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# Fuori dalla torre di Babele: interoperabilità e sistemi grafici pre-moderni



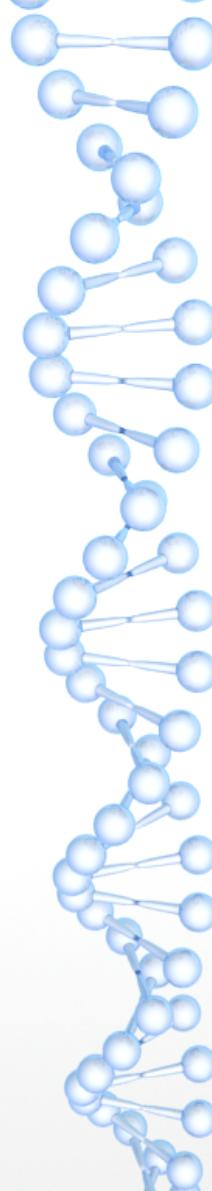
*Out of the Tower of Babel :  
interoperability and pre-modern  
writing systems*

December 4, 2019  
[ve]dph

Venice Centre for  
Digital and Public  
Humanities

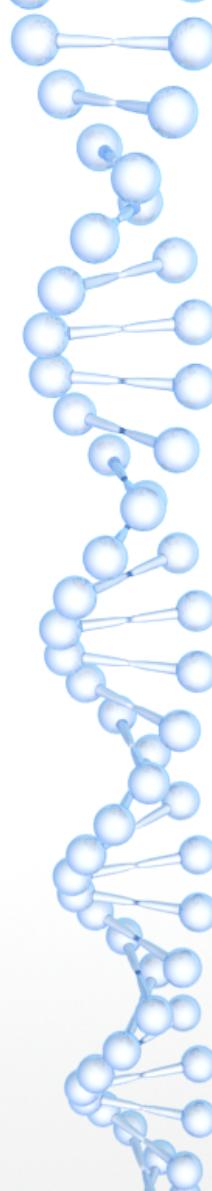


# The interoperability issue



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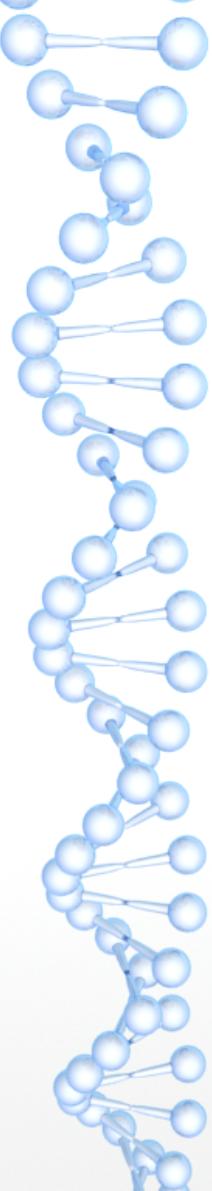
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# The interoperability issue

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- uenenū



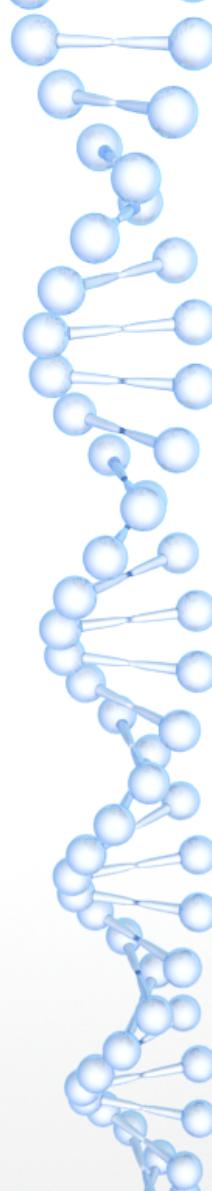
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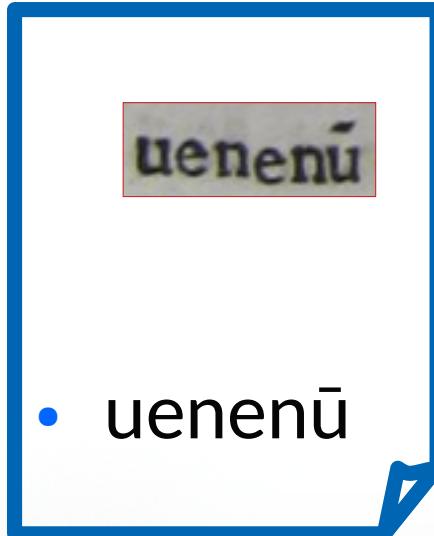
- uenenū

Diplomatic

- Historical documentation
- Visualization

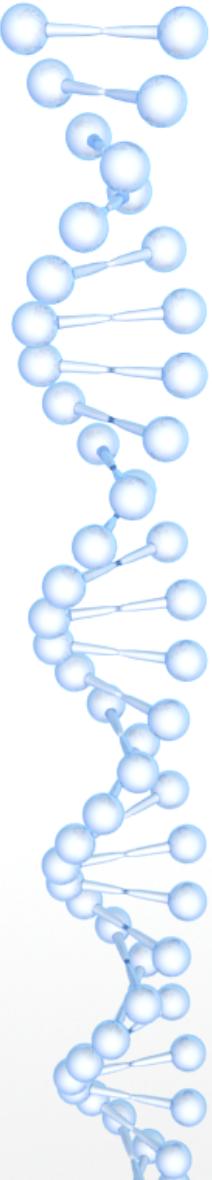


# The interoperability issue



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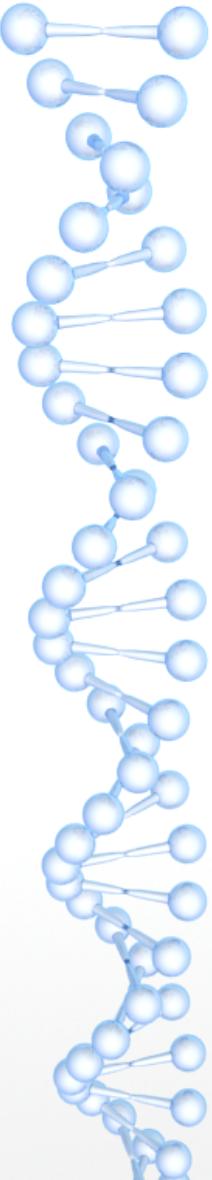


# The interoperability issue

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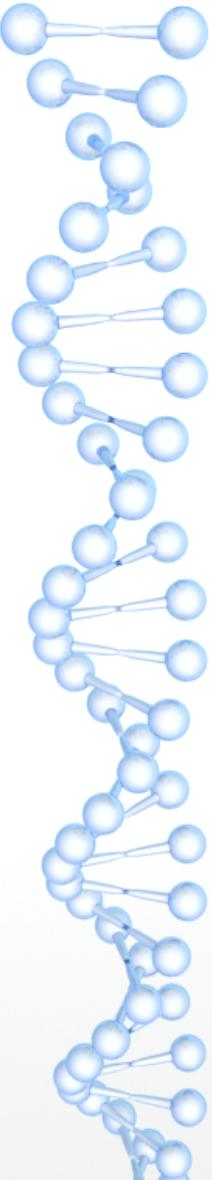
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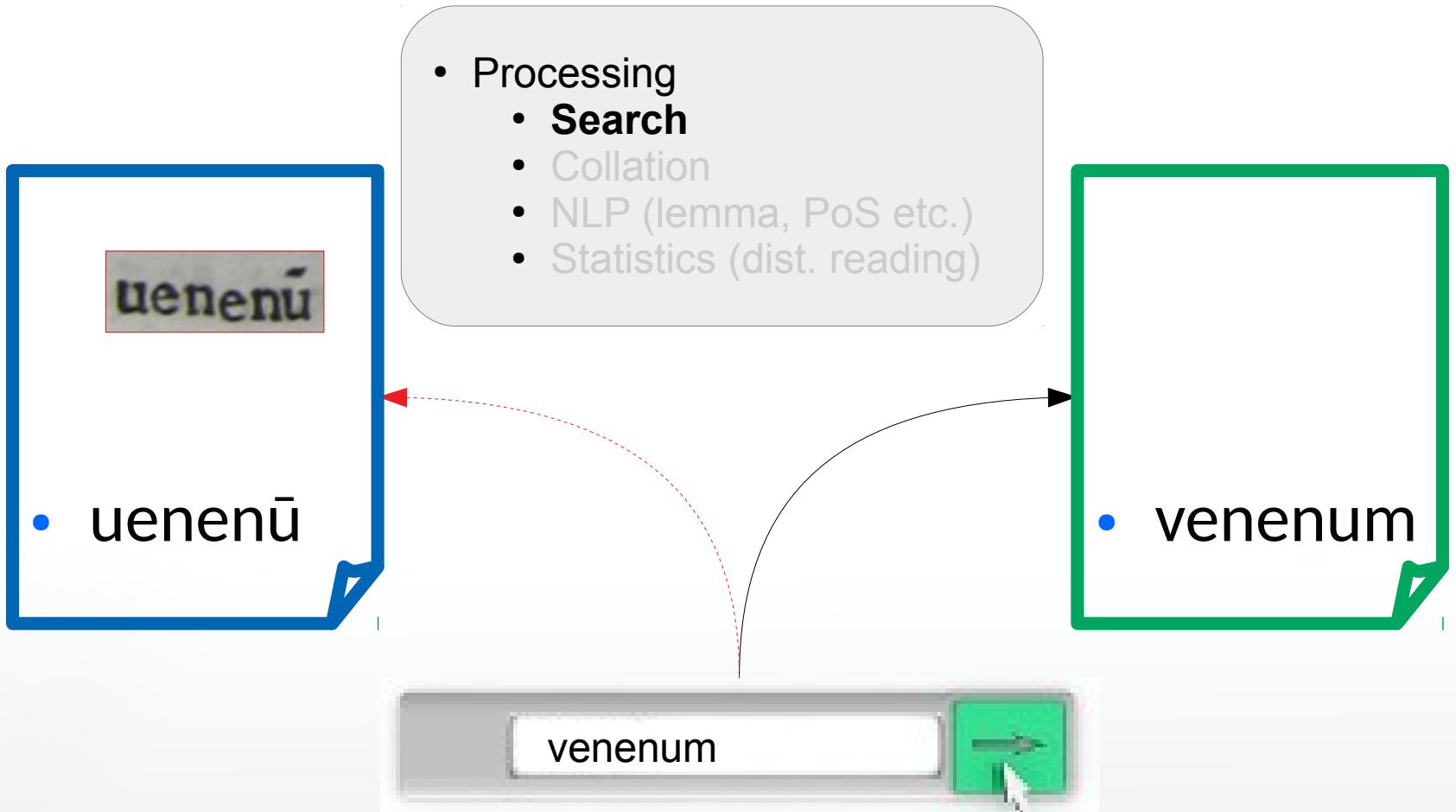
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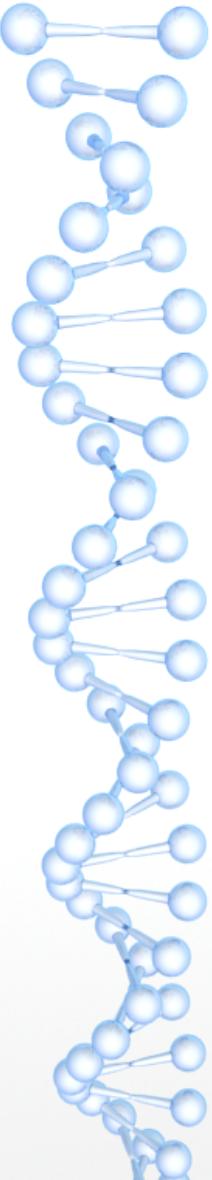
- Processing
  - Search
  - Collation
  - NLP (lemma, PoS etc.)
  - Statistics (dist. reading)

- venenum



# The interoperability issue





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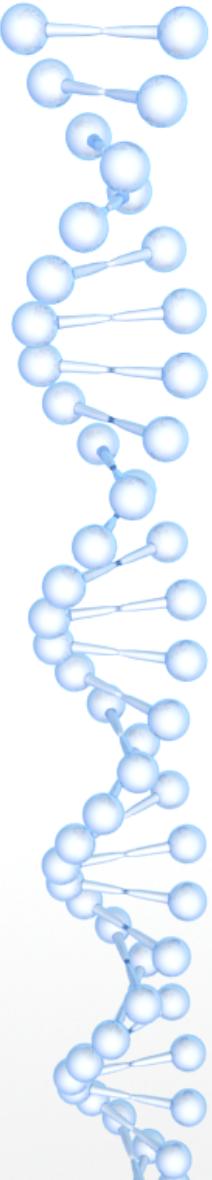
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  - Search
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- venenum

112 excedit] excedit corr. ex  
exceditis R n70  
114 obicitur] obiceretur V S n71  
114 sunt] sint S n72



# The interoperability issue

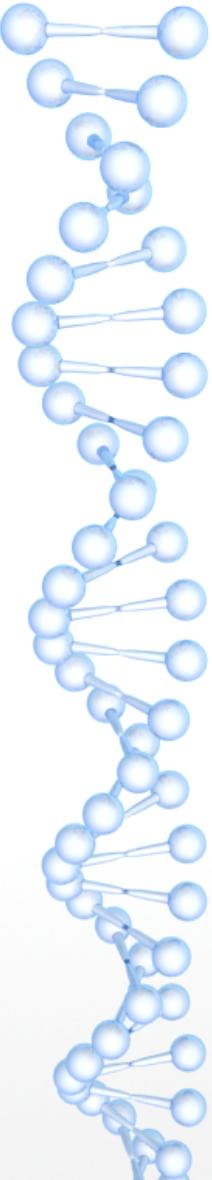
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focal plane n : the plane particular to the axis and passes through focal point n : the point was the focal point focal ratio n : F = fo'-c'sle var of FO 1fo'-c'us \fō-kəs\ \-sī\ [NL, fr. L which rays (as converge or appear to do

- venenum



# The interoperability issue

- Processing
  - Search
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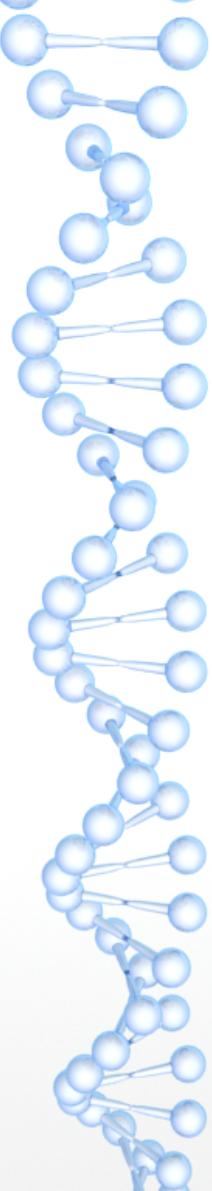
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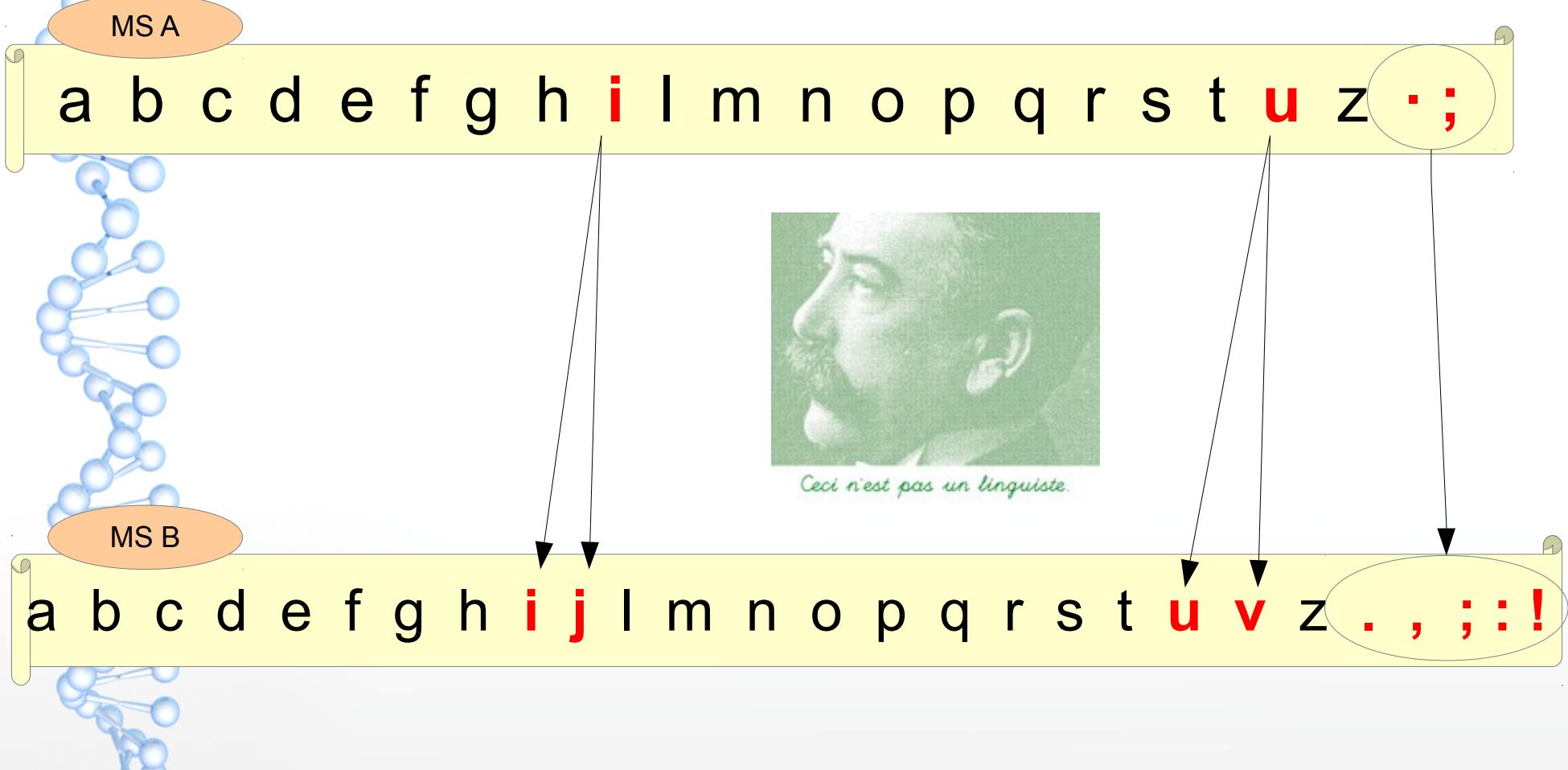




# The interoperability issue

- ***My focus: European Medieval handwriting***
- Pre-Gutenberg
  - Handwriting
  - Early print → imitating handwriting
- Alphabetic writing systems
  - **Latin** script (Italian, English...), Greek, Cyrillic...
  - No Cuneiform, Arabic, Chinese etc.

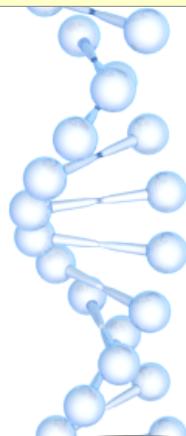
# The interoperability issue



# The interoperability issue

OCR from Teubner

a b c d e f g h i l m n o p q r s t u z . ;

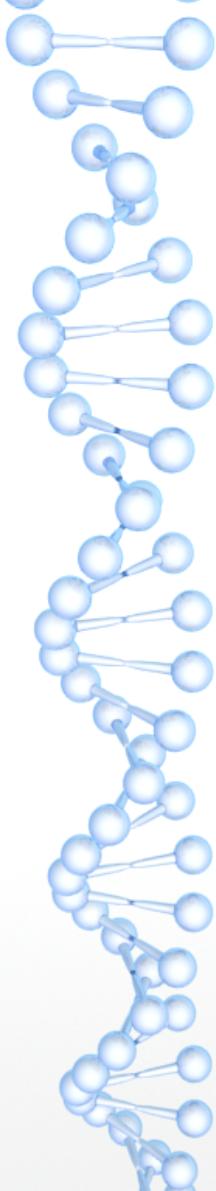


OCR from Loeb

a b c d e f g h i j l m n o p q r s t u v z . , ; !

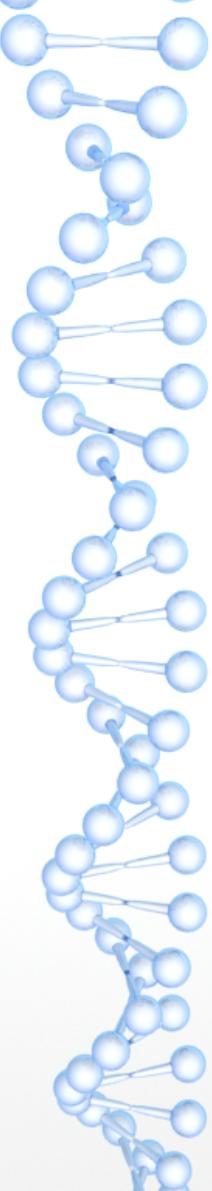


# **Out of the Tower**



# Unicode: the short way out (as TEI says)?

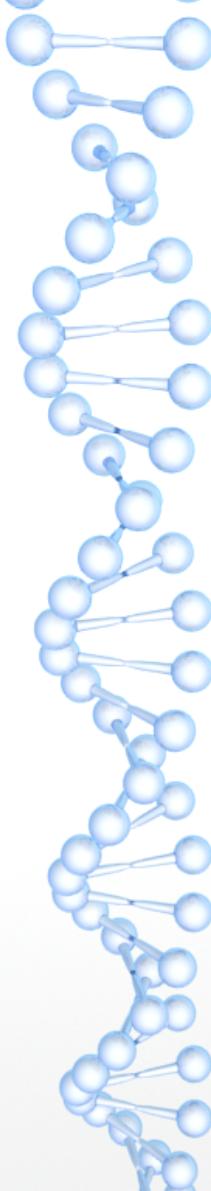
- Solution for new digital texts
- Not enough for pre-modern writing systems
  - Ligatures
    - & (U+0026; ASCII 38)
    - Have I encoded that it is equivalent to “e + t” in that MS?
  - Allographs
    - ſ (U+017F) / ſ (U+0073; ASCII 115)
    - Have I encoded that they are variants of grapheme <s>?
  - Grapheme set
    - u (U+0075; ASCII 117)
    - Have I encoded whether it “covers” (or not) <u> and <v>?
  -



# Project-specific solutions

- Disposable home-made solutions
  - TEI: theory-agnostic
  - *Diplomatic*: Modelling pre-modern writing systems
  - *Normalized*: Normalization models / software





# Diplomatic/normalized: the surrender?

- *venenum*

Normalized

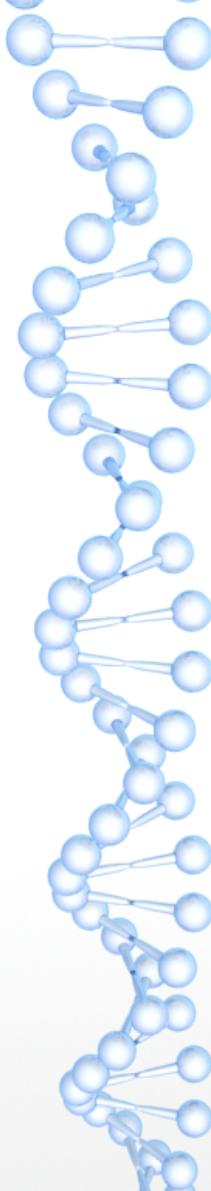
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- Processing
  - Search
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  - Statistics (distant reading)...

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Diplomatic

- Historical documentation
- Visualization



# Modelling: the (long) way out

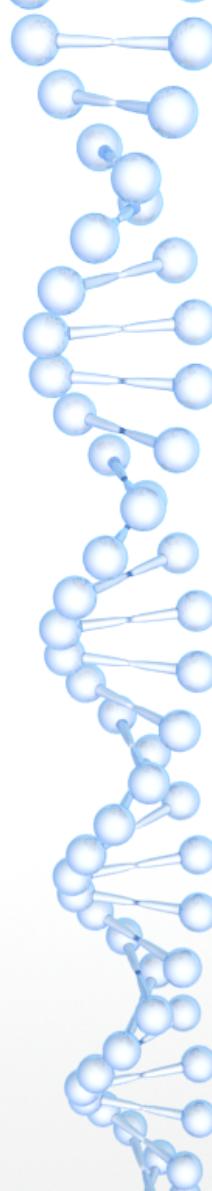


**WANTED**

**DEAD OR ALIVE  
REWARD  
\$4,000**

- Scholarly discussion on **modelling**
- Documentation on project-specific modelling
  - formal (data models, software code, tables)
  - prose
- Shared models
- Reusable **software** libraries

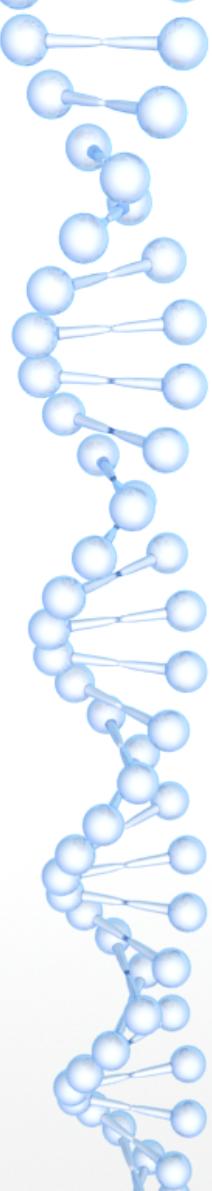
# In a nutshell



## In a nutshell

- The interoperability issue
- Interoperability through modelling
- Open issues

Diplomatic/normalized



# Diplomatic/normalized

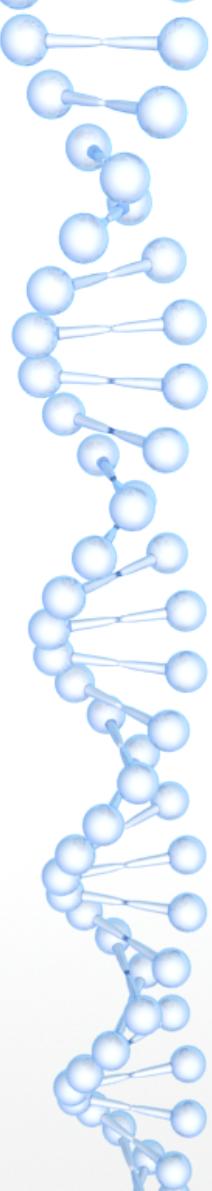
- *venenum*

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Diplomatic

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# Diplomatic/normalized

- *venenum*

Normalized

- Processing
  - Search
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**uenenū**

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Diplomatic

- Historical documentation
- Visualization

# Diplomatic/normalized

The Digital Vercelli Book beta

Magnifier HotSpot TextLink

DOTR 104v Diplomatic

1:1 27%

7 **þ**Wæt ic swefna

7 **þ**Wæt ic swefna cýjt secgan wylle hæt mege mætte  
8 to midre nihte syððan reord berend reste wunedon.  
9 þuhte me hæt ic ge fawe yllicre treow onlyft  
10 lædan leahtr be wunden beama beorhtoþt call hæt  
11 beacen wær be gotten mid golde gimmer flodon fiegere  
12 æt foldan sceatum . swylce hæt fife wæron uppe  
13 onfham eaxle ge fspanne be healdon þær engel dryht  
14 nef calle fiegere þurh forð ge sceaf newarð ðærhuru  
15 fracodes gealga . ȝachine hæt beheoldon halige gaſtar  
16 men ofer moldan ȝeall þeof mære ge sceaf ;  
17 Syllic wær je rige beam ȝic pynnū fih for wunded  
18 mid wommū ge seah ic wuldref treow. wædum geweor  
19 ðode wynnū scinan ge gyred mid golde gimmer hafdon  
20 be wrigene weorðlice wealdes treow ; hwæðre ic  
21 þurh hæt gold ongytan meahte earmra ærgewin  
22 hæt hit ærest ongan swartan on ha swiðran healf

<http://vbd.humnet.unipi.it/beta/#104v>

# Diplomatic/normalized

The Digital Vercelli Book beta

Magnifier HotSpot TextLink

DOTR 104v Interpretative

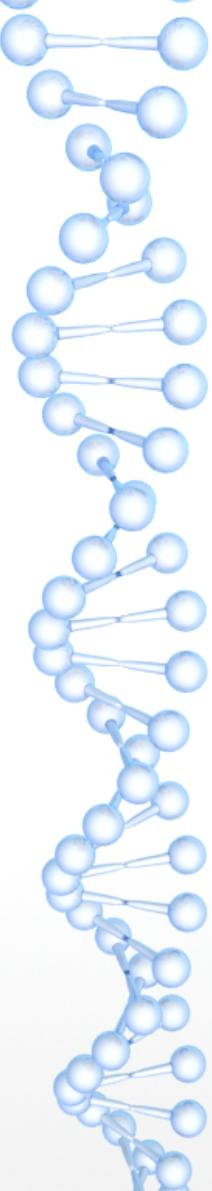
Diplomatic Interpretative

7 HWæt ic swefna cyst secgan wylle hæt me gematte  
8 to midre nihte syðan reordberend reste wunedon.  
9 þuhte me hæt ic gesawe syllcre treow on lyft  
10 lædan leohte bewunden beama beorhtost call hæt  
11 beacen was begoten mid golde gimmas stodon fægere  
12 æt foldan sceatum . swylce hæf fife weron uppe  
13 on þam eaxlegespanne beholdon hæf engel dryht  
14 nes ealle fægere þurh forigesceaft ne was ðær huru  
15 fracodes gealga . ac hine hæf beholdon halige gastas  
16 men ofer moldan and eall þeos mære gesceaft .  
17 Syllic was se sigebeam and ic synnum fah fwundene  
18 mid wommum geseah ic wuldres treow. wædum geweor  
19 ðode wynnum scinan gegyred mid golde gimmas hæfdon  
20 bewrigene weorðlice wealdes treow . hwædrc ic  
21 þurh hæf gold ongytan meahte earmra ærgewin  
22 hæf hit ærest ongan swætan on þa swiðran healfc

