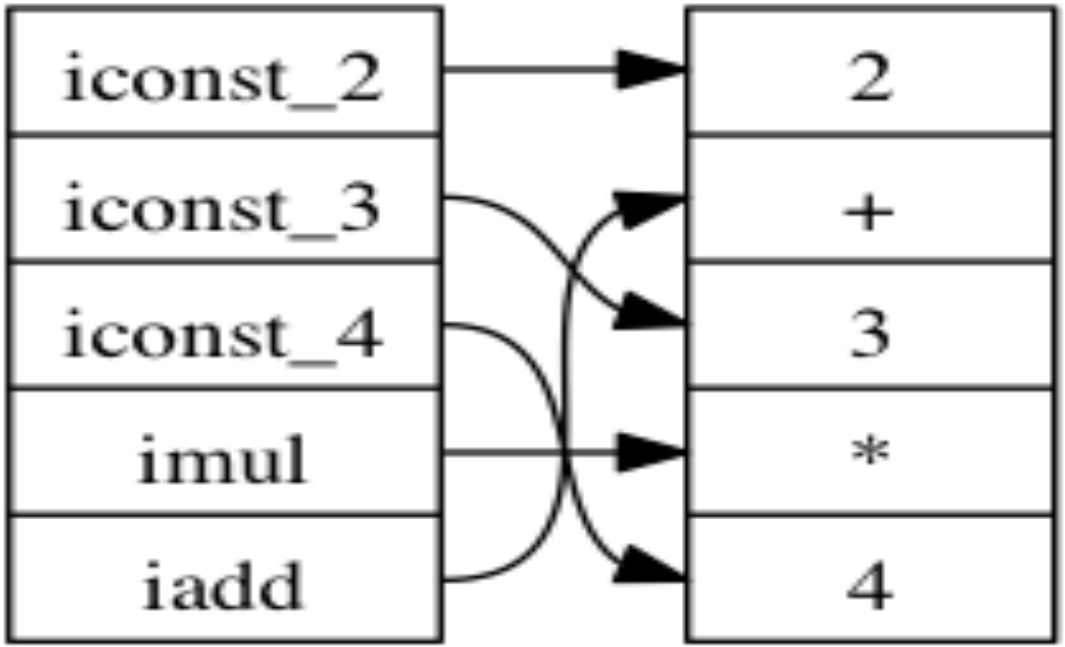
Compiler example

2 + 3 * 4

Plus Num_2 (Times Num_3 Num_4)

iconst_2 iconst_3 iconst_4 imul iadd

Word alignment in a compiler



A very simple example

```
abstract Grammar = {
cat
 S ;
 NP ;
 VP ;
 TV ;
fun
 Pred : NP -> VP -> S ;
 Compl : TV -> NP -> VP ;
 I : NP ;
 You : NP ;
 Love : TV ;
```

A very simple example

```
abstract Grammar = {
cat
 S ;
 NP ;
 VP ;
 TV ;
fun
 Pred : NP -> VP -> S ;
 Compl : TV -> NP -> VP ;
 I : NP ;
 You : NP ;
 Love : TV ;
}
```

```
concrete GrammarEng
  of Grammar = {
lincat
  S = Str ;
  NP = Str ;
  VP = Str ;
  TV = Str ;
lin
  Pred np vp = np ++ vp ;
  Compl tv np = tv ++ np ;
  I = "I" ;
  You = "you" ;
  Love = "love" ;
}
```

A very simple example

```
abstract Grammar = {
cat
 S ;
 NP ;
 VP ;
 TV ;
fun
 Pred : NP -> VP -> S ;
 Compl : TV -> NP -> VP ;
 I : NP ;
 You : NP ;
 Love : TV ;
}
```

```
concrete GrammarEng
  of Grammar = {
lincat
  S = Str ;
  NP = Str ;
  VP = Str ;
  TV = Str ;
lin
  Pred np vp = np ++ vp ;
  Compl tv np = tv ++ np ;
  I = "I" ;
  You = "you" ;
  Love = "love" ;
}
```

```
concrete GrammarChi
  of Grammar = {
lincat
  S = Str ;
  NP = Str ;
  VP = Str ;
  TV = Str ;
lin
  Pred np vp = np ++ vp ;
  Compl tv np = tv ++ np ;
  I = "我" ;
  You = "你" ;
  Love = "爱" ;
}
```

What can you do with GF?

2. Translation

Incremental translation demo

http://cloud.grammaticalframework.org/minibar/minibar.html

http://www.grammaticalframework.org/demos/phrasebook/

Wide coverage translation demo

http://cloud.grammaticalframework.org/wc.html

The mobile speech translator

http://www.grammaticalframework.org/demos/app.html

http://www.grammaticalframework.org/~aarne/App11.apk

What can you do with GF?

3. Query systems

Find answers to questions

How far is the station from the airport?

Find answers to questions

How far is the station from the airport?

parsing

(Distance Station Airport)

Find answers to questions

How far is the station from the airport?

parsing

(Distance Station Airport)

calculation / database search

(Km 16)

Find answers to questions

How far is the station from the airport?

parsing

(Distance Station Airport)

calculation / database search

(Km 16)

linearization

16 kilometers

Shared answering in abstract syntax

How far is the station from the airport?

parsing

(Distance Station Airport)

calculation / database search

(Km 16)

linearization

16 kilometers

Shared answering in abstract syntax

从 机 场 到 车 站 有 多 远 ？

parsing

(Distance Station Airport)

calculation / database search

(Km 16)

linearization

16公里

What can you do with GF?

4. Language learning

Use the multilingual grammar

Abstract syntax: see the similarities

Concrete syntax: pinpoint the differences

The Adult Advantage: Grammar

Within language, there are certain functions that will always be there. Functions to communicate the relationships between words. Ways to express ownership, or who did what to whom.

Chris Lonsdale, *The Third Ear*

Inflection tables

Minibar

Mobile app

The Translation Quiz

On the GF cloud

What else can you do with GF?

5. Natural language interfaces
6. Dialogue systems
7. Natural Language Generation
8. Controlled Languages
9. Linguistic theory
10. Language typology

...

What is there for Chinese?

What is there for Chinese?

1 . Resource grammar

RGL statistics

2012: Zhuo-Lin Qiqige, Aarne Ranta, Chen Peng, Qiao Haiyan

80 categories, 180 syntax functions, 500 words

1200 lines of GF code

What is there for Chinese?

2 . A phrasebook application

What is there for Chinese?

3 . A wide-coverage dictionary

Dictionary statistics

Coverage: 35,000 words

Linked with 10 other languages

Authors: students at Sun Yat-Sen University, Qiao Haiyan

Later sources: Wiktionary, HSK, Wordnet


nghc Translate.hs ParseEng.pgf ParseEngChi.pgf ParseEng
pgf-translate ParseEng.pgf Phr ParseEng ParseEng ParseEngAbs3.probs < translate.lex.tm
p > translate.out.tmp
SOURCE> our computer knows fifteen thousand words
TREE> PhrUtt NoPConj (UttS (UseCl (TTAnt TPres ASimul)PPos (PredVP (DetCN (DetQuant (P
ossPron we_Pron)NumSg)(UseN computer_N)) (ComplSlash (SlashV2a know_V2)(DetCN (DetQuan
t IndefArt (NumCard (NumNumeral (num (pot3 (pot1as2 (pot1to19 n5)))))))(UseN word_N)))
))) NoVoc
METAS>
ParseChi> 我 们 的 计 算 机 知 道 一 万 五 千 个 文 字.
ParseEng> Our computer knows fifteen thousand words.
ook-Pro:engfin aarne$

What is special about Chinese?

What is special about Chinese?

1 . Writing system and segmentation

Syllabic writing, no spaces

Current approach: grammar based segmentation.

