

# Abstractions for Type-Level Programming

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Olivier Blanvillain

Wednesday, 25 May 2022

Welcome!

Bienvenue à ma défense de thèse !

défanse

défence

défance

Welcome!

Bienvenue à ma soutenense de thèse !

soutenanse

soutenence

soutenance

# Spell checkers to the rescue

The screenshot shows a web browser window with the URL <https://www.scribens.fr>. The page title is "CORRECTEUR ORTHOGRAPHE & CORRECTION GRAMMAIRE". Below the title, a subtitle reads: "Corrigez l'orthographe et la grammaire de vos textes avec l'outil d'expression écrite Scribens." The main content area contains three paragraphs of text with color-coded underlines indicating spelling or grammatical errors.

Le réseau public **fluviale**, créant une liaison forte entre les régions, **les** départements et les **cantons mais** excluant de nombreux **petit** villages, **serais** un des plus importants d'Europe par sa taille. Avec ses **8500** km de voies d'**eaux** navigables, **celui ci** s'étend de **Dunkerke** à Marseille.

**Quelque** soient les perspectives économiques, la plupart des économistes **saccorde** à dire que **se** transport **ce** développera durablement.

Les péniches que les industriels ont **décidées** d'exploiter, **sont en effet très** **sollicité** par le **ministère de l'éologie** et font **parties** des moyens de transport du futur (et l'intérêt est bien **la**) **telle** que le dirigeable ou le **telephérique**.

# Programming Methods Laboratory

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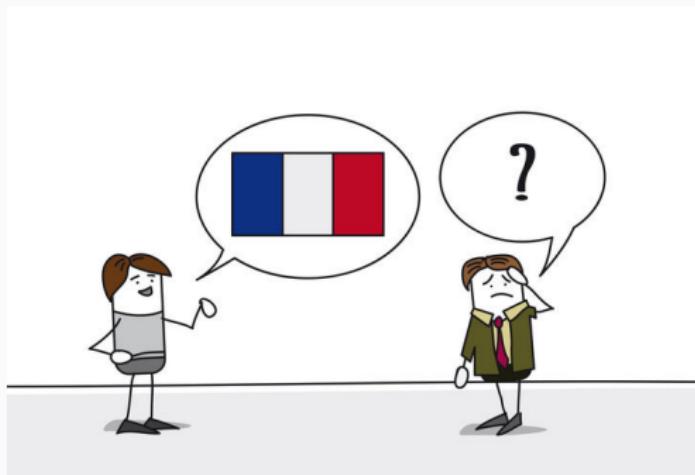
An analogy...

Programming ↔ Poetry



An analogy...

Scala  $\longleftrightarrow$  La Langue Française



An analogy...