1:1 27%

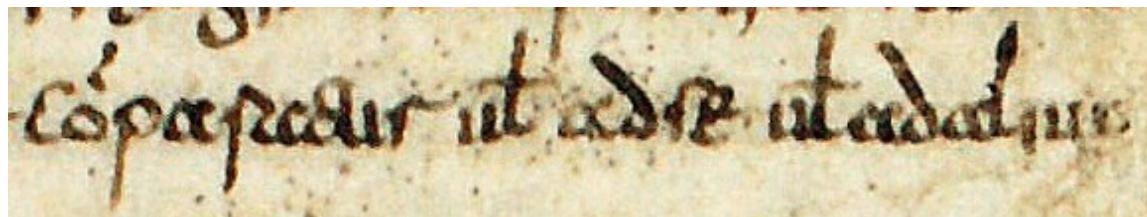
7 HWæt ic swefna

<http://vbd.humnet.unipi.it/beta/#104v>



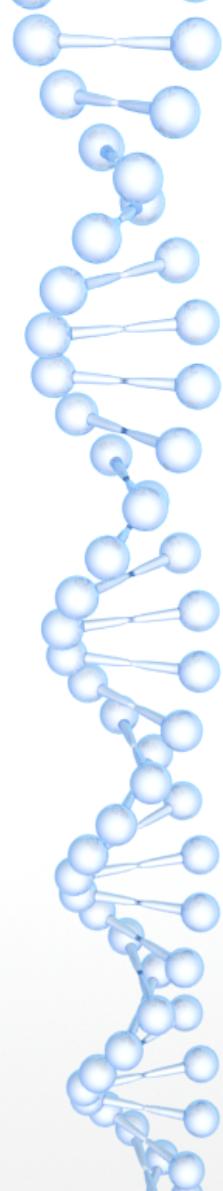
# Diplomatic/normalized

- Comparatur vel ad se vel ad alium



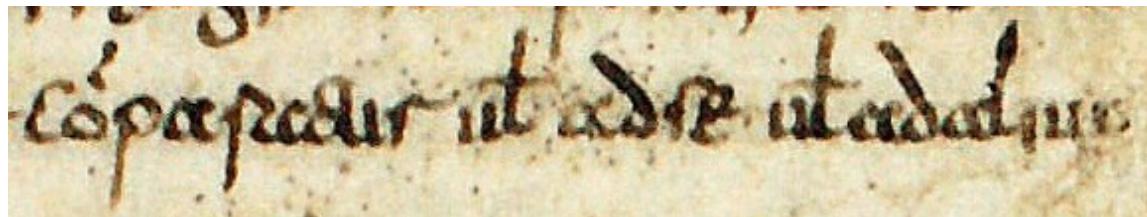
- cōparaEUR uł adfe uładalium

**What's “normal”?**

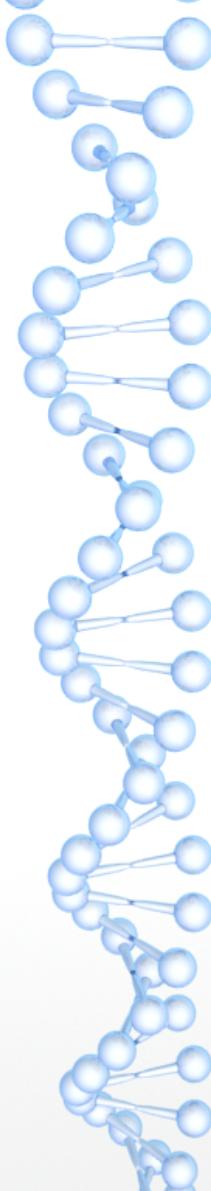


## What's “normal”?

- Comparatur vel ad se vel ad alium

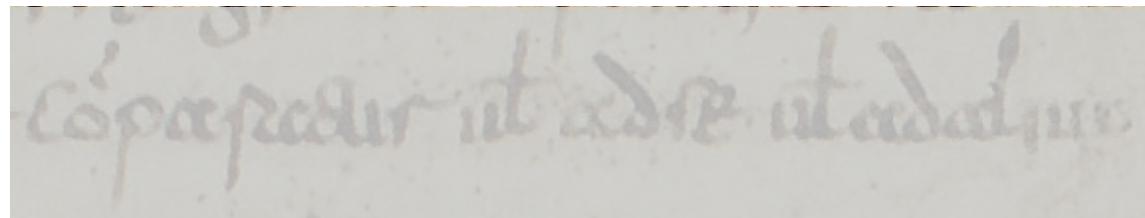


- cōparaEUR      uł adfe    uładalium

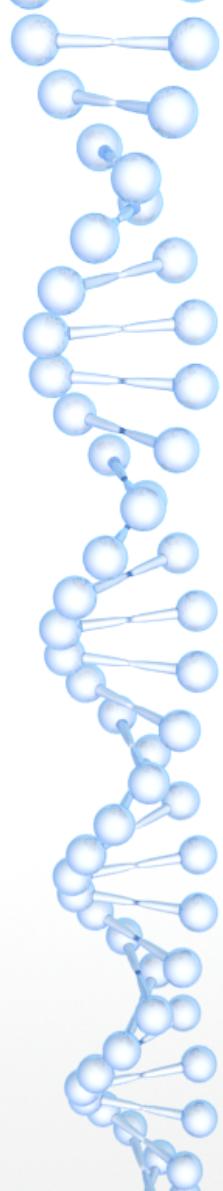


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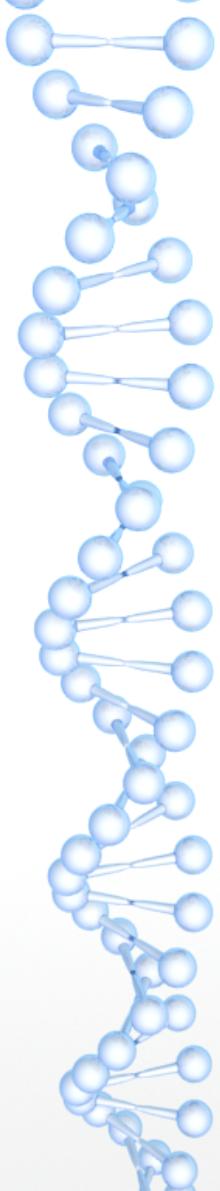


- cōparaEur uł adfe uładalium



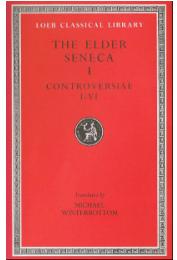
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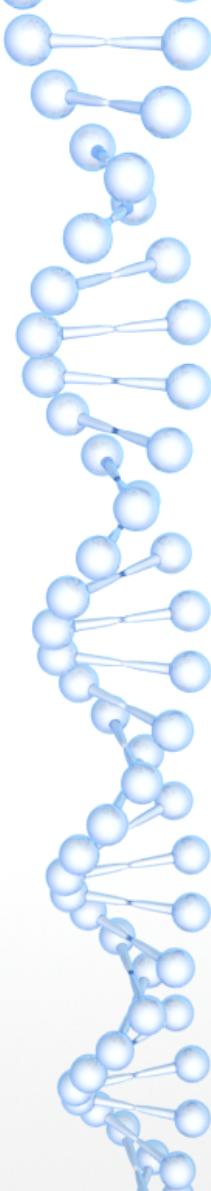
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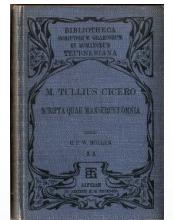
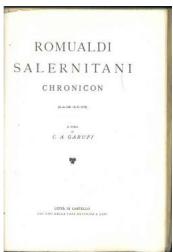
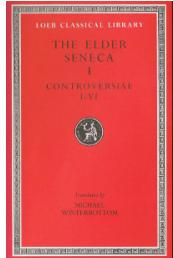
- *Vel comparatur ad se vel iam ad Valerium*

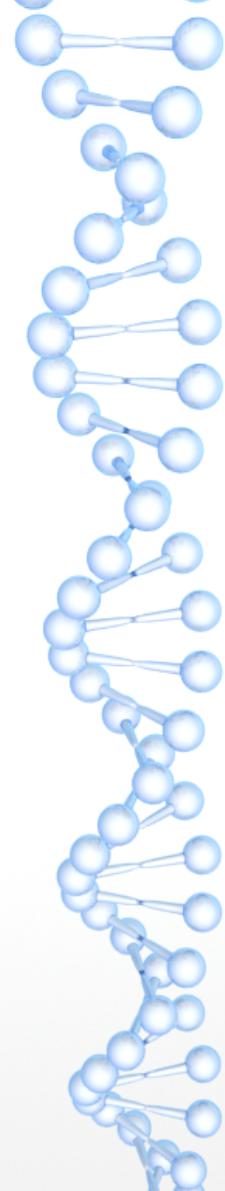




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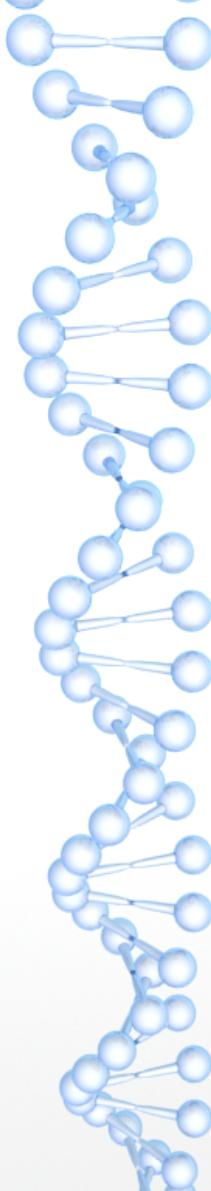
- Vel comparatur ad se vel **iam** ad Valerium
- Vel comparatur ad se vel **jam** ad Valerium
- **U**el comparatur ad se **uel** iam ad **U**alerium
- **V**el comparatur ad se **uel** iam ad **V**alerium
- **u**el comparatur ad se **uel** iam ad **V**alerium





## What's “normal”?

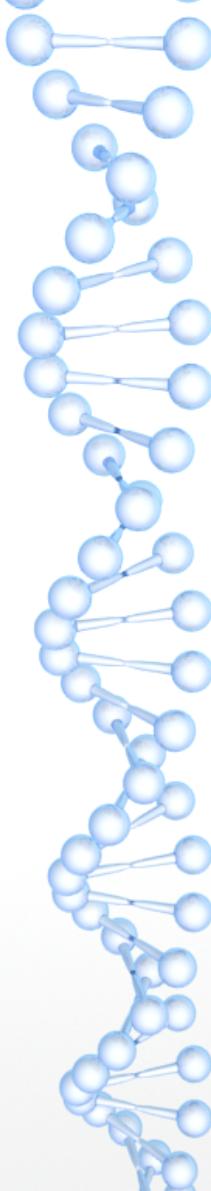
- te. Ego / te. ego
- u / v / U / V
- i / j
- Ae / æ
- Oe / œ
- bonum est / bonum'st  
/ bonumst
- [punctuation]
- [macron / breve]



# What's “normal”?

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- Processing
  - Search
  - Collation
  - NLP (lemma, PoS etc.)
  - Statistics (distant reading)...



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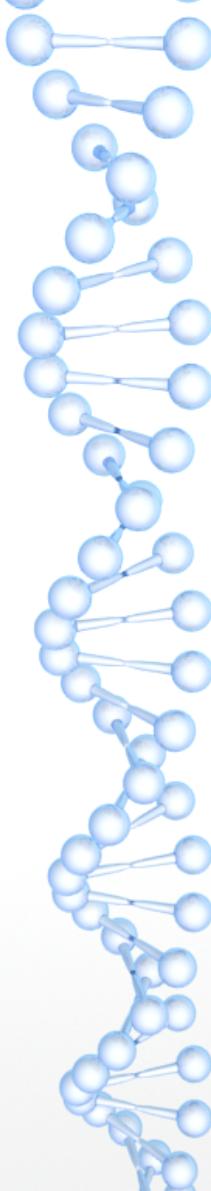
- Processing
  - Search
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"pertinet": [pertineo] Verbal, II conjug,  
Active indicative, Present, III singular

**pertinet**

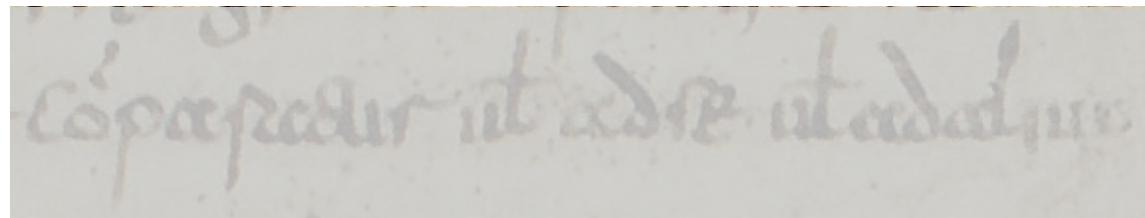
**ptinet**

- My Ursus edition (IX Century)  
[www.unipa.it/paolo.monella/ursus](http://www.unipa.it/paolo.monella/ursus)

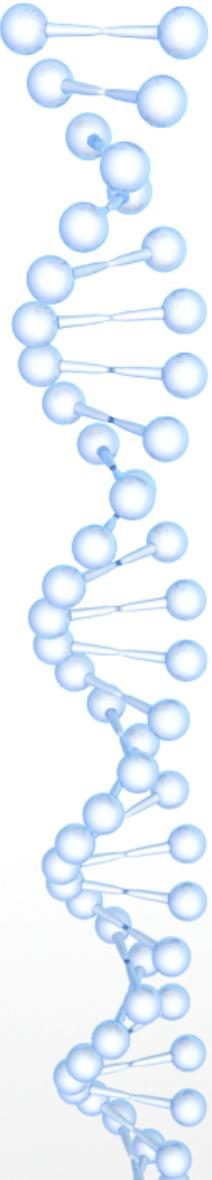


# What's “normal”?

- Comparatur vel ad se vel ad alium

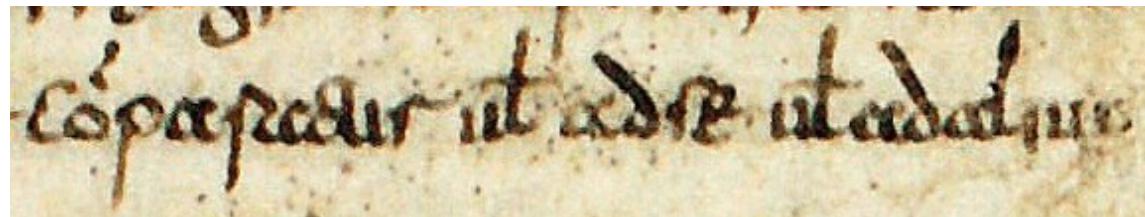


- cōparaEur uł adfe uładalium



# “Diplomatic”...

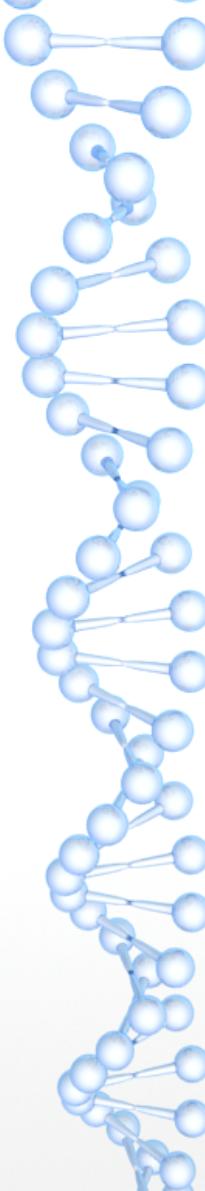
- Comparatur vel ad se vel ad alium



- cōparaEUR uł adfe uładalium

# Modelling “Gutenbergian” writing systems

# Modelling “Gutenbergian” writing systems



JULIO VERNE

132

Pero me parece que ahora los otros animales acuden a tomar parte en la lucha: la mariposa, la ballena, el lagarto, la tortuga; los eréneos a todo instante. Se los muestra al islandés, y éste mueve la cabeza en señal negativo.

—Tía —dice con calma.

—¡Cómó! ¡dos! Pretende que sólo dos animales...

—Y tiene mucha razón —exclama mi tío, que no aparta el ojo del grupo.

—¿Es posible?

—¡Ya lo creo! El primero de estos monstruos tiene hocicos de mariposa, cabeza de lagarto, dientes de cocodrilo, y por esto no le engañado. Es el icтиosauro, el más temible de los animales antediluvianos.

—¿Y el otro?

—El otro es una serpiente escondida bajo el caparazón de una tortuga, el plesiosaurio, implacable enemigo del primero.

Hans tiene mucha razón. Sólo dos monstruos turban de esta manera la superficie del mar, y tengo ante mis ojos dos reptiles de los primitivos océanos. Veo el ojo ensangrentado del icthiosauro, que tiene el tamaño de la cabeza de un hombre. La Naturaleza le ha dotado de un apetito óptico de extraordinario poder, capaz de resistir la presión de las capas de agua en que habita. Se le ha llamado la ballena de los saurios, porque posee su misma velocidad y tamaño. Su longitud no es inferior a cien pies, y, cuando saca del agua las aletas verticales de su cola, me hago cargo mejor de su enorme magnitud. Sus mandíbulas son enormes, según los naturalistas, no posee menos de 182 dientes.

El plesiosaurio, serpiente de tronco cilíndrico, tiene la cola corta y las patas dispuestas en forma de remos. Su cuerpo se halla todo él revestido de un enorme campacho, y su cuello, flexible como el del cinc, ergúese treinta pies sobre las olas.

Los dos animales se atan con indescriptible furia. Levantan nubes de agua que llegan hasta la balsa, y nos ponen veinte veces a punto de zozobrar. Se oyen silbidos de una intensidad prodigiosa. Las dos bestias se encuentran enlazadas, no siéndome posible distinguir la una de la otra. ¡Hay que temerlo todo de la furia del vencedor!

Transcurre una hora, dos y continúa la lucha con el mismo encendido. Los monstruos se acercan a la balsa unas veces y retroceden otras, se precipitan a la agua y se aproximan a la balsa unas veces y

VIAJE AL CENTRO DE LA TIERRA.

133

Pero, de improviso, una enorme cabeza lanza fuera del agua: la colada del plesiosaurio. El monstruo está herido de muerte. No descubre su inmenso campacho. Sólo su largo cuello se yergue, se abate, se vuelve gigantesco y se rehuece como una lombriz dividida en dos pedazos. Salió el agua a considerable distancia y nos ciega materialmente; pero pronto toca a su fin la agonía del reptil; disminuyen sus movimientos, decrecen sus contorciones y su largo tronco de serpiente se extiende como una masa inerte sobre la serena superficie del mar.

En cuanto al icthiosauro, ¿ha regresado de nuevo a su caverna submarina o va a reaparecer otra vez?

XXXIV

Miércoles 19 de agosto.—El viento, por fortuna, que sopla con bastante fuerza, nos ha permitido huir rápidamente del teatro del combate. Hans sigue siempre empuñando la caña del timón. Mi tío, a quien los incidentes del combate han hecho olvidar de momento sus absorbentes ideas, vuelve a examinar el mar con la misma impaciencia que antes.

El viaje recobra de nuevo su uniformidad monótona, que no deseamos interrumpida por peligros tan inminentes como el que corrimos ayer.

Jueves 20 de agosto.—Brisa NNE. Bastante desigual. Temperatura devada. Marchamos a razón de tres leguas y media por hora.

A eso de mediiodia, oyese un ruido lejano.

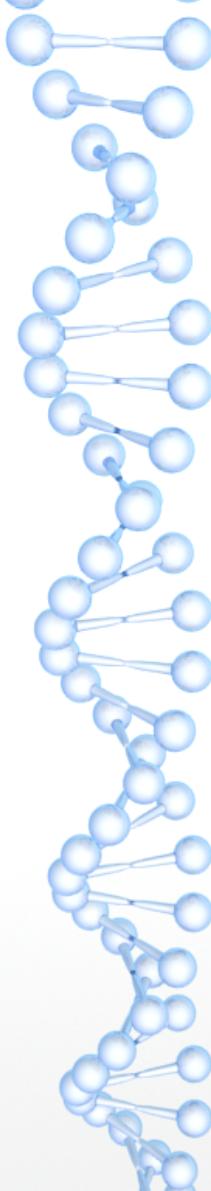
Consigno el hecho sin saber cuál pueda ser su explicación. Es un rugido continuo.

—Hay —dice el profesor—, a alguna distancia de aquí, alguna roca o islote contra el cual se estrellan las olas.

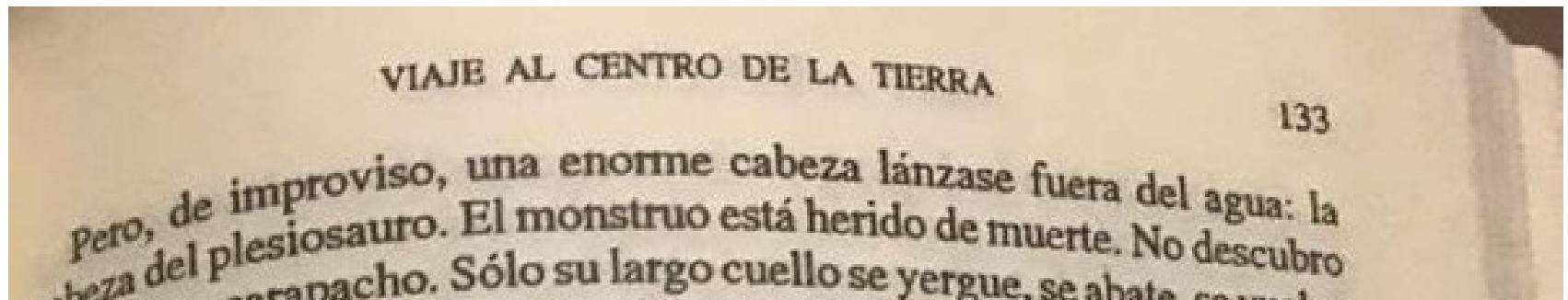
Hans sube al extremo del palo, pero no descubre ningún escollo. La superficie del mar aparece toda lisa hasta el mismo horizonte.

Así transcurren tres horas. Los rugidos parecen provenir de una catarrata lejana.

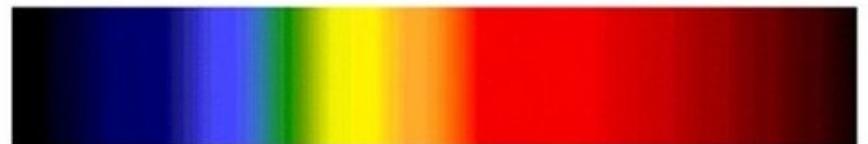
Manifesto mi opinión a mi tío, que sacude la cabeza. Esto no obstante, tengo la convicción de que no me equivoco. ¡Corremos tal vez hacia una catarrata que nos precipitará en el abismo? Es posible que este fenómeno de descenso sea del agrado del profesor, porque se acerca a la

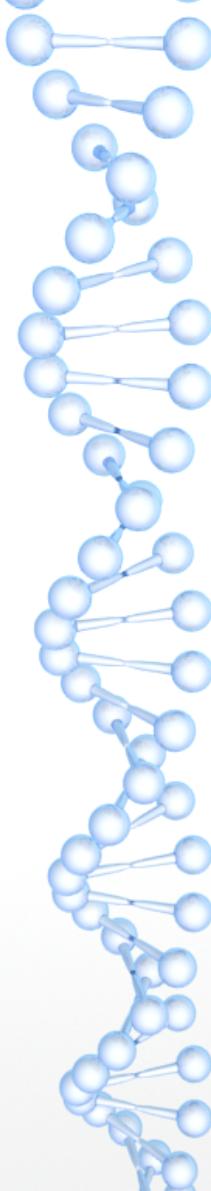


# Modelling “Gutenbergian” writing systems



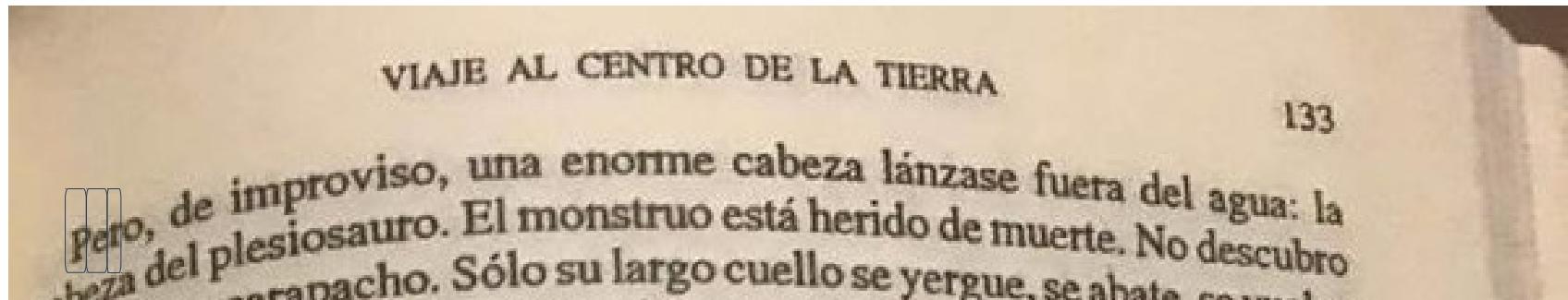
Digital modelling



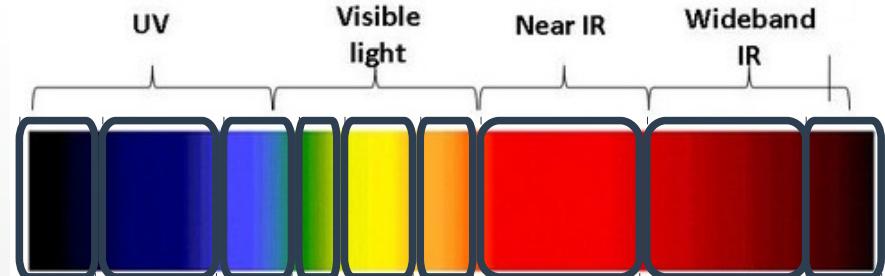


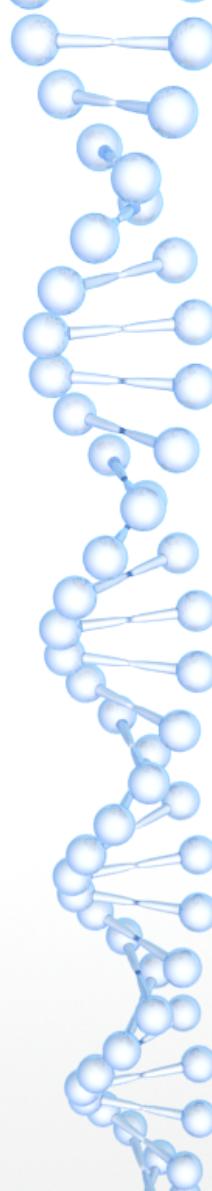
# Modelling “Gutenbergian” writing systems

- Pero, de improviso, una enorme cabeza...



Digital modelling





# “Gutenbergian” principles

- Pero, de improviso, una enorme cabeza...



1  $\leftrightarrow$  1

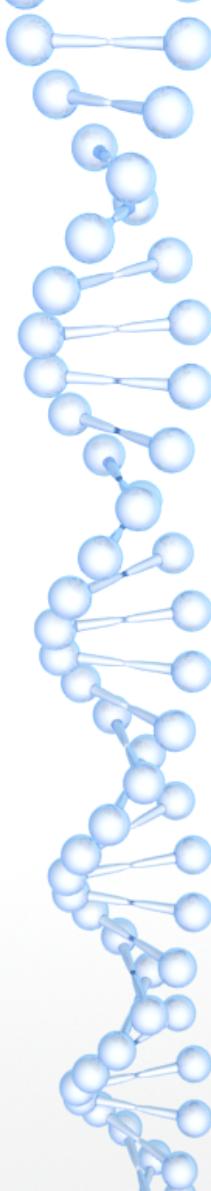


1 = 1



1, 2, 3...





# “Gutenbergian” principles

- Pero, de improviso, una enorme cabeza...

1 ↔ 1

1 = 1

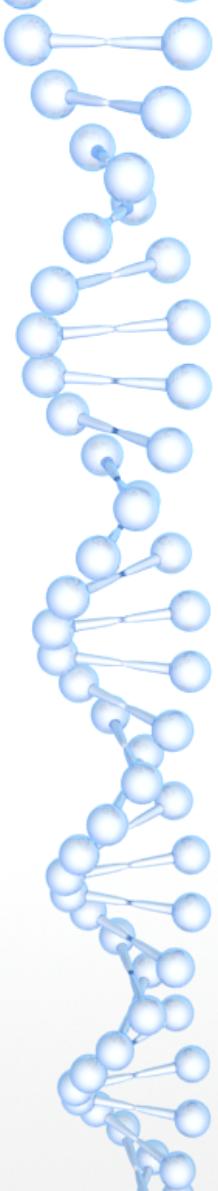
1, 2, 3...