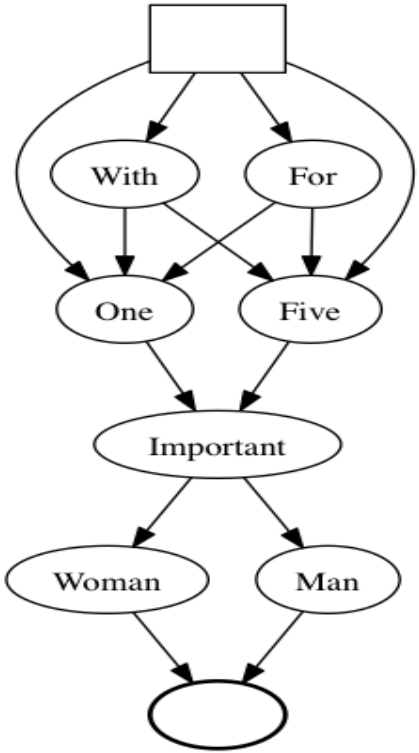
Hypothesis: this is the optimal way.

Observation: it only rarely adds ambiguity to parsing.

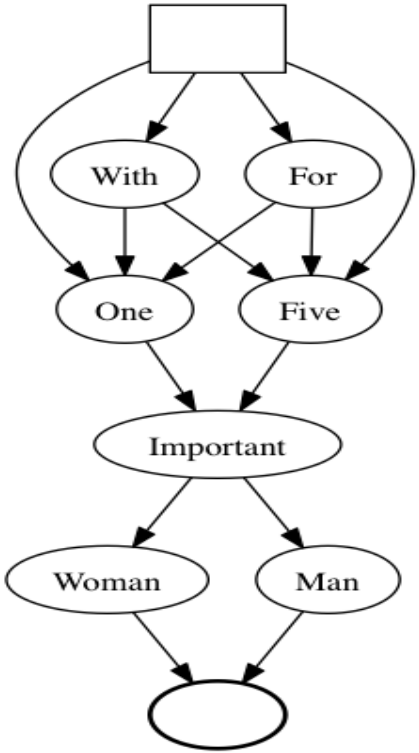
What is special about Chinese?

