



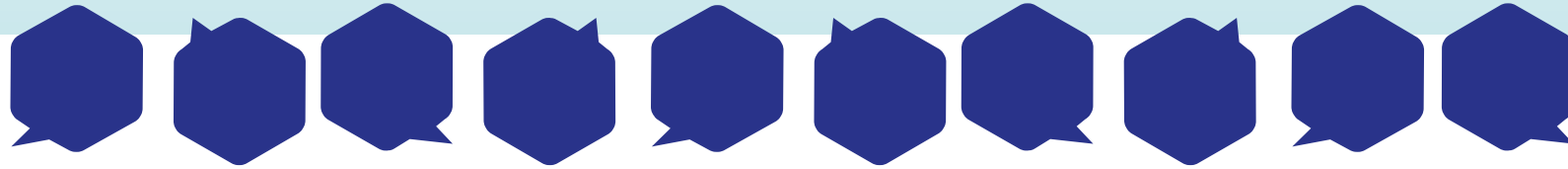
author biographies



Danielle Stephenson is a Principal Statistical Programmer at Atorus Research. She has experience with many aspects of CDISC-compliant study programming from CRF annotation through SDTM, ADaM, TFL, and define.xml creation. Danielle has been a clinical programmer since 2017, and is currently Lead Programmer on a team working in both SAS® and R.

Laura Mino is a Senior Trainer at Atorus Academy who specializes in translating complex technical concepts into practical, adoptable workflows. Formerly a microbial ecologist, she transitioned to the pharma industry in 2024, where she now guides programmers in translating their coding skills between SAS® and R.

Code Switching



Parallels Between Human Languages and Multilingual Programming

Paper Number ET19



What is language?

Language is a powerful
tool for **creation** and
communication...

...and for
miscommunication and
frustration.

Linguistics, the study of
human language, has
methods, tips, and
known issues that we
can pull from as we
venture into **multilingual
programming**.



How do we apply linguistics to programming?



Linguistics, the study of human language, has methods, tips, and known issues that we can pull from as we venture into **multilingual programming**.

te



techniques for learning

immersion

engaging multiple
neuropathways

What enhances
our ability to learn
human languages?