1 mark,  
1 letter

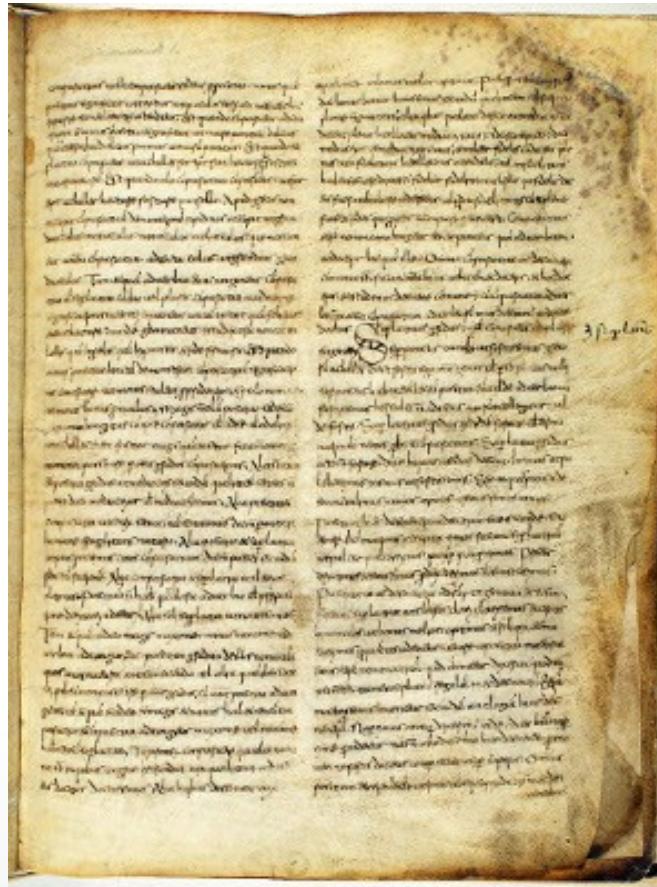
All marks  
are (born)  
equal

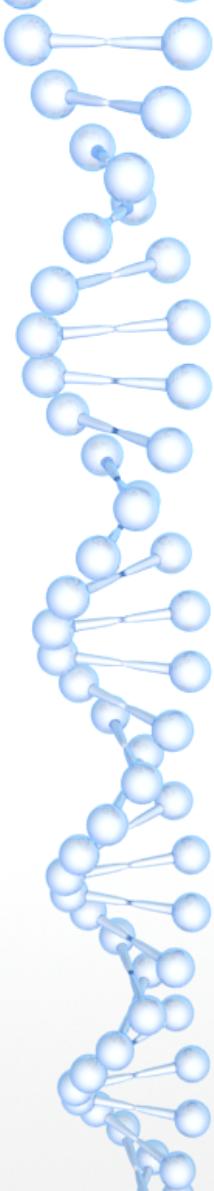
Sequence  
(one dimension)

# Modelling pre-modern writing systems



# Modelling pre-modern writing systems





# Modelling pre-modern writing systems

3 Gutenbergian principles

$1 \leftrightarrow 1$

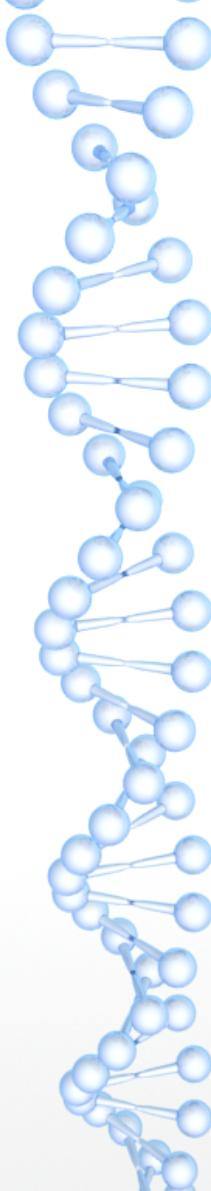
$1 = 1$

$1, 2, 3\dots$

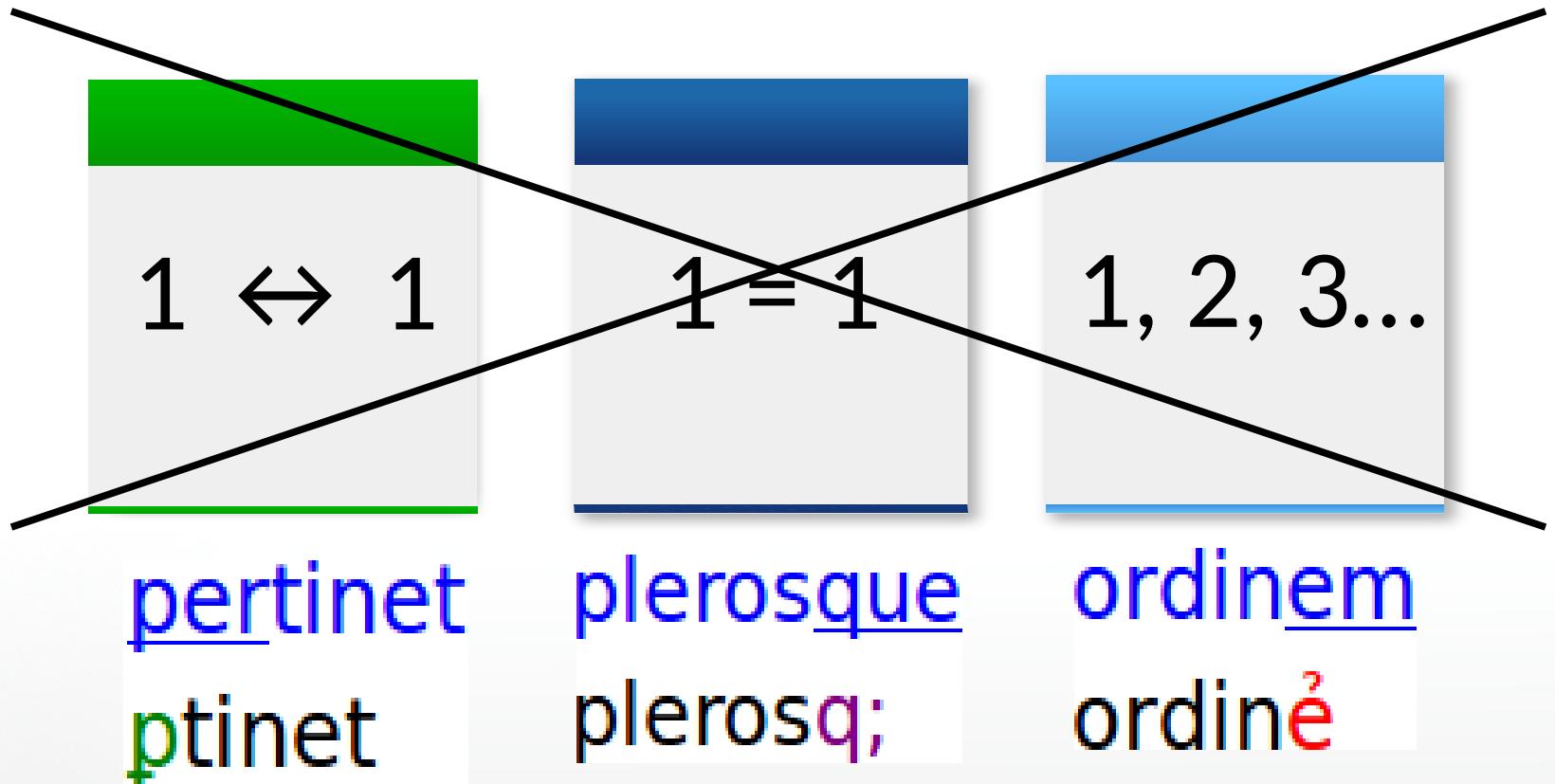
1 mark,  
1 letter

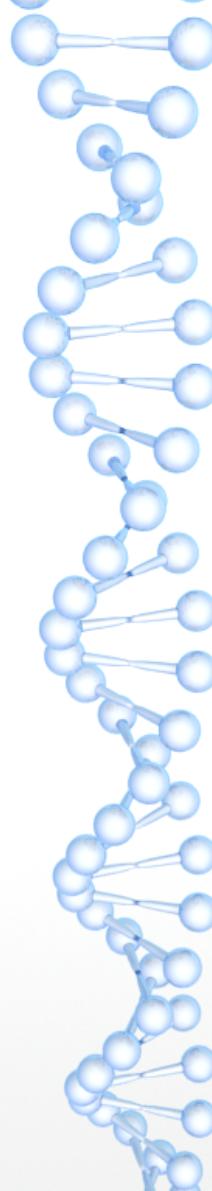
All marks  
are (born)  
equal

Sequence  
(one dimension)

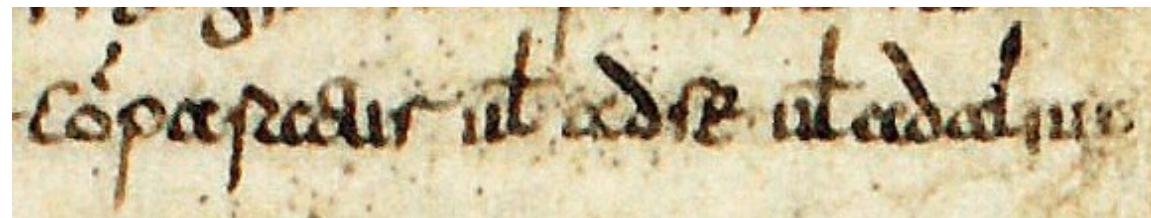


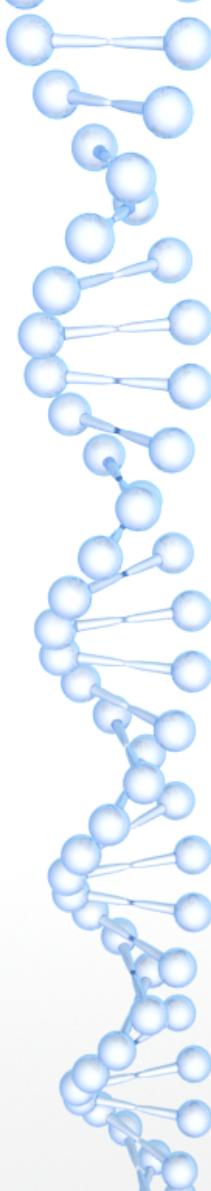
# Modelling pre-modern writing systems



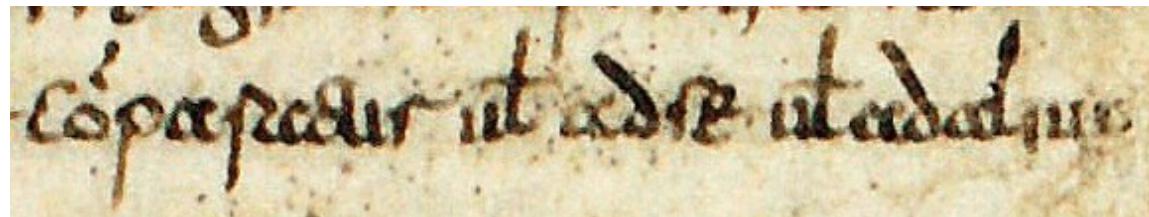


# Modelling pre-modern writing systems

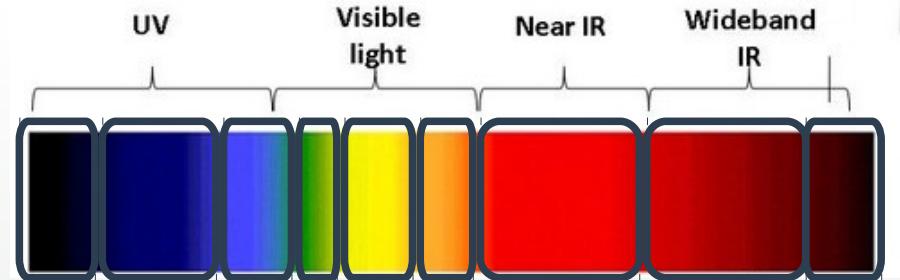


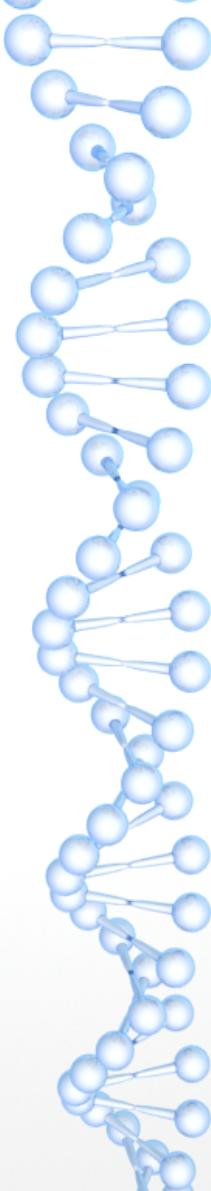


# Modelling pre-modern writing systems



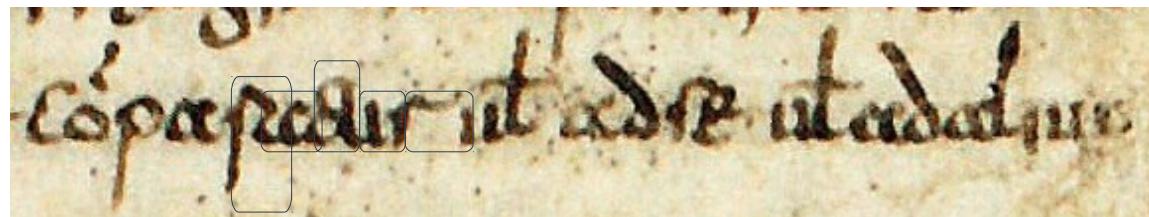
*Digital modelling*





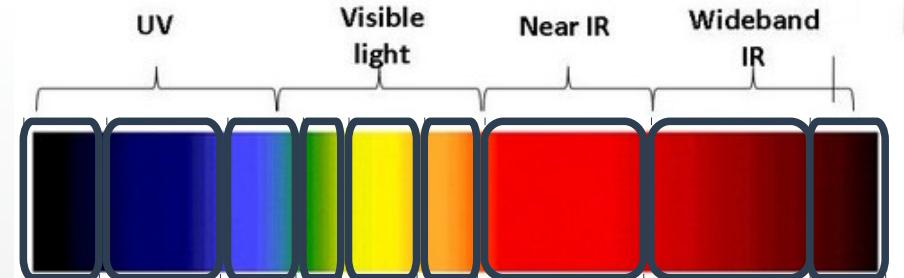
# Modelling pre-modern writing systems

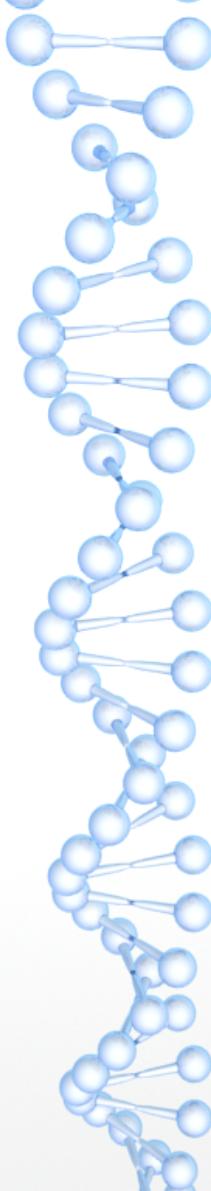
- Comparatur vel ad se vel ad alium



- cōparaEUR uł adfe uładalium

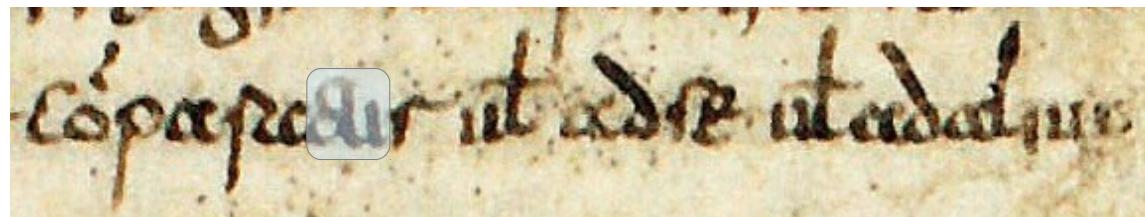
Digital modelling





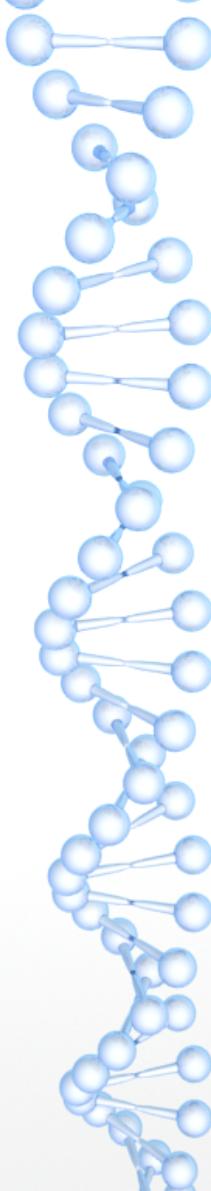
# Modelling pre-modern writing systems

- Comparatur vel ad se vel ad alium



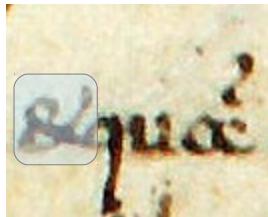
- cōparaEur uł adfe uładalium

Ligatures



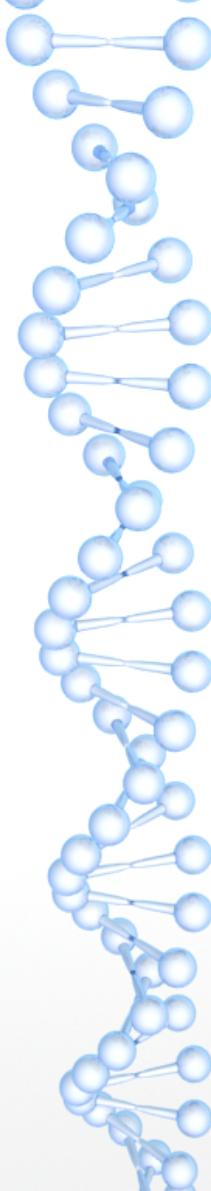
# Modelling pre-modern writing systems

- et quam



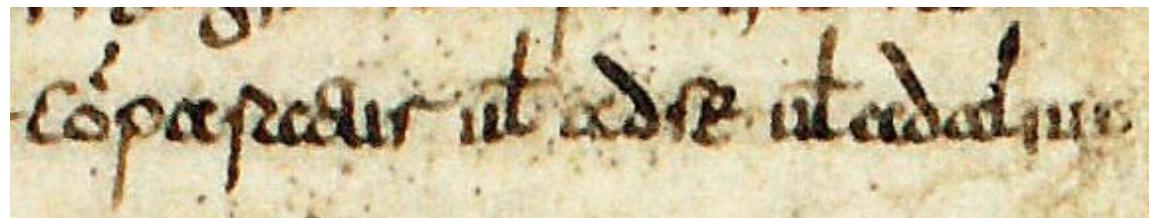
- & quam

Ligatures

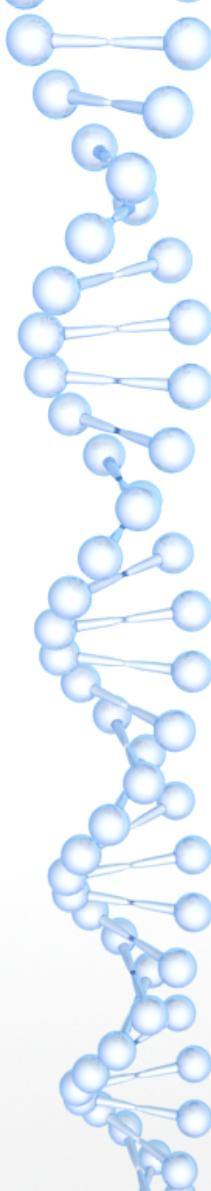


# Modelling pre-modern writing systems

- Comparatur vel ad se vel ad alium

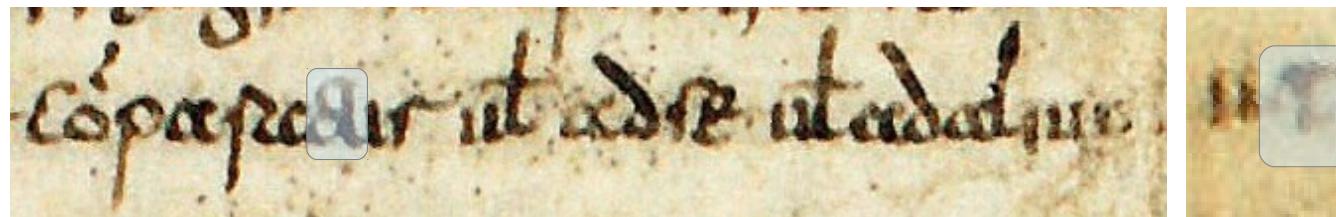


- cōparaEur uł adfe uładalium



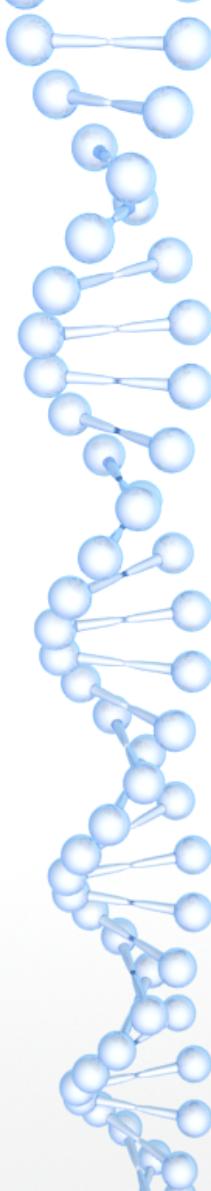
# Modelling pre-modern writing systems

- Comparatur vel ad se vel ad alium ut



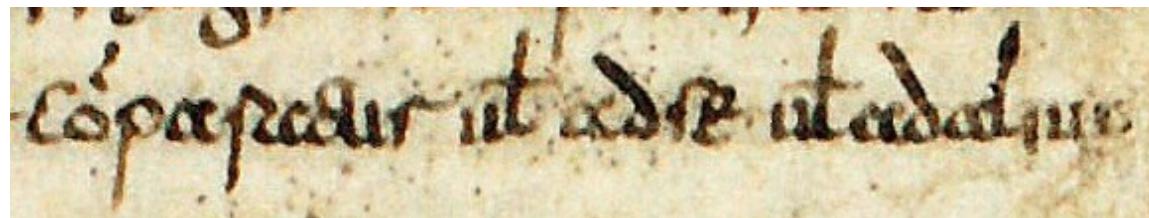
- cóparaEur uł adfe uładalium uł

Allographs

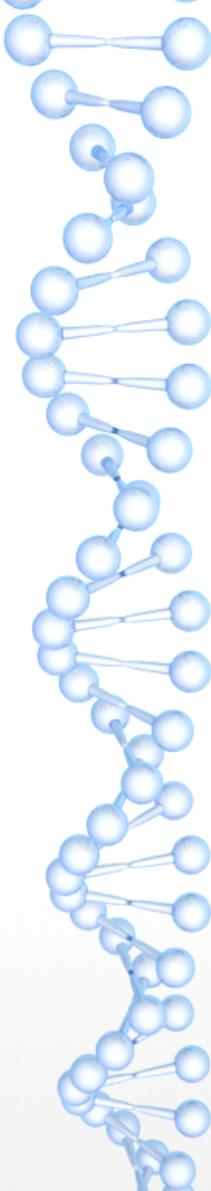


# Modelling pre-modern writing systems

- Comparatur vel ad se vel ad alium

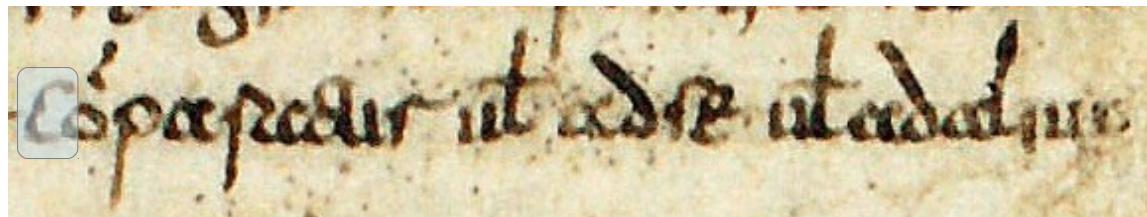


- cōparaEur uł adfe uładalium



# Modelling pre-modern writing systems

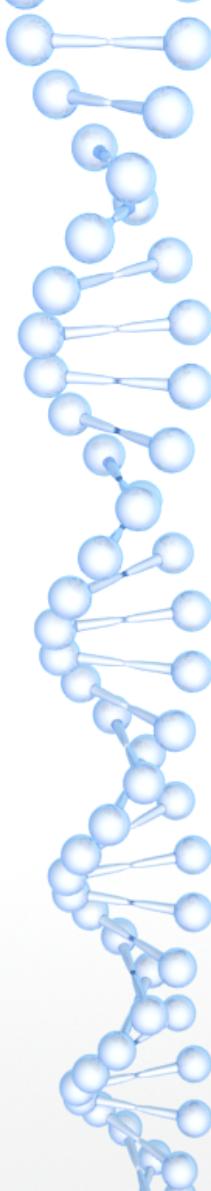
- Comparatur vel ad se vel ad alium



- cōparaEUR uł adfe uładalium

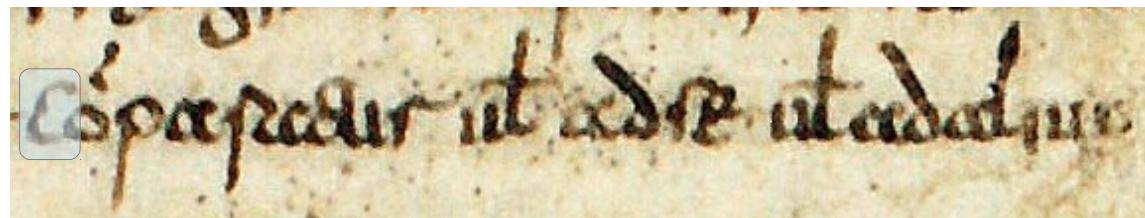
Capitalization?

Allographs



# Modelling pre-modern writing systems

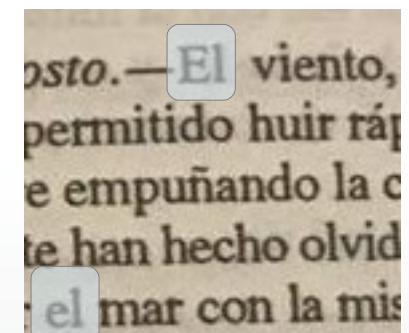
- Comparatur vel ad se vel ad alium

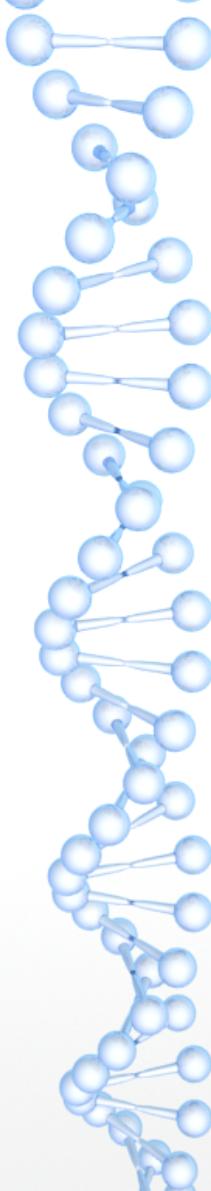


- cōparaEUR uł adfe uładalium

Capitalization?

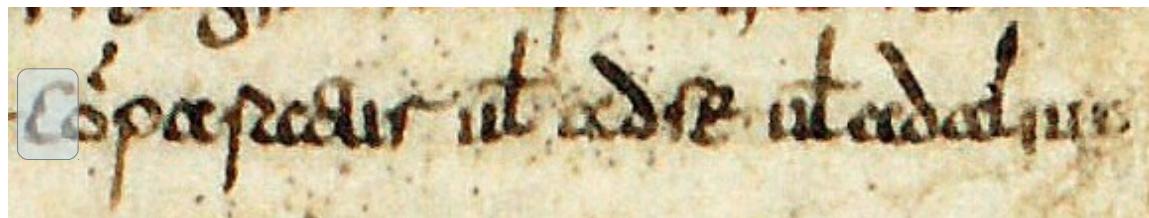
Allographs





# Modelling pre-modern writing systems

- Comparatur vel ad se vel ad alium

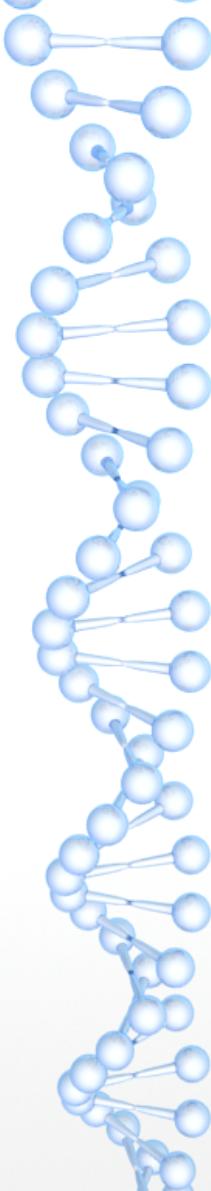


- cōparaEUR uł adfe uładalium

Capitalization?

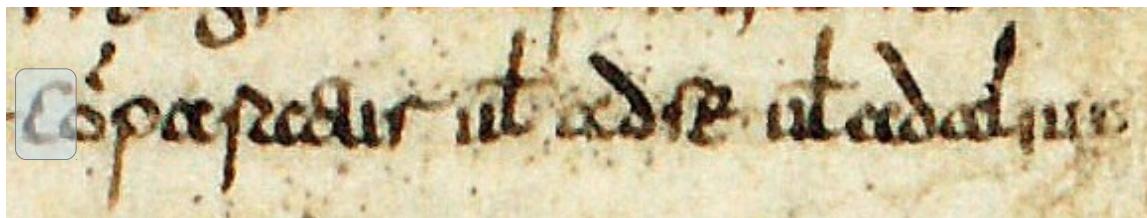
Allographs

Bari  
bari



# Modelling pre-modern writing systems

- Comparatur vel ad se vel ad alium

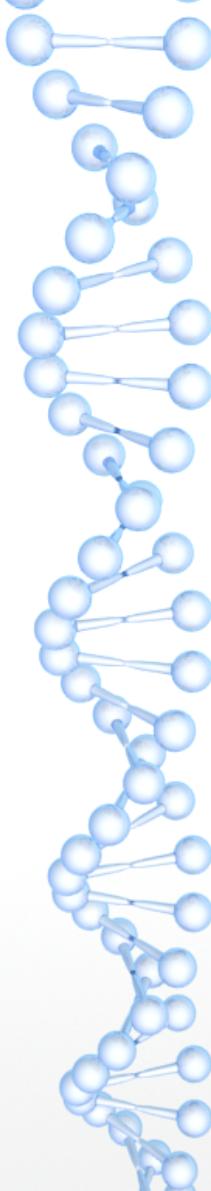


- cōparaEUR uł adfe uładalium

Capitalization?

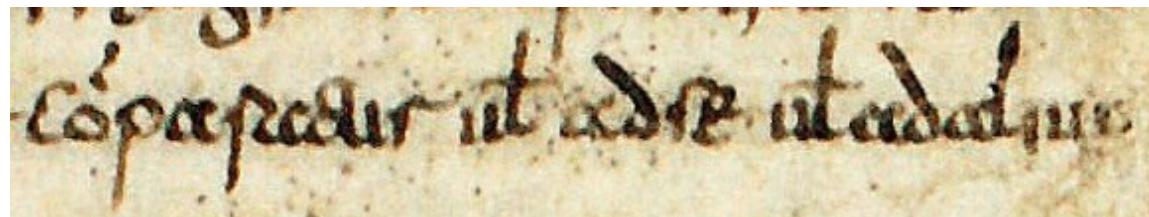
Allographs

ODD  
odd

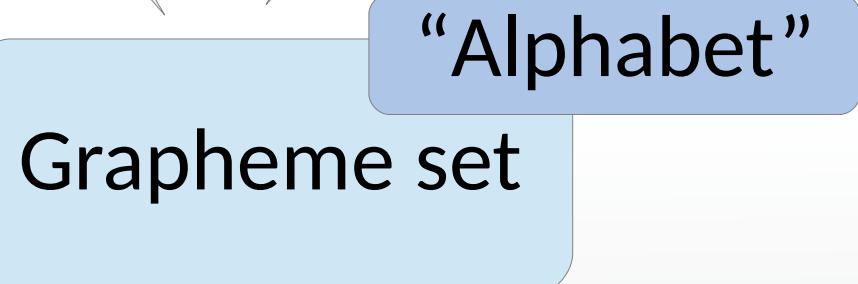


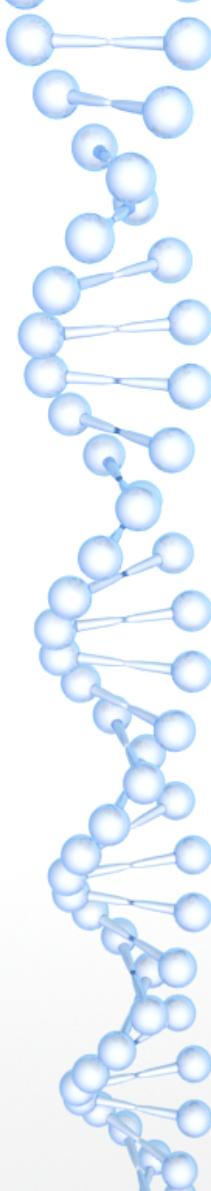
# Modelling pre-modern writing systems

- Comparatur vel ad se **vel** ad alium



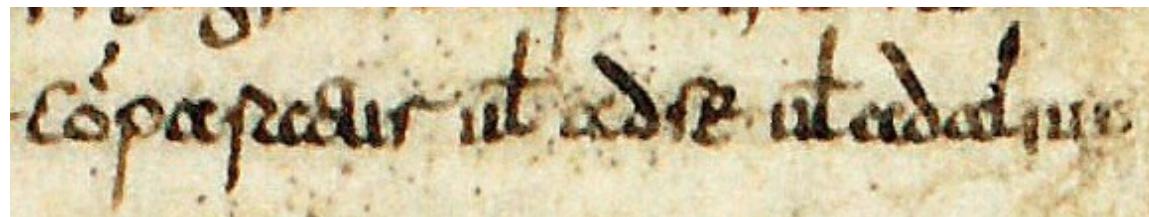
- cōparaEUR uł adfe **uładalium**





# Modelling pre-modern writing systems

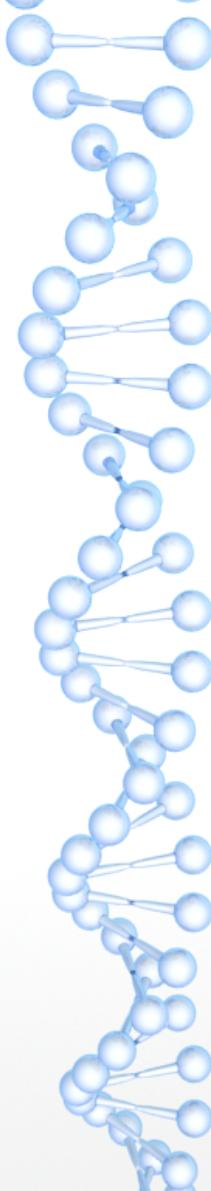
- Comparatur vel ad se vel ad alium.