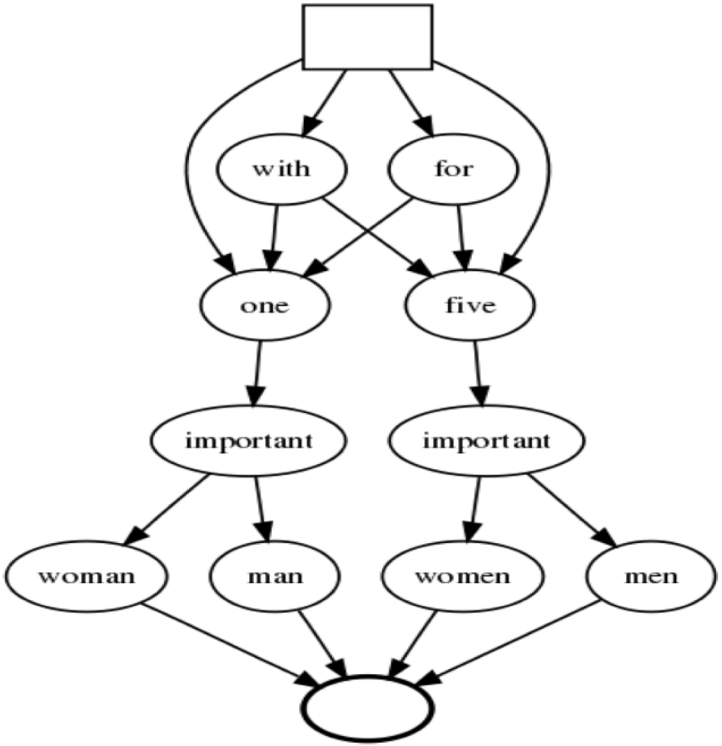
2 . No morphology

How simple is Chinese: an illustration

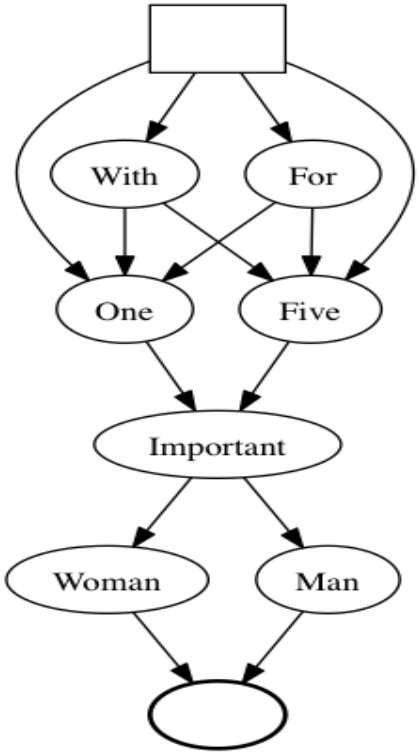


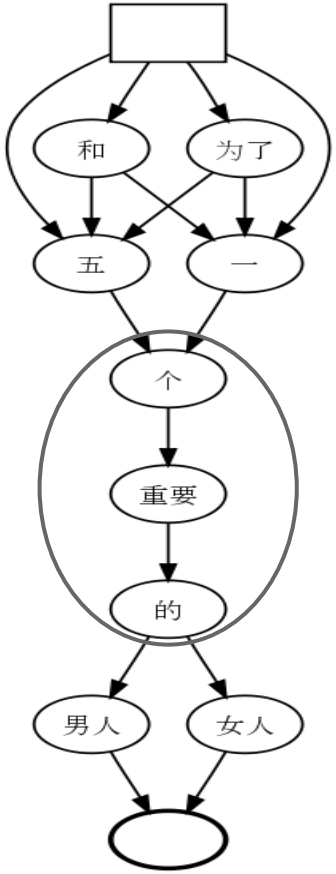
How simple is Chinese: an illustration

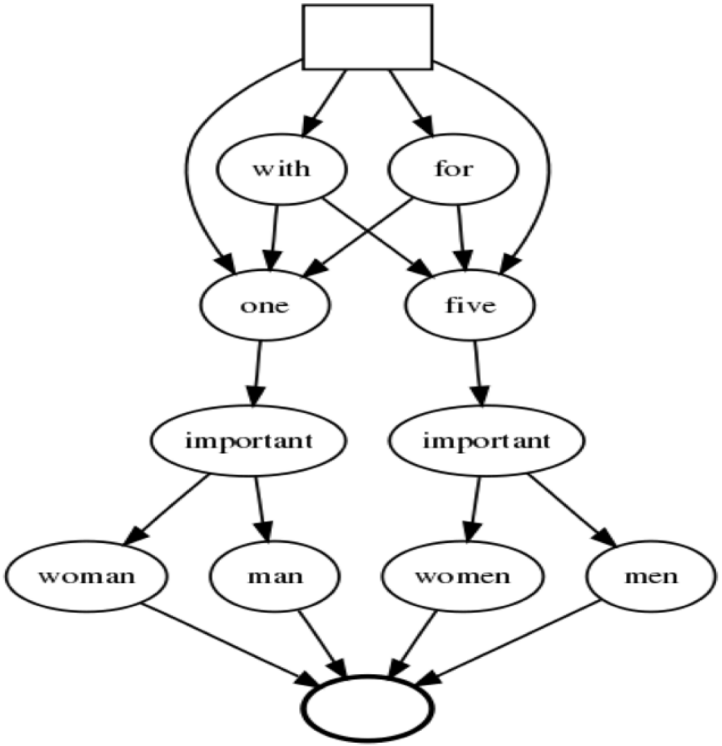




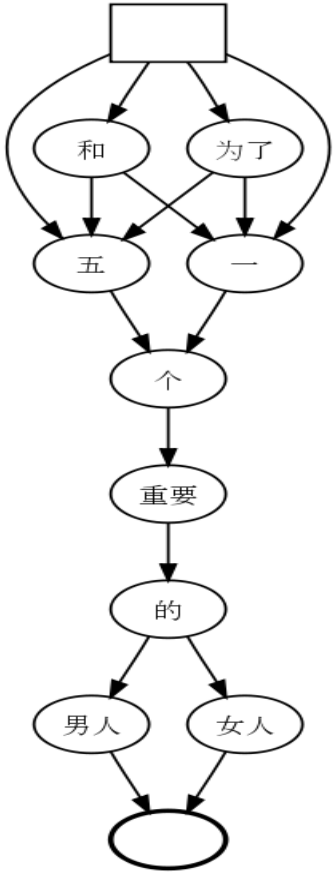
How simple is Chinese: an illustration

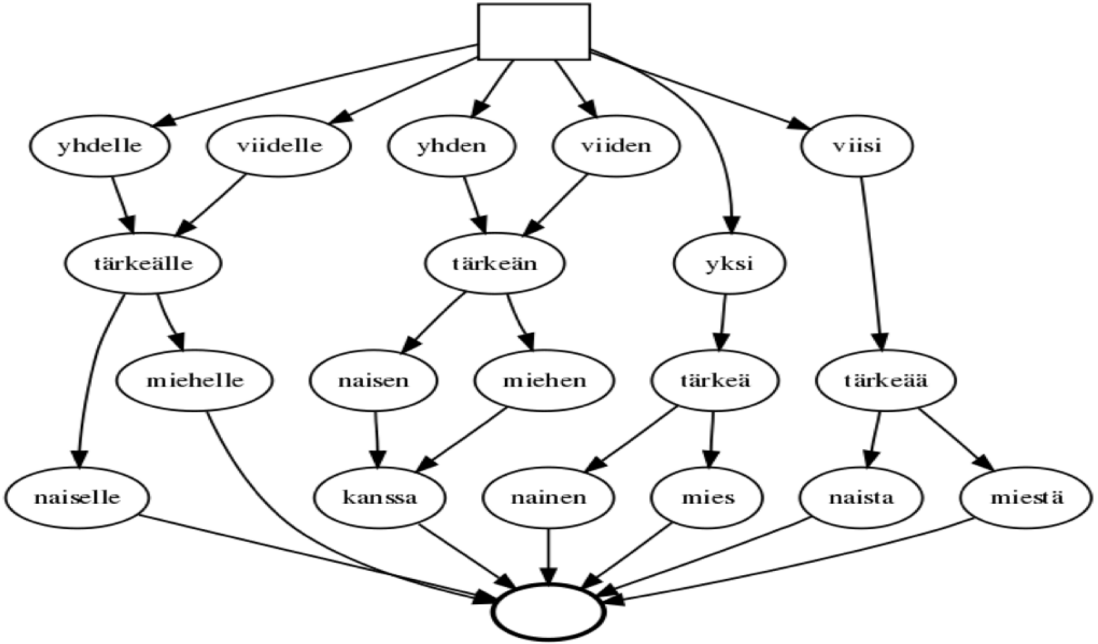




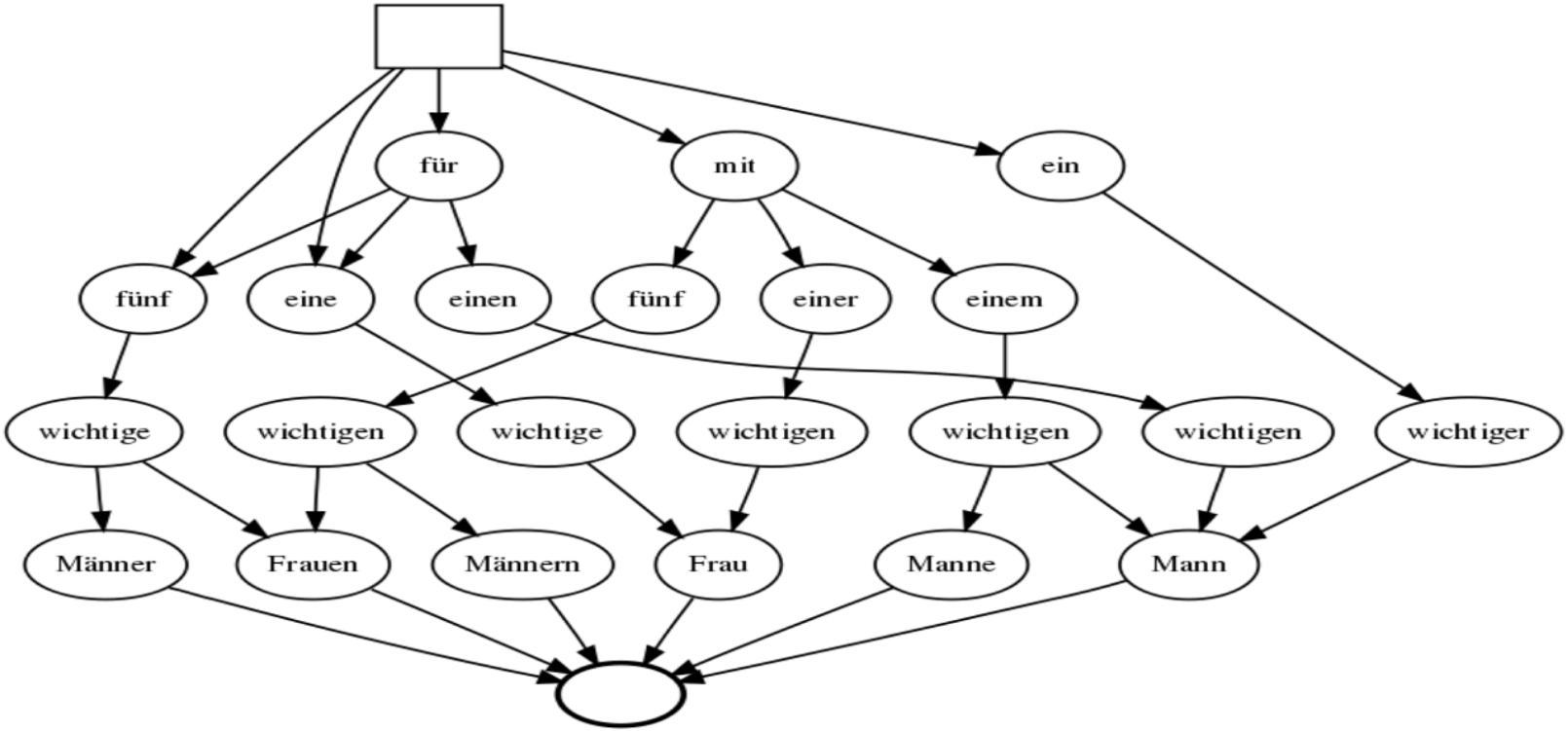


How simple is Chinese: an illustration





How simple is Chinese: an illustration



How simple is Chinese: some figures

Superficial measure: lines of code and development time for RGL

language	syntax	morphology	total	months	remarks
Chinese	1000	100	1100	1	not quite finished
English	1000	800	1800	6	the first RGL
Finnish	1500	1500	3000	6	one of the first
French	1800	1800	3600	6	shared Romance
Swedish	1600	700	2300	4	shared Scandinavian

The effort for new languages is typically 2 to 4 kLoC, 3 to 6 pm.

How simple is Chinese: some figures

A more exact measure: size of source code syntax tree

language	morphology	syntax	morphology #	syntax #
Chinese	I	II	316	666
English	III	IIIII	1029	1468
Finnish	IIIIIIIIIIIIIIIIIIIII	IIIIIIIIII	7191	3499
French	IIIIIIIII	IIIIIIII	2999	2720
Swedish	IIIIIII	IIIII	2115	1404

I = 300 nodes. Morphology = mkN+mkV. Syntax = Pred + Compl

How simple is Chinese: some figures

The compression effect of GF's abstractions

language	CF rules	CF/GF
Chinese	219	5
English	8319	189
Finnish	887297	20166
French	631477	14352
Swedish	3351	76

Measured with Miniresource, the core of RGL, 44 GF rules.

What is special about Chinese?

3 . Strict word order

PP attachment

I ate bread with butter

I ate bread with you

What I get from Google translate

I ate bread with butter.

我吃面包，黄油。

I ate bread with you.

