Time Group Analyzer (TGA)

TGA: An Online Tool for Time Group Analysis

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Time Group Analyzer: Summary

- TGA specifications
  - Requirements, design, implementation
- Design and Implementation
- TGA Input, screenshot
- TGA Output (CGI response)
  - text extraction
  - syllable duration statistics reports
  - Duration Bars & Duration Difference Tokens
  - DDTs, DBs and Time Tree bracketing, DDT n-gram count
  - induced Time Tree
  - Wagner Quadrant Plot
- Pubished applications: example
- Planned: NLP applications, box plots

TGA specifications

- Requirements specification
- Design and implementation
- Input parameters
- Outputs
- Applications

Requirements specification (1)

- Annotation mining: the extraction of information from annotations, e.g. Praat TextGrids.
- In speech technology, annotated data are generally mined (semi-)automatically and efficiently.
- In phonetics, manual or semi-manual mining is common but inefficient:
  - copying Praat information into a spreadsheet
  - defining functions sich as nPVI in the spreadsheet
  - calculating and generating graphics
- In phonetics and linguistics there is a need for faster and more consistent mining of larger numbers of annotated (e.g. TextGrid) files, without necessarily working with programming experts

Requirements specification (1)

The Time Group Analyzer (TGA) is designed to support phoneticians by automatizing a wide range of relevant computational tasks:

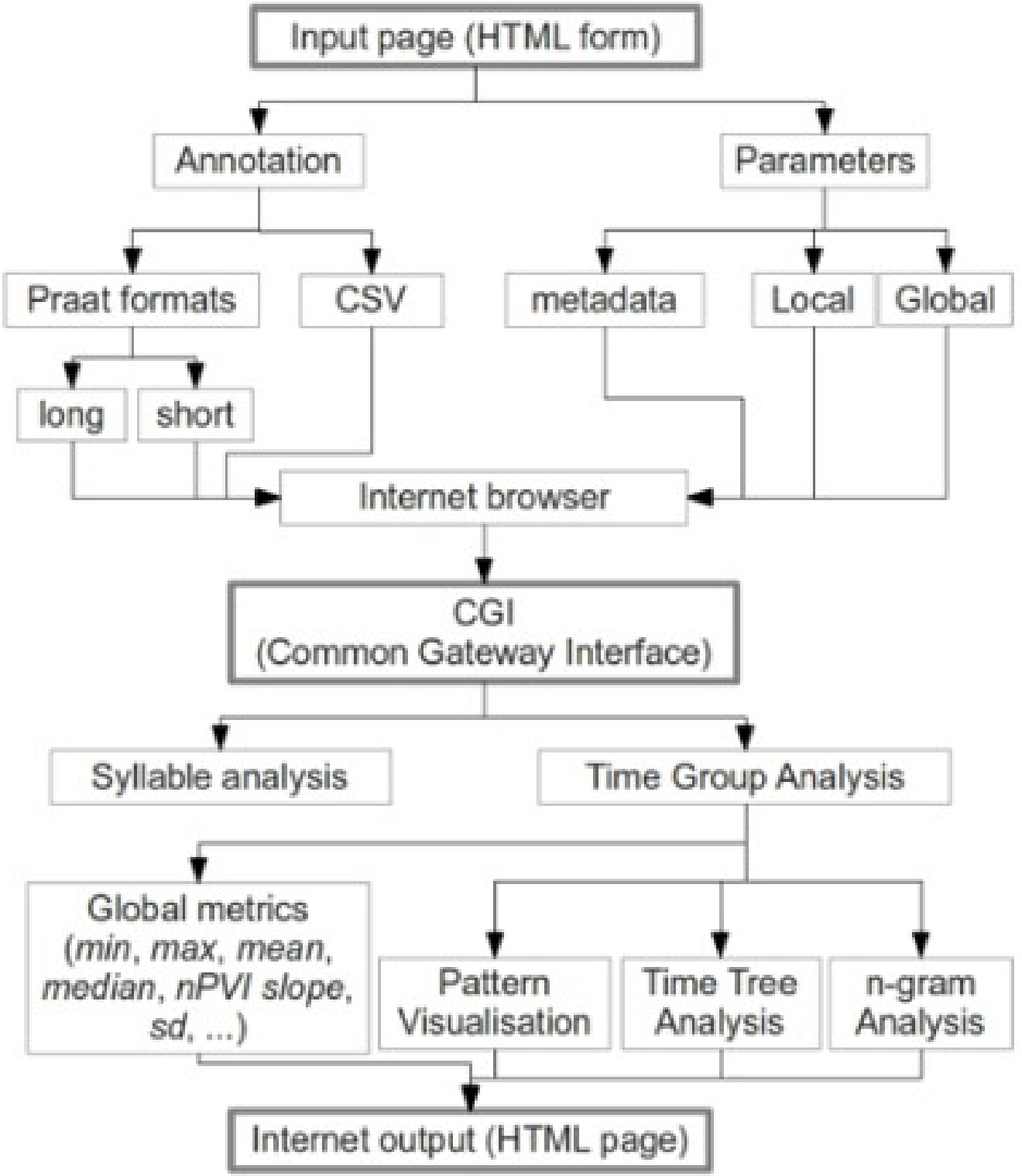
- duration extraction from TextGrids to table format,
- basic descriptive statistics, slope, nPVI …,
- novel visualisations of timing structure:
  - global acceleration/deceleration patterns
    - local acceleration/deceleration (trochaic/iambic, shorter/longer) Duration Difference Tokens (DDTs) and DDT sequences, for study of rhythm
  - Time Trees, for comparison of timing with grammatical structure
  - Wagner Quadrant plots
  - Box plots of unit durations

Design and Implementation (1)

- Software Development Environment:
  - HTML, CGI, Python 2.7
- Input:
  - Praat TextGrid (long or short),
  - CSV (Character Separated Values, with various separator chars).
- Output:
  - HTML with text, syllable propertues, interpausal group statistics, Difference Tokens, Time Trees
  - CSV for further processing.