- cōparaEUR uł adfe uładalium;

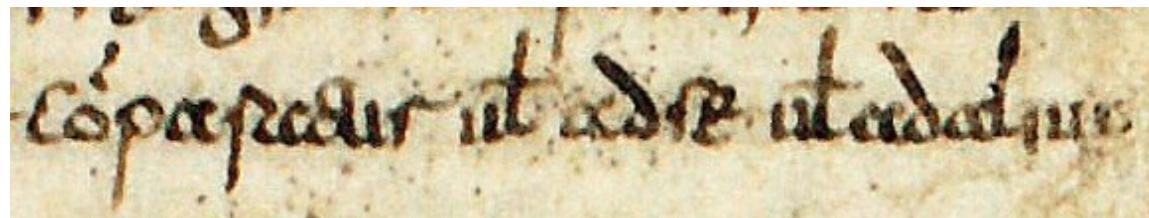
Grapheme set

Punctuation

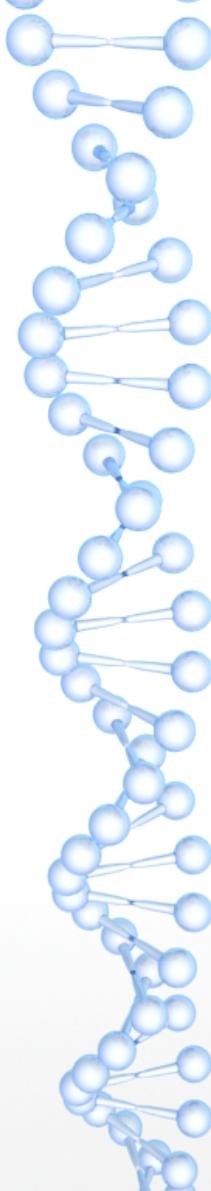


# Modelling pre-modern writing systems

- Comparatur vel ad se vel ad alium

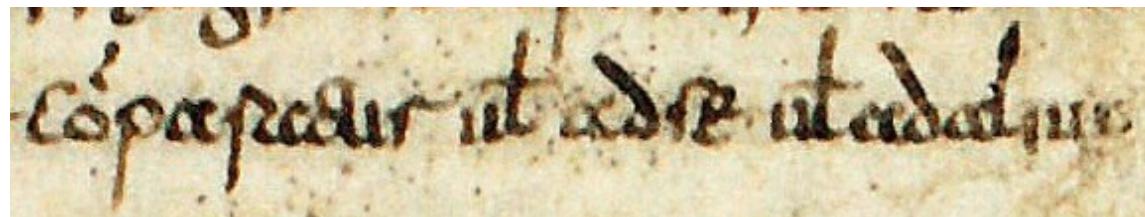


- cōparaEur uł adfe uładalium



# Modelling pre-modern writing systems

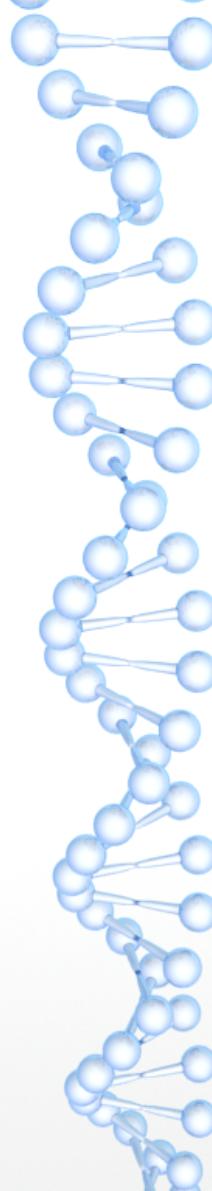
- Comparatur vel ad se vel ad alium



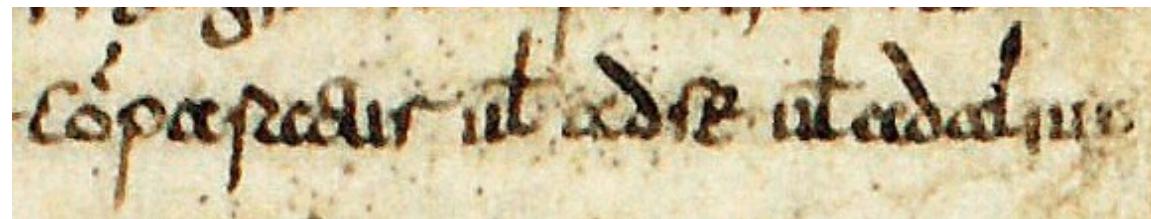
- coparaEUR      uł    adfe    uładalium

Abbreviations

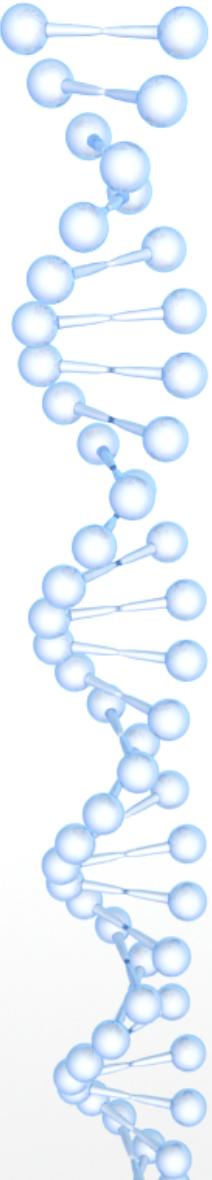
# A structuralist approach to digital modelling for pre-modern writing systems



# Modelling

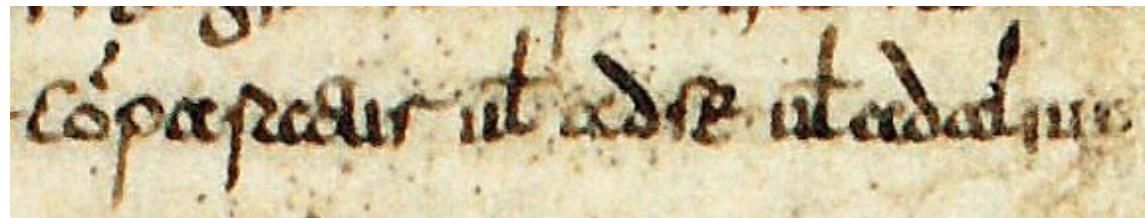


Cōrā sc̄ur ut adē atādīus

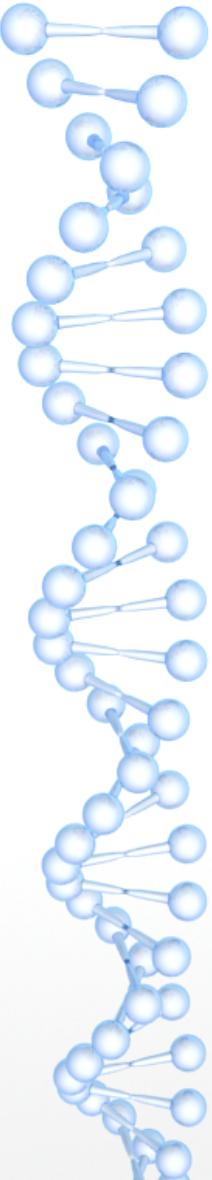


# Modelling

- Comparatur vel ad se vel ad alium

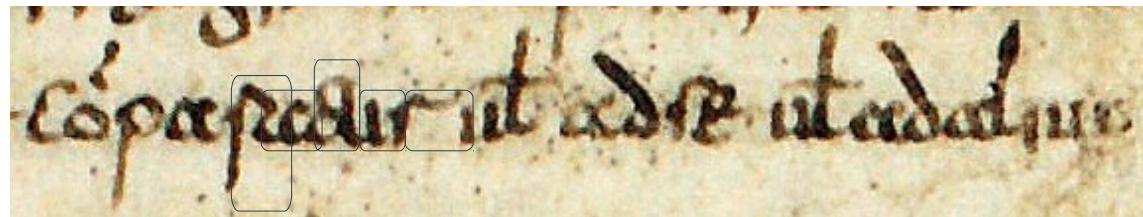


- cōparaEUR      uł adfe    uładalium

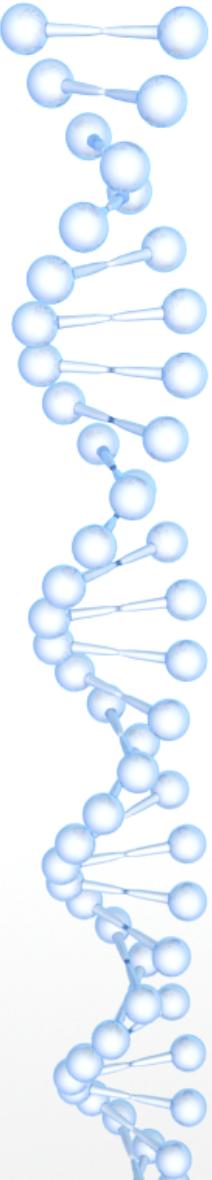


# Modelling

- Comparatur vel ad se vel ad alium

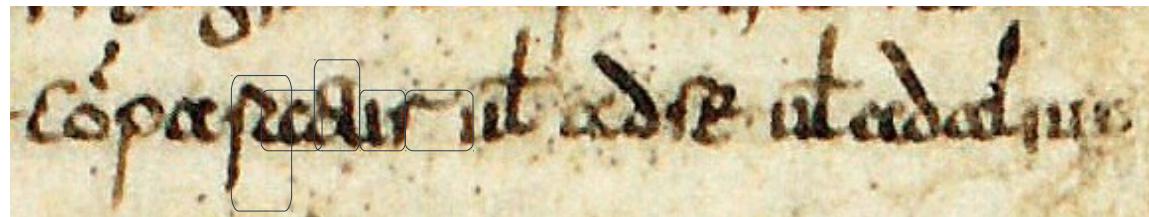


- cōparaEUR uł adfe uładalium



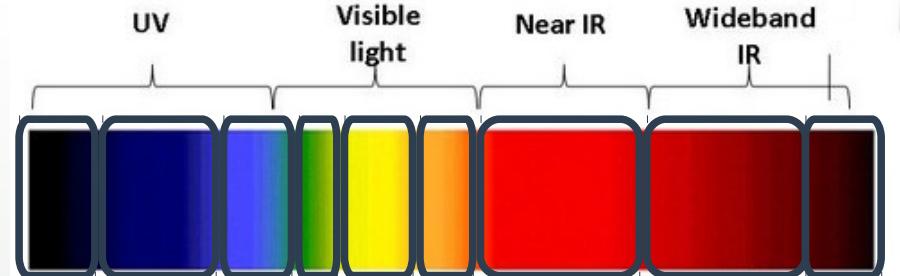
# Modelling

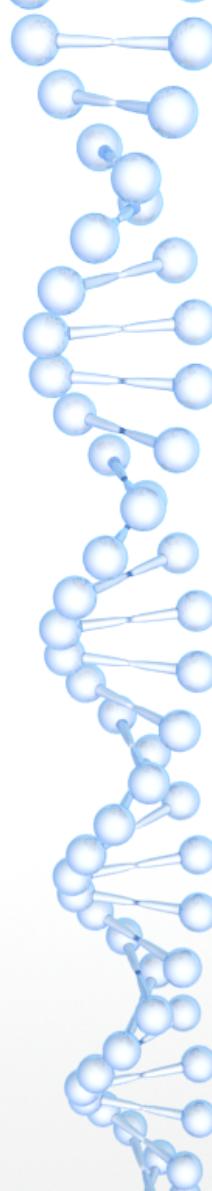
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- cōparaEur uł adfe uładalium

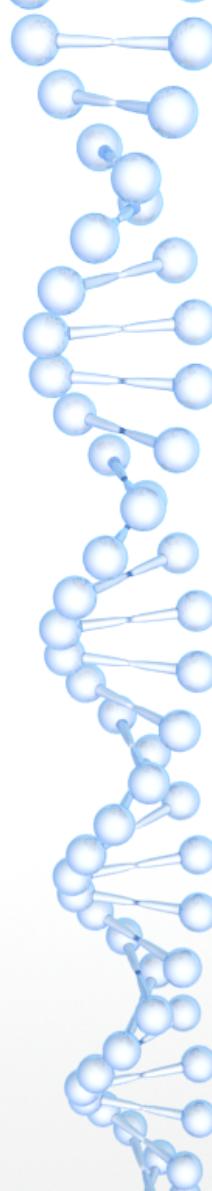
Digital modelling





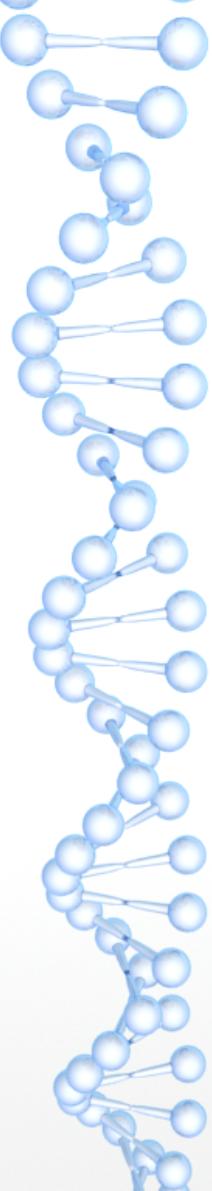
# Modelling

- cóparaEur uł adfe uładarium



# Modelling

- cóparaEur  adfe uładarium



# System / text

- cóparaEur

Syntagmatic (text, process)

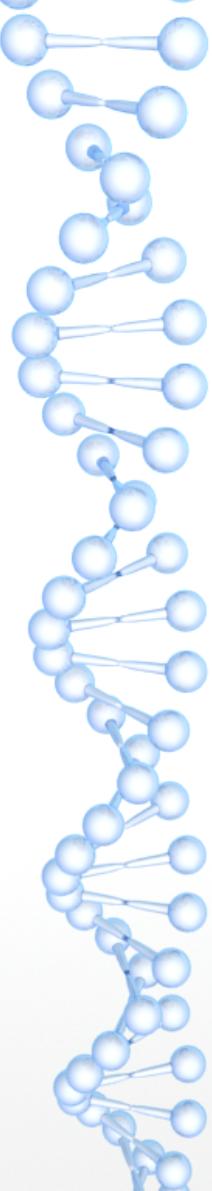
uł

adfe

uładarium

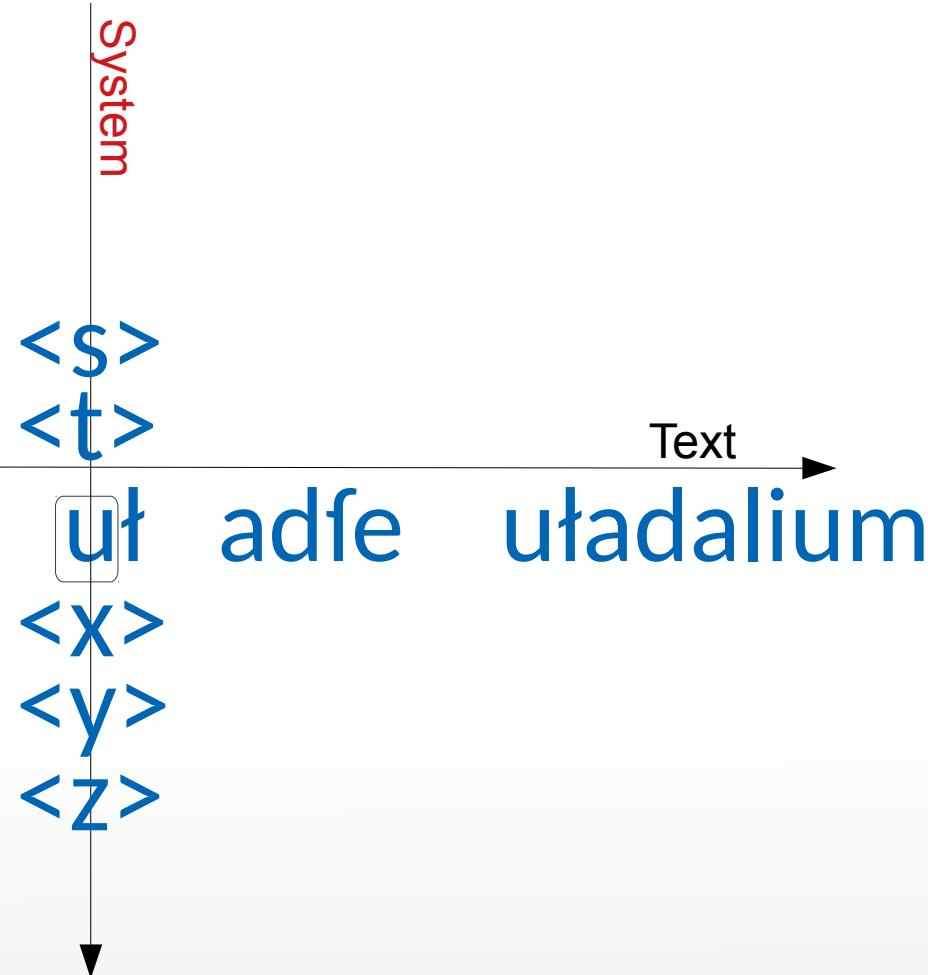
Paradigmatic

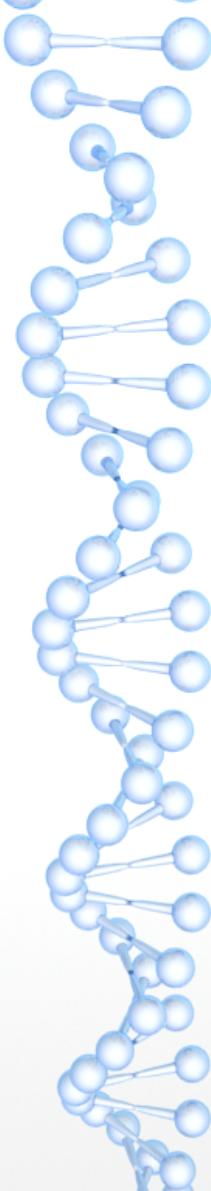
(langue, system)



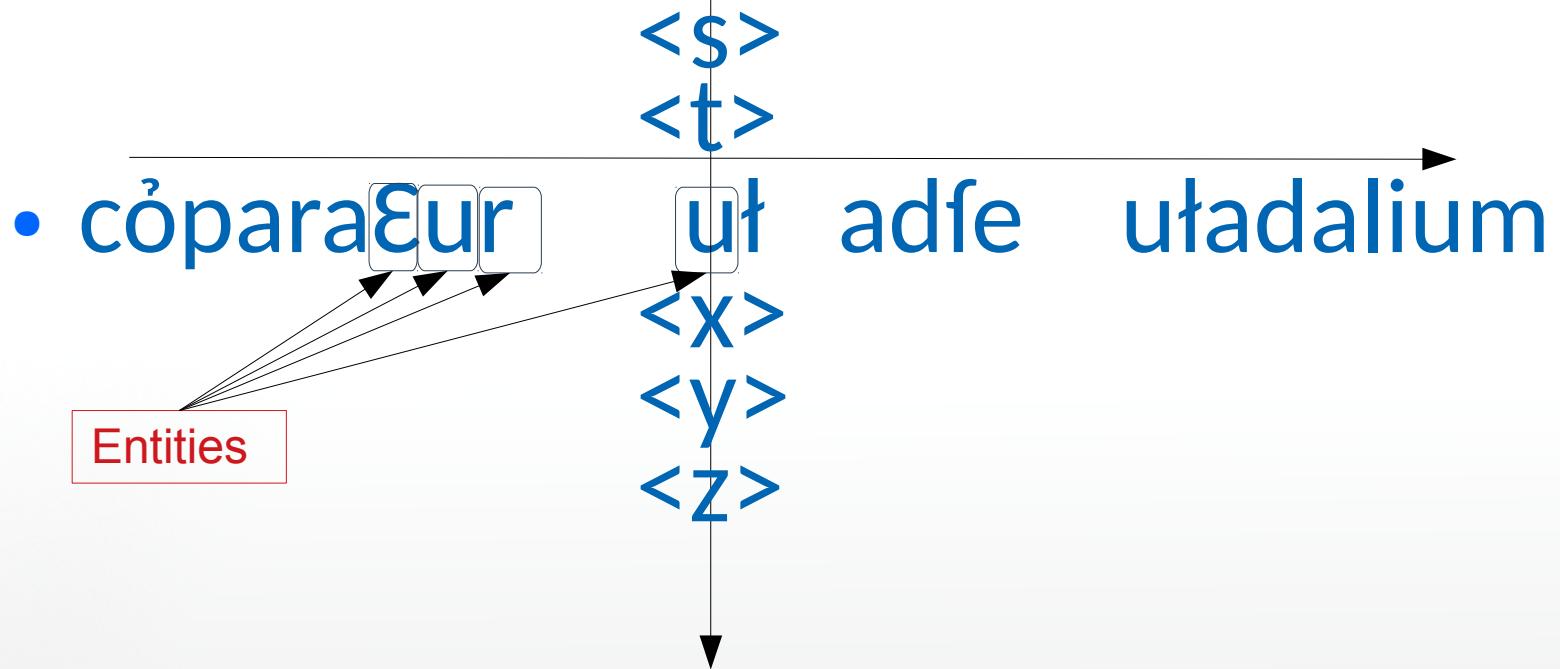
## System / text

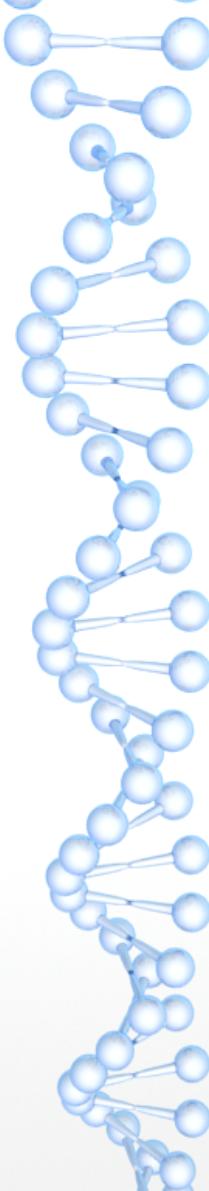
- cóparaEur



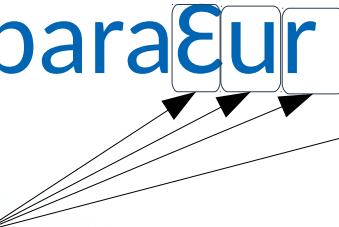


# Modelling/“analysis”: entities





# Modelling/“analysis”: entities

- cóparaEur  uł adfe uładalim

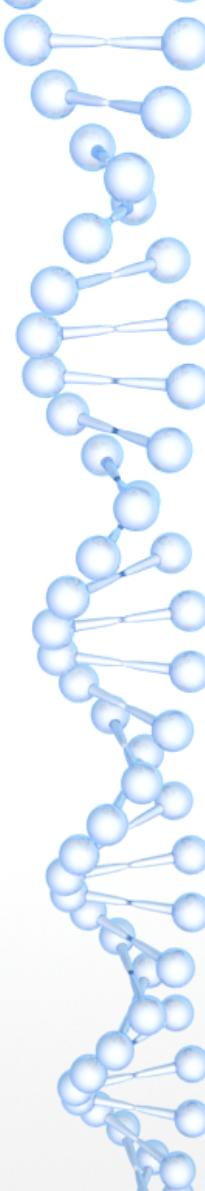
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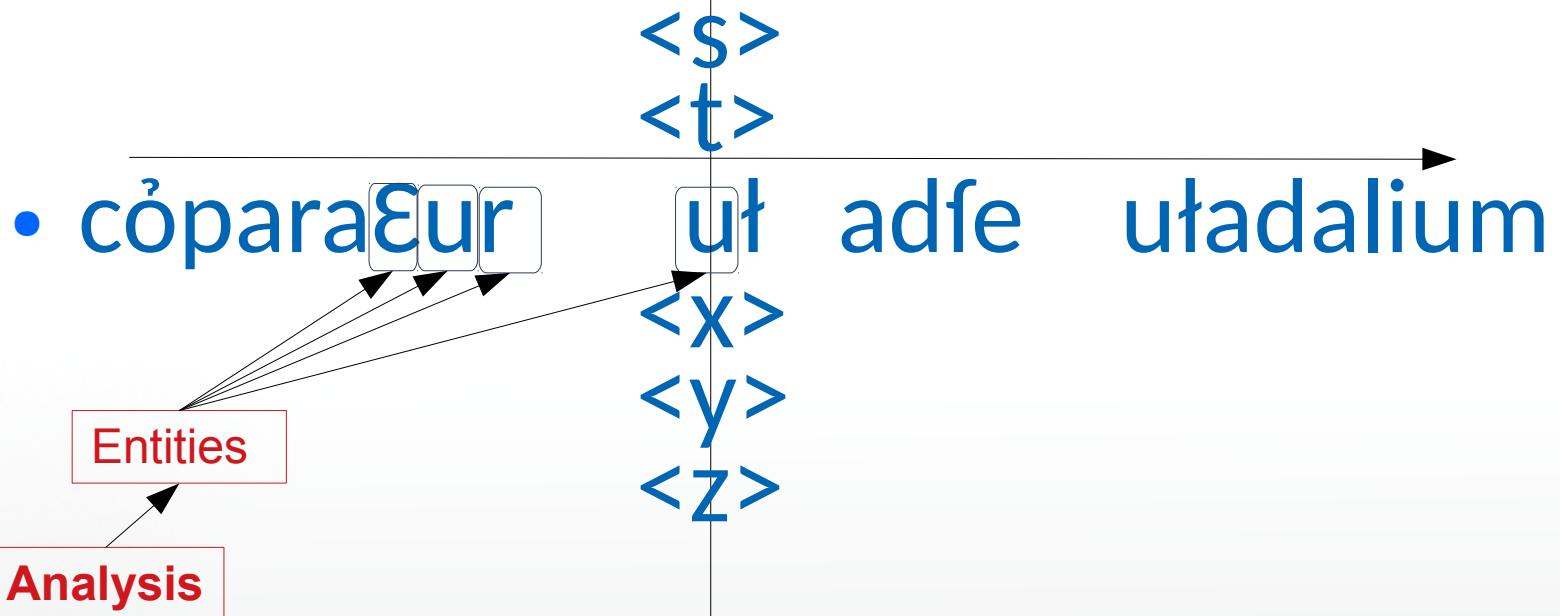
<x>  
<y>  
<z>

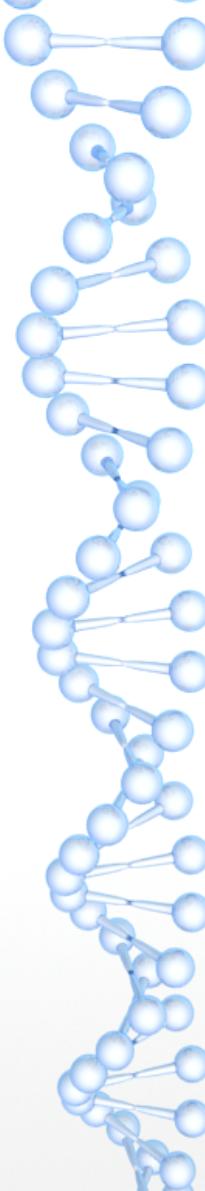


“If [we are] given anything..., it is the as yet unanalyzed *text* in its undivided and absolute integrity”  
 (“**deduction**”, *Prol. Ch. 4*)