我吃了面包与你同在。

What I get from GF

I ate bread with butter

我吃了和黄油一起的面包

I ate bread with you

我在和你一起吃了面包

Actually I could also get

I ate bread with butter

我在和黄油一起吃了面包

I ate bread with you

我吃了和你一起的面包

Structural ambiguity

I ate (bread (with butter))

I ((ate bread) (with friends))

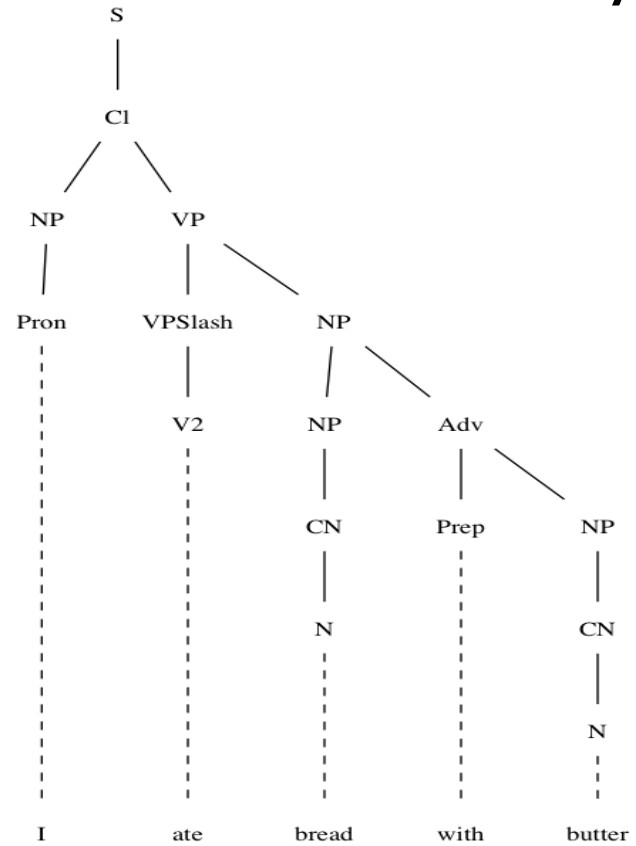
Familiar from mathematics

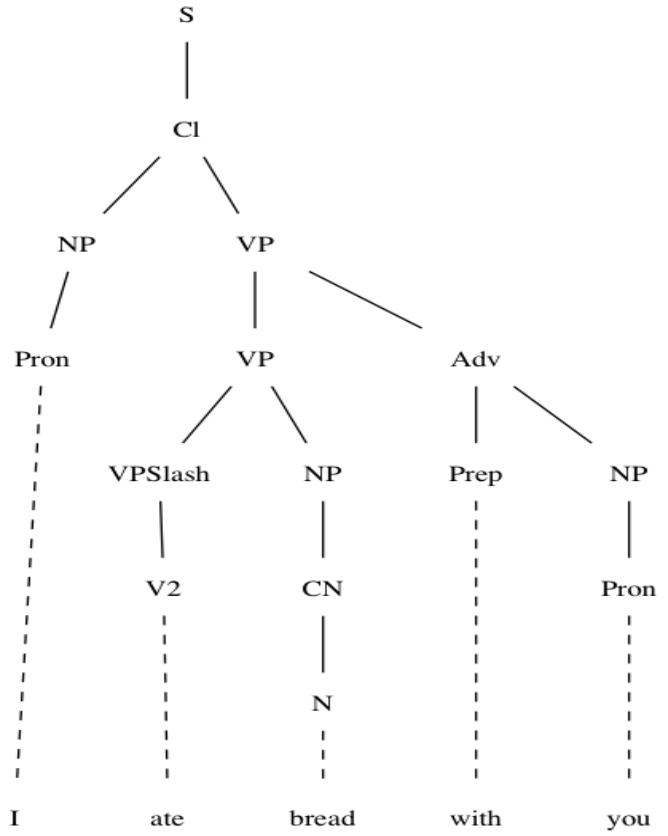
two plus three times four

2 + 3 * 4 = 14 // = 2 + (3 * 4)

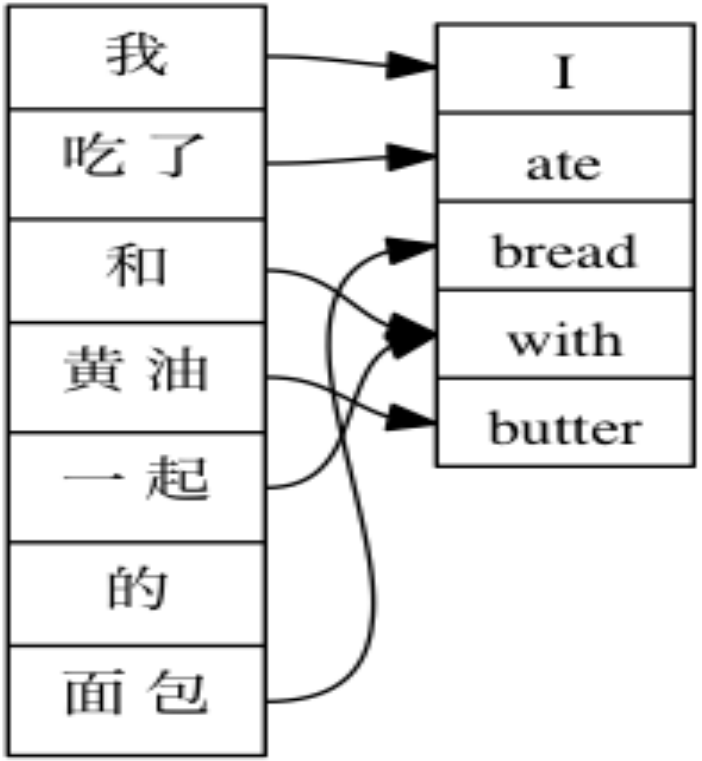
(2 + 3) * 4 = 20

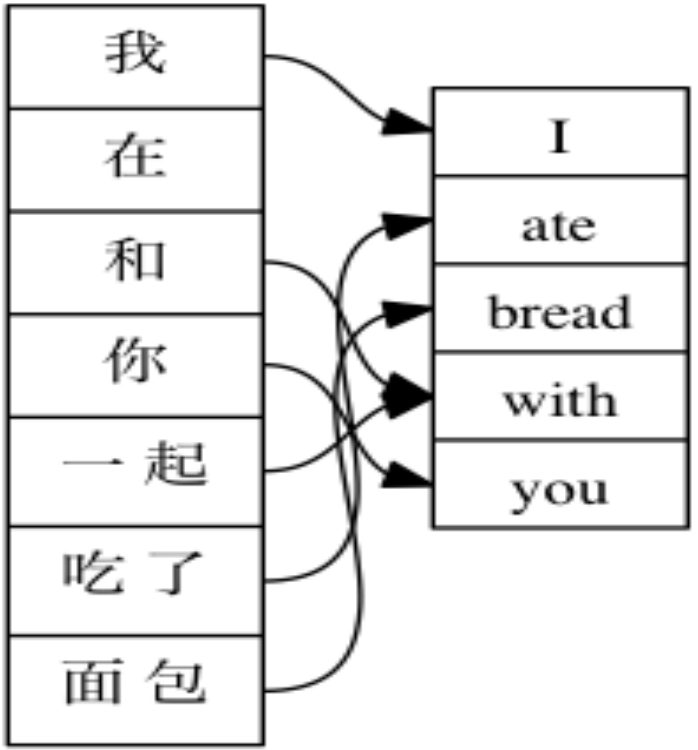
Different syntax trees



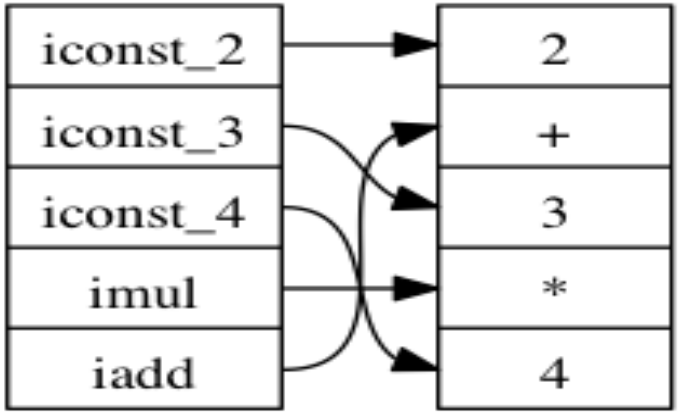


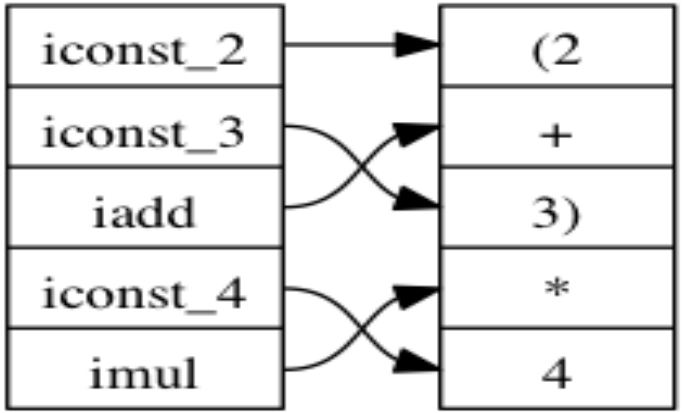
Word alignments





Compilers: aligning Java and JVM





What is special with Chinese?