Design and Implementation (2)

TGA dataflow



TGA Input Parameters

- Input form
  - Input control parameter choices
  - Time Group duration difference parameters
  - TextGrid (long or short) or CSV file
- Output parameter choices
  - Statistics
    - Global (for entire file)
    - Local (for each time group)
  - Visualisations
    - Local (Duration Bars, Duration Difference Tokens)
    - Global (Wagner Quadrant Plots; sequence plots)

TGA Input Form: screenshot

TextGrid input control parameters (long or short TextGrid format accepted; only Interval Tiers, obviously)

Tier name: Syllables (max length 20; not needed for CSV formats)

Pause symbol: _ (max length 20; also needed for CSV formats)

More than one pause symbol permitted; separate with spaces. Delete any of the examples which might occur as an annotation label. If your pause symbol is not in the examples given, enter it

Time Group duration difference parameters:

TG criterion: ◉ *pausegroup* ○ *deceleration* (increasing) ○ *acceleration* (decreasing)

Local threshold: 10 ms (try values less than common syllable lengths, e.g. 0 ... 300 ms)

Used for local pattern extraction and TimeTree parsing.

Local pattern symbols: **Longer:** \ (1 char) **Shorter:** / (1 char) **Same:** = (1 char)

Time Tree criterion: ○ *(quasi-)iambic TTgt* ○ *(quasi-)trochaic TTlt* ◉ *show all TT*
○ *(quasi-)iambic TTgte* ○ *(quasi-)trochaic TTlte* ○ *do not show TT*

Global TG threshold range: 90 ... 120 ms (minimal duration difference)

Ranges > 30 are not permitted because of possible server overload.
Global threshold is ignored with the 'pausegroup' criterion.
Experiment with values from 0 to 500 (negative values are permitted).
Equal range boundaries are adjusted to have range of 1, not null; if necessary values are switched to ensure 'low before high'.

Min TG length: > 2 (generally >2, as 'minimal rhythm')

Time Group output control parameters:

Print text?	◉ *no* ○ *yes*	***n*-grams?**	◉ *no* ○ *yes*	**All outputs:**	○ *no* ◉ *yes*
TG element info?	◉ *no* ○ *yes*	**Time Trees?**	◉ *no* ○ *yes*		
TG detail?	◉ *no* ○ *yes*	**CSV output?**	◉ *no* ○ *yes*		

TGA Input Form: parameter choices

- Input control parameter choices
  - Textgrid tier name selection (e.g. 'Syllables', 'syllable', 'syll' - the tier can also be other items than syllables)
  - Pause symbol selection (e.g. '_', 'p', 'sil') for segmenting into interpausal groups
- Time Group duration difference parameters:
  - Local TG threshold: sets the minimal difference (in ms) which counts as a difference; any difference below this threshold counts as equal duration
  - Local TG pattern symbols: select the symbols used for longer, shorter and equal duration difference relations ('duration difference n-grams')
  - Global threshold range: for time group induction
  - Minimum TG length in syllables (e.g. 2, 3)

TGA Input Form: parameter choices

- Output control parameter choices
  - Text extracted from labels
  - General information about TG elements
    - descriptive statistics, nPVI, regression slope and intercept
  - Details about individual interpausal groups:
    - descriptive statistics
    - visualisation:
      - Duration Difference Token (DDT) sequences
      - Time Trees (TT) types
  - DDT n-grams
  - TT types
  - Conversion of input TextGrid to Character Separated Value (CSV) format

TGA Output (CGI response)

- Text extraction
- Statistics
- Time Group visualisations
  - DDT n-grams (local threshold dependent)
  - Time Trees (four types; local threshold dependent)
- TextGrid input format reformatted as tables in Character Separated Value (CSV) format

TGA Output: text extraction

_
'mO: 'nju:z @ 'baUt D@ 're vr@n 'sVn 'mjVN 'mu:n _
'faUn d@ r@v D@ ,ju: nI fI 'keI Sn 'tS3:tS _
'hu:z 'kV r@nt lI In 'dZeIl _
f@ 't{ks I 'veI Zn _

Extract from first annotation file in Aix-MARSEC corpus

TGA Output: syllable duration properties

Duration properties (syllables)

Attributes	Values	Attributes	Values
n:	31	intercept:	192.177
min:	50	slope:	0.242
max:	500	std:	102.258
mean:	195.81	nPVI:	54
median:	160.0	rPVI:	97
total:	6070	100*rPVI/med:	61
range:	450	nPVI*med/100:	86

TGA Output: four dispersion measures

$$PIM(I_{1,\ldots n}) = \sum_{i \neq j} \left| \log \frac{I_i}{I_j} \right|$$

$$PFD(foot_{1\ldots n}) = \frac{100 \times \sum \left| MFL - len(foot_i) \right|}{len(foot_{1\ldots n})}$$

$$\text{where MFL} = \frac{\sum_{i=1}^{n} len(foot_i)}{n}$$

$$rPVI(d_{1\ldots m}) = \sum_{k=1}^{m-1} \left| d_k - d_{k+1} \right| / (m-1)$$

$$nPVI(d_{1\ldots m}) = 100 \times \sum_{k=1}^{m-1} \left| \frac{d_k - d_{k+1}}{(d_k + d_{k+1})/2} \right| / (m-1)$$

TGA Output: overall statistics summary

Summary table of global and accumulated TG duration functions (some do make sense...)
Time Group criterion: pausegroup, local threshold: 10, Min valid TG length: 2
Only inter-pause intervals measured; pauses not included