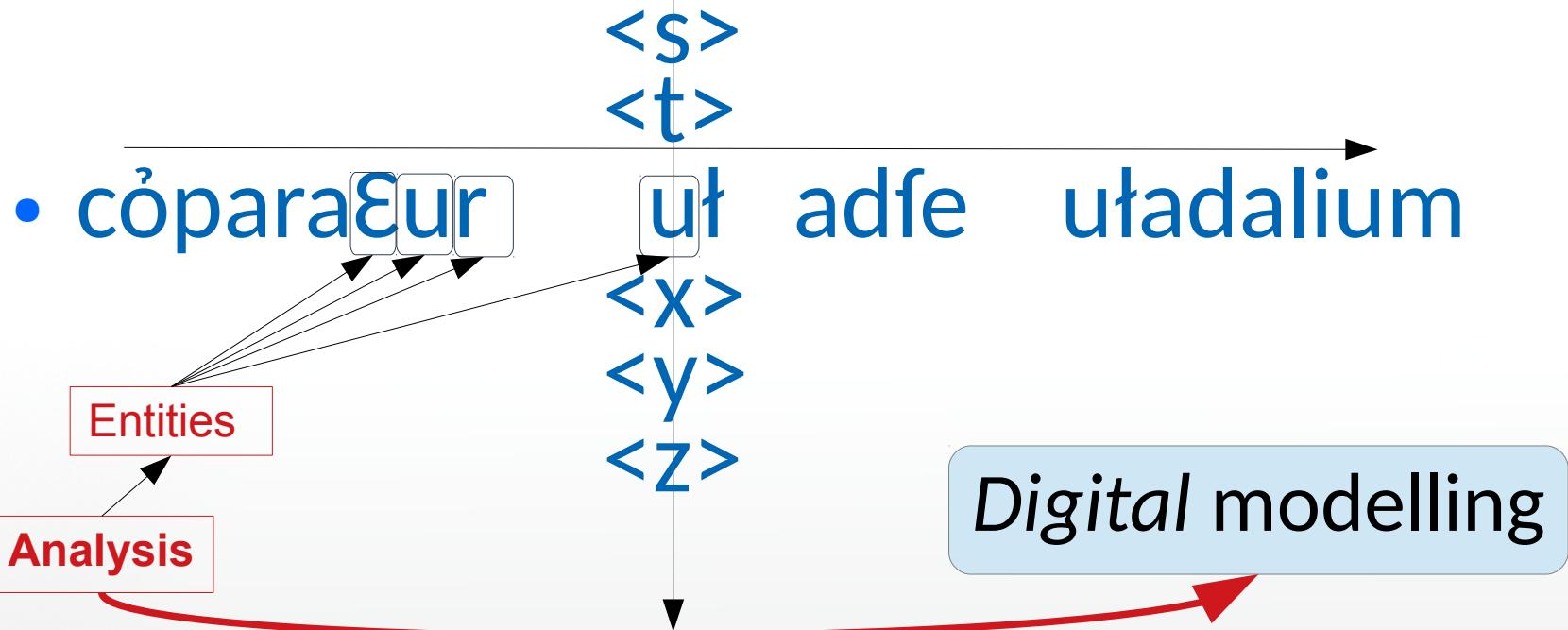


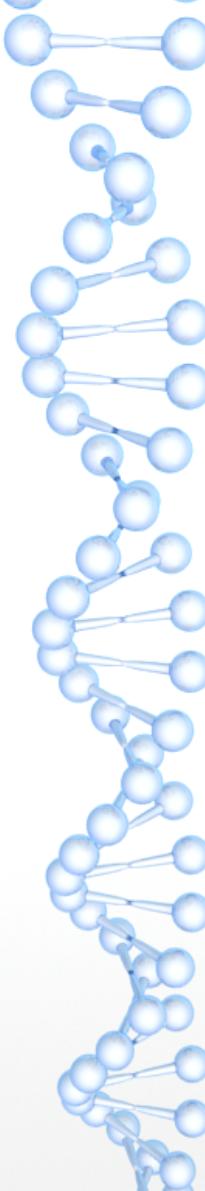
# Modelling/“analysis”: entities



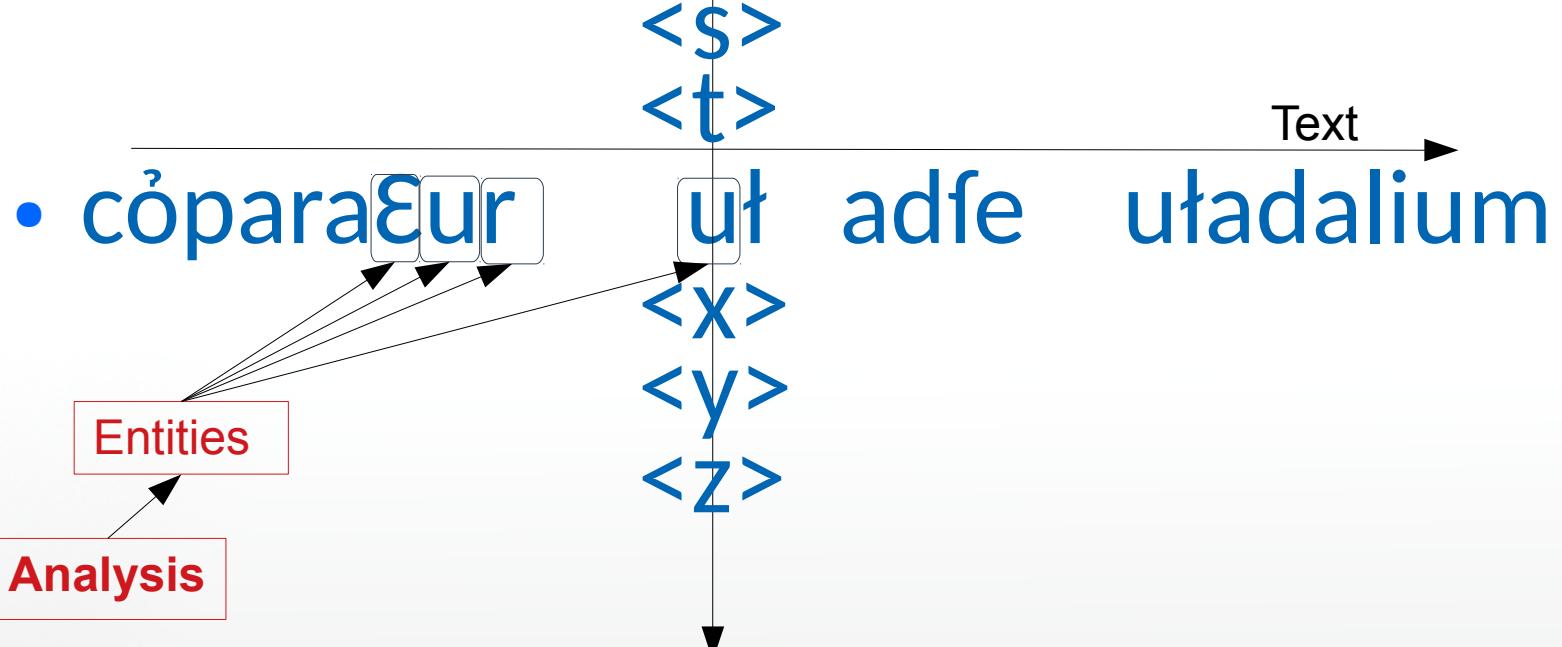


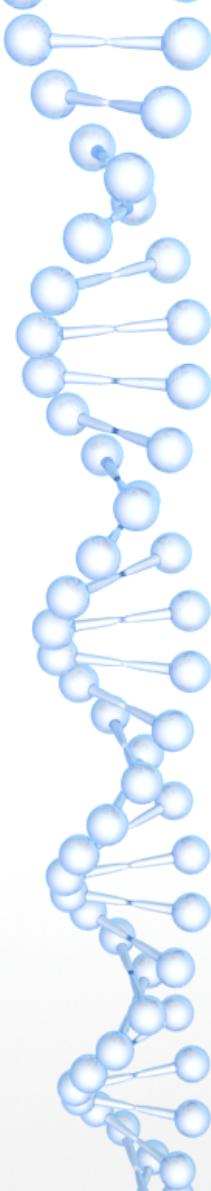
# Modelling/“analysis”: entities



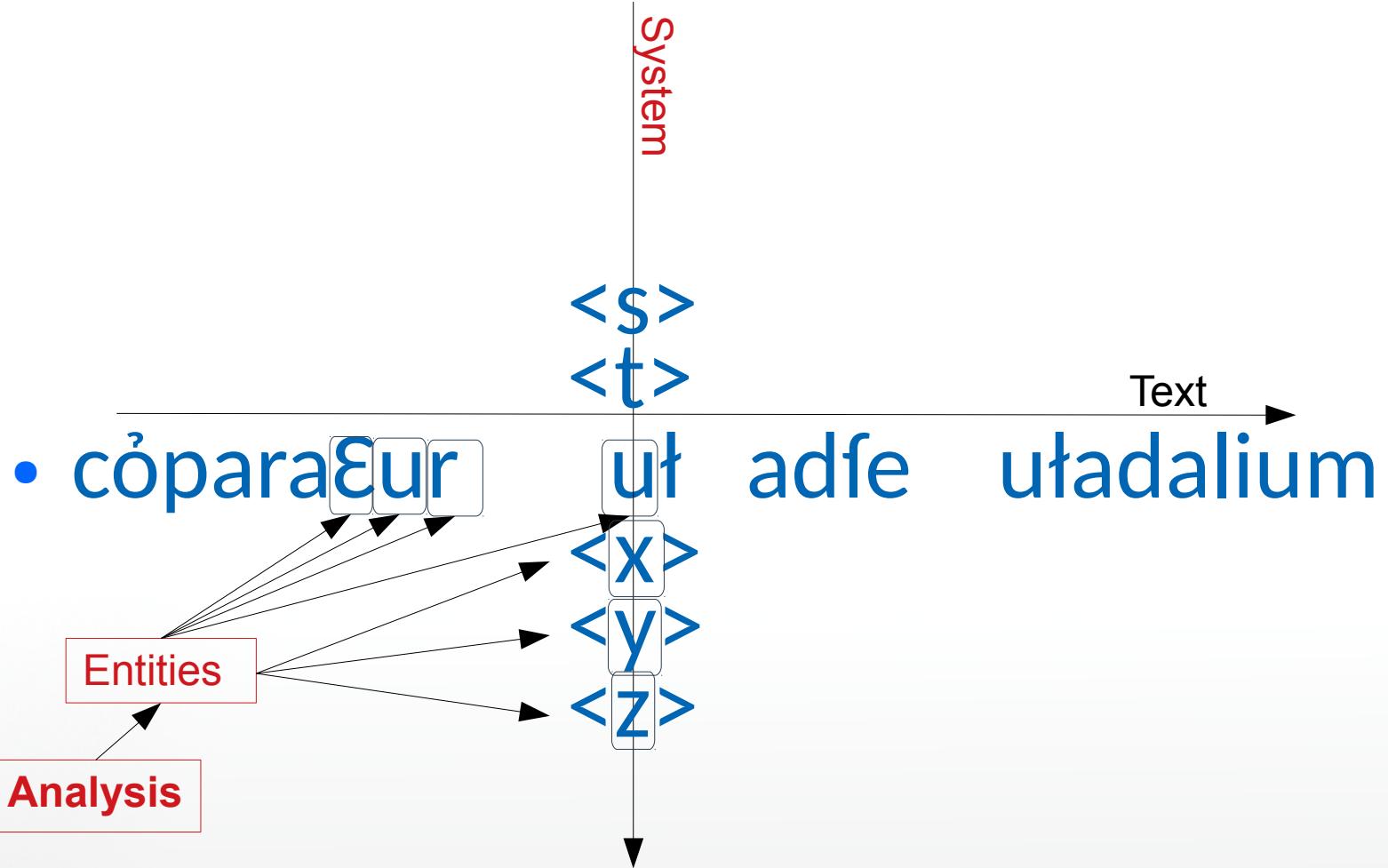


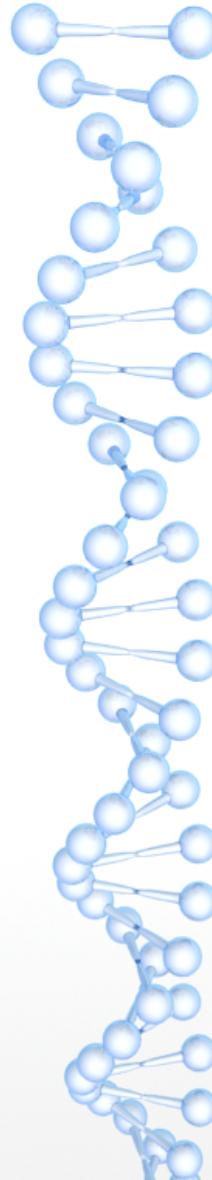
# Modelling/“analysis”: entities



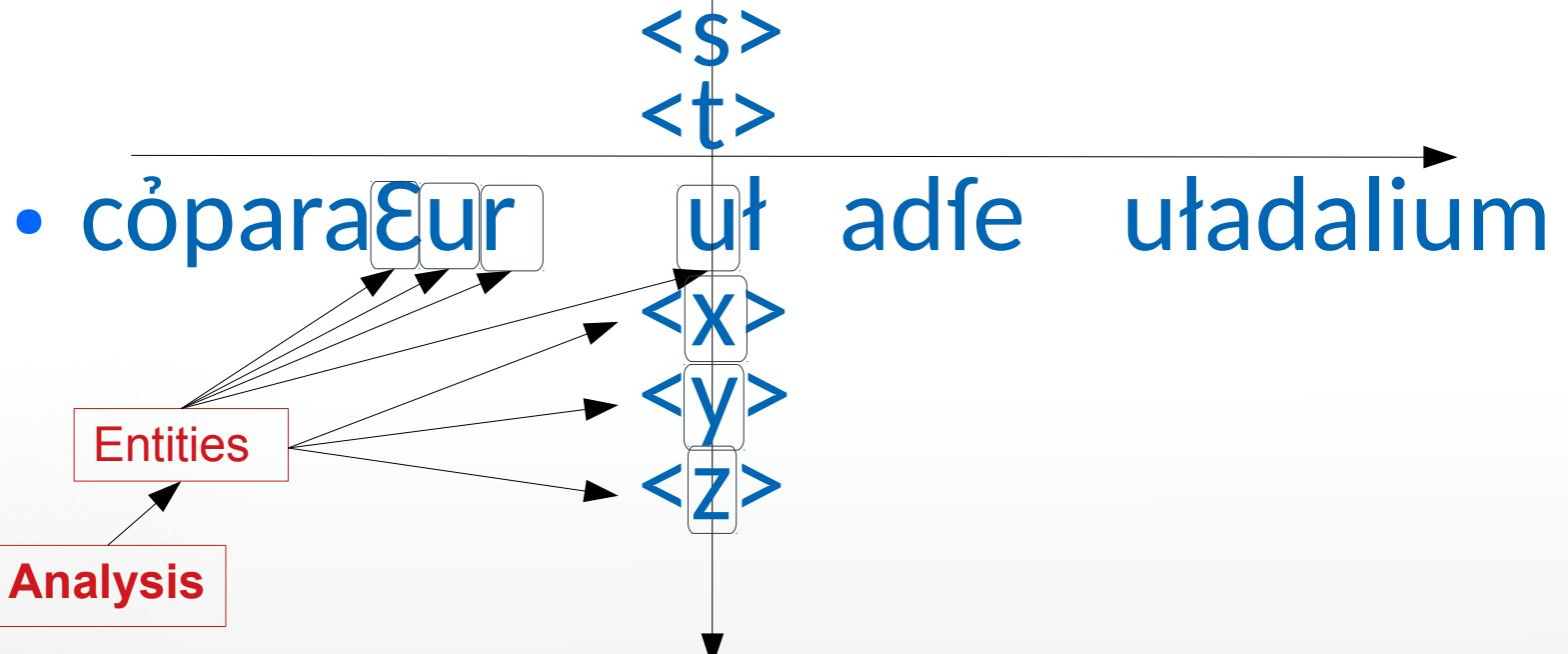


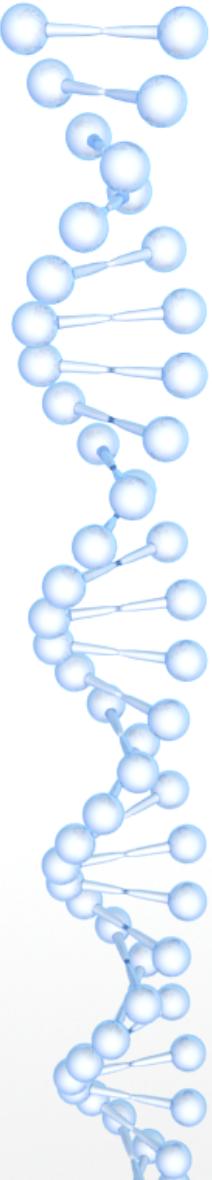
# Modelling/“analysis”: entities



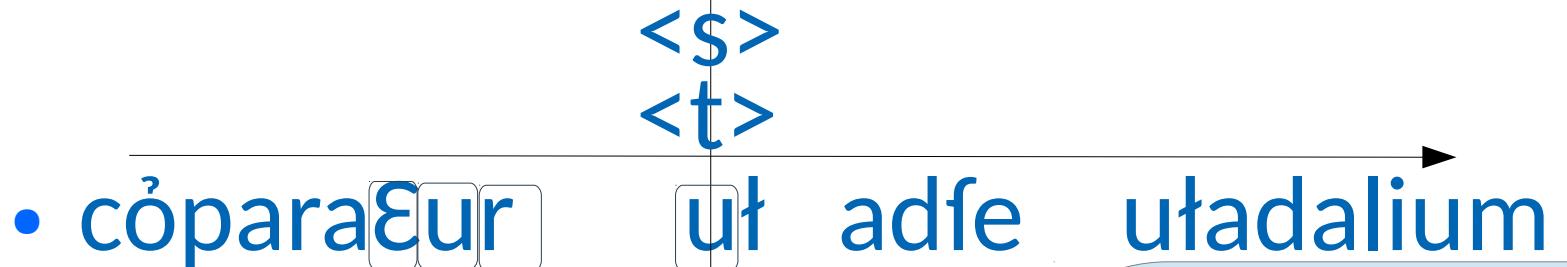


# Graphemes as entities?

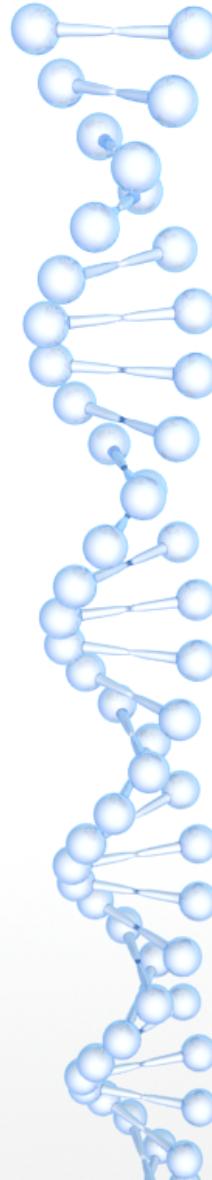




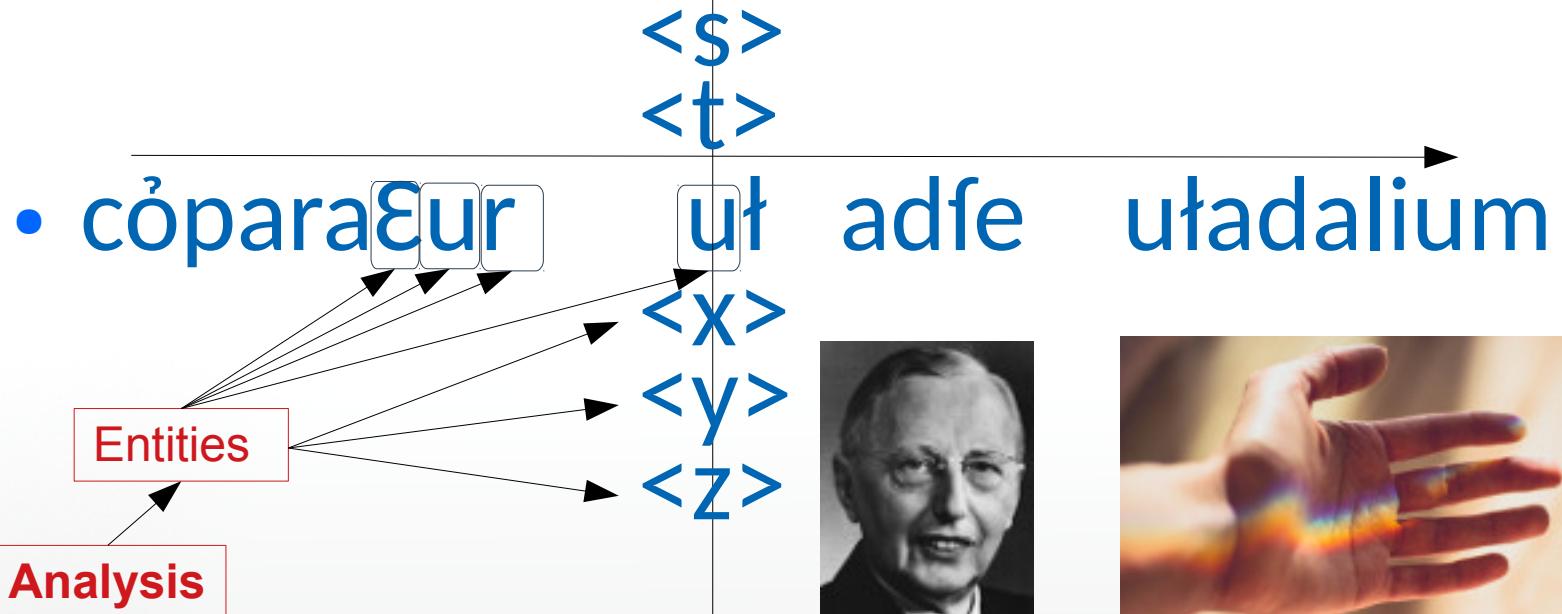
# Graphemes as entities?

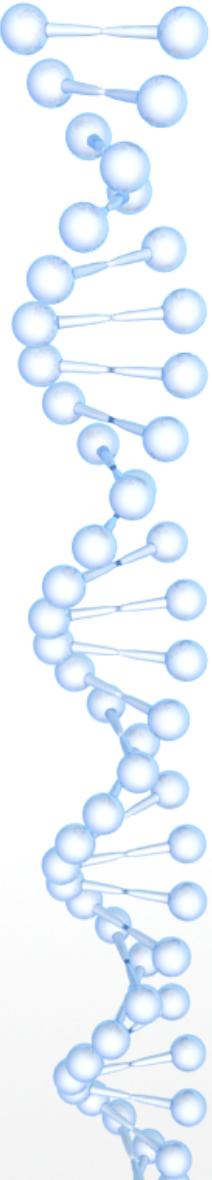


“Thus the same linguistic form may also be manifested in writing... Here is a graphic ‘substance’... Describing the actually present expression... system” (Prol. Ch. 21)



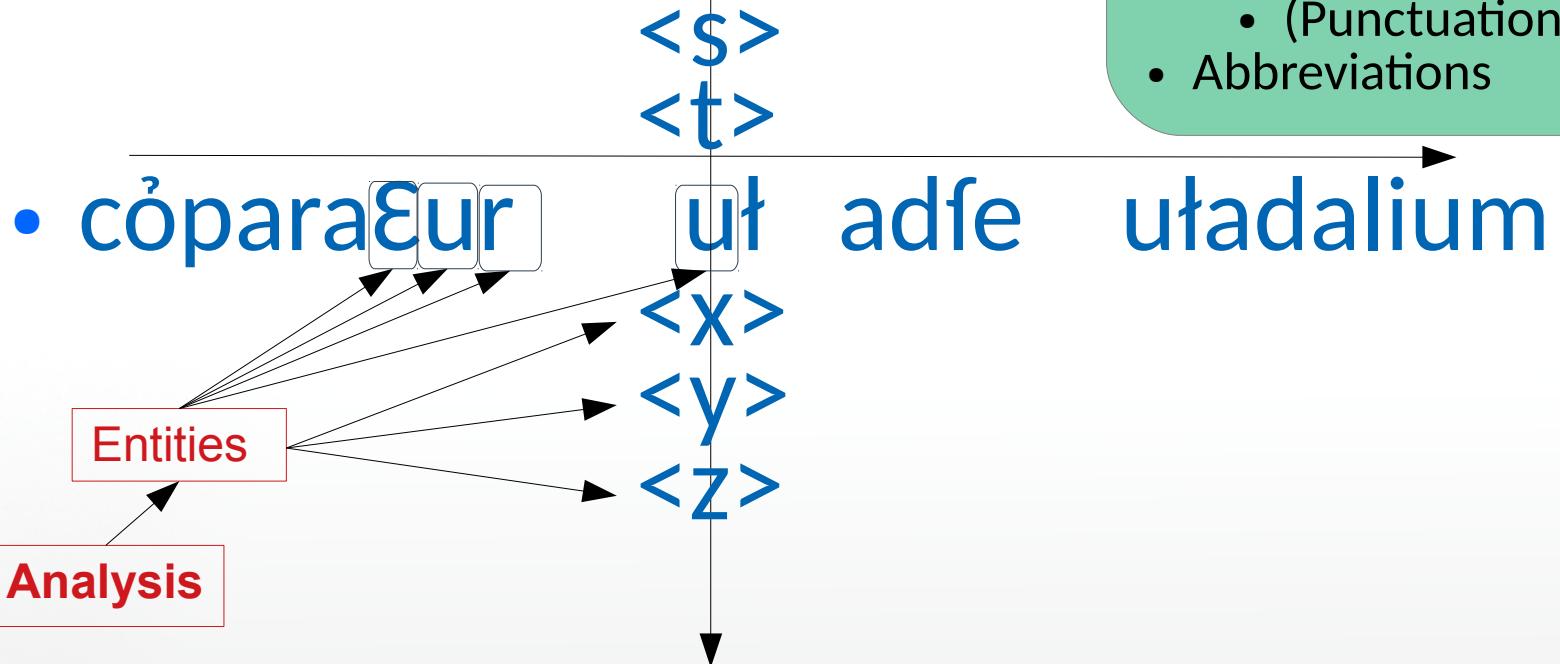
# Graphemes as entities?

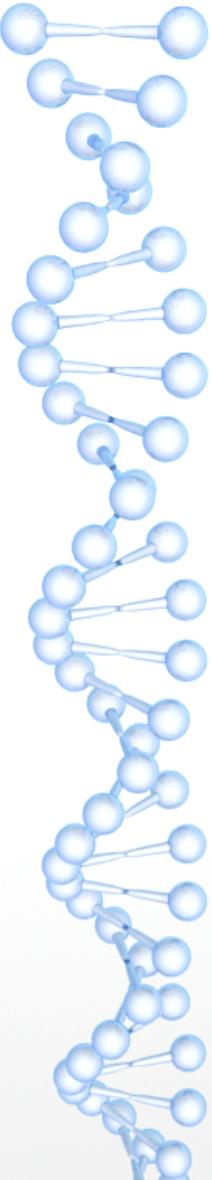




# Graphemes as entities?

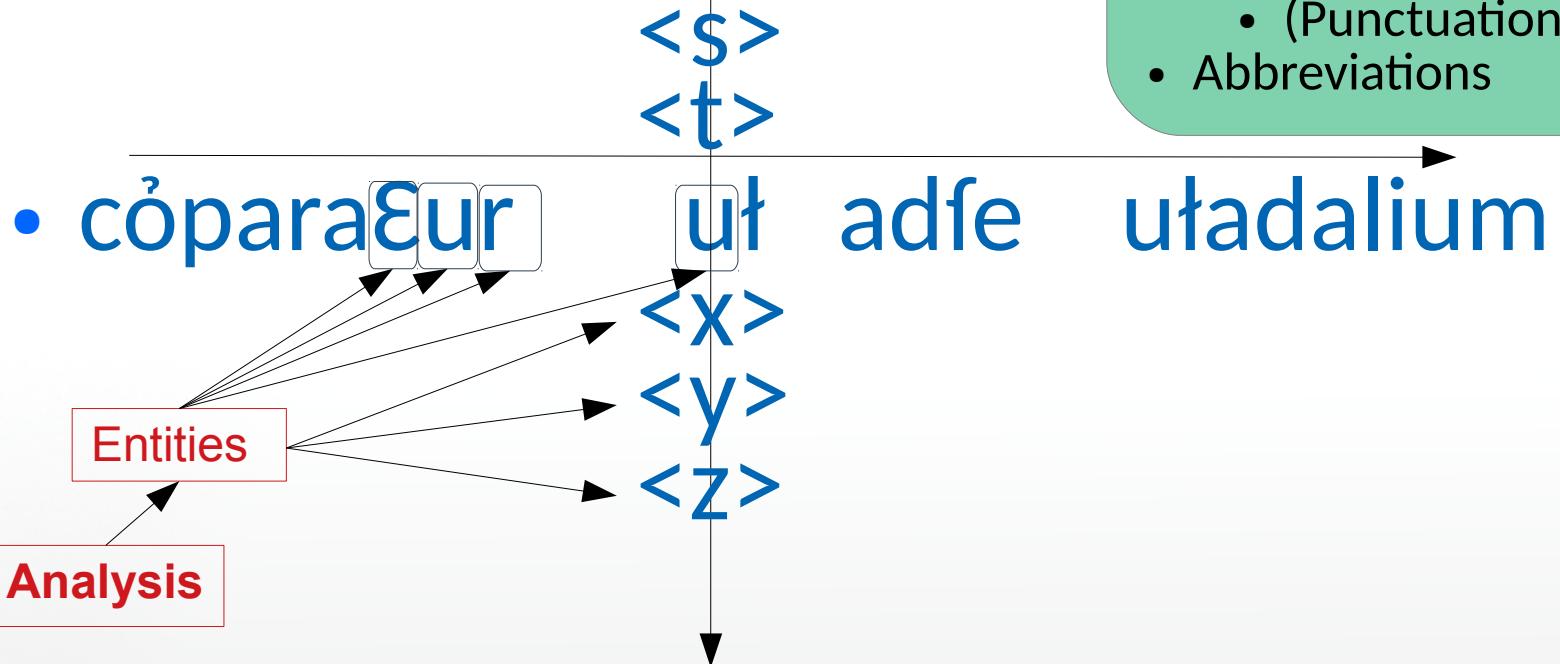
- Digital (discrete)
- Ligatures
- Allographs
  - (Capitalization)
- Grapheme set
  - (Punctuation)
- Abbreviations

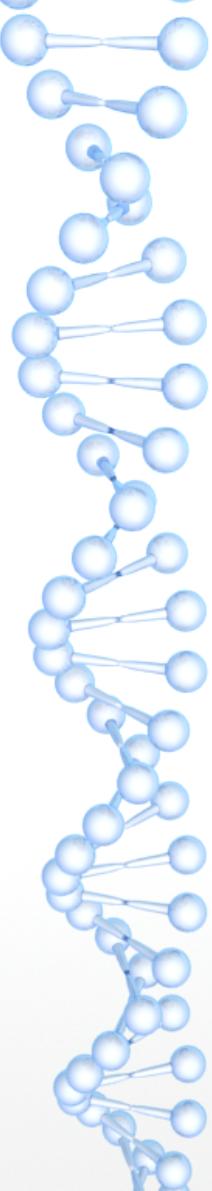




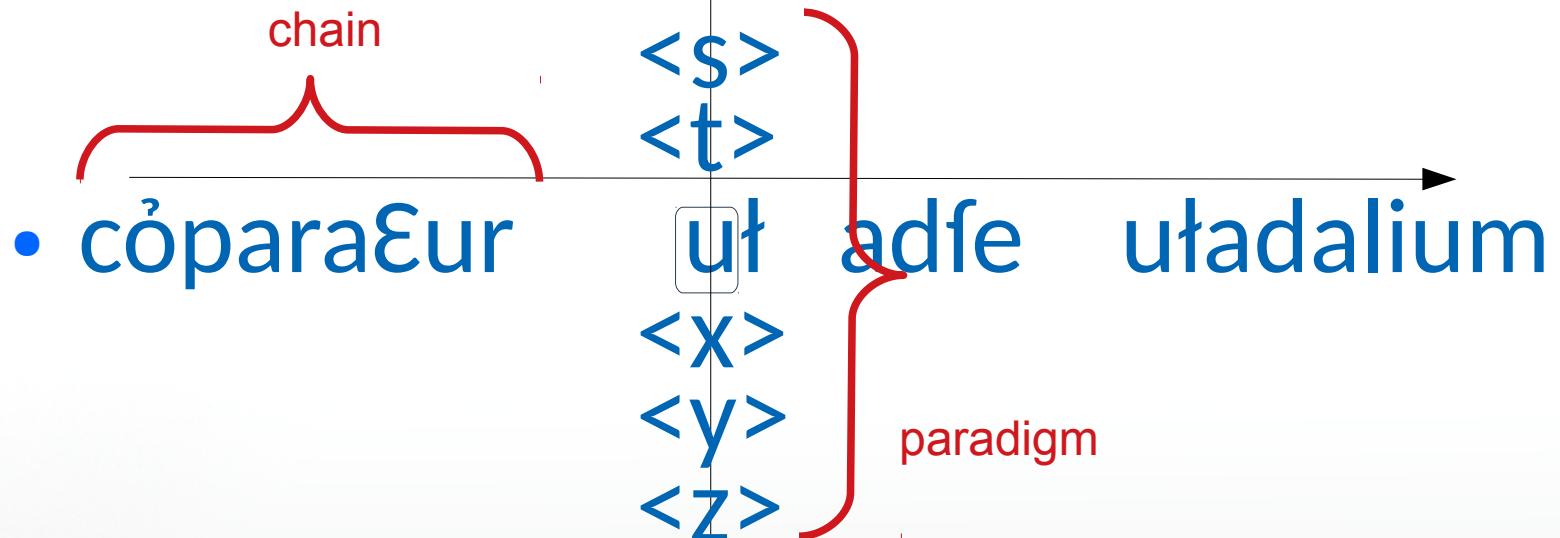
# Graphemes as entities?

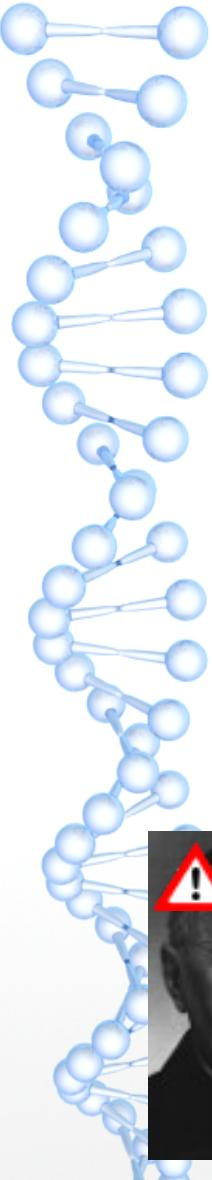
- Digital (discrete)
- Ligatures
- Allographs
  - (Capitalization)
- Grapheme set
  - (Punctuation)
  - Abbreviations





# Chains and paradigms

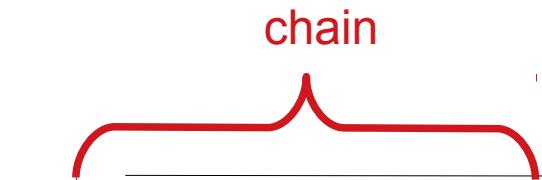




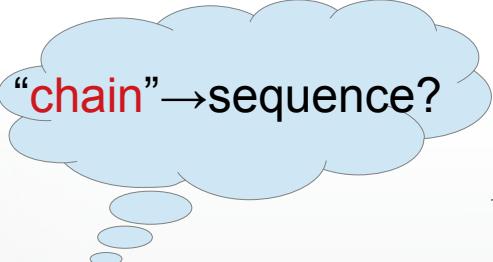
# Chains and paradigms

• **cóparaEur**

chain



“chain” → sequence?