4 . Discontinuous constituents

Noun + classifier

Try this at home with your favourite statistical machine translation system:

I have five cats 我有五**只猫**

I have five very big cats 我有五**只**非常大的**猫**

Probable outcome: **只** changed to 个

```
lincat NP = Str

lincat Det = Str

lincat CN = {s : Str ; cl : Str}

lin DetCN det cn = det.s ++ cn.c ++ cn.s

lin cat_CN = {s = “猫” ; c = “只”}
```

What is special about Chinese?

5 . Reduplication

Question form “V + not + V”

你去不去广州？
你有没有茶？

An instance of the **copy language**.

Shows that Chinese is not context-free!

```
lincat NP = Str

lincat VP = {verb, neg, compl : Str}

lincat QS = Str

lin Quest np vp =
  np ++ vp.verb ++ vp.neg ++ vp.verb ++ vp.compl


Compl have_V2 tea_NP =
  {verb = “有” ; neg = “没” ; compl = “茶”}
```

What can you do?

1 . Test the applications

The GF cloud

http://cloud.grammaticalframework.org

The Human Language Compiler

http://www.grammaticalframework.org/~aarne/App11.apk

What can you do?

2 . Evaluate translations

The post-editing campaign

Phrasebook: PQuestion (QProp (PropAction (AModVerbPhrasePlace MCan YouPlurPolMale (V2Wait WeFemale) (SuperlPlace TheClosest Cinema))))

PhrasebookEng: can you wait for us at the nearest cinema ?

PhrasebookChi: 你 们 能 在 最 近 的 那 个 电 影 院 等 我 们 吗 ？

What can you do?

3 . Revise and extend the lexicon

This is how it looks

```
lin show_VQ = mkVQ (mkV "显示") ;
lin show_V2 = mkV2 "亮" | mkV2 "发" | mkV2 "显示" | mkV2 "表现" | mkV2 "表示" | mkV2 "露" ;
lin show_V = mkV "亮" | mkV "发" | mkV "显示" | mkV "表现" | mkV "表示" | mkV "露" ;
lin course_N = mkN "经过" "個" | mkN "课" "堂" | mkN "课程" "堂" | {-HSK-} mkN "课程" ;
lin company_2_N = mkN "公司" ;
lin company_1_N = mkN "公司" ;
lin under_Prep = S.under_Prep ;
lin problem_N = mkN "困难" "個" | mkN "问题" "個" | mkN "难" | {-HSK-} mkN "问题" ;
lin against_Prep = mkPrep "针对" ;
lin never_Adv = mkAdv "从来没有" ;
lin most_Adv = mkAdv "最" | {-HSK-} mkAdv "顶" ;
lin service_N = mkN "服务" ;
lin try_VV = mkVV "试" | {-HSK-} mkVV "试图" ;
lin try_V2 = mkV2 "尝试" | {-HSK-} mkV2 "试" ;
lin try_V = mkV "试" | {-HSK-} mkV "试图" ;
lin call_V2 = mkV2 "叫" | {-HSK-} mkV2 "称呼" ;
```

What can you do?

4 . Extend the grammar

English to Chinese translation

rather complete

Grammatical framework. Programming with multilingual grammars.

语法的框架.和些多種語言的语法一起的编程.

Chinese to English translation

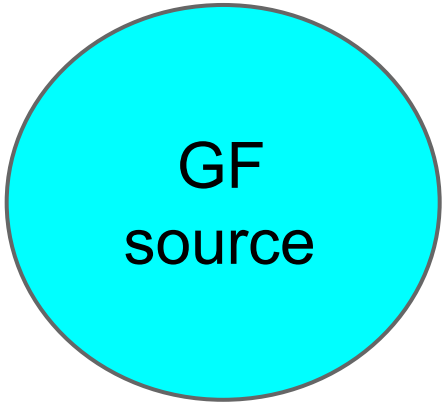
lacks many idiomatic expressions

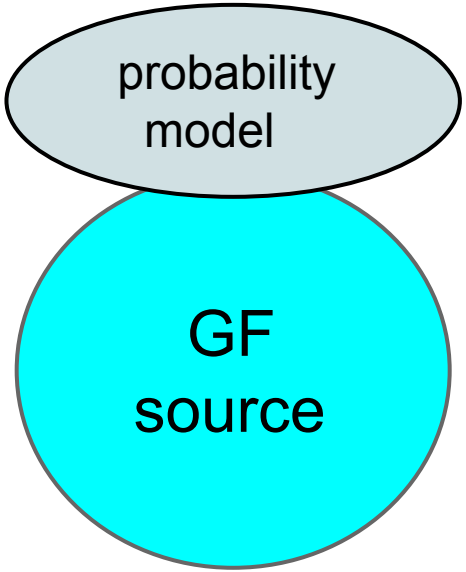
语法框架 为多种自然语言语法编程

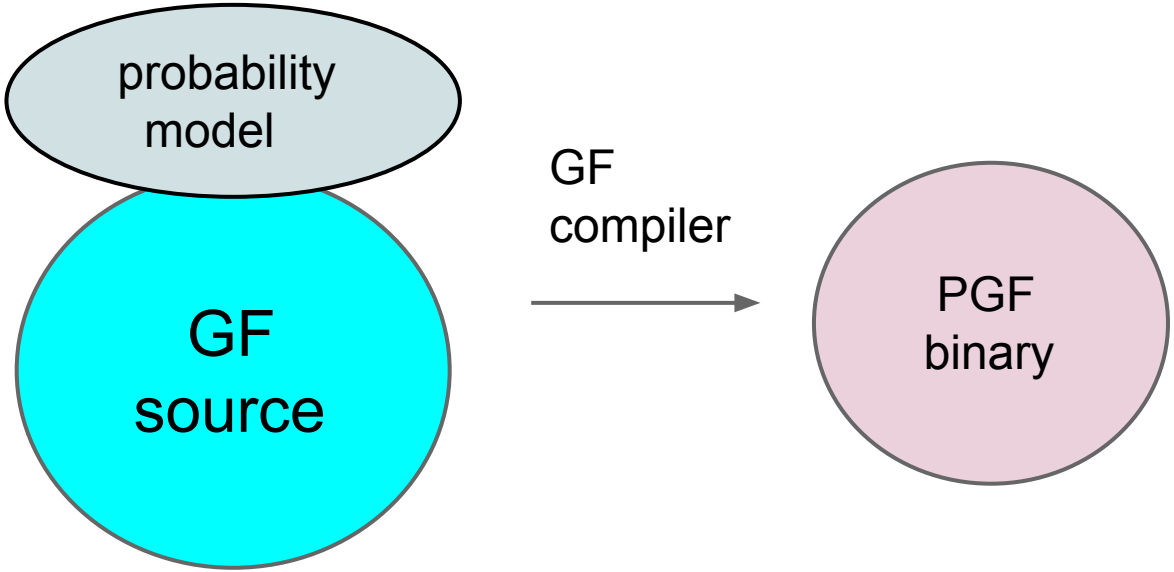
Grammar frames for many nature languages grammar programs

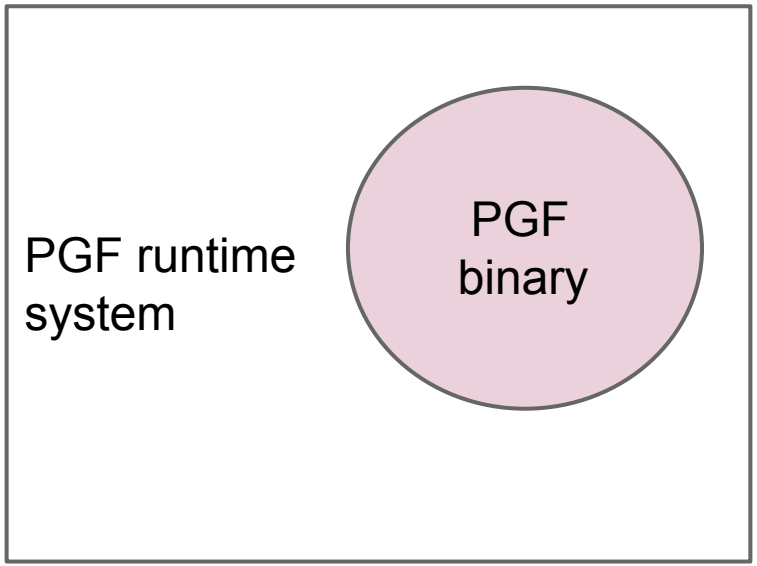
What can you do?

