

Towards Reproducibility in ANS Performance



9th SESAR Innovation Days

Enrico Spinielli & Rainer Koelle
EUROCONTROL, Performance Review Service



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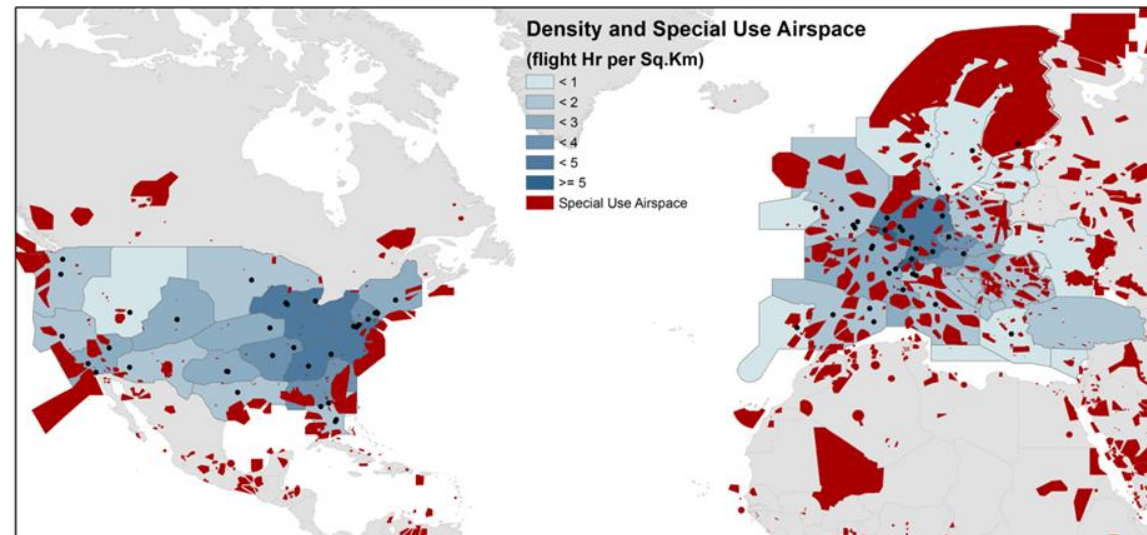
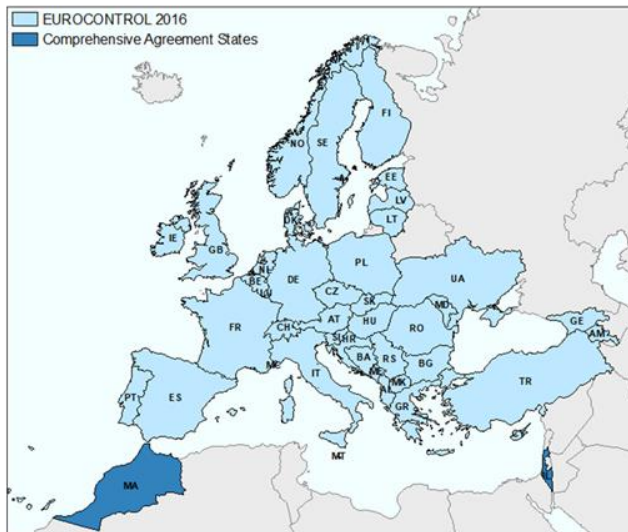
2 – 6 December 2019, Athens, Greece



Context / 1

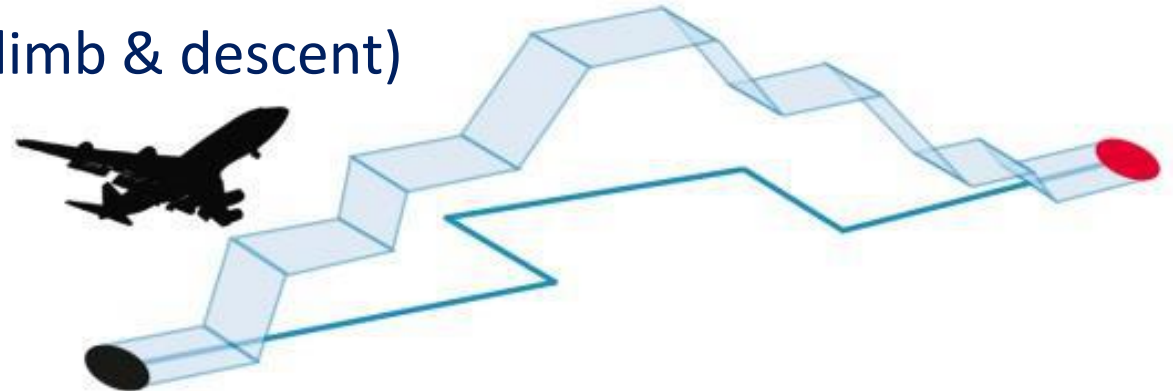
EUROCONTROL's Performance Review Service (was Unit) deals with ANS' performance review for

- all ANS in EUROCONTROL Member States (41 + 2)
- EU-US comparison
- International Studies (Brasil, China, Japan, Singapore)



Context / 2

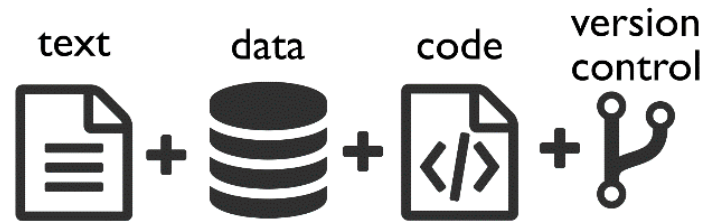
- PRS/U provides the European Commission with some of the indicators under the Single European Sky Performance Scheme
- (Some of) Our indicators:
 - Traffic counts (Country FIR & ANSP, ACC, ...)
 - Horizontal Flight Efficiency
 - Vertical Flight Efficiency (en-route, climb & descent)
 - Additional ASMA time
 - Traffic Complexity