<S>  
<t>

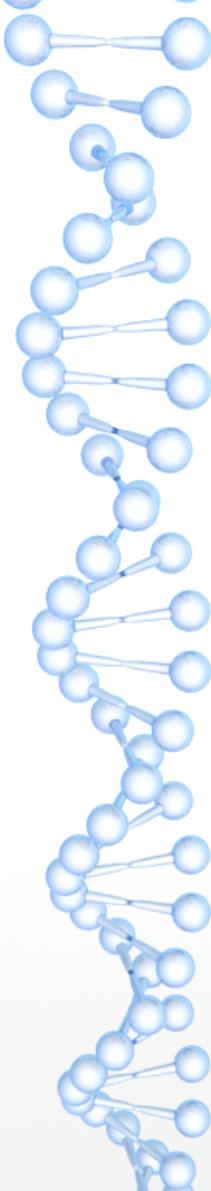
uł

<x>  
<y>  
<z>

adfe

paradigm

uładalium

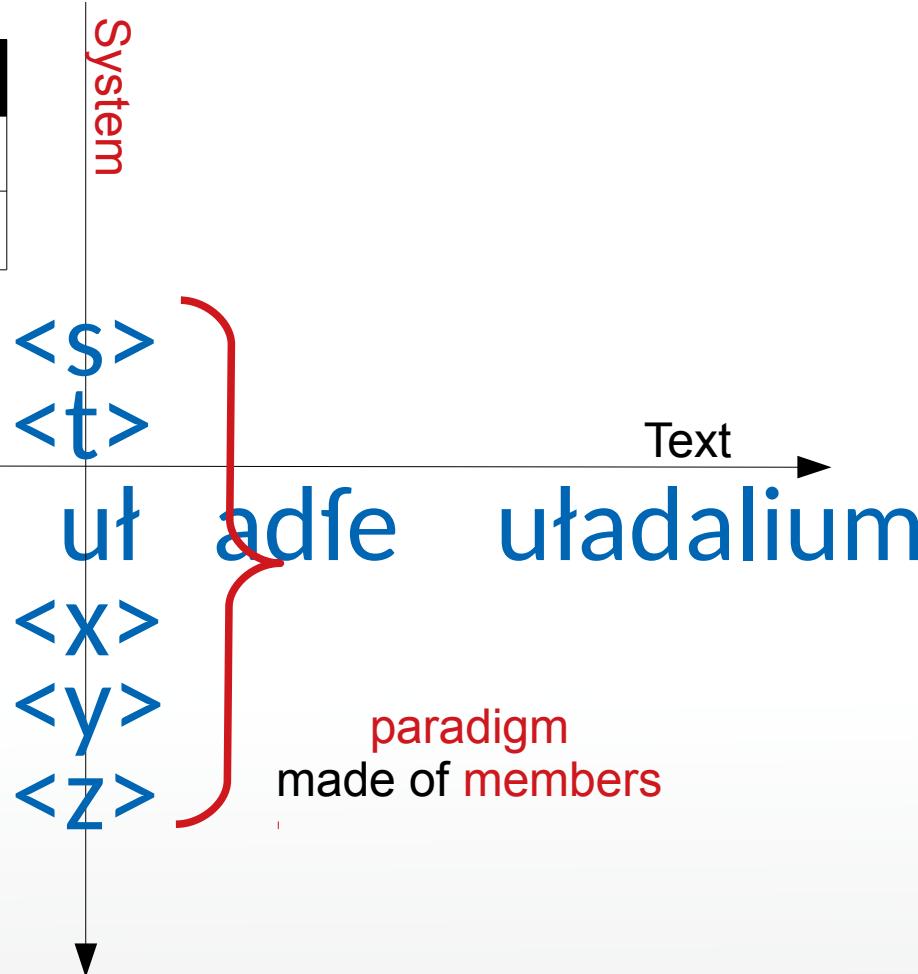


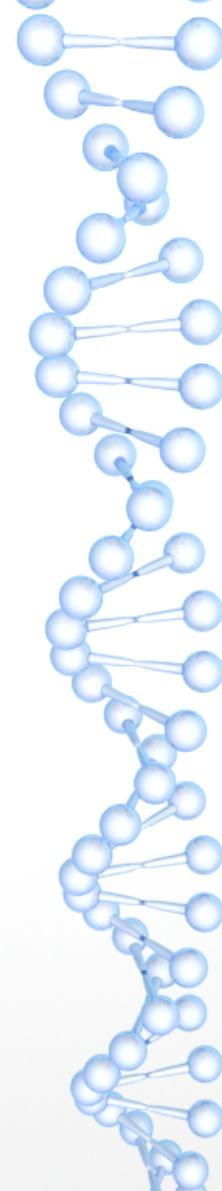
# Classes: chains and paradigms

class	components
chain	parts
paradigm	members

- cóparaEur

chain  
made of parts





# Functions



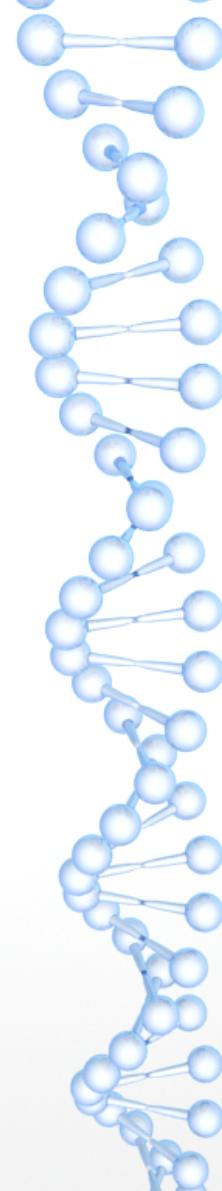
- cóparaEur

Function

<\$>  
<t>

<x>  
<y>  
<z>

uł adfe uładalium



# Functions

- cóparaEur

Function

<\$>  
<t>  
<x>  
<y>  
<z>

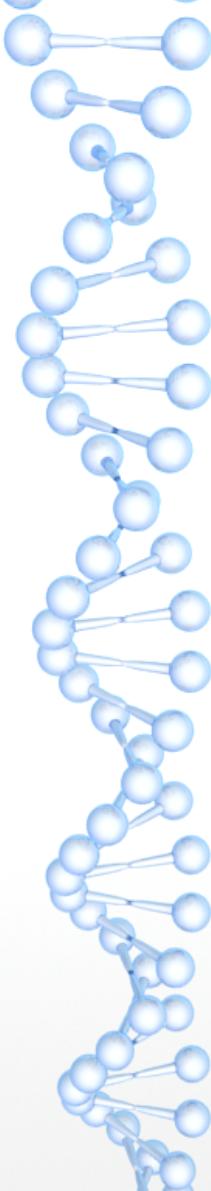
uł

y

adfe

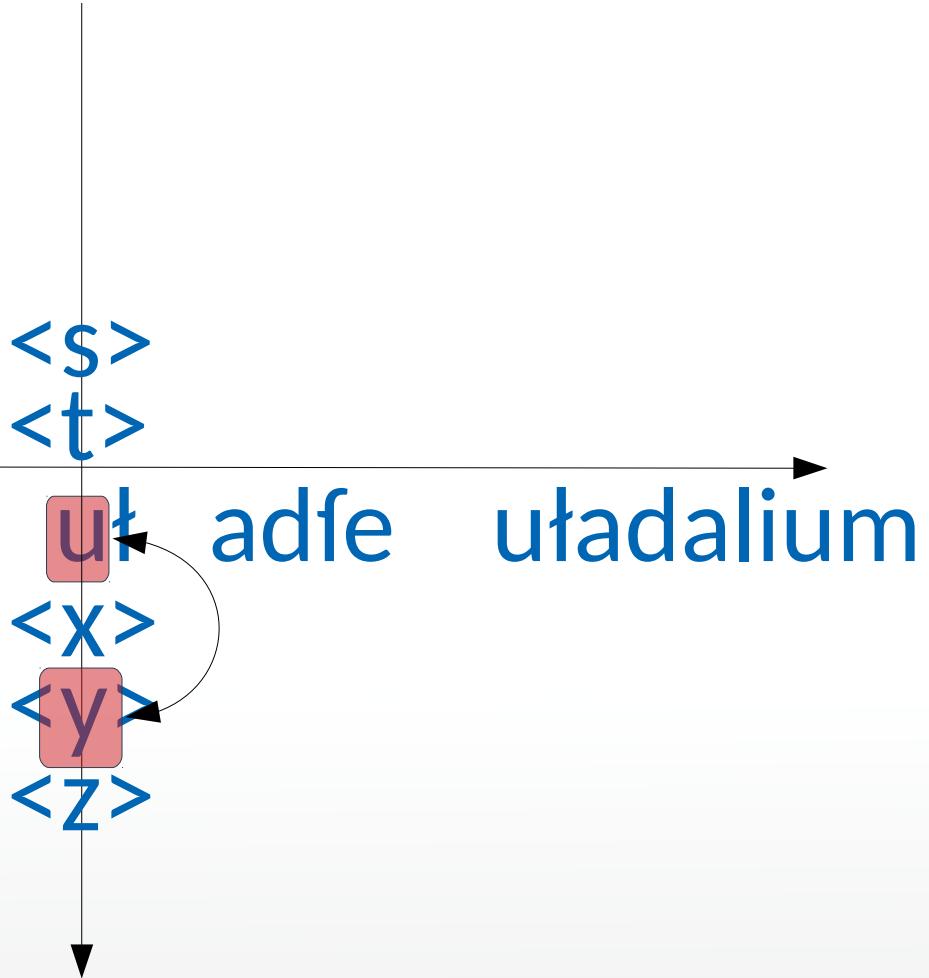
ułdalium

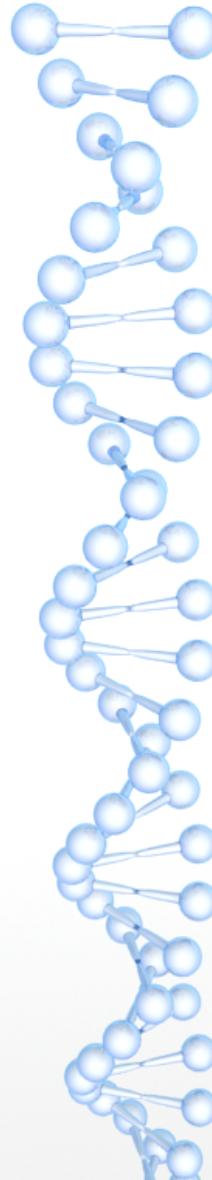
# Graphemes/allographs



# The commutation test

- cóparaEur



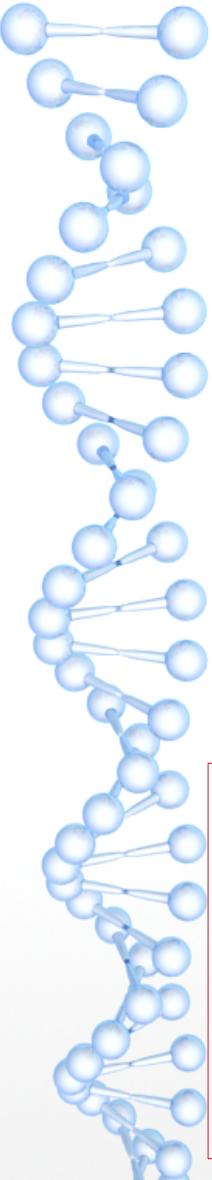


# The commutation test

- cóparaEUR
  - « $\sigma$ »
  - « $\sqrt{ }$ »
- $\langle \$ \rangle$
- $\langle t \rangle$
- $uł$
- $\langle x \rangle$
- $y$
- $\langle z \rangle$

adfe

ułdalium



# The commutation test

- cóparaEur

Function

**Substitution:**  
→ No change  
in “meaning”

daEur / daσur

« $\sigma$ »

«√»