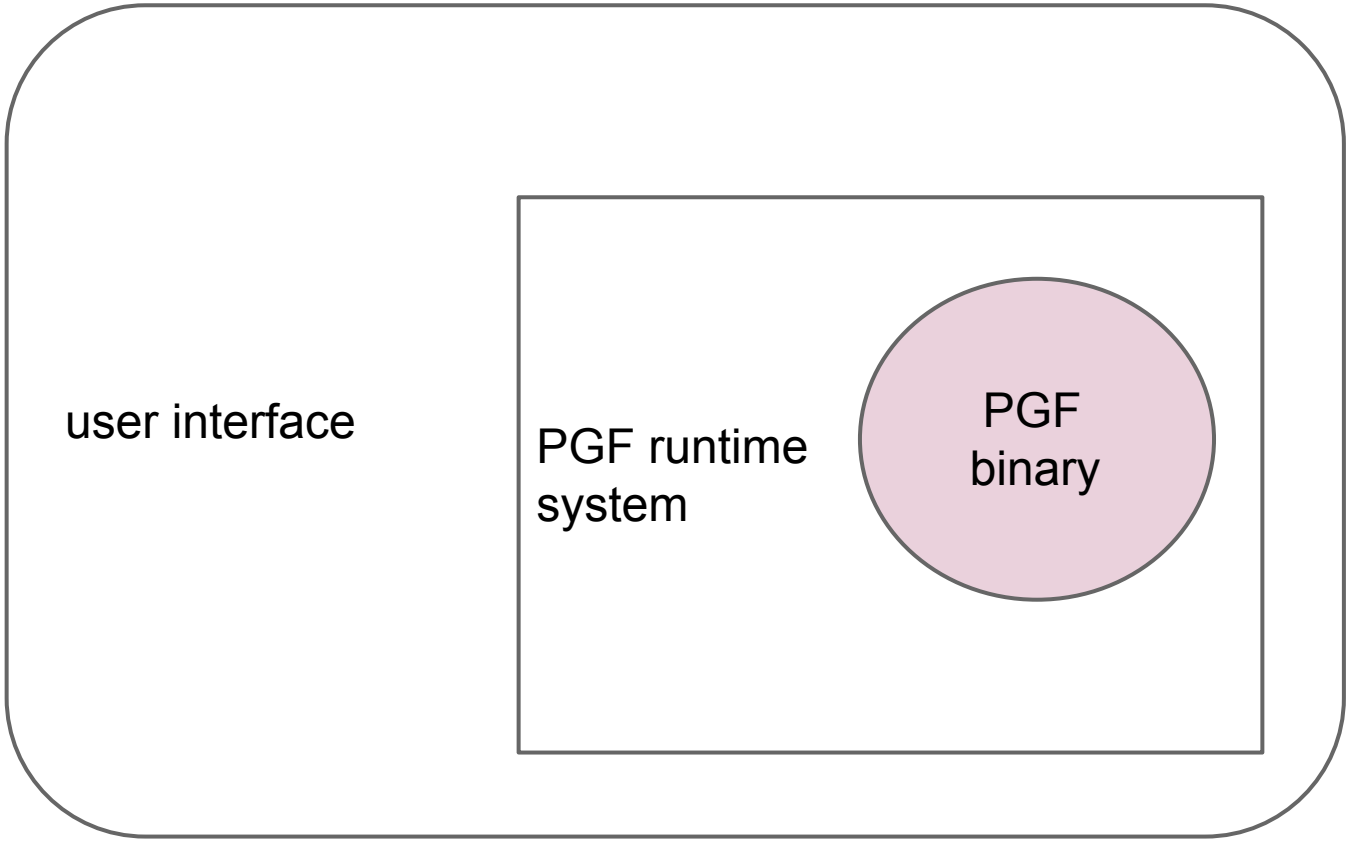
5 . Build applications

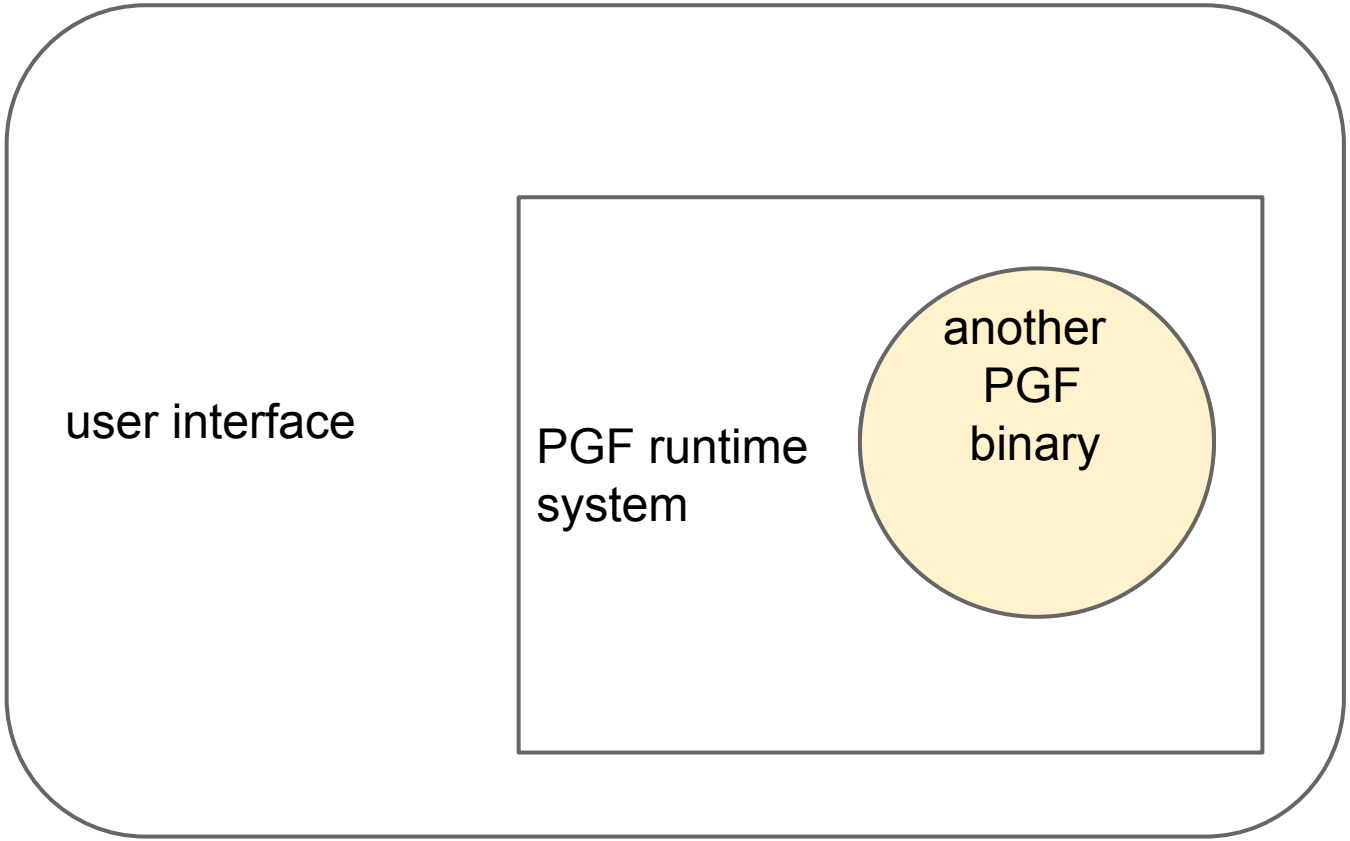

GF
source

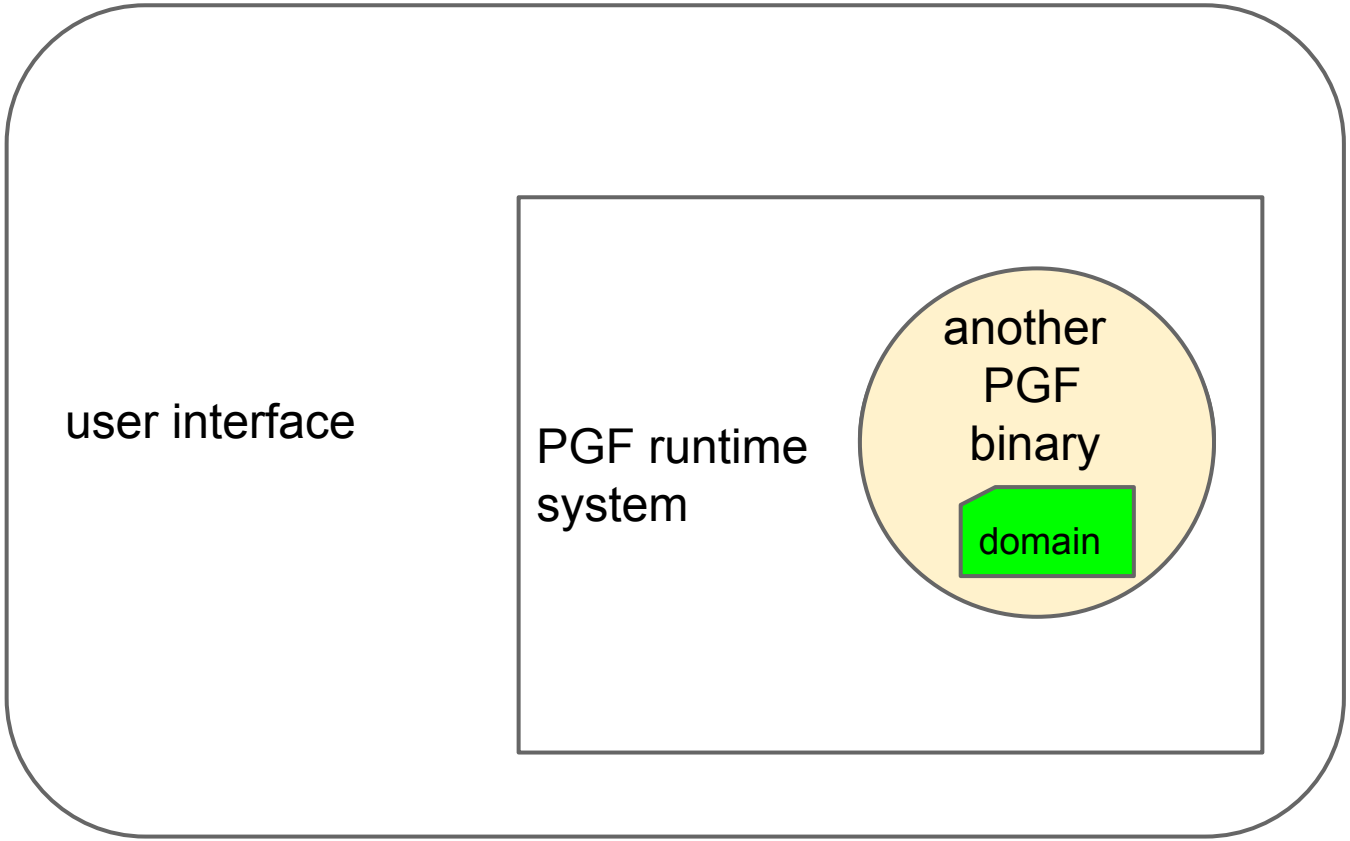

probability
model
GF
source

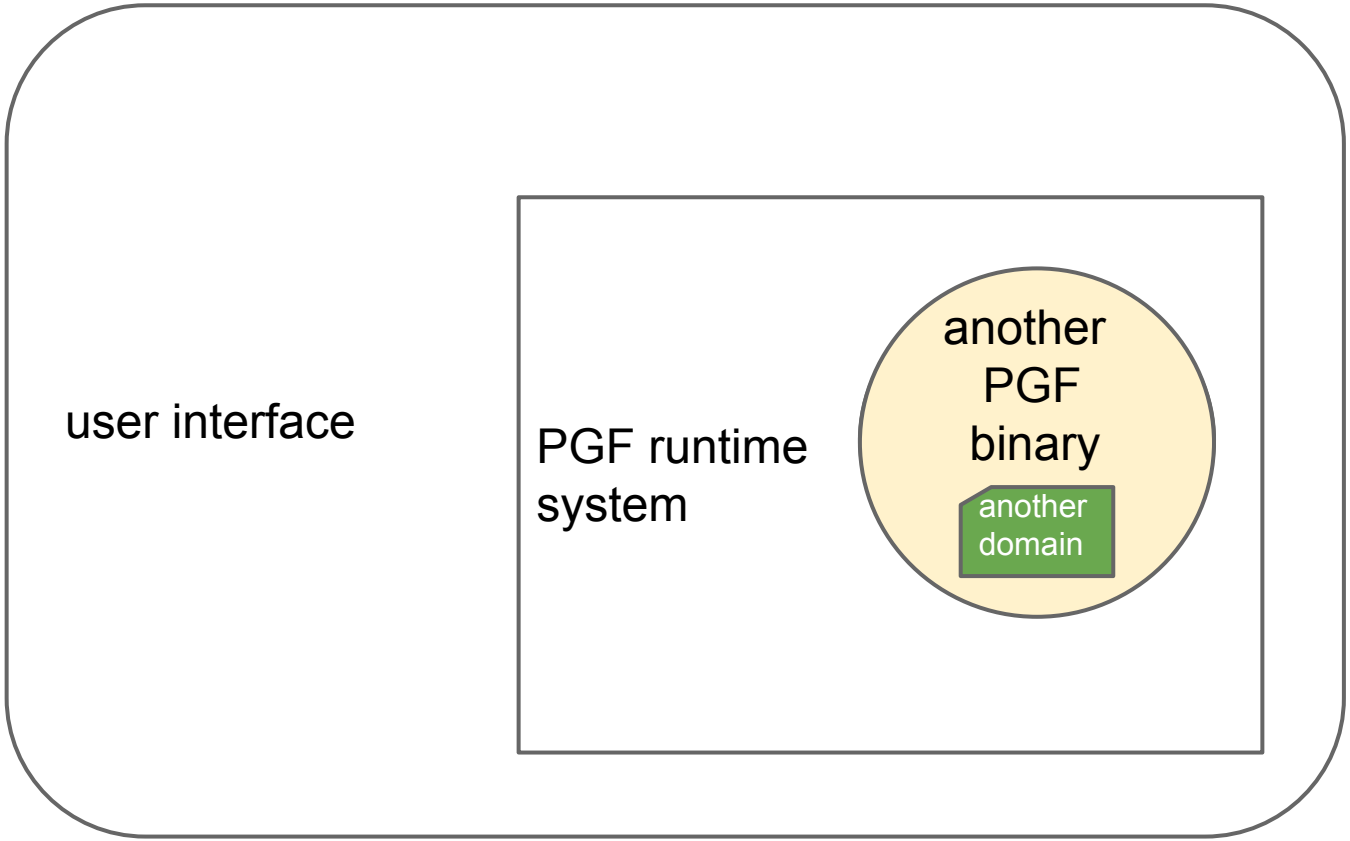

probability
model
GF
source
GF
compiler
PGF
binary


PGF runtime system
PGF binary

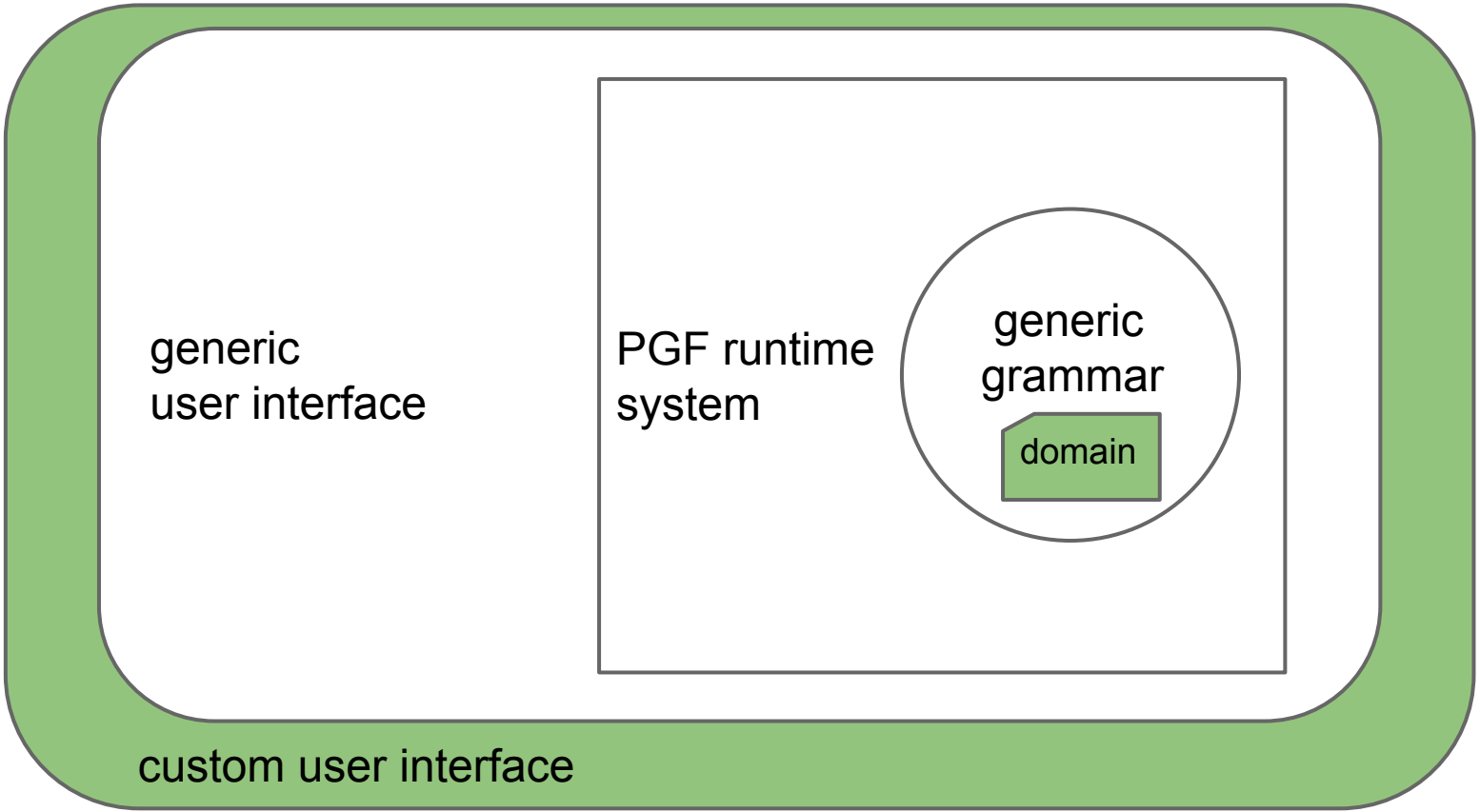

user interface
PGF runtime system
PGF binary


user interface
PGF runtime system
another PGF binary


user interface
PGF runtime system
another PGF binary
domain


user interface
PGF runtime system
another PGF binary
another domain