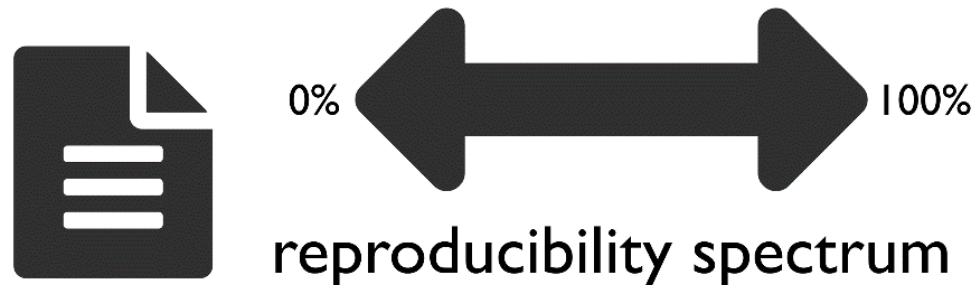
Reproducibility fosters Collaboration

- Transparency
- Scrutinazable (maybe a neologism)
- Open to feedback (and mistakes)

advertising:
text & final
results only



science:
text, code &
data available,
linked & licensed



Adapted with permission from Rodríguez-Sánchez F, Pérez-López AJ, Barrocas I, Worts S (2018) Cienos reproducibles que por qué, cómo. Ecosistemas, 25(2): 83-92. <https://doi.org/10.7818/EECO.2018.25.2.11>
See also Harwell, B. (2016). Computational Reproducibility in Archaeological Research: Basic Principles and a Case Study of Their Implementation. Journal of Archaeological Method and Theory, 23(2): 1-27. <https://doi.org/10.1007/s10816-015-9072-5>. This figure is CC-BY.



Case study

- Fully reproducible paper
 - Tools: Rmarkdown
 - Data: Reference Trajectory
 - Version controlled: GitHub repository
- (small scale) Usage of Reference Trajectory for ASMA
 - Replication of current version: time-based
 - Introduction of new variant: distance based



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Toolchain

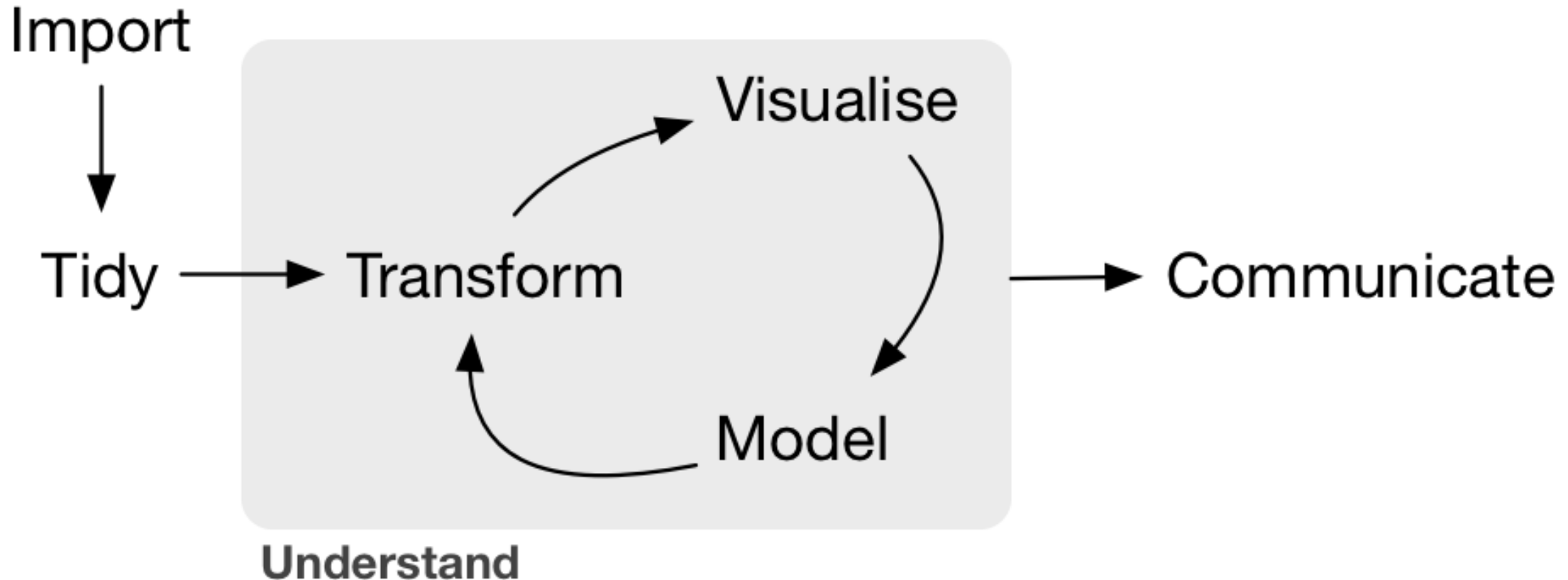
- R ecosystem
 - Rstudio
 - R engine
 - Tidyverse and RMarkdown packages
- Git/GitHub
- But NOT limited to above for other projects