$\langle \$ \rangle$   
 $\langle t \rangle$

uł

$\langle x \rangle$

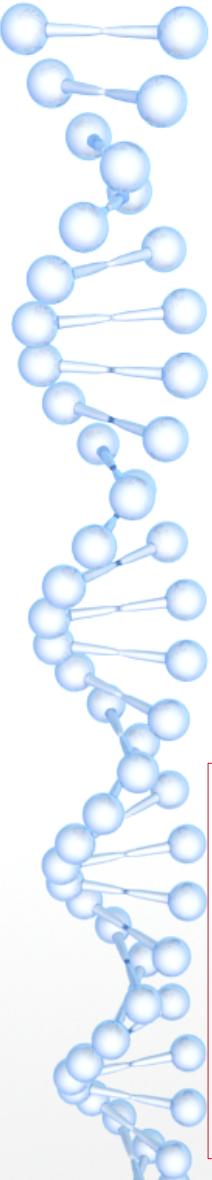
y  
 $\langle z \rangle$

adfe      uładalium

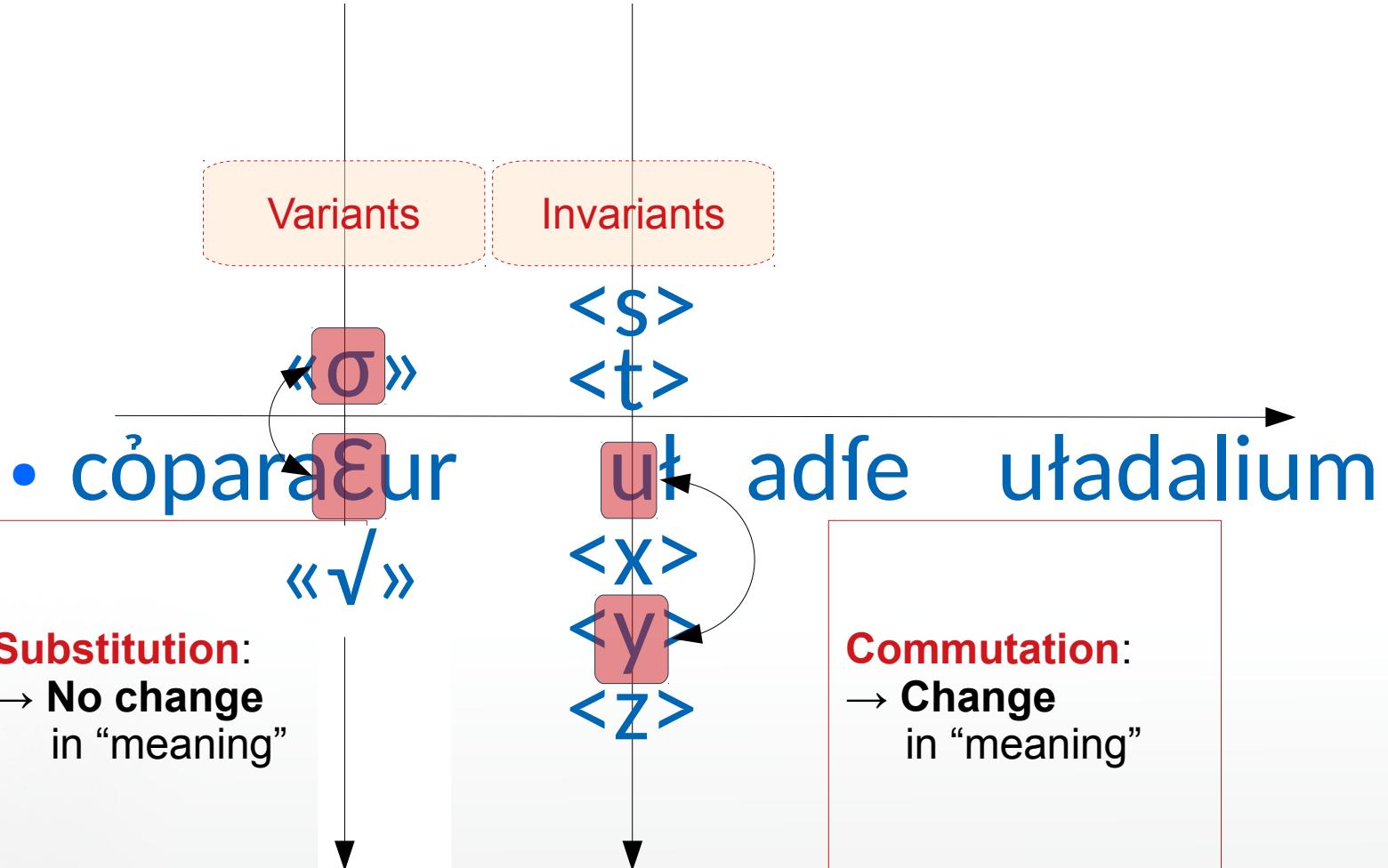
Function

**Commutation:**  
→ Change  
in “meaning”

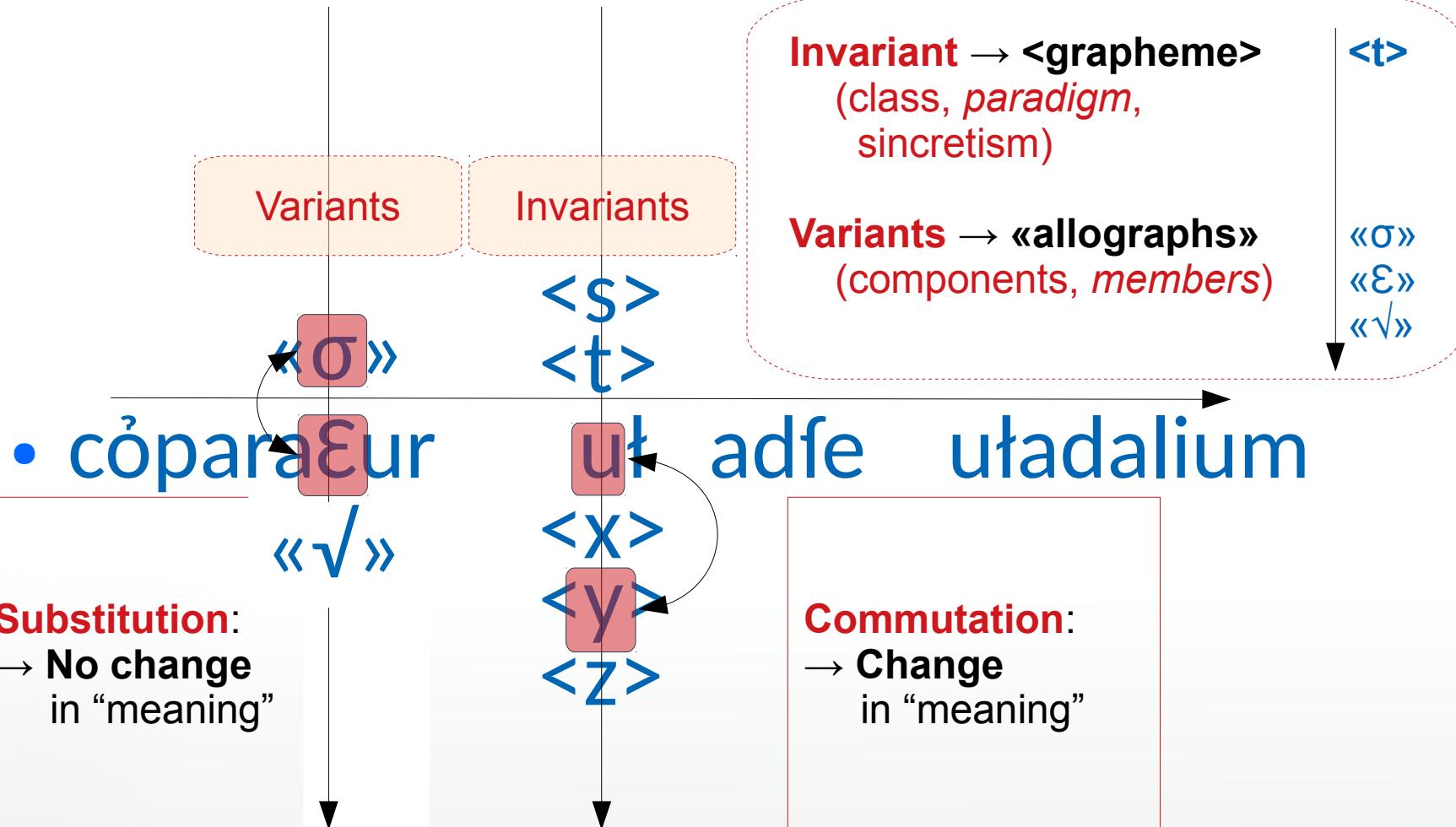
annus / annys

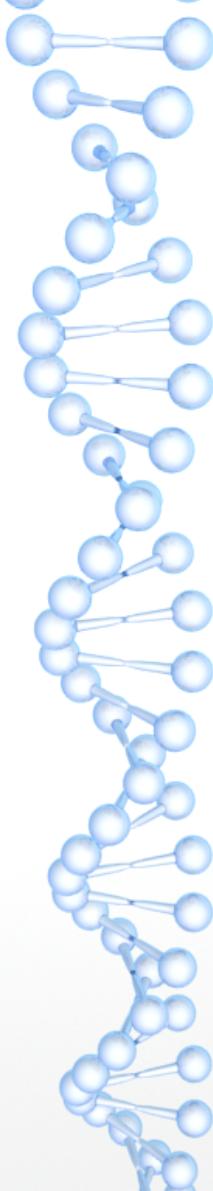


# The commutation test

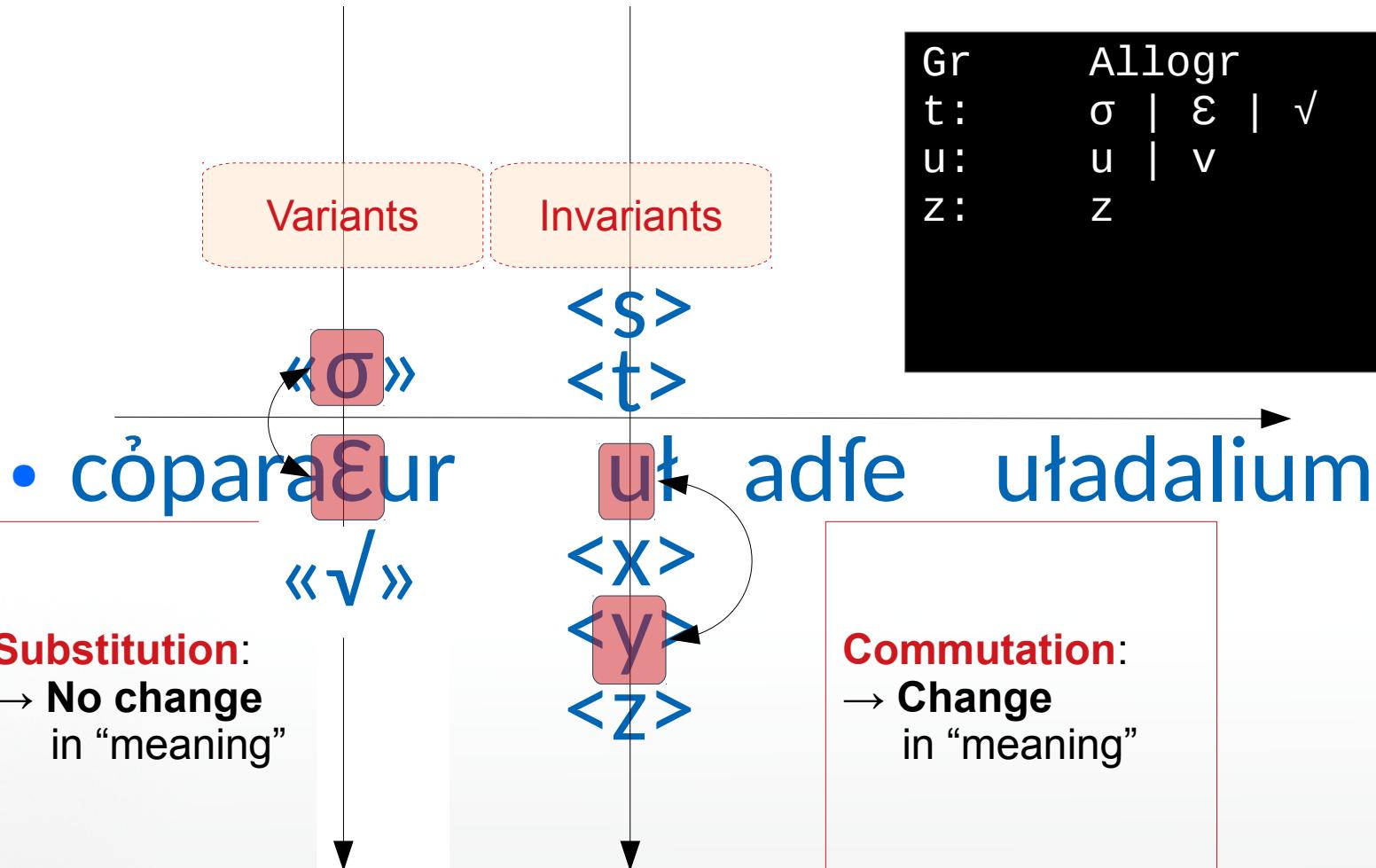


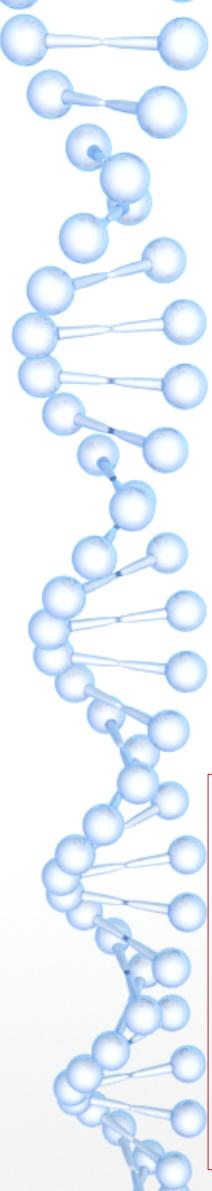
# Graphemes / allographs



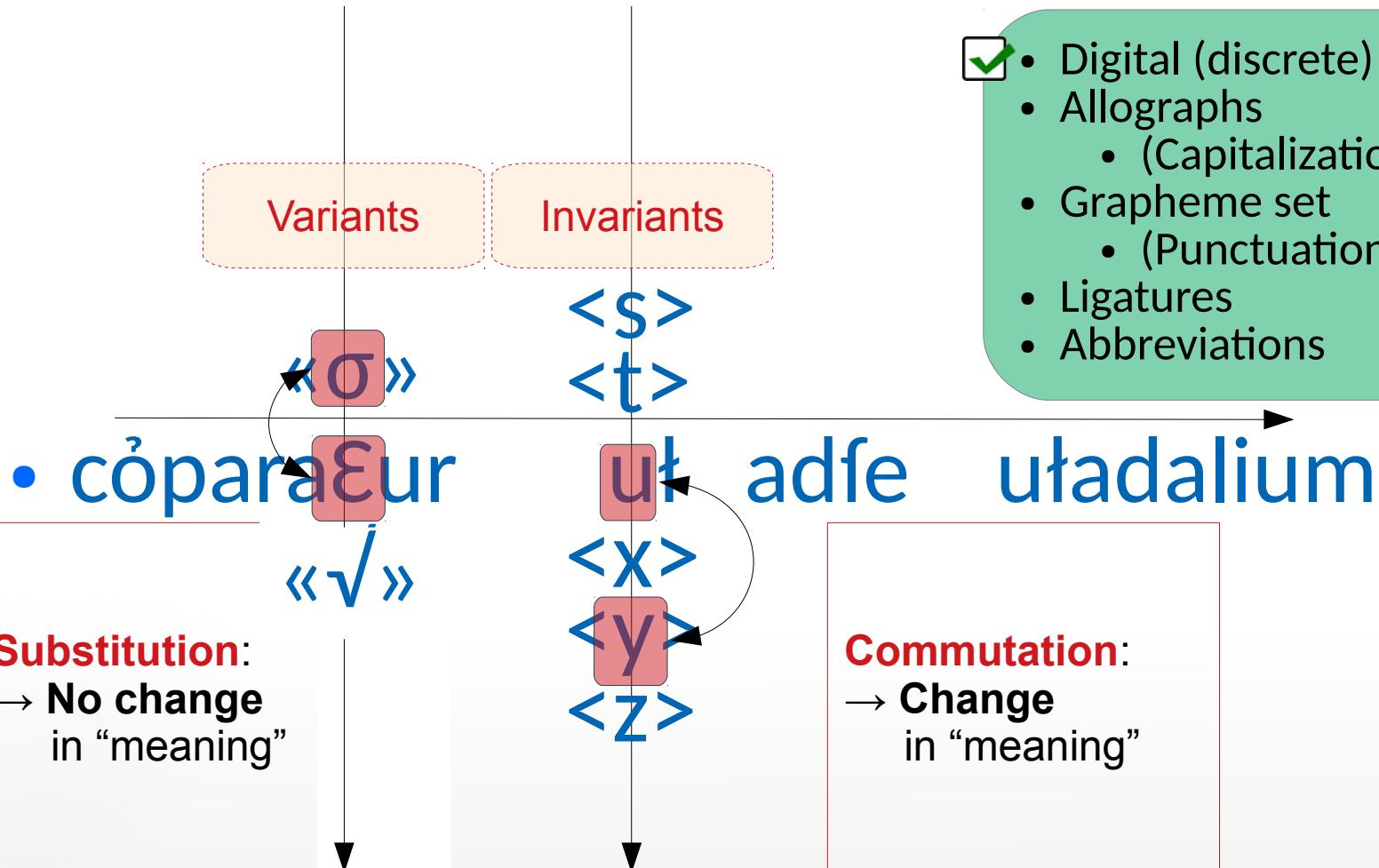


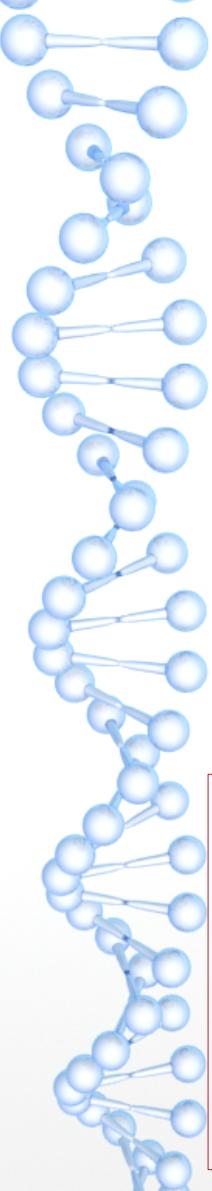
# Graphemes / allographs



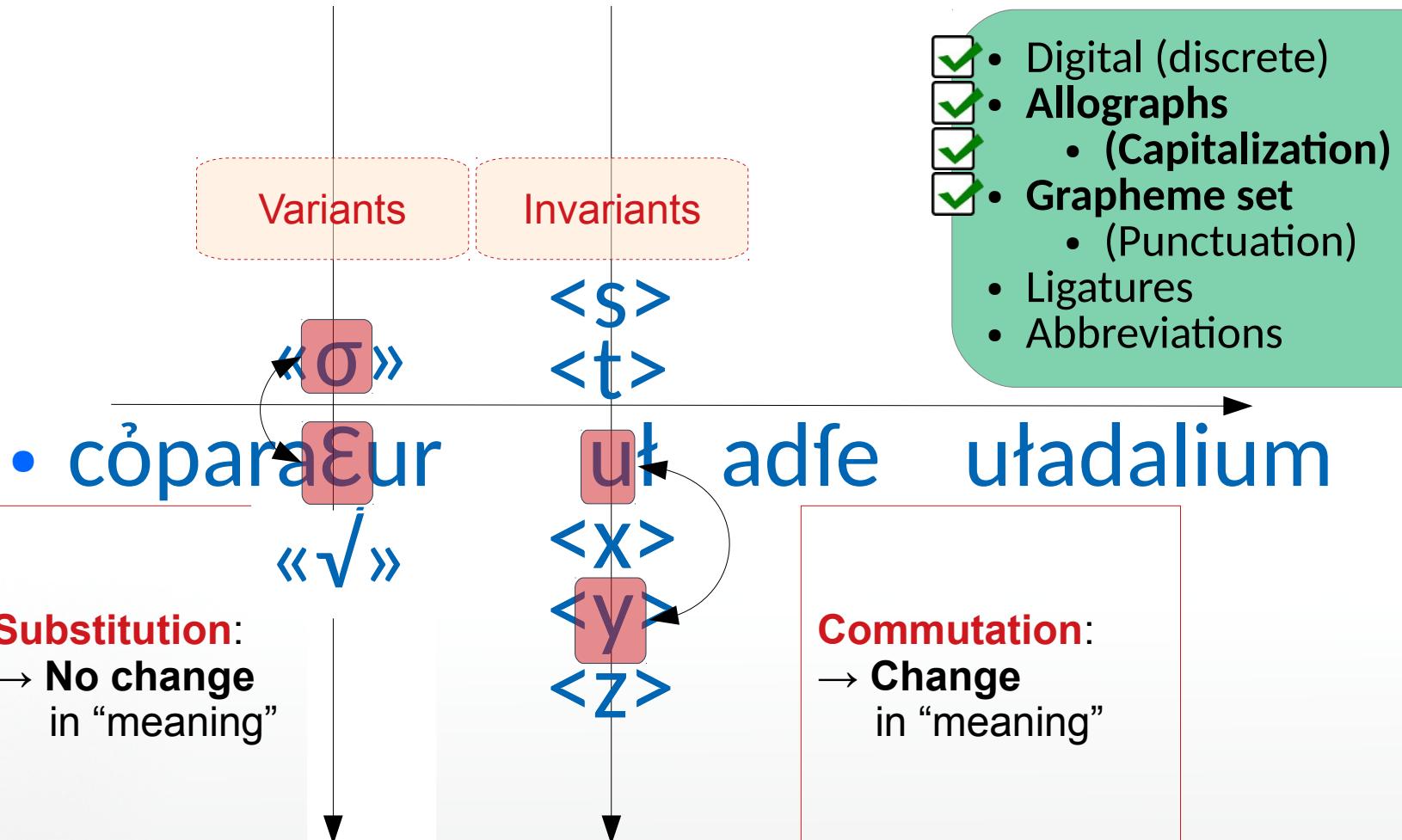


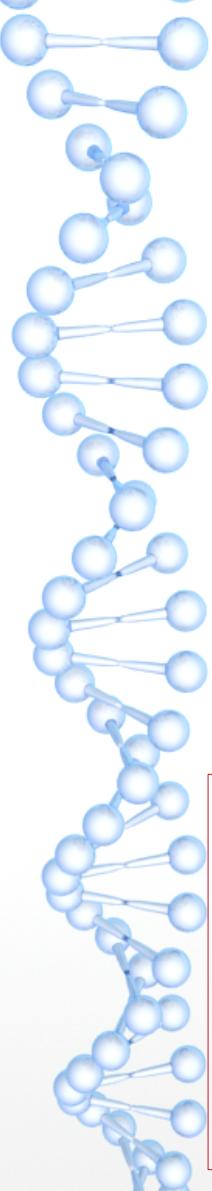
# Graphemes / allographs



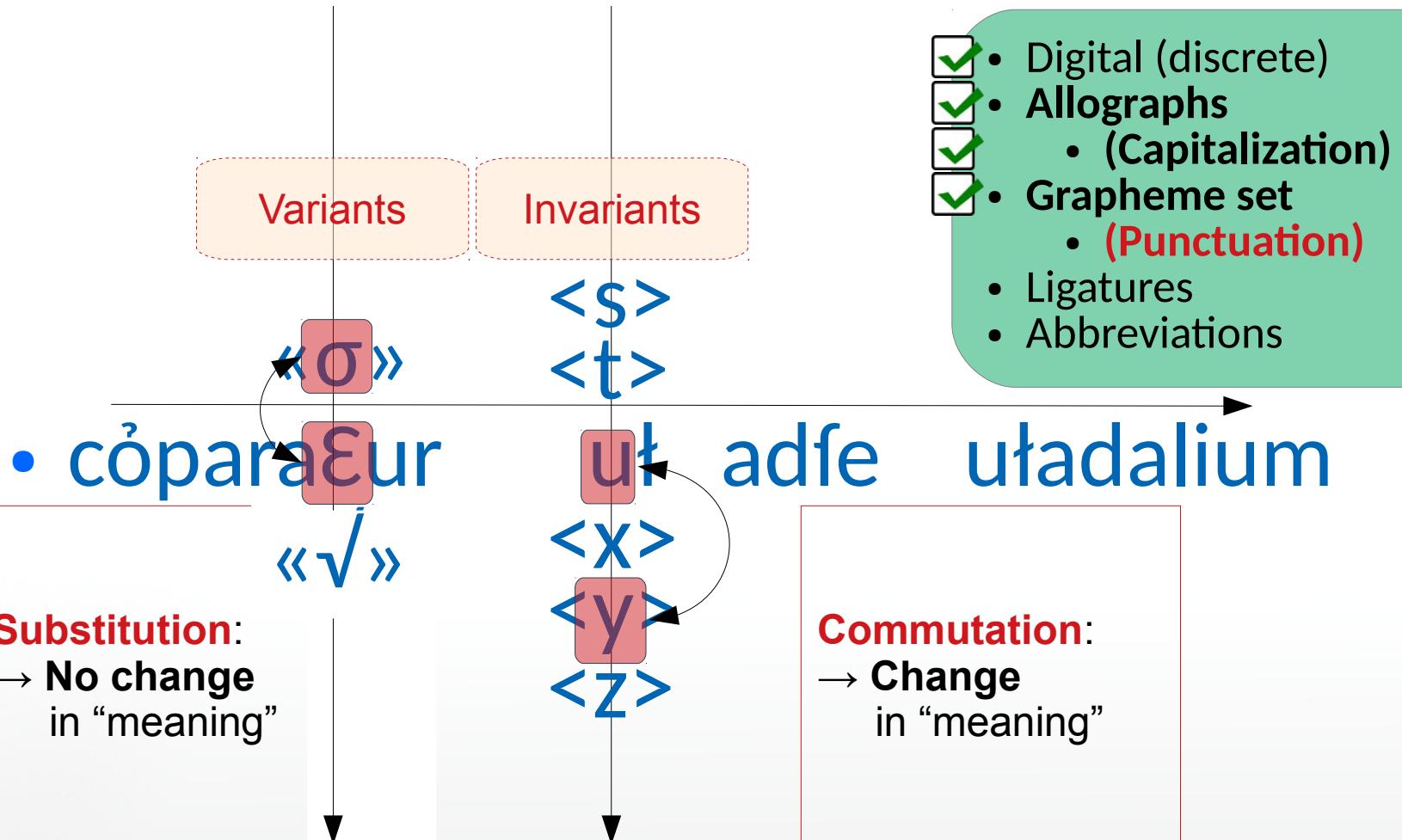


# Graphemes / allographs



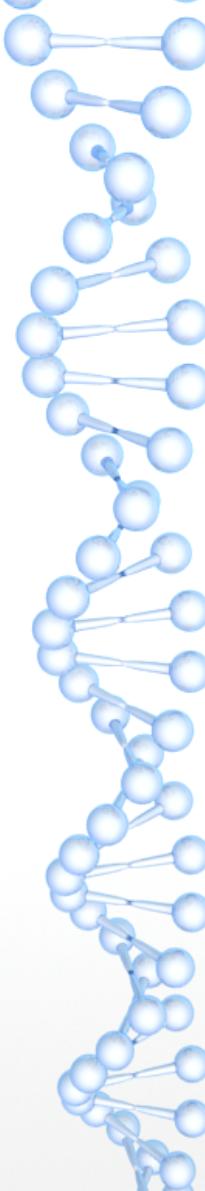


# Graphemes / allographs



# Punctuation

# Punctuation



- cóparaEur

« $\sigma$ »

«✓»

**Substitution:**  
→ No change  
in “meaning”

$\langle \$ \rangle$   
 $\langle t \rangle$

uł

$\langle X \rangle$

y

$\langle Z \rangle$

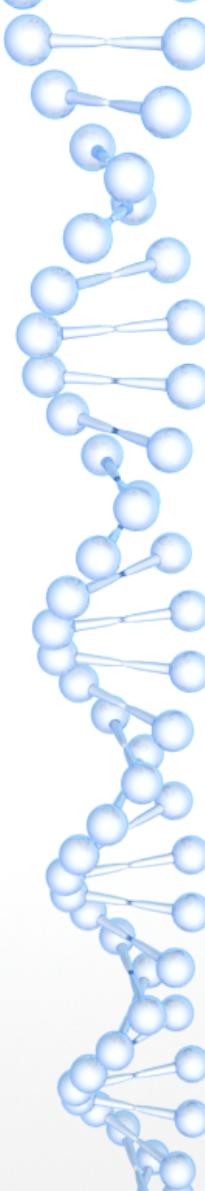
adfe uładarium



“content-form”  
(Prol. Ch. 13)

**Commutation:**  
→ Change  
in “meaning”

# Punctuation



• cóparaEur

« $\sigma$ »

«✓»

**Substitution:**  
→ No change  
in “meaning”

$\langle \$ \rangle$   
 $\langle t \rangle$

uł

$\langle x \rangle$

y

$\langle z \rangle$

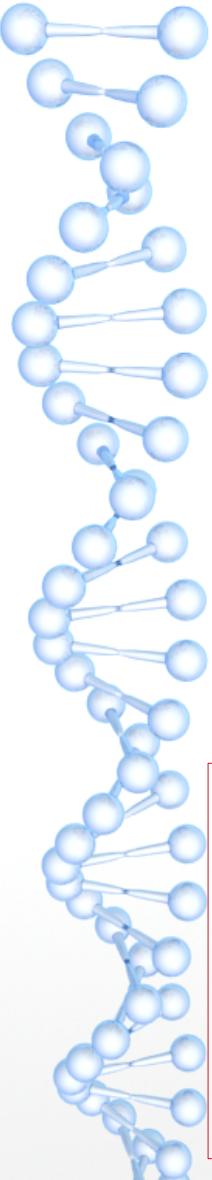
adfe uładarium



“content-form”  
(Prol. Ch. 13)

Including larger units, such as sentences

**Commutation:**  
→ Change  
in “meaning”



# Punctuation



“content-form”  
(Prol. Ch. 13)

Including larger units, such as sentences

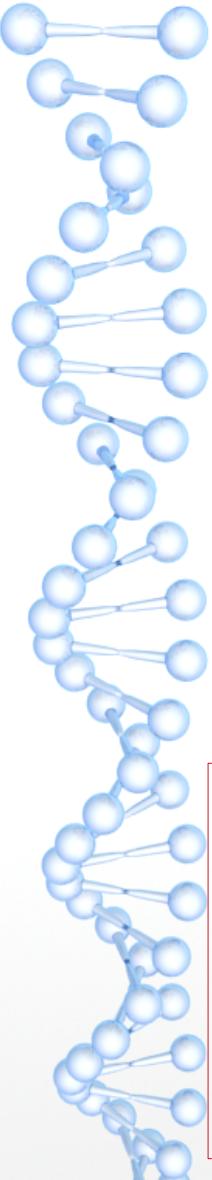
Truly I tell you, today you will be with me in paradise

Truly I tell you today, you will be with me in paradise

**Substitution:**  
→ No change  
in “meaning”

**Commutation:**  
→ Change  
in “meaning”





# Punctuation



“content-form”  
(Prol. Ch. 13)

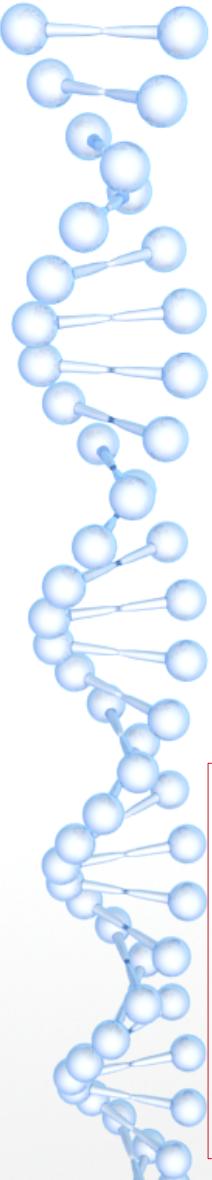
Including larger units, such as sentences

Truly I tell you, today you will be with me in paradise

Truly I tell you today, you will be with me in paradise

**Substitution:**  
→ No change  
in “meaning”

**Commutation:**  
→ Change  
in “meaning”



# Punctuation

• cóparaEur

« $\sigma$ »

«✓»

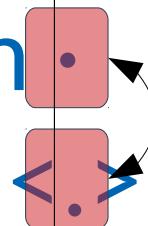
**Substitution:**  
→ No change  
in “meaning”

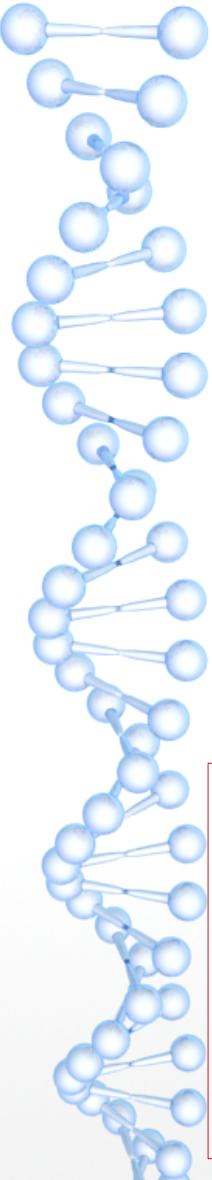
$\langle \$ \rangle$   
 $\langle t \rangle$

$\langle x \rangle$   
 $\langle y \rangle$   
 $\langle z \rangle$

uł adfe uładaliuṁ

**Commutation:**  
→ Change  
in “meaning”





# Punctuation

- Digital (discrete)
- Allographs
  - (Capitalization)
- Grapheme set
  - (Punctuation)
- Ligatures
- Abbreviations

• cóparaEur

«σ»

«√»

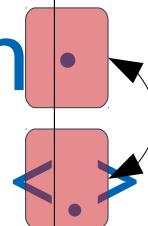
**Substitution:**  
→ No change  
in “meaning”

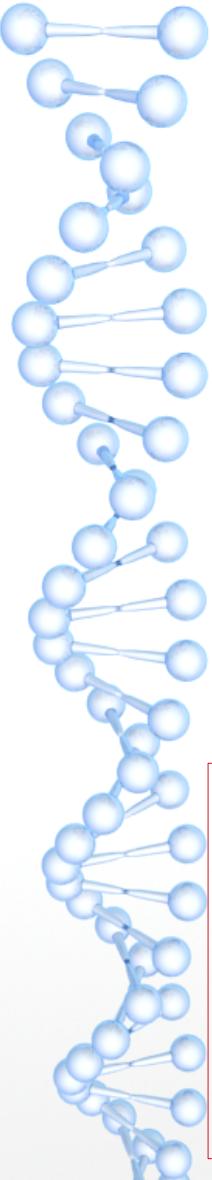
**<S>**  
**<t>**

**<x>**  
**<y>**  
**<z>**

uł adfe uładalim

**Commutation:**  
→ Change  
in “meaning”





# Punctuation

- Digital (discrete)
- Allographs
  - (Capitalization)
- Grapheme set
  - (Punctuation)
- Ligatures
- Abbreviations

• cóparaEur

«σ»

«√»

**Substitution:**  
→ No change  
in “meaning”

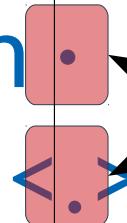
**<S>**  
**<t>**

**<x>**  
**<y>**  
**<z>**

uł

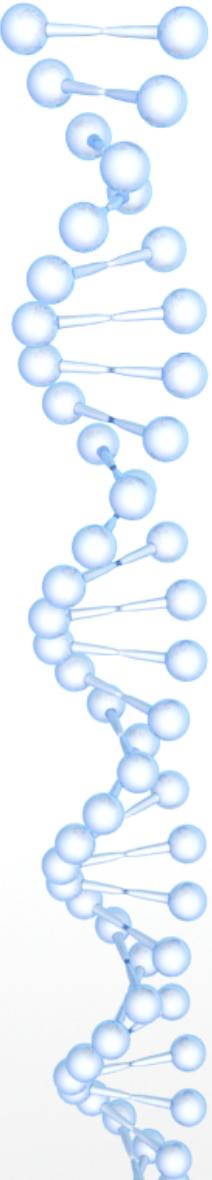
adfe

uładalium



**Commutation:**  
→ Change  
in “meaning”

# Ligatures



# Ligatures



- cóparaEur

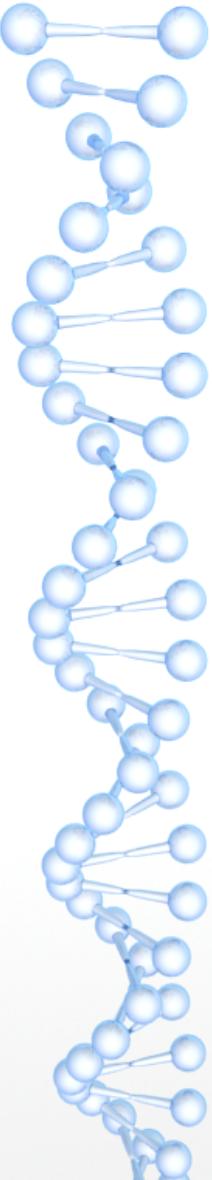
Function

“Ligature”  
(entities, parts of a chain)

<\$>  
<t>

<x>  
<y>  
<z>

uł adfe uładaliuṁ



# Ligatures

Varieties



«œ»

- cóparaœur

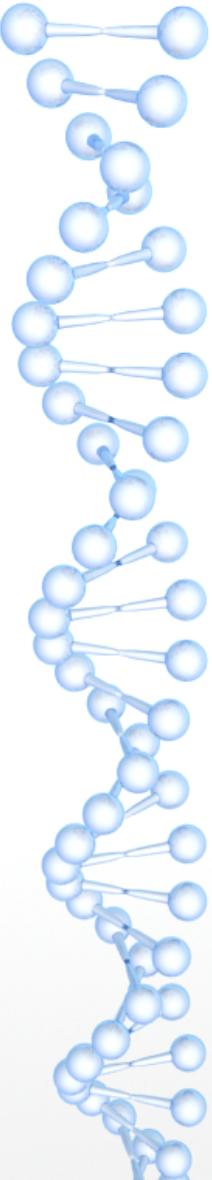
«œ»

<S>  
<t>

<x>  
<y>  
<z>

uł adfe

uładalium



# Ligatures

Varieties:  
Solidal  
variants



«œ»

- cóparaEur

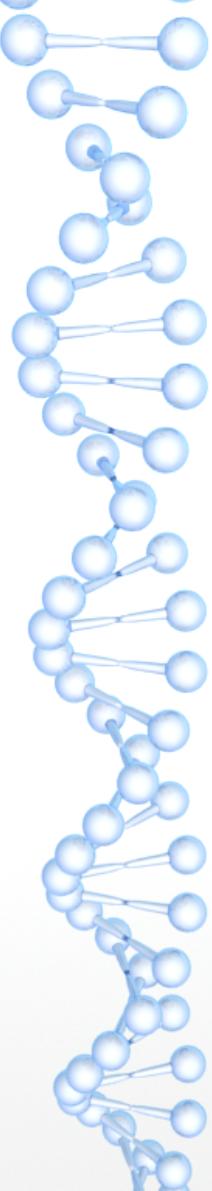
«œ»

<S>  
<t>

<x>  
<y>  
<z>

uł adfe

uładalium



# Ligatures

Varieties:  
Solidal  
variants



«σ»

- cóparaEur

«γ»

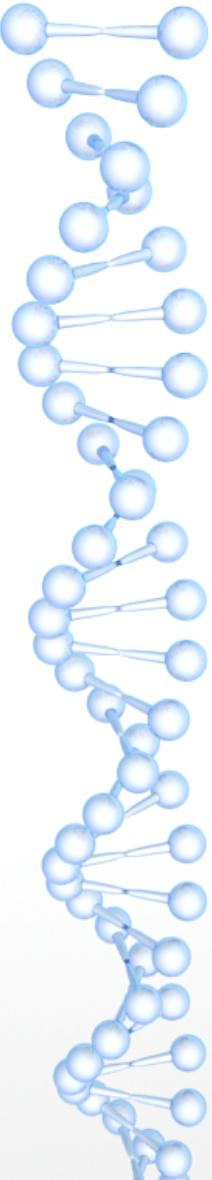
<S>  
<t>

<x>  
<y>  
<z>

```
<seg type="lig">tu</seg>  
"lig"/tu → ε+Ц → t+u
```

```
<g ref="ligTU"/>  
"ligTU" → ε+Ц → t+u
```

uł adfe uładalim



# Ligatures

Varieties:  
Solidal  
variants



- cóparaEur

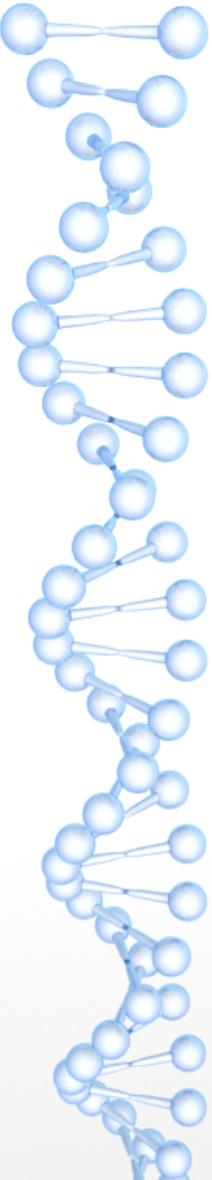
<\$>  
<t>

<x>  
<y>  
<z>

uł adfe

uładaliūm

- Digital (discrete)
- Allographs
  - (Capitalization)
- Grapheme set
  - (Punctuation)
- Ligatures
- Abbreviations



# Ligatures

Varieties:  
Solidal  
variants



- cóparaEur

<\$>  
<t>

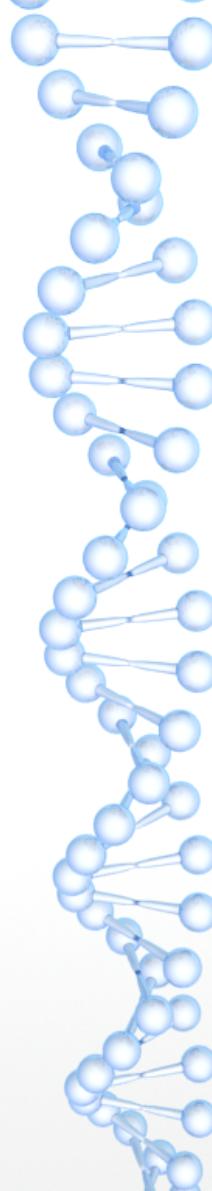
<x>  
<y>  
<z>

uł adfe

uładalium

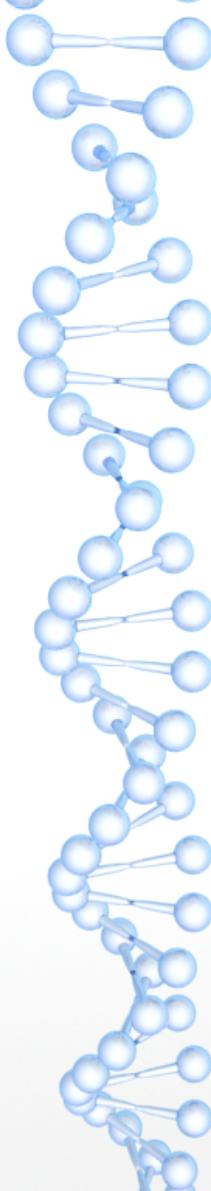
- Digital (discrete)
- Allographs
  - (Capitalization)
- Grapheme set
  - (Punctuation)
- Ligatures
  - Abbreviations

# Abbreviations



# Abbreviations

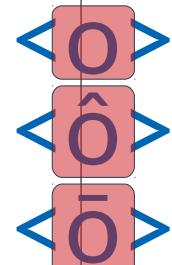
- coparaEur uł adfe uładalium



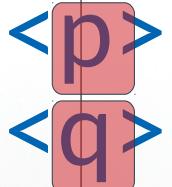
# Abbreviations: one grapheme?

1. One **entity**

- Whole abbreviation = grapheme (**invariant**)

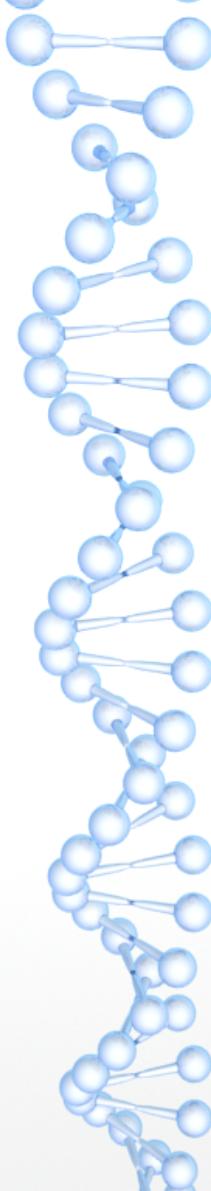


- coparaEur



uł adfe uładalium

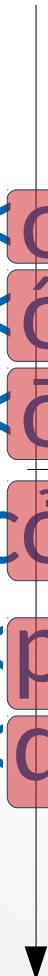




# Abbreviations: one grapheme?

- coparaEur

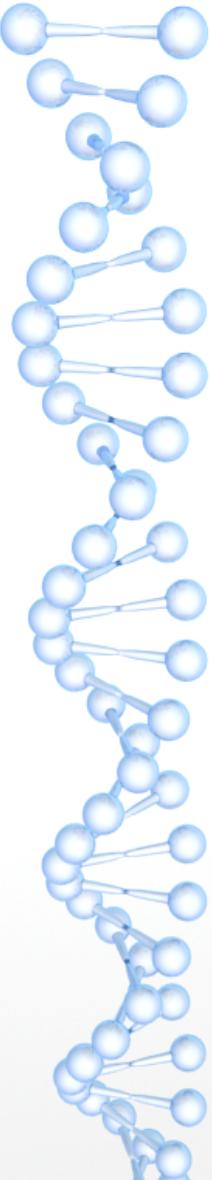
<p>  
<q>



uł adfe uładalim



Principles: **simplicity**,  
**economy**, **reduction**  
(Prol. Ch. 6)  
“lowest possible number  
of elements” (Ch. 13)



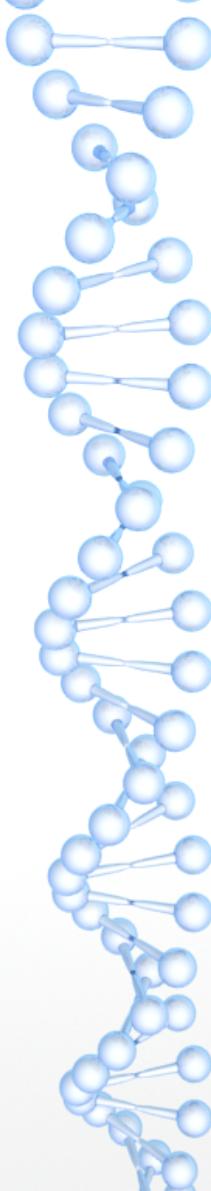
# Abbreviations: function

1. One **entity**  
- Whole abbreviation = grapheme (**invariant**)
2. Two **entities (function)**

• coparaEur      uł adfe      uładalium

Function

(entities)



# Abbreviations: function → ligature?

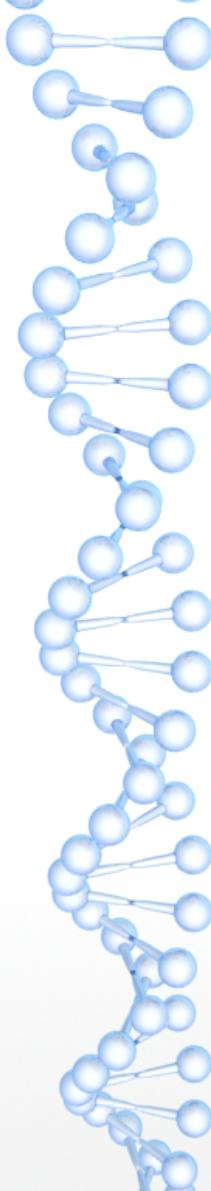
1. One **entity**  
- Whole abbreviation = grapheme (**invariant**)
2. Two **entities (function)**  
**2A.** Ligature (**solidal variants** in a chain)

• coparaEur      uł adfe      uładalium

Function

“Ligature”  
(**Solidal variants**)





# Abbreviations: function → ligature?

1. One **entity**  
- Whole abbreviation = grapheme (**invariant**)
2. Two **entities (function)**  
**2A.** Ligature (**solidal variants** in a chain)

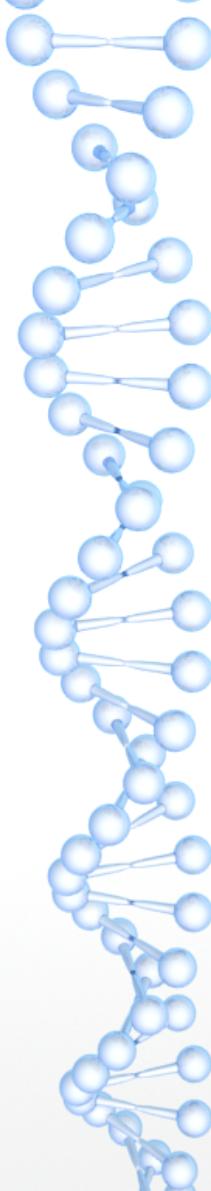
• coparaEur      uł adfe      uładalium

Function

“Ligature”  
(**Solidal variants**)

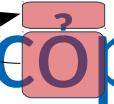


**Solidal:** both mandatory



# Abbreviations: function → selection?

1. One **entity**  
- Whole abbreviation = grapheme (**invariant**)
2. Two **entities (function)**
  - 2A. Ligature (**solidal variants in a chain**)
  - 2B. **Selection** (one governs the other)

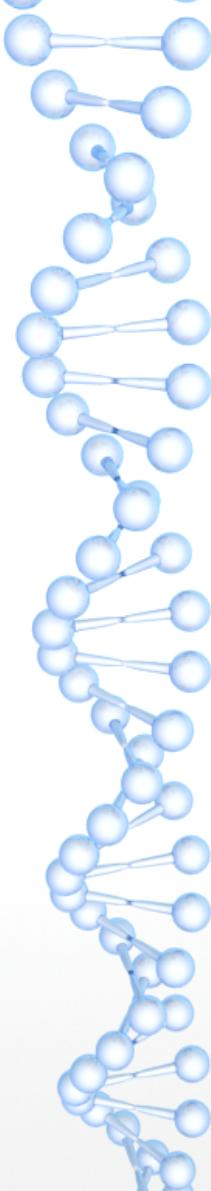
•  coparaEur      uł adfe      uładalium

Function

Selection:

- one is optional
- one governs the other





# Abbreviations: function → selection?

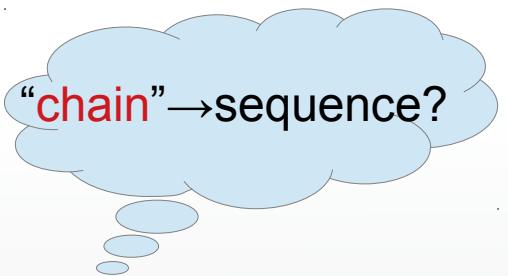
• coparaEur

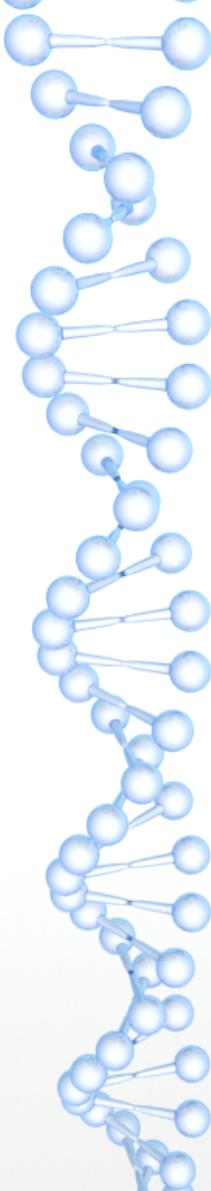
Function

Selection:

- one is optional
- one governs the other

uł adfe uładalium





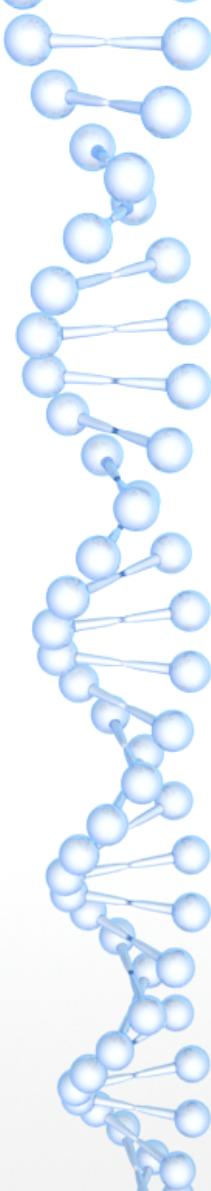
# Abbreviations: function → complementarity?