White: free, open-source. **Green**: what you can sell.



What can you do?

6 . Do research

Compare with other grammars

Chinese grammars in other formalisms

- compare
- exchange information

Test with a Chinese treebank

The Penn Chinese Treebank

- test
- learn probabilities
- try to approach its coverage

How to get started

How to get started

1 . Today’s tutorial

Tutorial topics

Writing grammars in the GF cloud

Using the Resource Grammar Library

Installing and running the GF shell

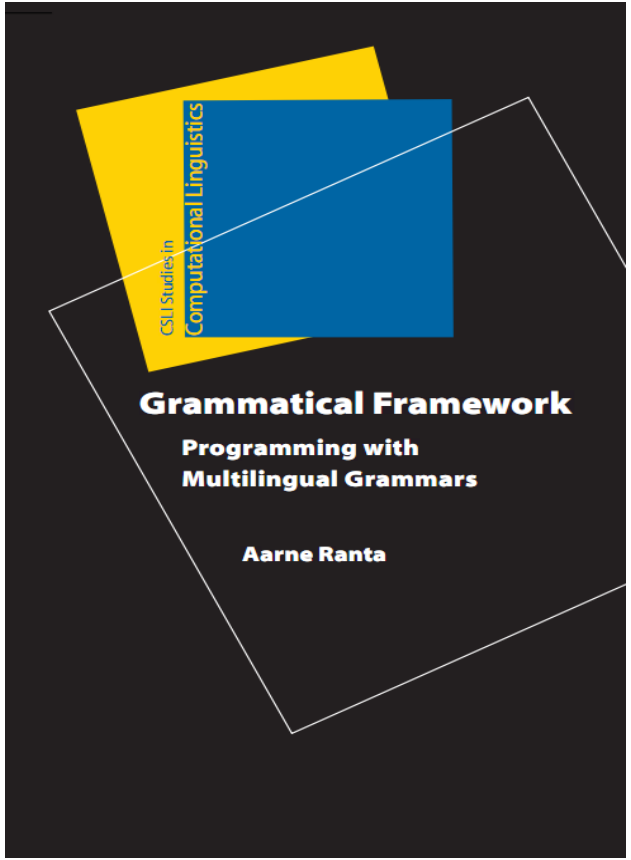
Hands-on lexicon project

Building Android applications