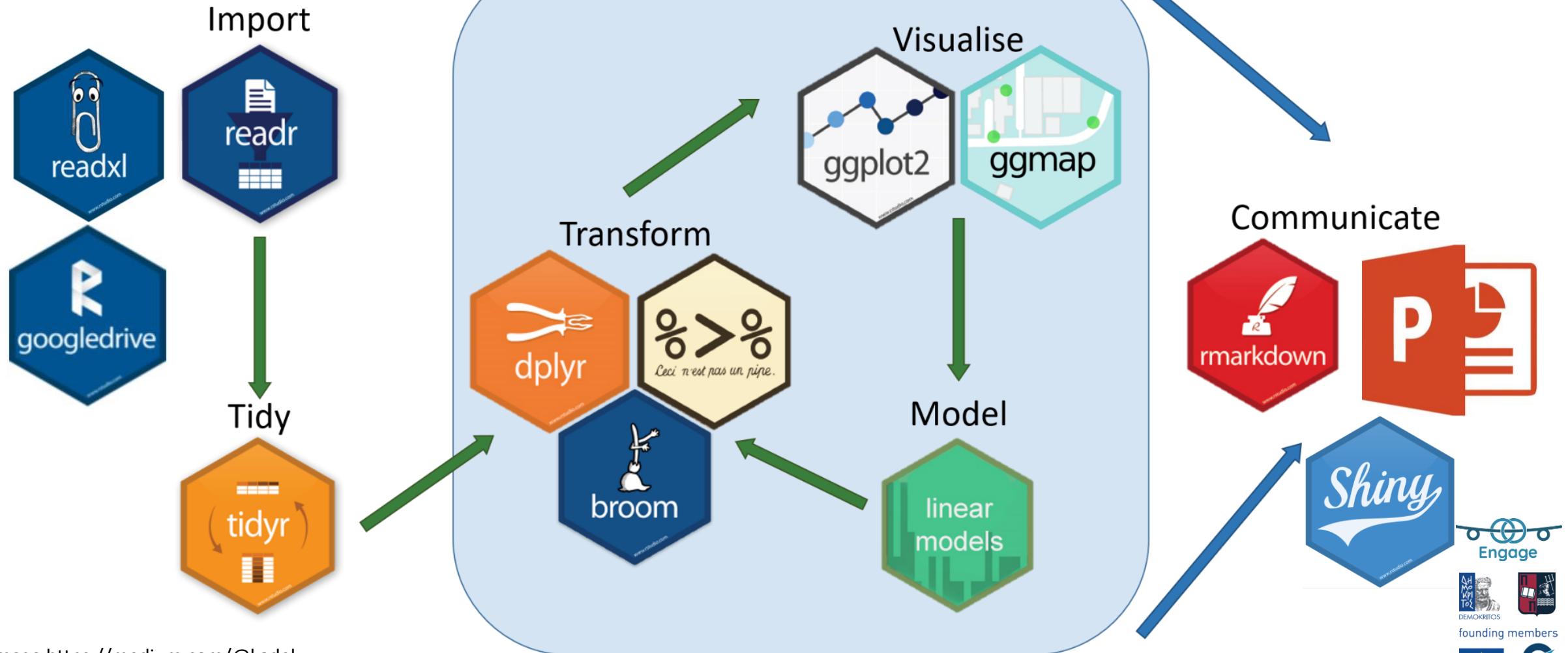
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Model of data science tools



Tidyverse



R Markdown example

John Doe

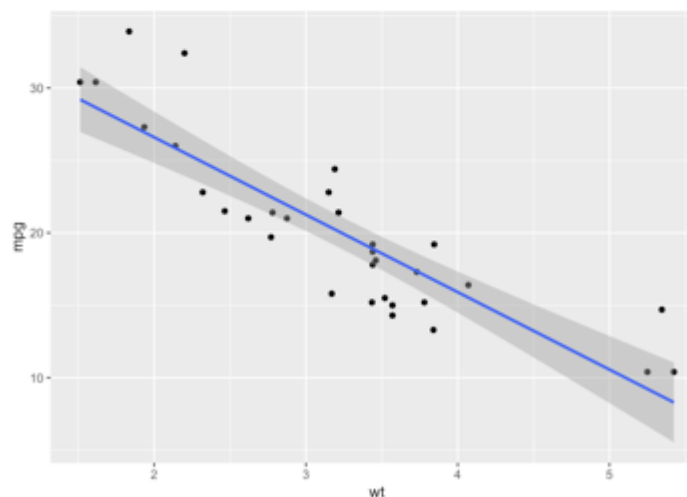
2019-02-17

Some math $\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2$, followed by numbered list:

1. *italics* and **bold** text
2. then bullets
 - simple, eh?

and a code chunk:

```
library(ggplot2)
fit = lm(mpg ~ wt, data = mtcars)
b = coef(fit)
ggplot(mtcars, aes(x = wt, y = mpg)) +
  geom_point() +
  geom_smooth(method = lm, se = TRUE)
```



The slope of the regression is -5.3444716.

```
---
title: "R Markdown example"
author: "John Doe"
date: "2019-02-17"
output: html_document
---
```

Some math
 $\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2$,
followed by numbered list:

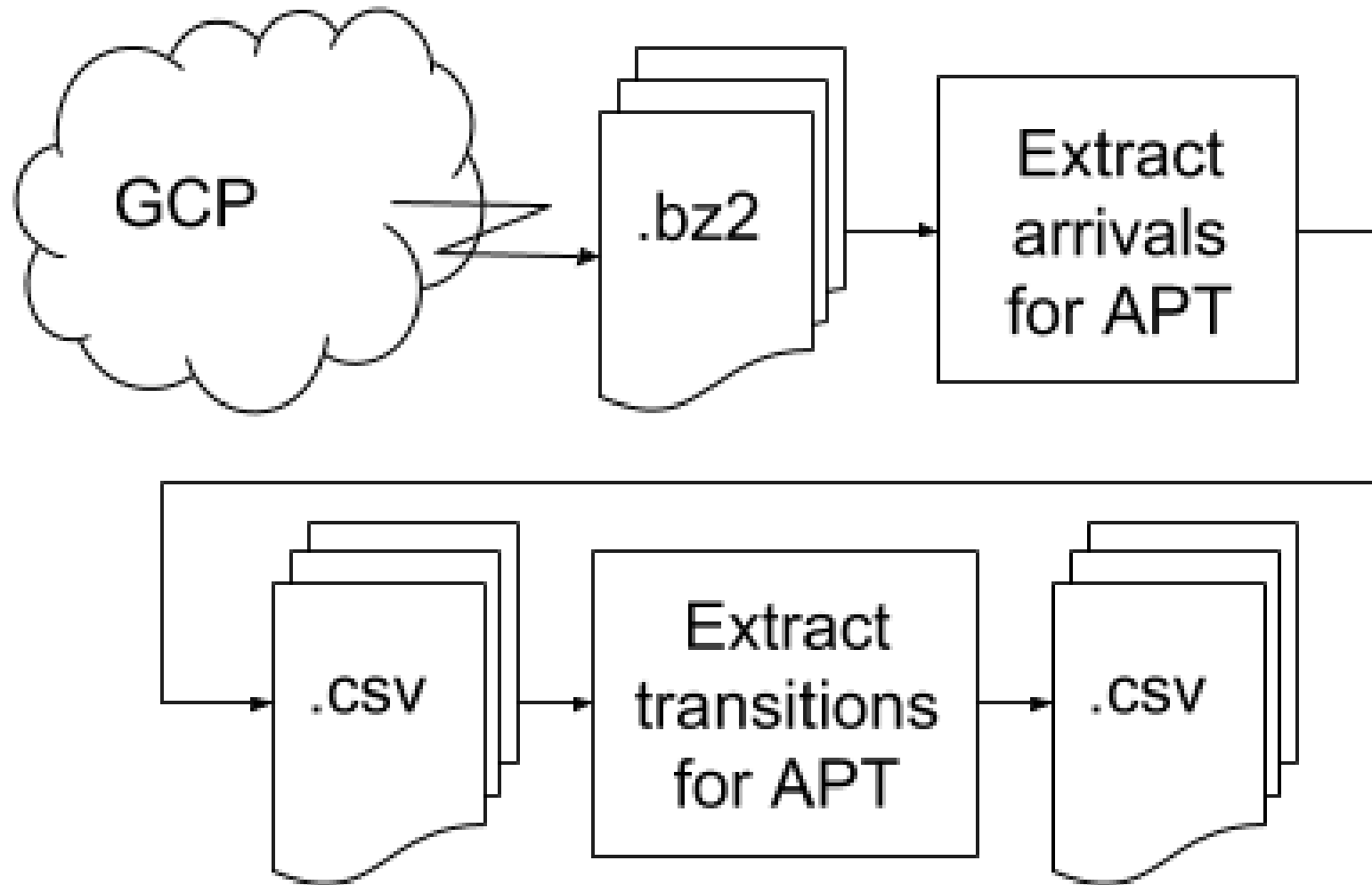
1. *italics* and **bold** text
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and a code chunk:

```
““{r}
library(ggplot2)
fit = lm(mpg ~ wt, data = mtcars)
b = coef(fit)
ggplot(mtcars, aes(x = wt, y = mpg)) +
  geom_point() +
  geom_smooth(method = lm, se = TRUE)
““
```

The slope of the regression is ‘r b[1]’.

Data chain



Dublin, EIDW

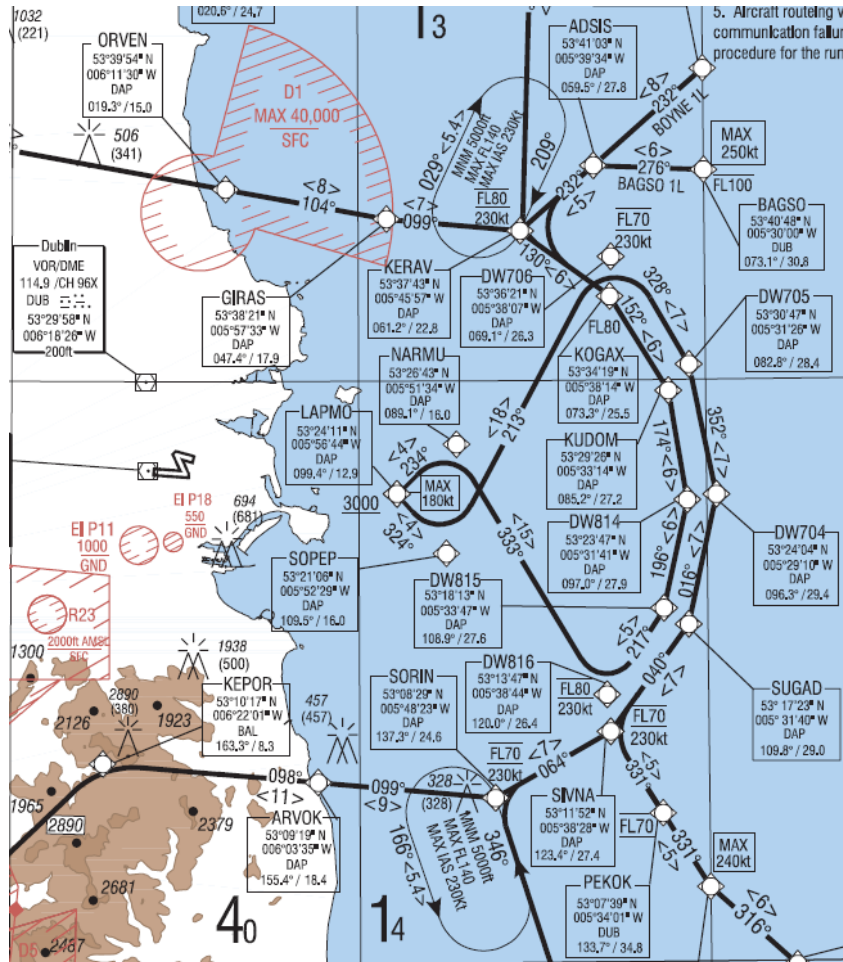
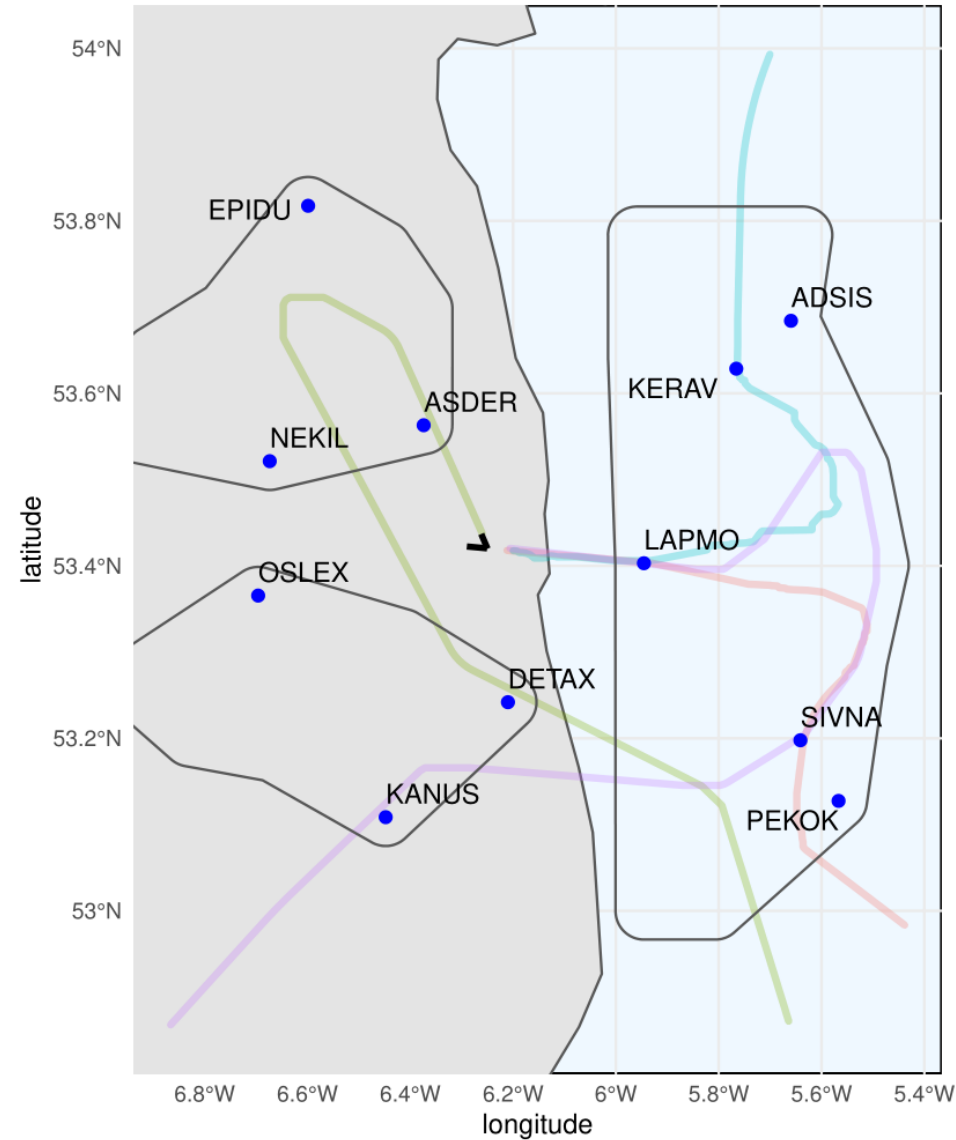