Overall duration:	6070	Overall raw longer, ms:	1510	Overall raw shorter, ms:	1410
Overall min:	50.00	Overall max:	500.00	Overall range:	450.00
Valid Time Groups:	4	Overall rate/sec:	5.11		

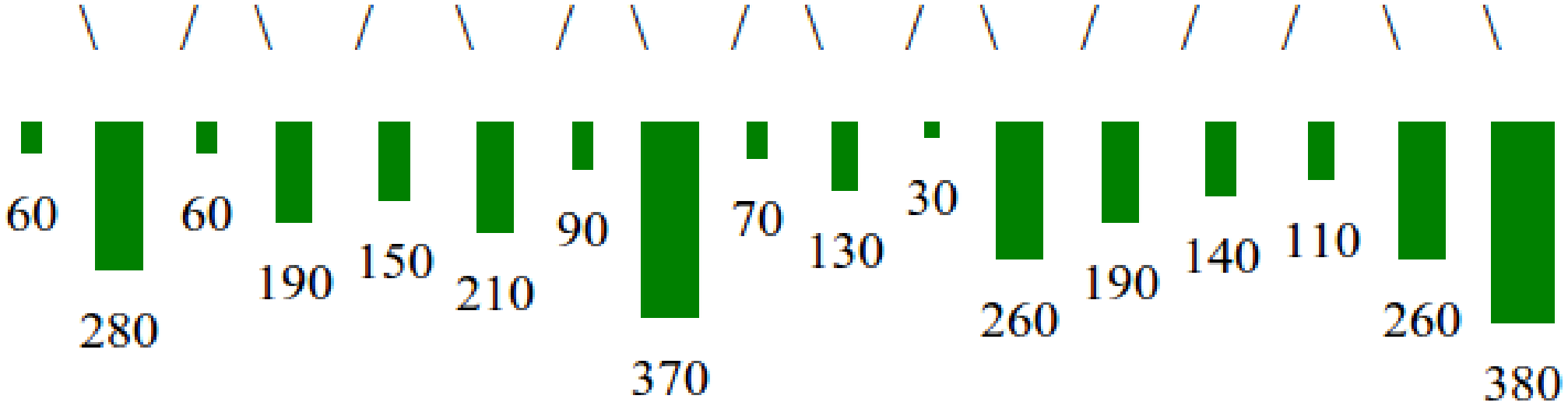
Components: global tendencies

Overall mean:	195.81	Overall median:	160.00	Overall SD:	102.26
Overall npvi:	54.00	Overall intercept:	192.18	Overall slope:	0.24
Mean of means:	196.00	Median of means:	194.50	SD of means:	23.89
Mean of medians:	187.50	Median of medians:	170.00	SD of medians:	43.95
Mean of SDs:	93.25	Median of SDs:	89.12	SD of SDs:	18.97
Mean of nPVIs:	58.00	Median of mnPVIs:	52.00	SD of nPVIs:	5.59
Mean of intercepts:	154.94	Median of intercepts:	137.78	SD of intercepts:	56.84
Mean of slopes:	7.52	Median of slopes:	9.90	SD of slopes:	14.97

Components: correlations

mean::TGdur:	0.384	median::TGdur:	-0.296	SD::TGdur:	0.935
nPVI::TGdur:	-0.623	slope::TGdur:	0.875	intercept::TGdur:	-0.762
nPVI::mean:	0.408	slope::mean:	-0.020	intercept::mean:	0.288
nPVI::median:	0.931	slope::median:	-0.710	intercept::median:	0.832
nPVI::SD:	-0.317	slope::SD:	0.666	intercept::SD:	-0.483

TGA Output:
Duration Difference Tokens and Duration Bars



Duration Difference Tokens:

/ long-short
\ short-long
= equal

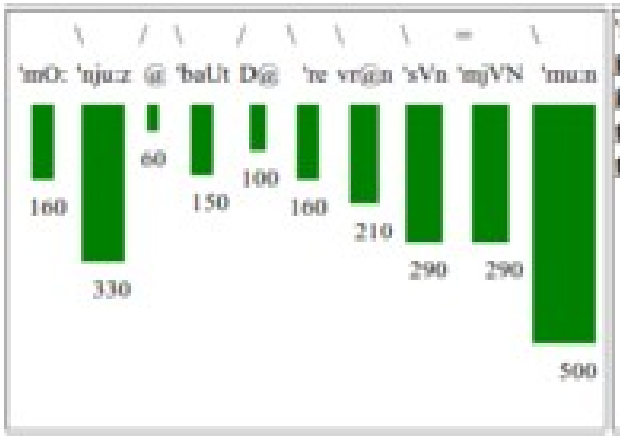
Identification depends on local duration difference threshold.

Duration Bars:

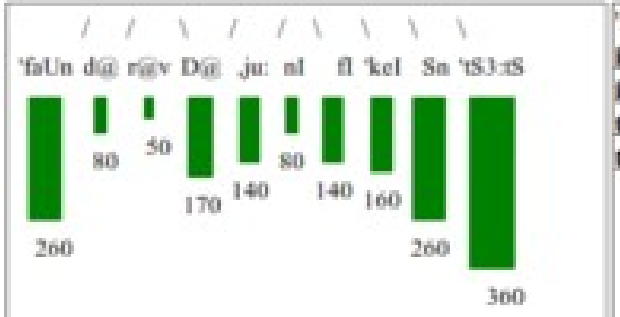
Linear relations to durations for both width and length.
Eyeball impression of rhythm, rate change, final lengthening...

Inspect the relation between DDTs and DBs directly.