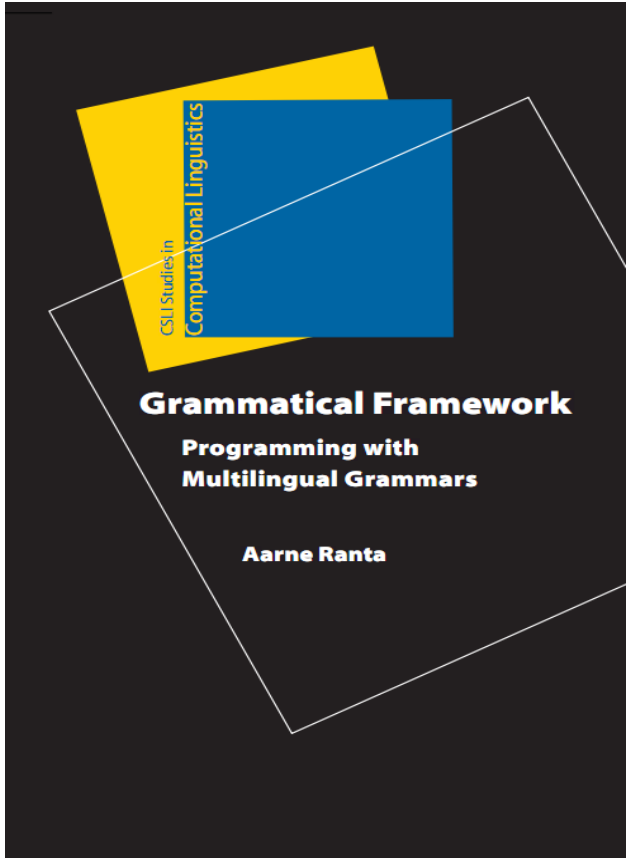
Evaluating translations

How to get started

2 . The GF Book



CSLI, Stanford, 2011



CSLI, Stanford, 2011

语法框架

为多种自然语言语法编程

Grammatical Framework

Programming with Multilingual Grammars

[瑞典] Aarne Ranta 著

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How to get started

3 . Install GF

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4 . The `gf-dev` group

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5 . GF Summer School

Barcelona, 2011

Bayern, 2013

Göteborg, 2009

Next Summer School:
Malta, 2015

谢谢！ / 多謝！