Image: Irish AIP



London Heathrow, EGLL

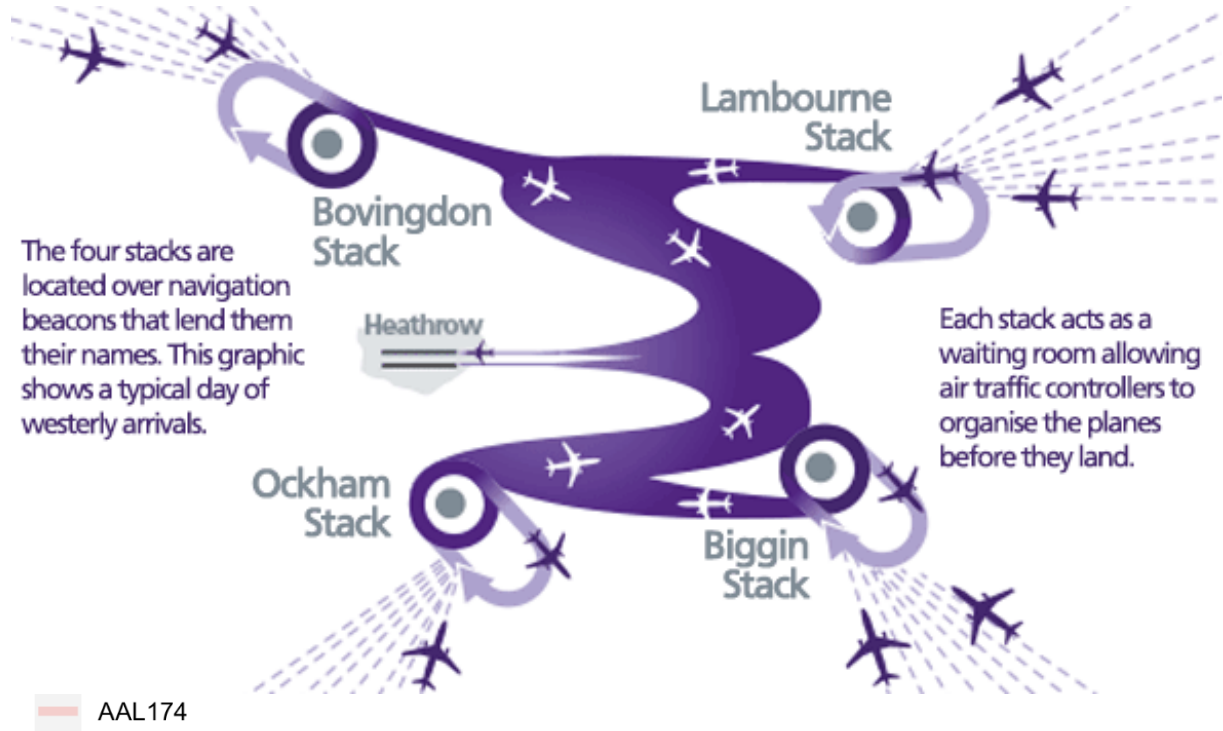
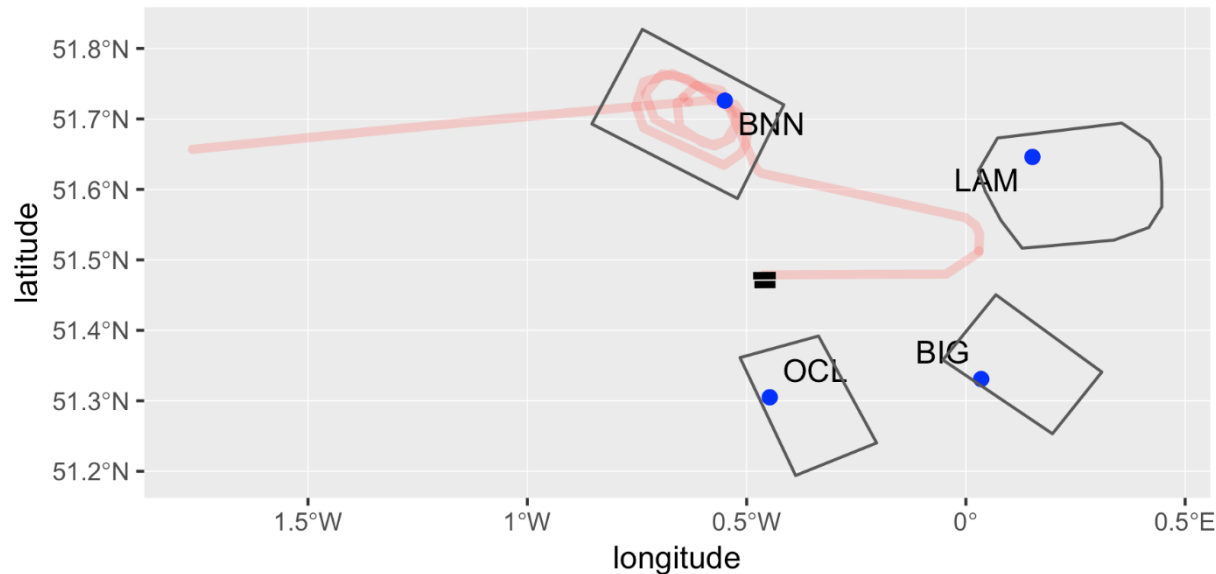