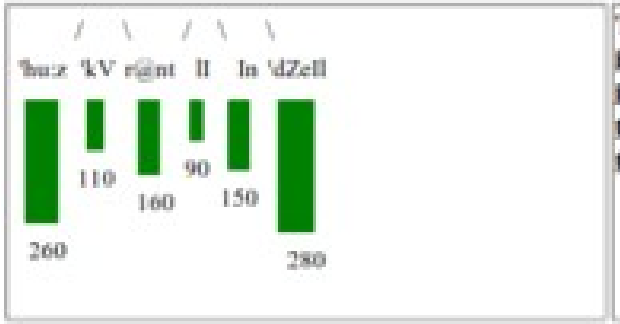
TGA Output: DDTs, DBs and Time Tree bracketing



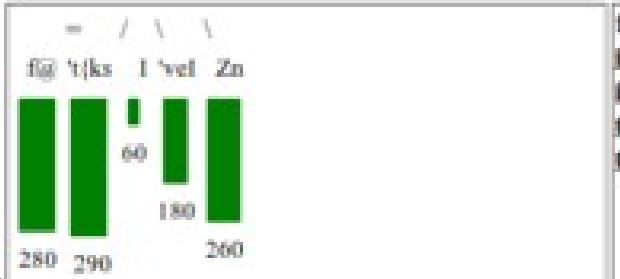
'mO::160 'nju:z:330 @:60 'baUt:150 D@:100 're:160 vr@n:210 'sVn:290 'mjVN:290 'mu:n:500 **PAUSE**:117 #
iambicTTgt: (('mO: 'nju:z) ((((@ 'baUt) ((D@ 're) vr@n)) 'sVn) ('mjVN 'mu:n)))
iambicTTgte: ('mO: 'nju:z @ 'baUt D@ 're vr@n ('sVn 'mjVN) 'mu:n **PAUSE**)
trochaicTTlt: (('mO: ('nju:z @)) ('baUt D@) ('re (vr@n ('sVn ('mjVN ('mu:n **PAUSE**))))))
trochaicTTlte: ('mO: 'nju:z @ 'baUt D@ 're vr@n 'sVn 'mjVN 'mu:n **PAUSE**)



'faUn:260 d@:80 r@v:50 D@:170 ,ju::140 nl:80 fl:140 'kel:160 Sn:260 'tS3:tS:360 **PAUSE**:184 #
iambicTTgt: ('faUn (((d@ (r@v D@)) ((ju: ((nl fl) 'kel)) Sn)) 'tS3:tS))
iambicTTgte: ('faUn d@ r@v D@ ju: nl fl 'kel Sn 'tS3:tS **PAUSE**)
trochaicTTlt: ((('faUn d@) r@v) ((D@ ju:) nl) fl 'kel (Sn ('tS3:tS **PAUSE**)))
trochaicTTlte: ('faUn d@ r@v D@ ju: nl fl 'kel Sn 'tS3:tS **PAUSE**)



'hu:z:260 'kV:110 r@nt:160 ll:90 ln:150 'dZell:280 **PAUSE**:30 #
iambicTTgt: ('hu:z (('kV r@nt) ((ll ln) 'dZell)))
iambicTTgte: ('hu:z 'kV r@nt ll ln 'dZell **PAUSE**)
trochaicTTlt: ((('hu:z 'kV) (r@nt ll)) (ln ('dZell **PAUSE**))))
trochaicTTlte: ('hu:z 'kV r@nt ll ln 'dZell **PAUSE**)



f@:280 't{ks:290 I:60 'vel:180 Zn:260 **PAUSE**:674 #
iambicTTgt: (f@ ('t{ks (((I 'vel) Zn) **PAUSE**)))
iambicTTgte: (f@ 't{ks I 'vel Zn **PAUSE**)
trochaicTTlt: ((f@ ('t{ks I)) 'vel Zn **PAUSE**)
trochaicTTlte: (f@ 't{ks I 'vel Zn **PAUSE**)

TGA Output: DDT *n*-gram count

Difference digram ranks and counts (n=270):

1.[22%(60):/\] **2.**[20%(55):\/] **3.**[11%(31):\\] **4.**[9%(24):\}] **5.**[6%(17):{\] **6.**[6%(15)://] **7.**[5%(14):{/] **8.**[4%(11):=\] **9.**[4%(11):/=] **10.**[3%(9):\=] **11.**[3%(8):=/] **12.**[2%(6):/}] **13.**[1%(4):=}] **14.**[1%(3):{=] **15.**[1%(2):==]

Summary:

42% alternations in the top 2 places

Next step:

Check DDT trigrams etc. for /\/, \/\, /\\, \// etc.

Note:

DDT *n*-gram identification is determined by the *local threshold*

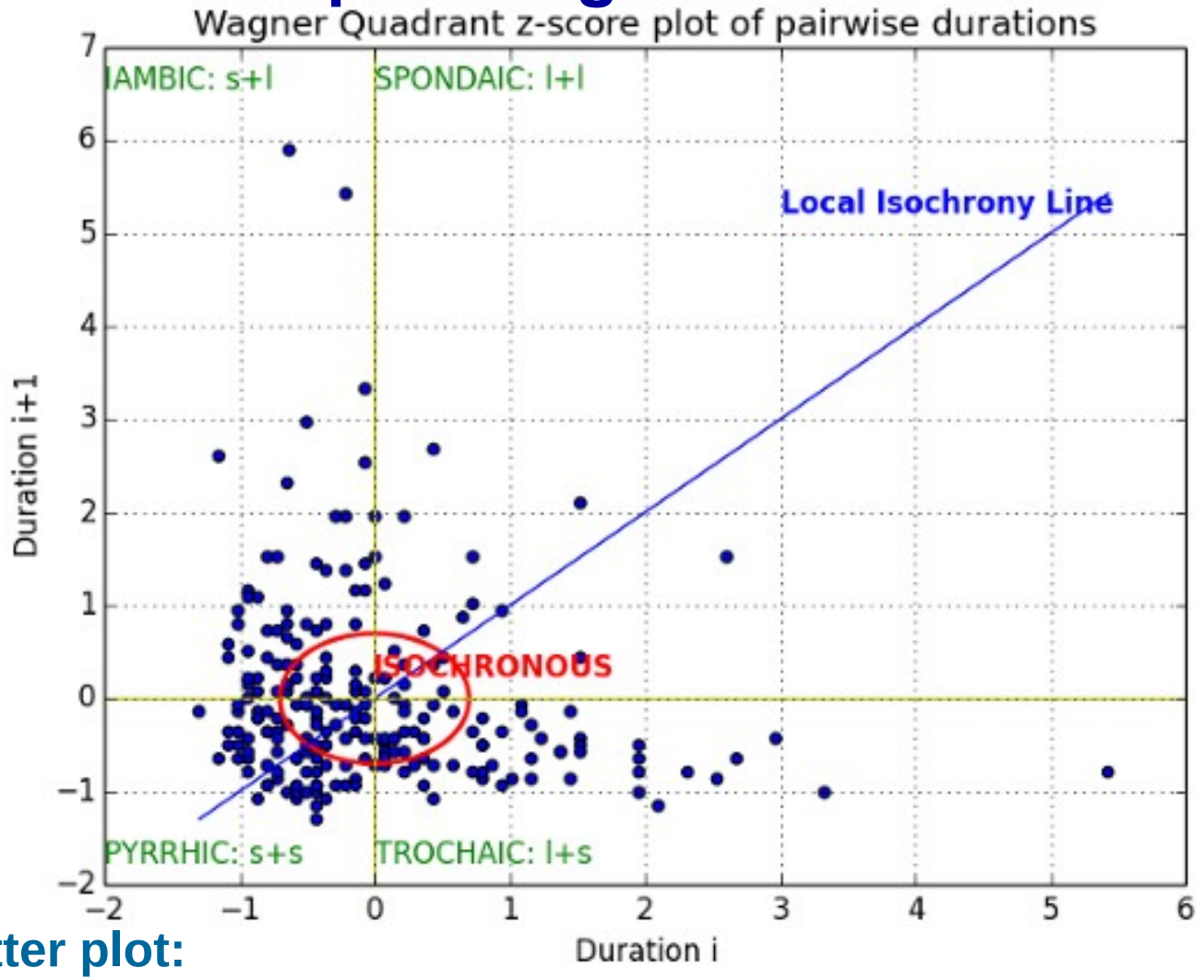
TGA Output: induced Time Tree

```
(((@   'baUt)
      ((('{N   glI)
            (kn   {m))
          ('bI   vl@ns)))
      ((((t@   D@)
            ('brI   tIS))
          (('kaUn
              (sl
                 (@v   'tS3:)))
           tSIz))
       PAUSE))
```

Time tree:

- Induced from digram duration relations
- Larger groupings inherit longest relation from constituent
- Parenthesis notation
- Python automatic prettyprint