understanding
beyond direct
translation

techniques for learning

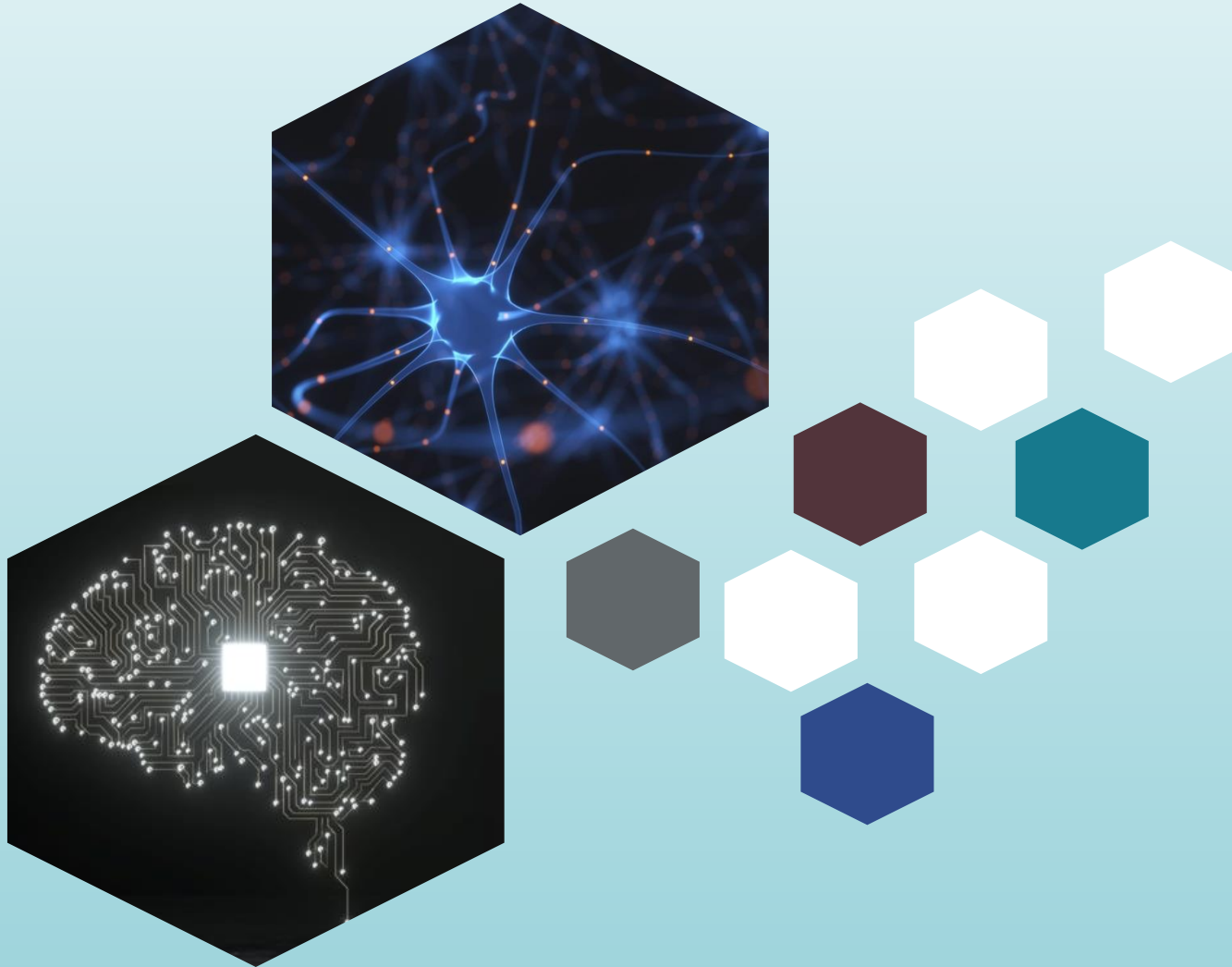
immersion

```
print("Hello, World!")
```



techniques for learning

engaging multiple
neuropathways



techniques for learning

understanding
beyond direct
translation

x

y

kerekere

please

mada
(“man-dah”)