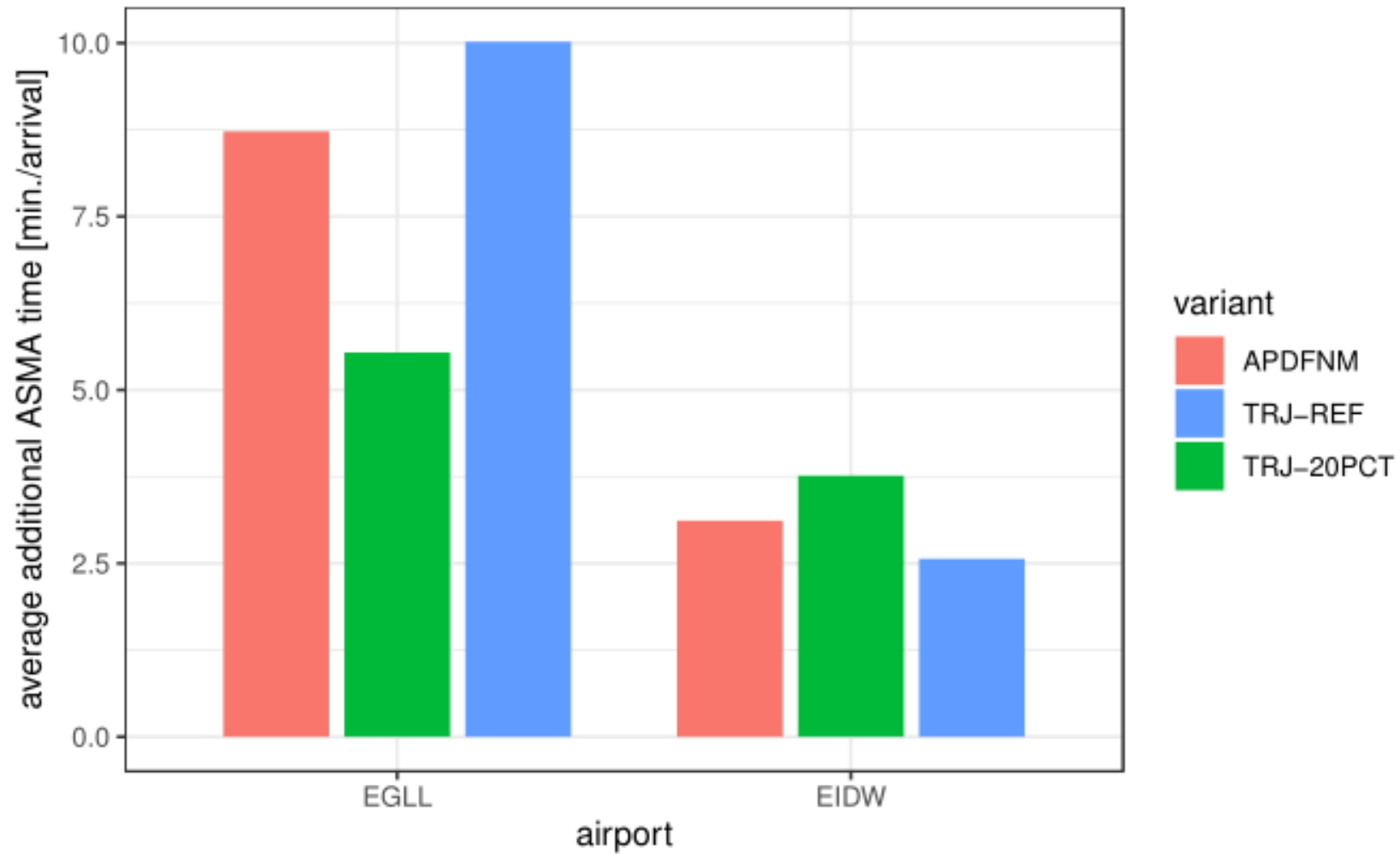
Image: Heathrow Airport



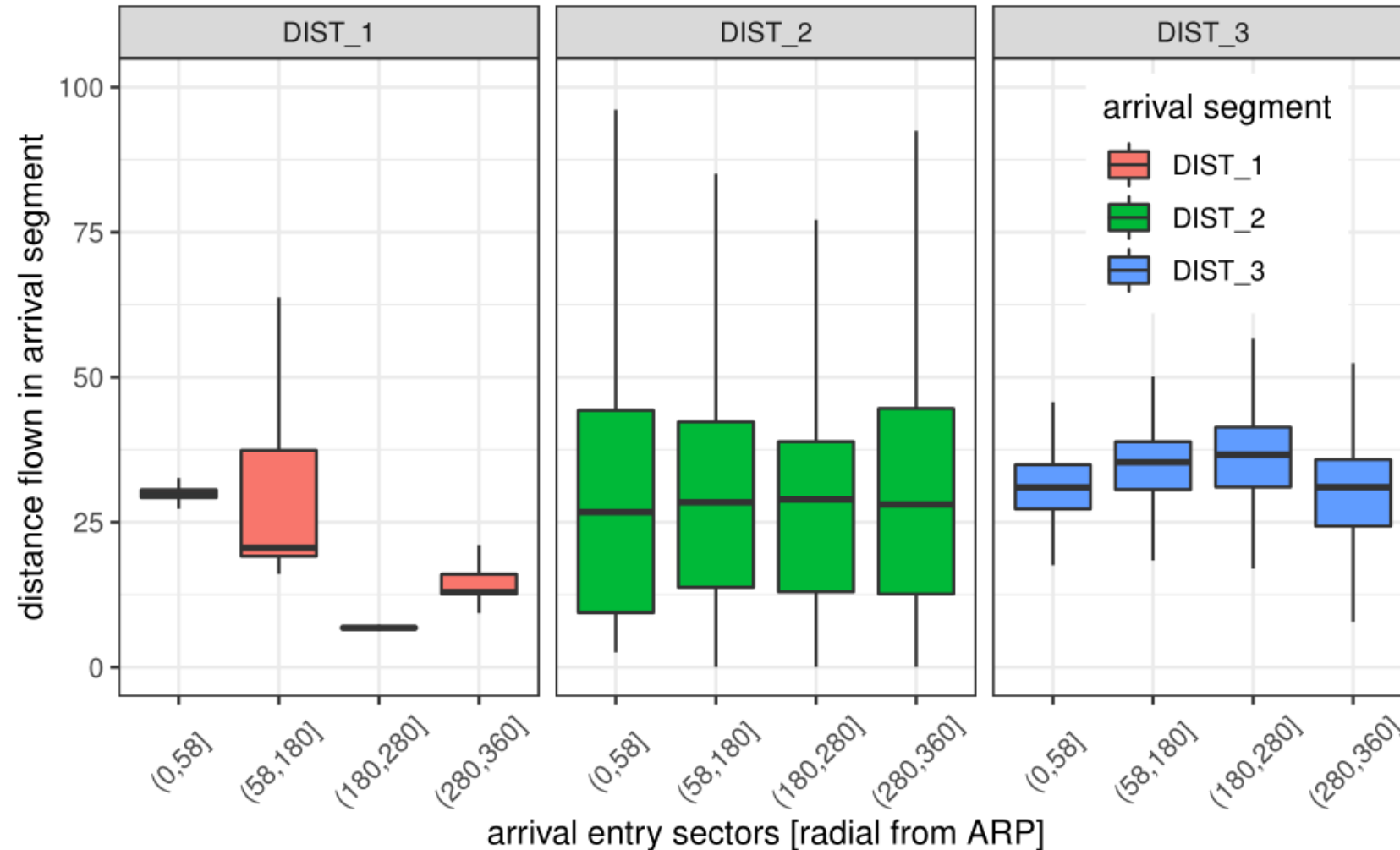