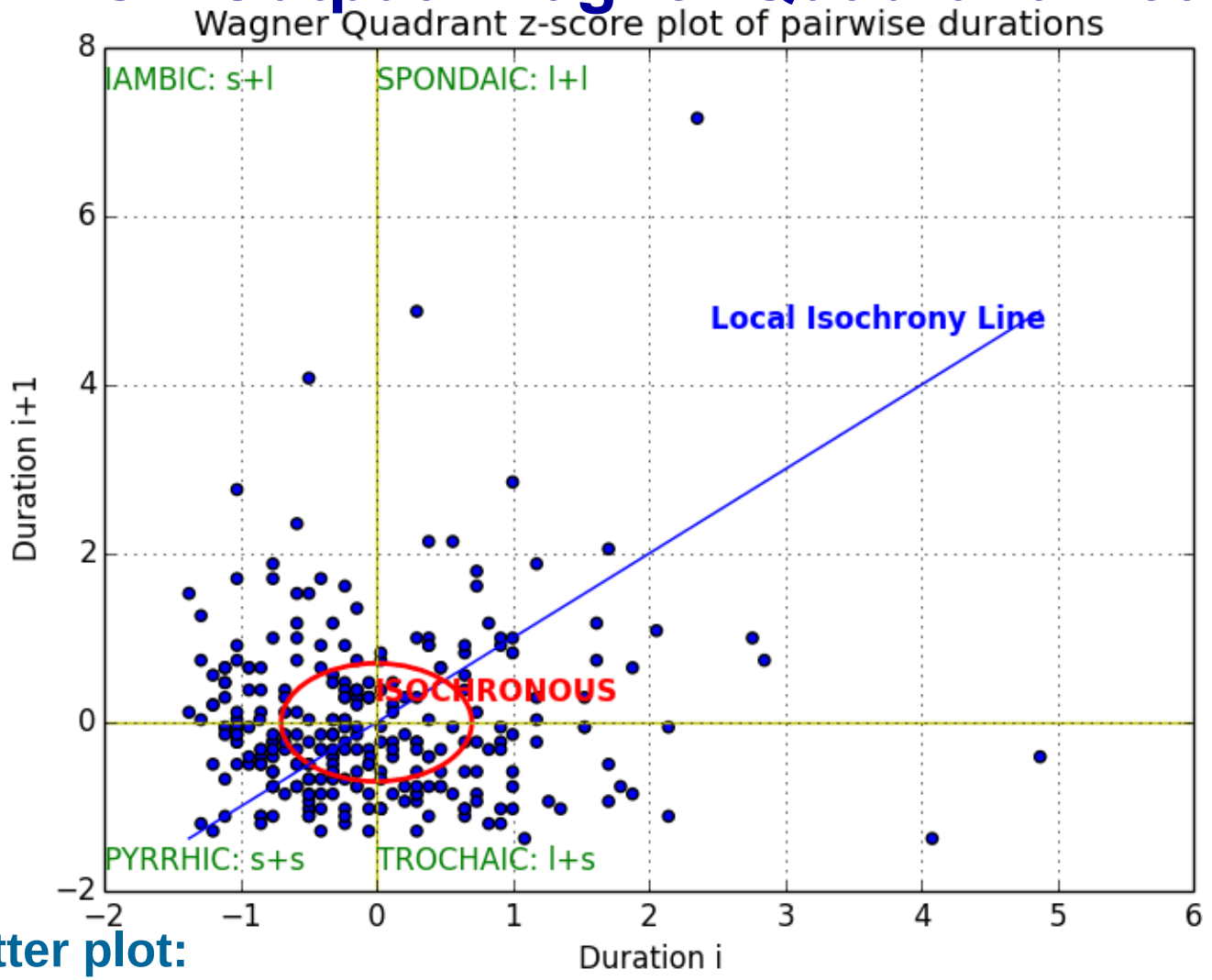
TGA Output: Wagner Quadrant Plot



Scatter plot:

- z-scores of durations
- duration relations d_i and d_{i-1} on X and Y axes
- syllable timing: typically random distribution
- foot/stress timing: typically 'L-shaped', as in this example (Aix-MARSEC genre G)

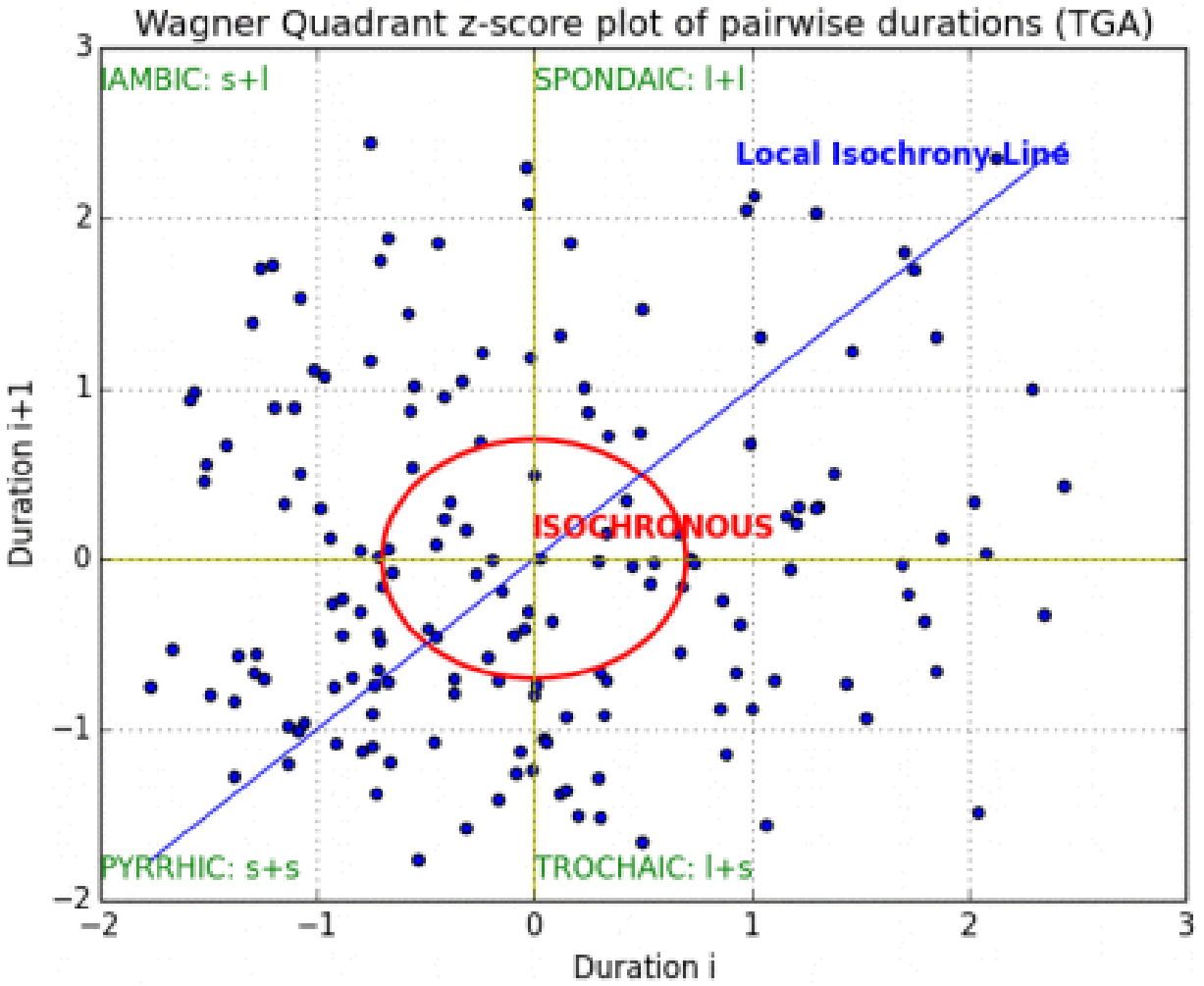
TGA Output: Wagner Quadrant Plot



Scatter plot:

- z-scores of durations
- duration relations d_i and d_{i-1} on X and Y axes
- syllable timing: typically random distribution
- foot/stress timing: typically ‘L-shaped’, as in this example (Aix-MARSEC all genres)