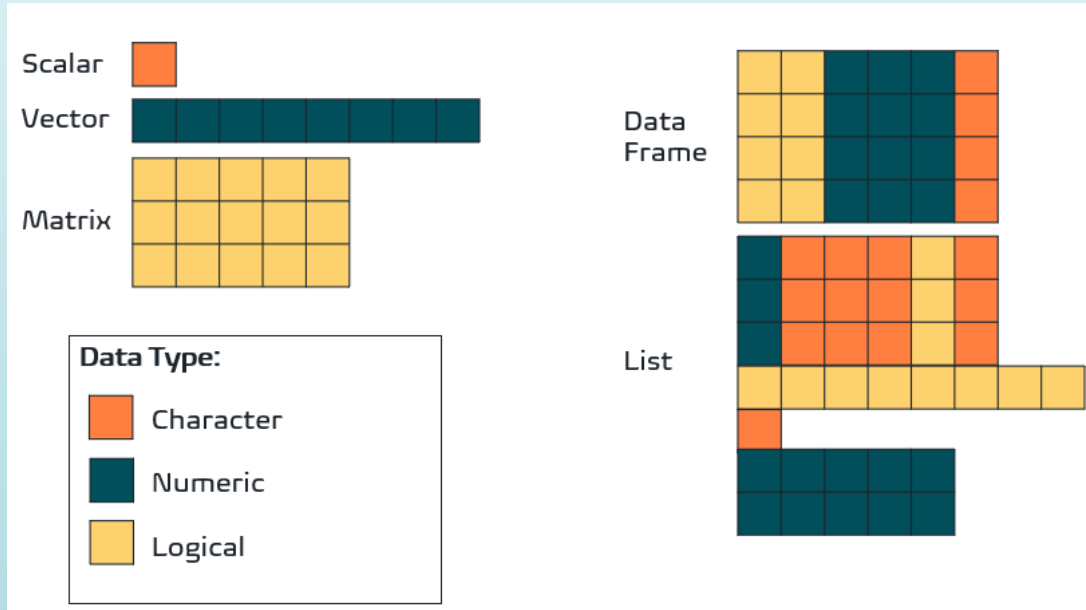


techniques for learning

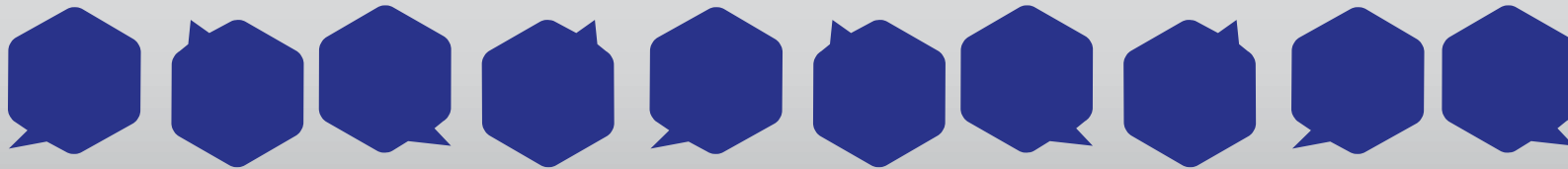
understanding
beyond direct
translation

*data
frame*

dataset



How do we apply linguistics to programming?



challenges to learning



challenges to learning

谢谢

xièxie

“thank you”



DATE9

unique
concepts



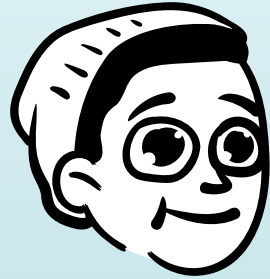
Apply
format
metadata

Huh?



challenges to learning

untranslatable
differences



¿Cuántos
años
tienes?