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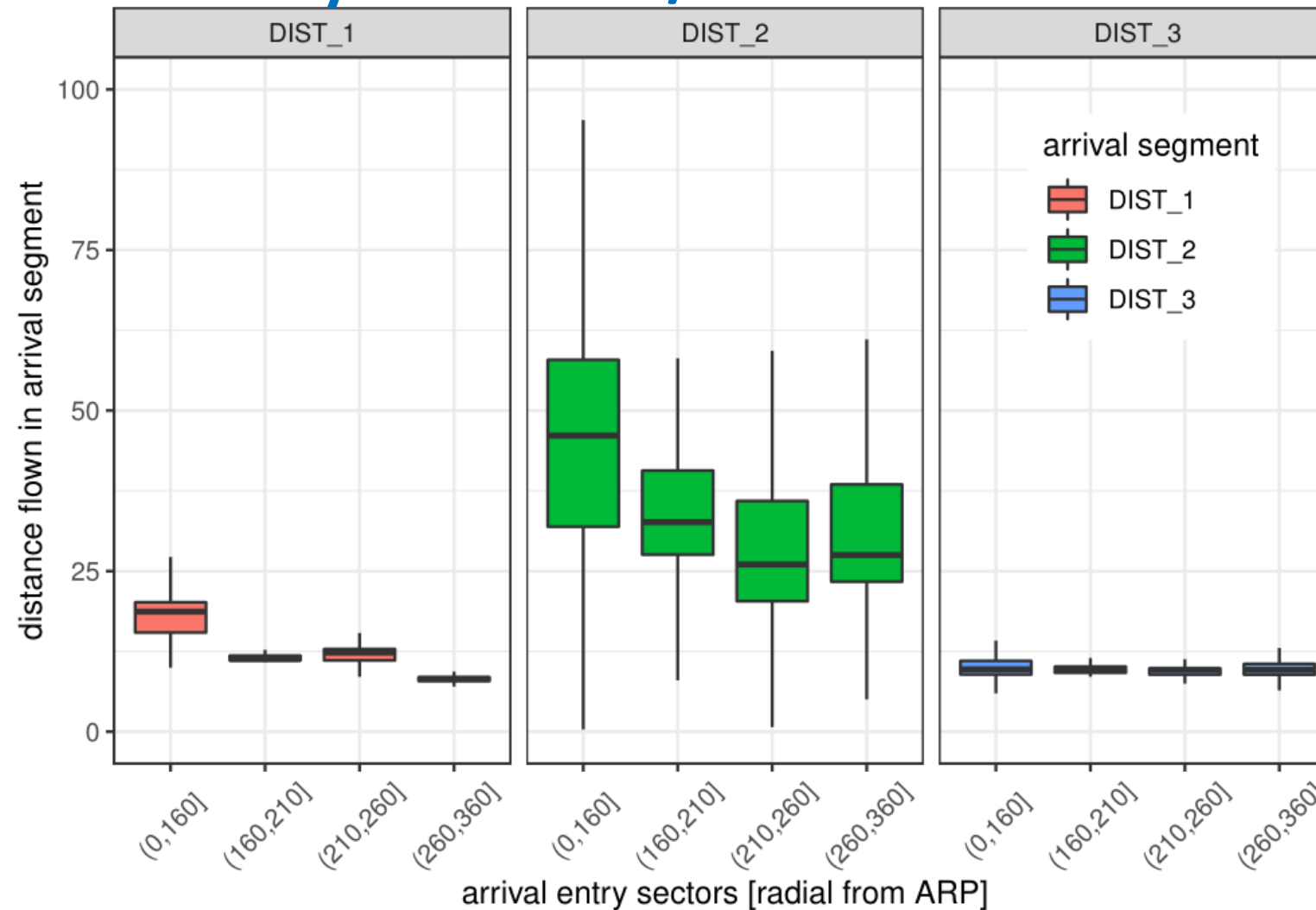
ASMA