Compiler ↔ Spell checker

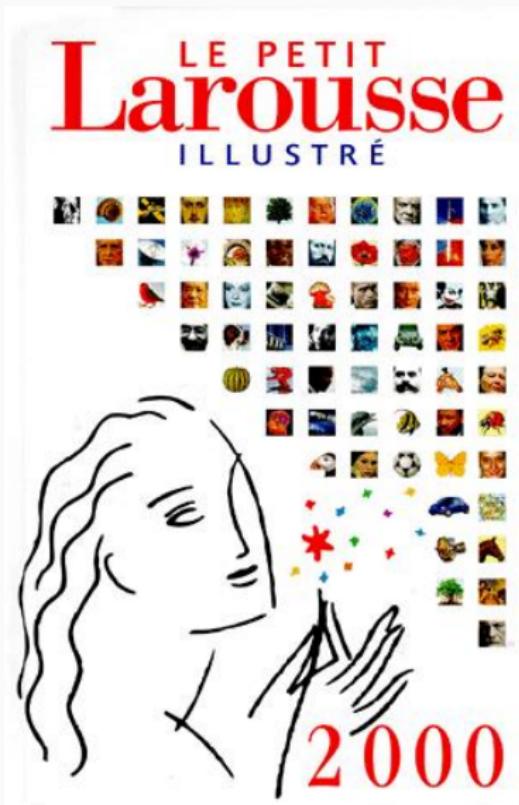
Nil.length



**value lenght is not a member of Nil  
did you mean Nil.length?**

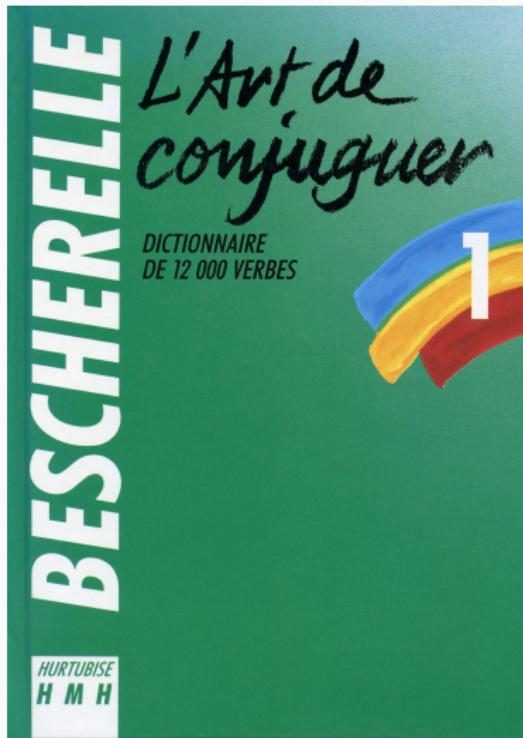
An analogy...

Standard library ↕



An analogy...

Type system ←→



# LAMP – Poetry Methods Laboratory

- Scala  $\longleftrightarrow$  La Langue Française
- Compiler  $\longleftrightarrow$  Spell checker
- Standard library  $\longleftrightarrow$  Le Petit Larousse Illustré
- Type system  $\longleftrightarrow$  Bescherelle (règles de grammaires)

## My Contribution

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## My contribution

My contribution:

A new Scala feature for type-level programming.

I will give you an intuition using examples:

- A poetry example
- A math example
- A programming example

## Type-level programming: poetry example

What do I mean by Type-Level Programming?

A way to customize the spell checker.

## Type-level programming: poetry example

What do I mean by Type-Level Programming?

A way to customize the spell checker.

Roses are red,  
violets are blue,  
so are you.

## Type-level programming: poetry example

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Roses are red,  
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## Type-level programming: poetry example

What do I mean by Type-Level Programming?

A way to customize the spell checker.

“En alexandrin”

Roses are red,  
violets are blue,  
so are you. ✗

## Type-level programming: poetry example

What do I mean by Type-Level Programming?

A way to customize the spell checker.

“En alexandrin”

Roses are red,  
violets are blue,  
and so are you. ✓

## Type-level programming: math example

How many ways are there to pick 13 cards from a 52-card deck?



## Type-level programming: math example

How many ways are there to pick 13 cards from a 52-card deck?



$$\binom{52}{13}$$

## Type-level programming: math example

The binomial coefficients are defined as follows:

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

## Type-level programming: math example

The  $\binom{n}{k}$  symbol usually read as:

- “n choose k” in English
- “k parmis n” in French

Programmers might confuse n & k? Should it be

- binomialCoefficient(n, k) or
- binomialCoefficient(k, n)?

## Type-level programming: math example

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## Type-level programming: math example

```
def binomialCoefficient(n: Int, k: Int): Int
```

binomialCoefficient(52, 13) ✓

binomialCoefficient(13, 52) ✓

## Type-level programming: math example

```
def binomialCoefficient(n: Int, k: Int)
  (implicit ev: n.type >= k.type =:= true): Int
binomialCoefficient(52, 13) ✓
binomialCoefficient(13, 52) ✗
```

# Type-level programming: regular expression example

A regular expression is a simple tool to validate and extract data from text.

L'horaire CFF.

De                              À

Genève



Lausanne

Date                              Heure

<  mer., 25.05.2022 >17:00

Dép.  Arr.

Rechercher →



## Type-level programming: regular expression example

input	pattern	out[0]	out[1]	out[2]
"17:00"	"(\d+)[.:h](\d+)"	"17"	"00"	
"25.05.2022"	"(\d+).(\d+).(\d+)"	"25"	"05"	"2022"

## Type-level programming: regular expression example

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## Type-level programming: regular expression example

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this case is unreachable since Tuple2  
is not a subclass of Tuple3

# Timeline of my PhD



# Conclusion

In this talk, I presented an analogy to explain what we do in the Poetry Methods Laboratory.

I also presented a few example to illustrate my contribution:



Thank you!

Thank you!

## Acknowledgments

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# Dragana & Leila



Thank you!

Thank you!