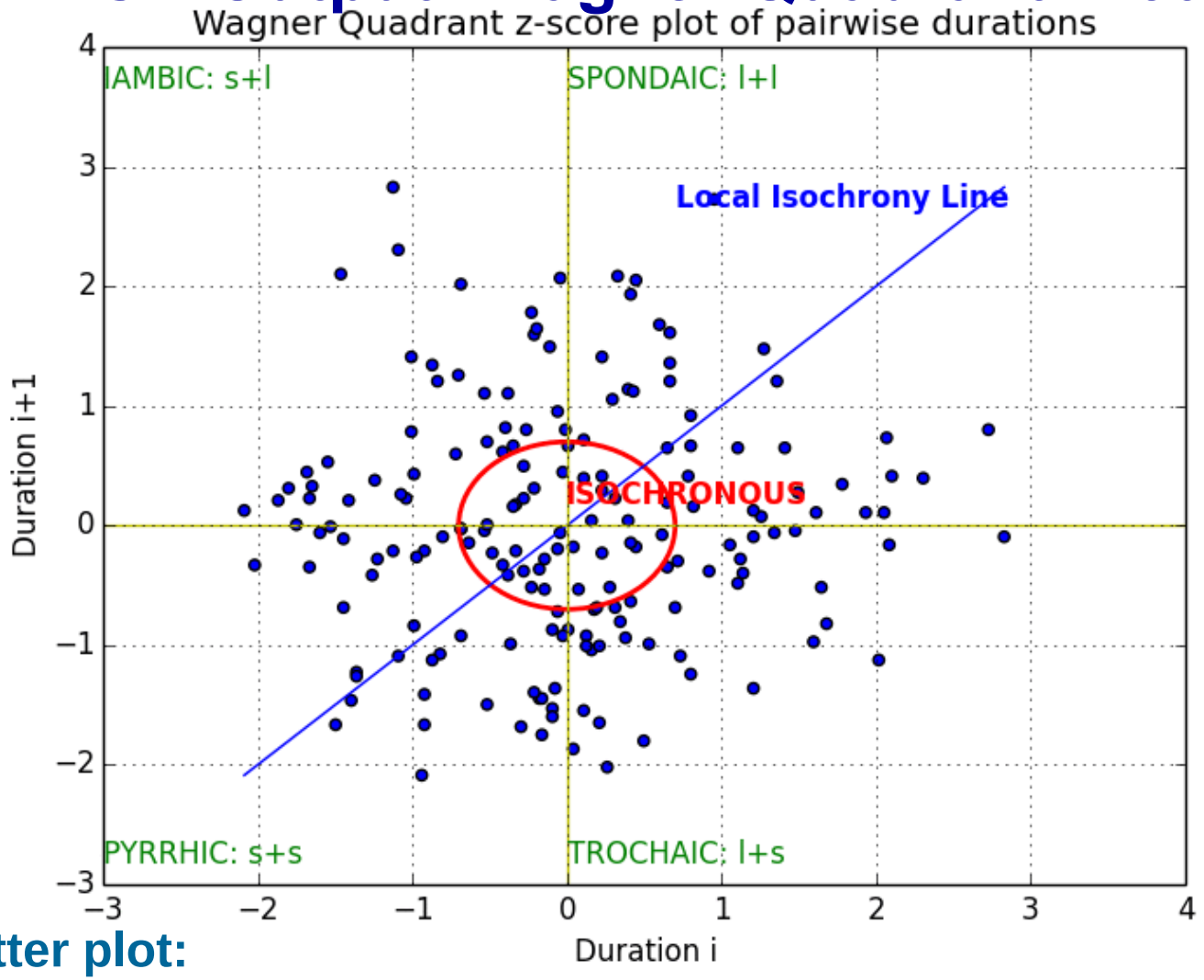
TGA Output: Wagner Quadrant Plot



Sca

- z-scores of durations
- duration relations d_i and d_{i-1} on X and Y axes
- syllable timing: typically random distribution
- toot/stress timing: typically ‘L-shaped’, as in this example
  (Mandarin L2 English – poor, advaiced; English native US)