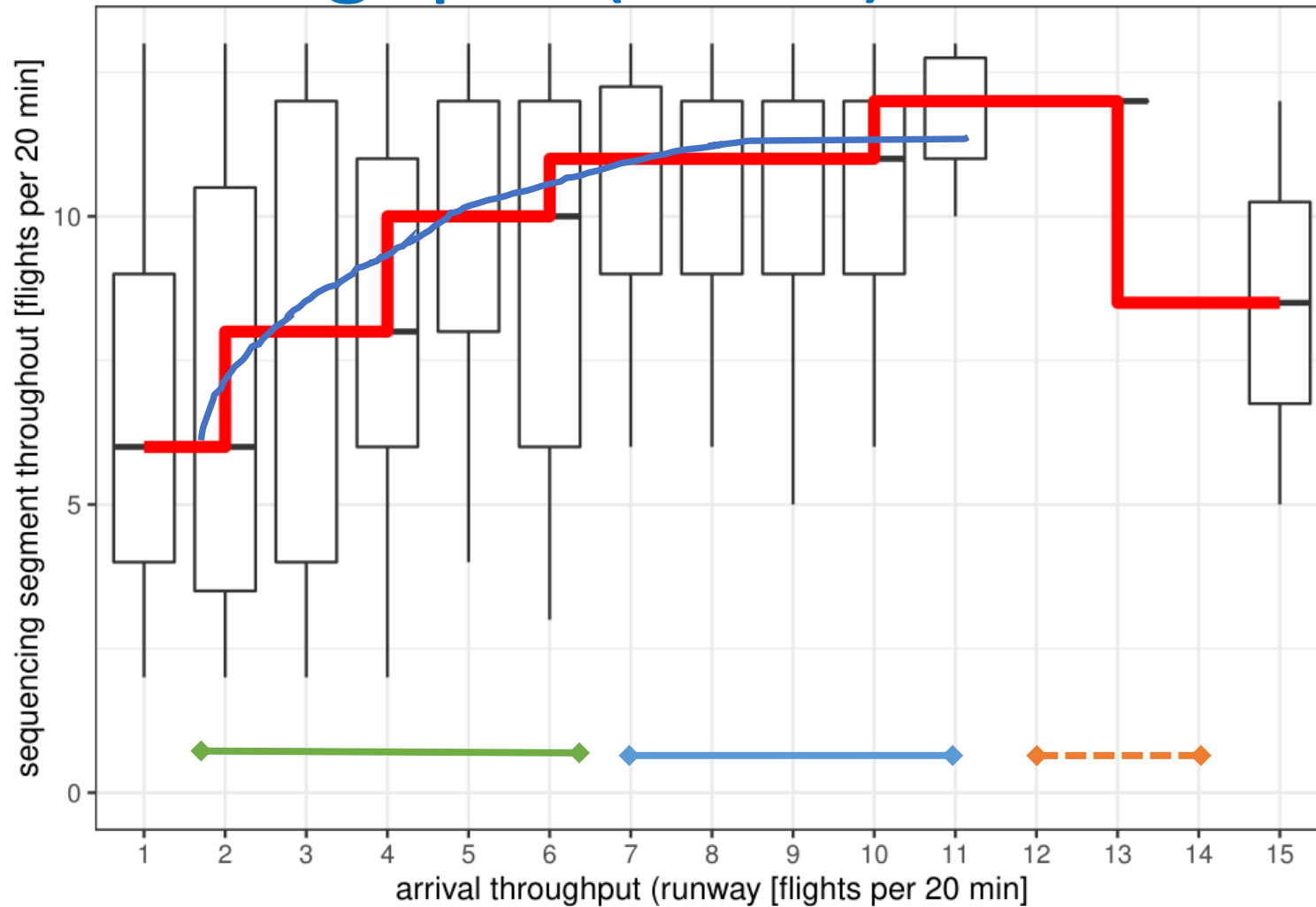
Arrival Sequencing (EIDW) / 1



Arrival Entry Sector / 2



Arrival Throughput (EIDW)





Conclusions

- Reproducibility is possible and necessary
- Reference Trajectory: a way to reproduce and collaborate
- LET THE DATA SPEAK: try “better” than reported data (APDF)
- Potential to be “quasi real-time” rather than monthly delay
- Distance-based analysis spots procedures that time-based cannot



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Cảm ơn ông Teşekkür ederim
आभारी आहे Terima kasih
شكر
ధన్యవాదములు
Na gode شكريا
Grazie شكرا
اركتو 謝謝
Спасибо! 謝謝
ممنونم بهت شكریه
Salamat ਸੁਕਰਿਆ
Terima kasih
Maturnuwun sanget
Terima kasih
ଆଭାର
Asante ಧನ್ಯವಾದ
Danke
धन्यवाद
ඔබගේ
Obrigado
Merci
ありがとう 感謝
감사합니다

Thank you



Change

The best way of not making a mistake is never trying anything



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