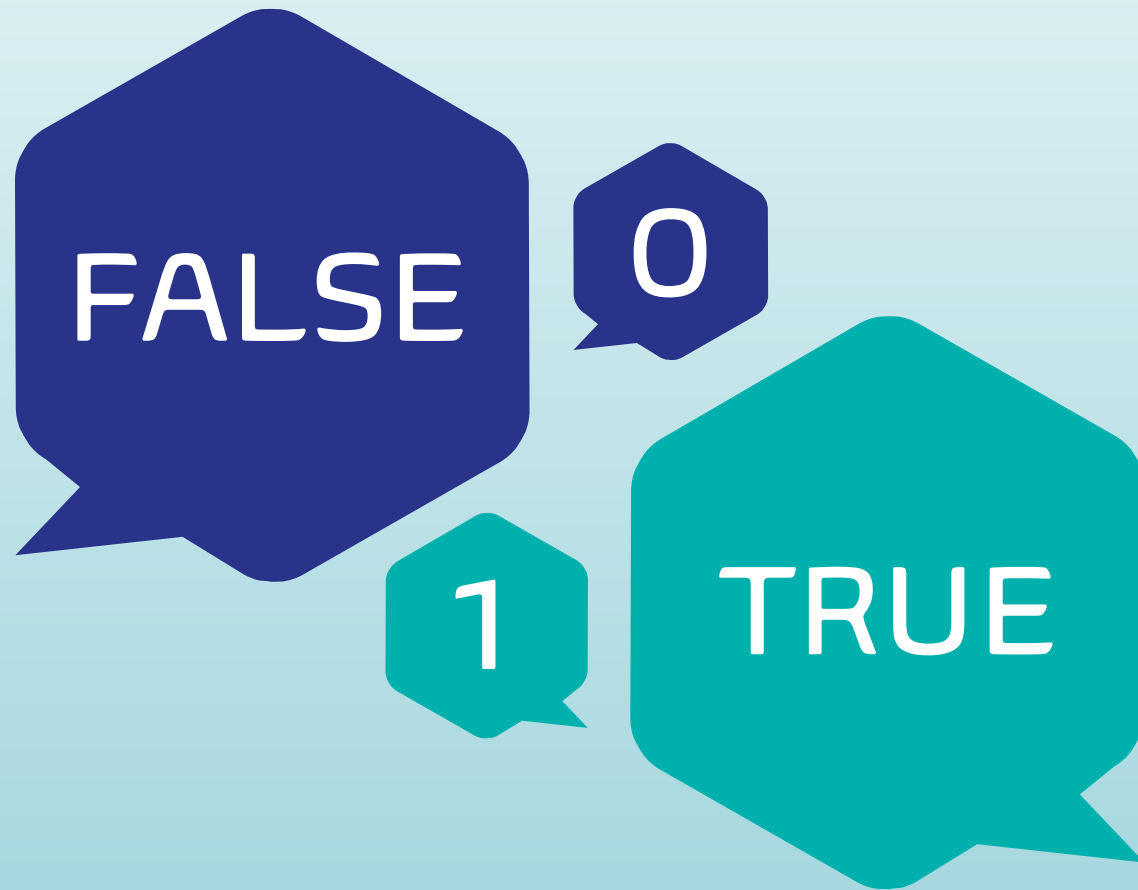
"How many
years do
you have?"

"How many
CENSORED do
you have?"

¿Cuántos
años
tienes?



challenges to learning



untranslatable
differences

challenges to learning

Магазин?



```
proc calis  
data=dat1 corr;  
factor n=2;  
run;
```



false cognates

```
sex <-  
factor  
(sex, levels =  
c("F", "M"))
```



challenges to learning

language artifacts

ka ma ma

ka ma ma



challenges to learning

language artifacts



Margaret Hamilton stands next to her handwritten code, which took NASA's Apollo 11 program to the moon in 1969.

historical context

challenges to learning

order of operations

```
if index(PCORRES, '<') = 0 then PCSTRESN = input(PCORRES, best.);  
else PCSTRESN = .;
```

Program 3. Complex SAS® if/else clause

```
PCSTRESN = if_else(str_detect(PCORRES, '<') == FALSE,  
as.numeric(PCORRES), NA)
```

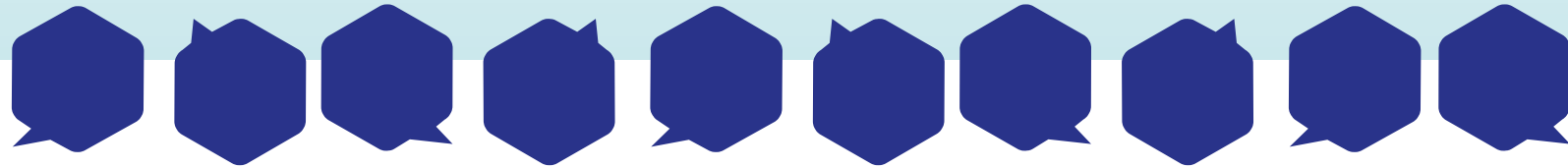
Program 4. Complex R dplyr if/else clause

```
PCSTRESN = if_else(str_detect(PCORRES, '<') == FALSE, as.numeric(gsub('<', '', PCORRES)),  
NA)
```

Program 5. Corrected Complex R {dplyr} if/else Clause



Code Switching



Insights from human language learning help us **identify**
and **overcome** challenges as we move into the
multilingual programming future.





contact information

Paper Number ET19

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