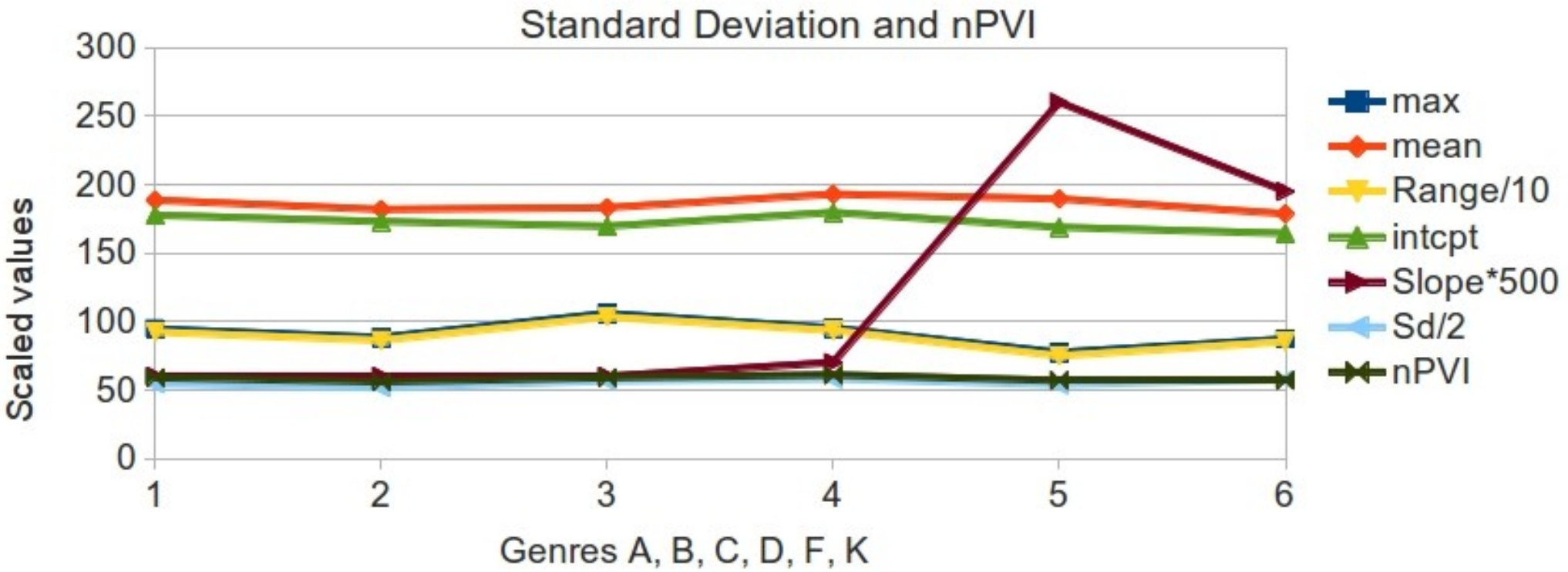
TGA Output: Wagner Quadrant Plot



Scatter plot:

- z-scores of durations
- duration relations d_i and d_{i-1} on X and Y axes
- syllable timing: typically random distribution
- foot/stress timing: typically ‘L-shaped’, as in this example (English – Mandarin - Tem)

Pubished applications: example



Comparison of different timing measures:

nPVI, SD, etc.

Planned: NLP applications; box plots

Computational linguistic applications:

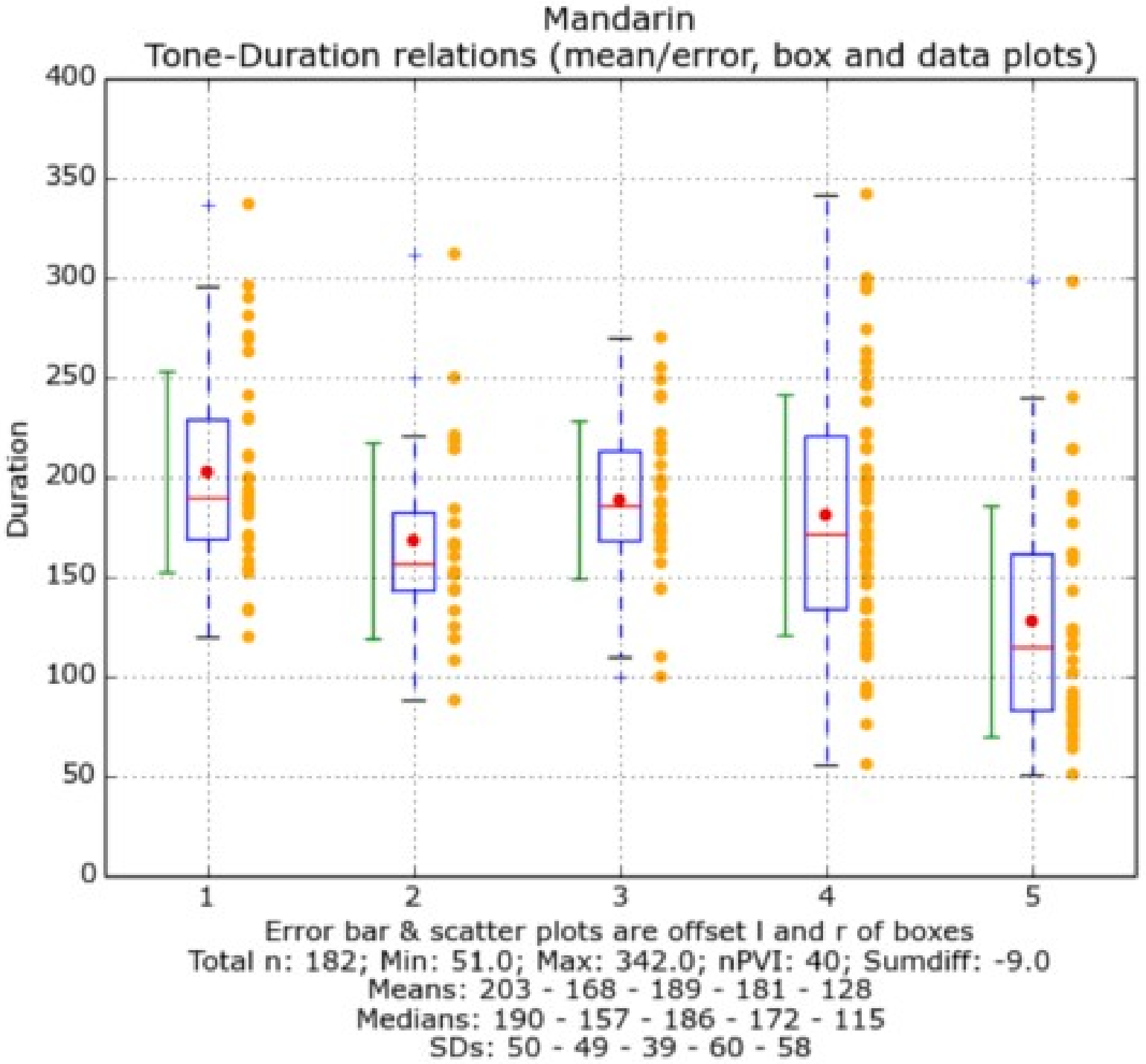
word frequency lists, concordance

New visualisations:

box plots

Example:

time-tone relations in Mandarin



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Time Group Analyzer: Bibliography

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