1. One **entity**  
- Whole abbreviation = grapheme (**invariant**)
2. Two **entities (function)**
  - 2A. Ligature (**solidal variants in a chain**)
  - 2B. **Selection** (one governs the other)
  - 2C. **Complementarity** (**interdependence**)

• coparaEur      uł adfe      uładalium

Function

Complementarity  
(interdependence in a **system**)



# Abbreviations: function → complementarity?

• coparaEur

Function

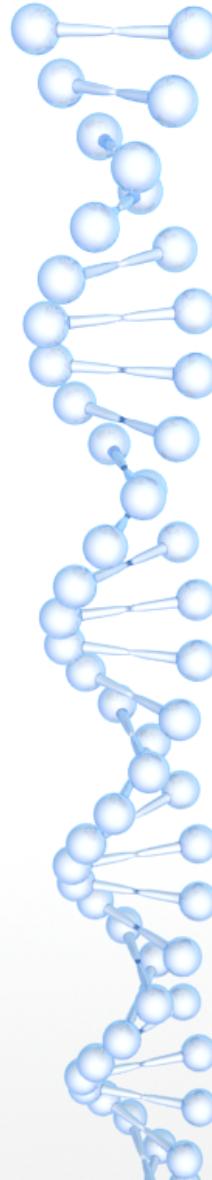
Complementarity  
(interdependence in a system)

uł adfe uładalim

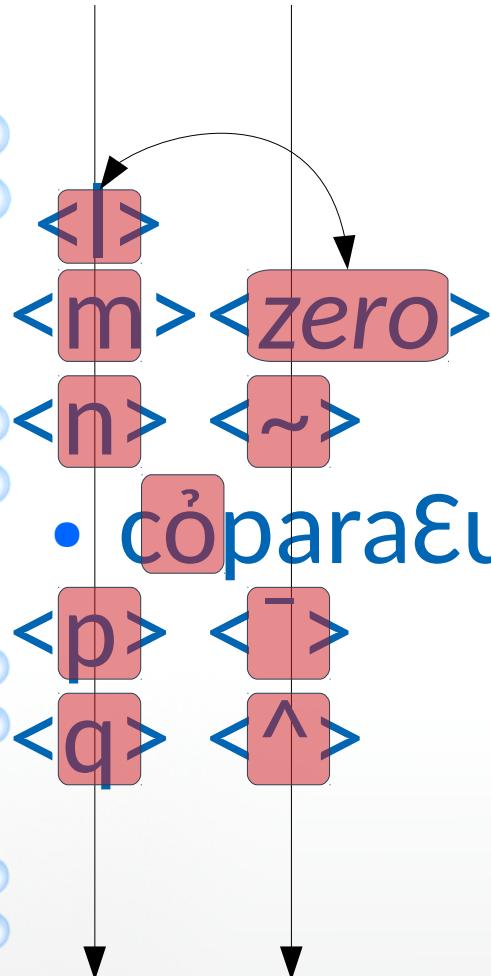
Example of  
complementarity

[case + gender + number]

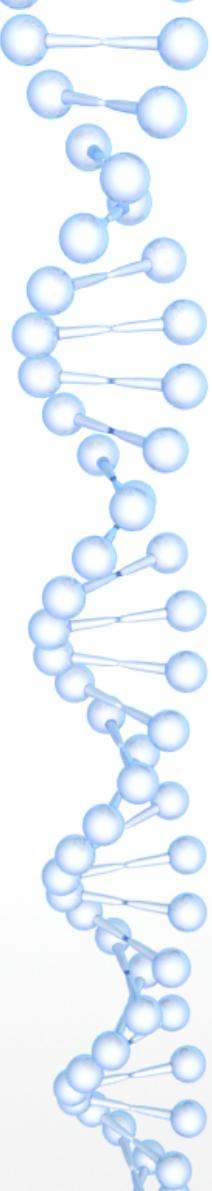
Alt -	us	nom+masc+sing
Alt -	orum	gen+m/neu+plur
Alt -	arum	gen+fem+plur



# Abbreviations: function → complementarity?



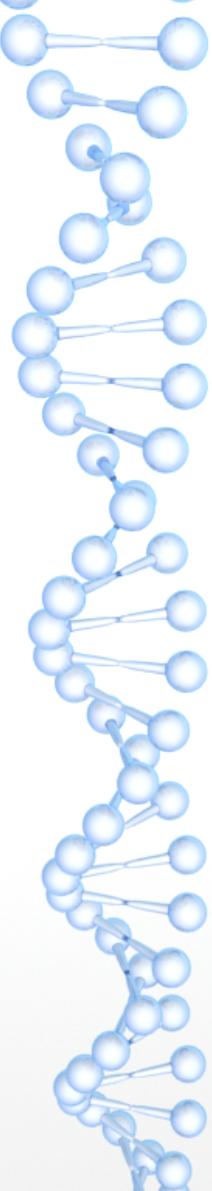
uł adfe uładalium



# Abbreviations

1. One **entity**
  - Whole abbreviation = grapheme (**invariant**)
2. Two **entities (function)**
  - 2A. Ligature (**solidal variants** in a chain)
  - 2B. **Selection** (one governs the other)
  - 2C. **Complementarity** (interdependence)

- coparaEur      uł adfe      uładalium

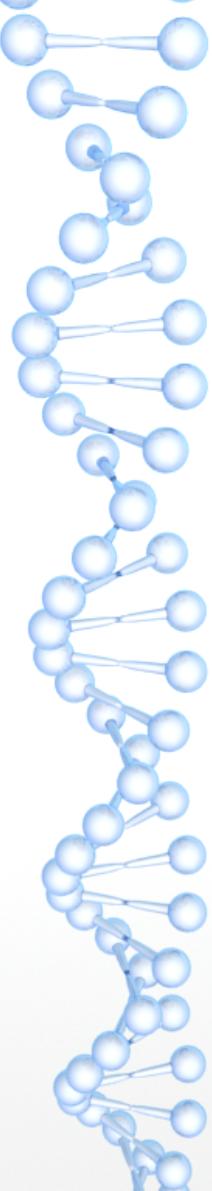


# Abbreviations

- Digital (discrete)
- Allographs
  - (Capitalization)
- Grapheme set
  - (Punctuation)
- Ligatures
  - Abbreviations

-  coparaEur

uł adfe uładalium



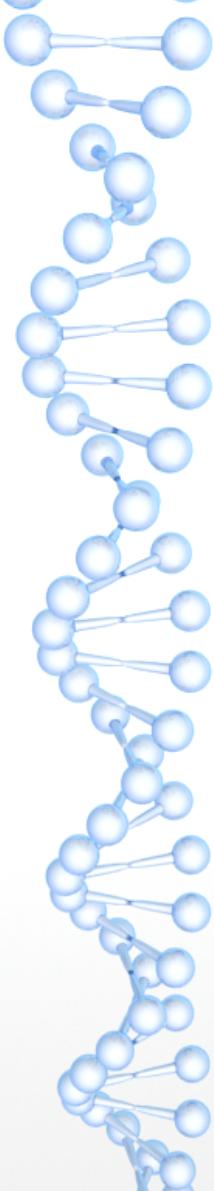
# Abbreviations

- Digital (discrete)
- Allographs
  - (Capitalization)
- Grapheme set
  - (Punctuation)
- Ligatures
- ? • Abbreviations

-  coparaEur

uł adfe uładalium

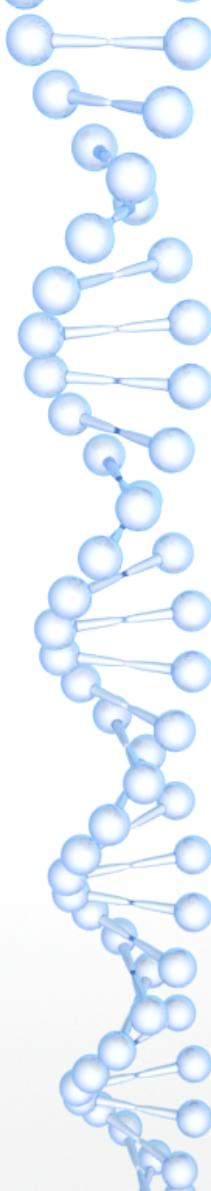
# Open issues



# Issues: 1. Abbreviations → functions

1. One **entity**
  - Whole abbreviation = grapheme (**invariant**)
2. Two **entities (function)**
  - 2A. Ligature (**solidal variants** in a chain)
  - 2B. **Selection** (one governs the other)
  - 2C. **Complementarity** (interdependence)

- **cóparaEur**      uł adfe      uładalium

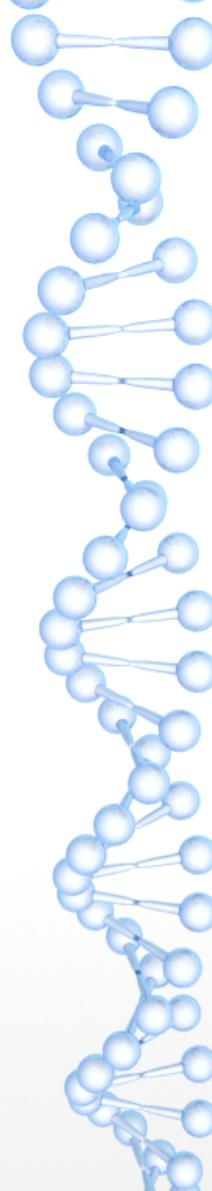


## Issues: 2. Abbreviations → one:many

- cóparaσur
- cóparaΕur

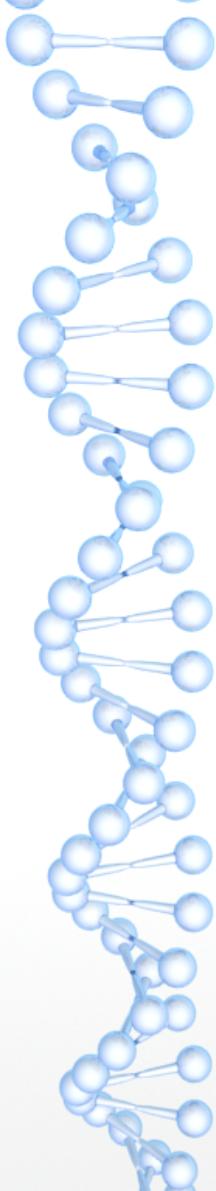


1:1



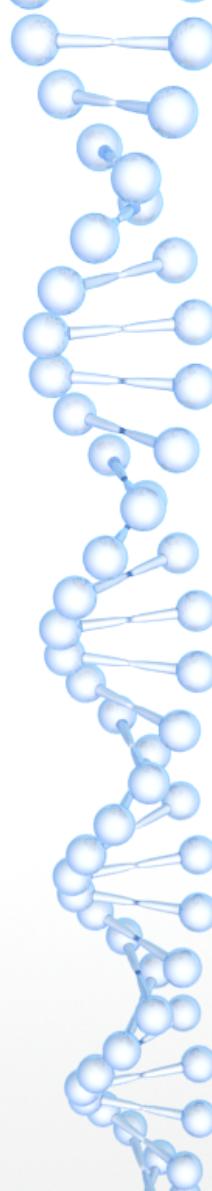
## Issues: 2. Abbreviations → one:many

- **comparaσur**
  - **cóparaΕur**
- 2:2 ( $2 \neq 2$ )



## Issues: 2. Abbreviations → one:many

- **praepositio**
  - **propositio**
- 2:4



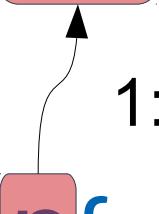
## Issues: 2. Abbreviations → one:many

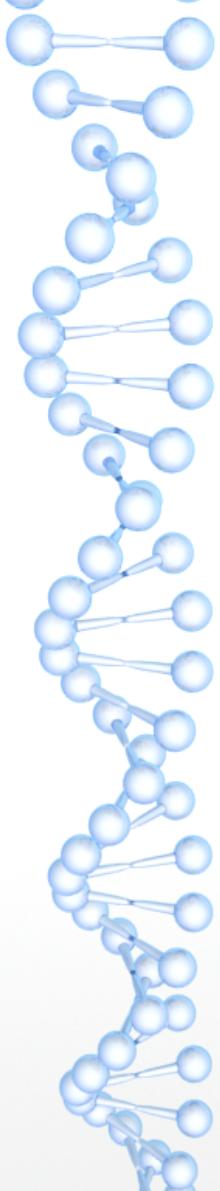
- **perfecta**
- **pfecta**

1:3

perfecta

pfecta





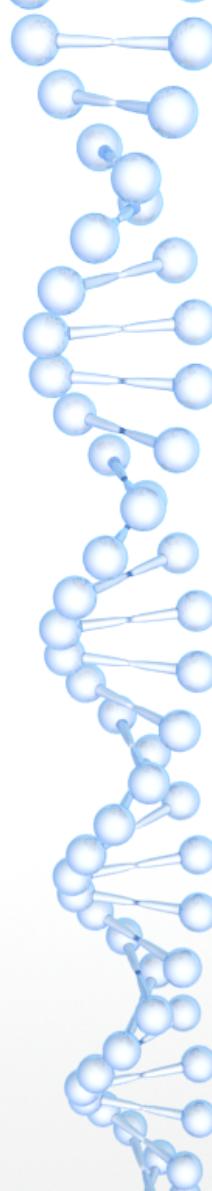
## Issues: 2. Abbreviations → one:many

- **perfecta**
- **pfecta**

1:3

Alphabemes  
(alphabetical letters)

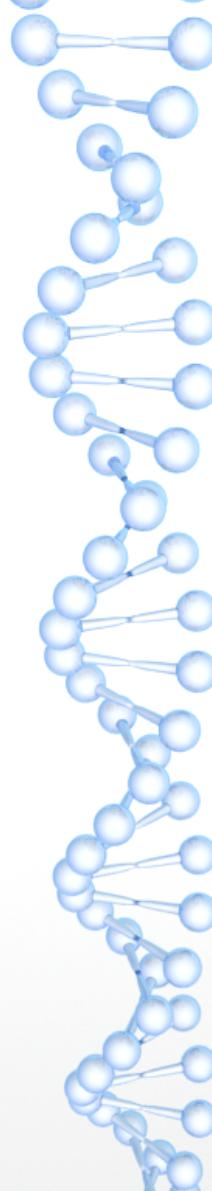
Graphemes



## Issues: 3. Ligatures

(syntagmatic)





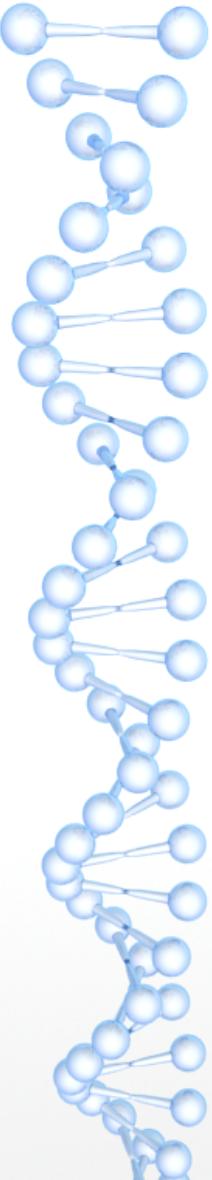
## Issues: 3. Ligatures



A



& (U+0026;  
ASCII 38)



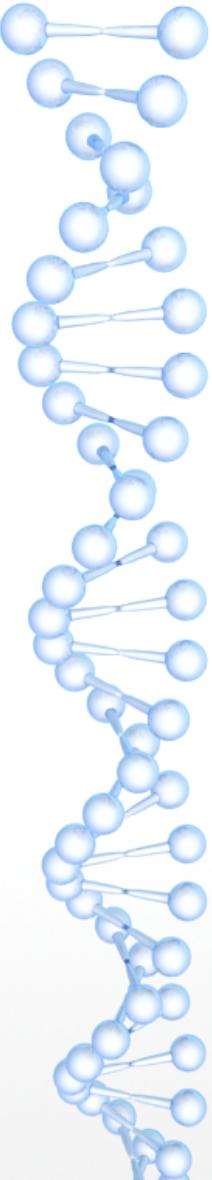
# Issues: 3. Ligatures



Historical/“etymological”  
considerations



& (U+0026;  
ASCII 38)



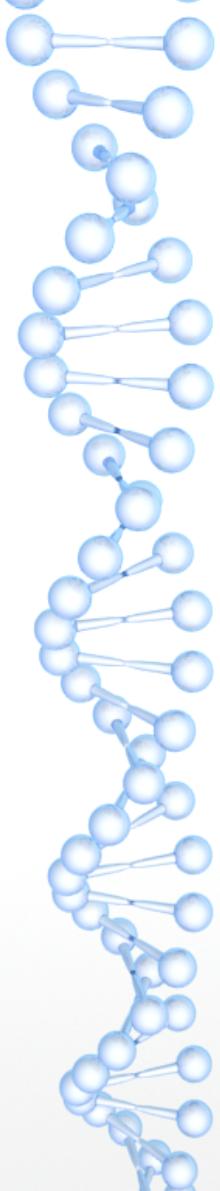
# Issues: 3. Ligatures



& (U+0026;  
ASCII 38)

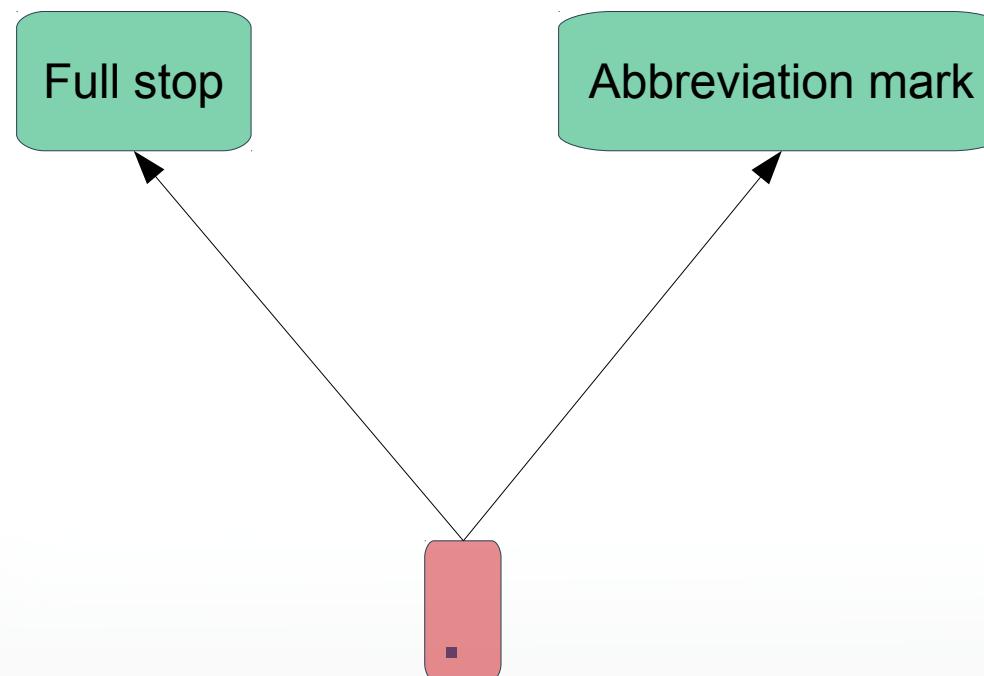
Historical/“etymological”  
considerations

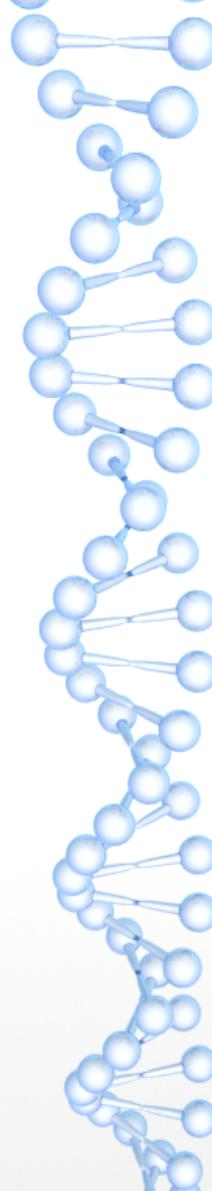




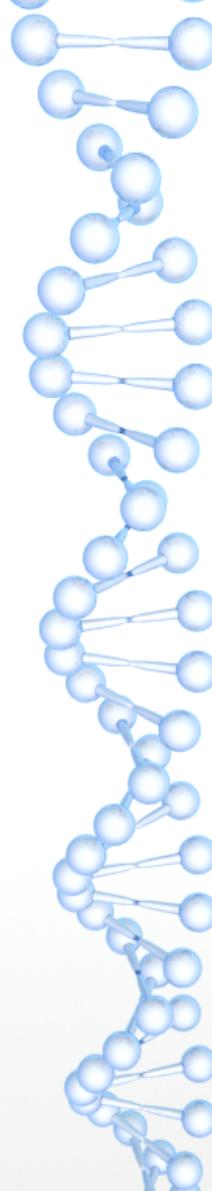
# Issues: 4. Grapheme definition

(paradigmatic)

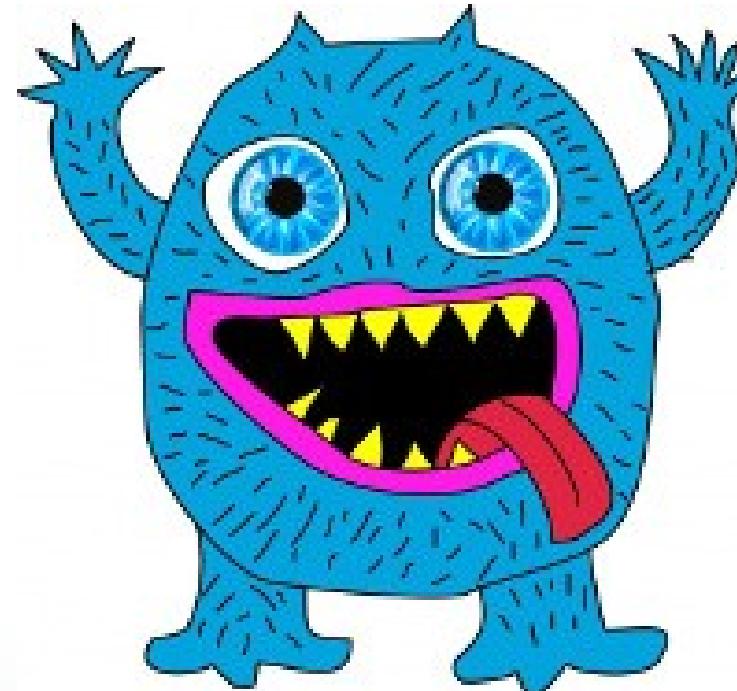


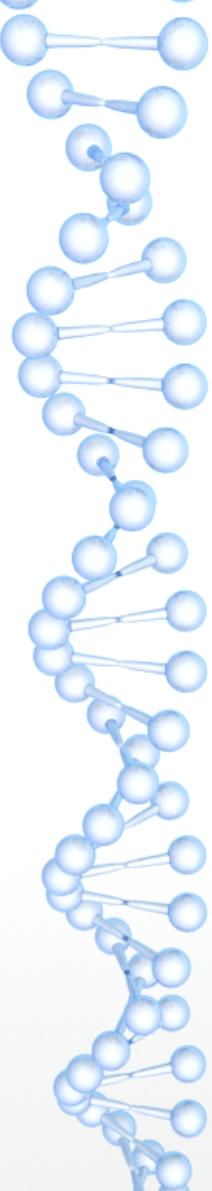


## **Issues: 5. Allograph definition (metasemiology)**

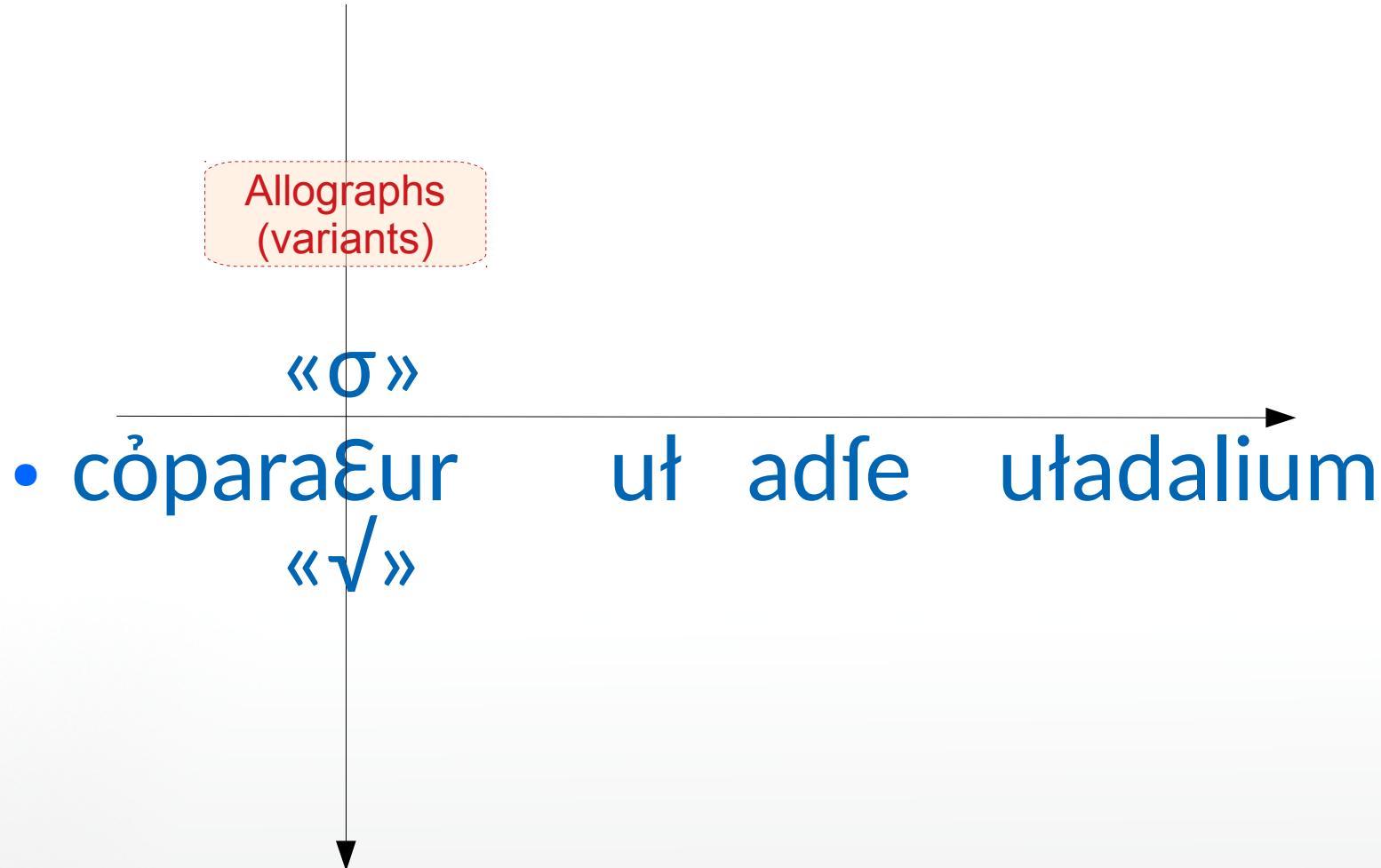


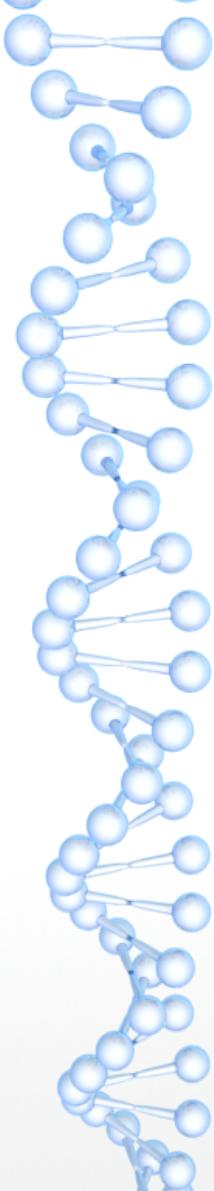
# Issues: 5. Allograph definition (metasemiology)





# Issues: 5. Allograph definition (metasemiology)





## Issues: 5. Allograph definition (metasemiology)

« $\Sigma$ »

• cóparaEur

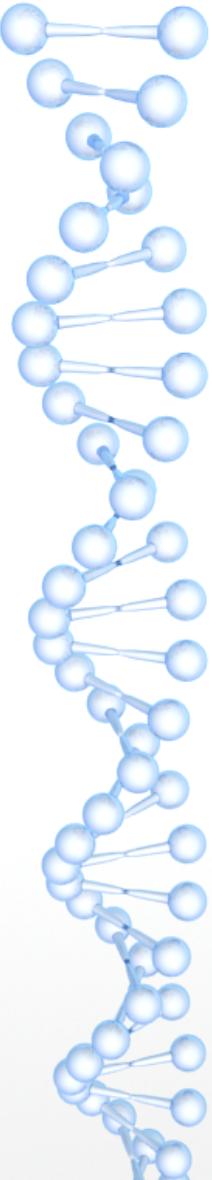
uł adfe uładalim

« $\checkmark$ »

« $\checkmark$ »

« $\checkmark$ »

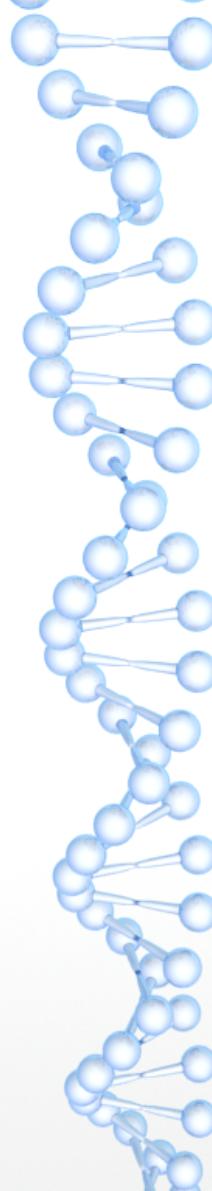
« $\checkmark$ »



# Open issues

1. Abbreviations → functions
2. Abbreviations → one:many
3. Ligatures
4. Grapheme definition
5. Allograph definition (metasemiology)

# In a nutshell



## In a nutshell

- The interoperability issue
- Interoperability through modelling
- Open issues