



## Driving R adoption in an NHS information service: barriers and solutions

Chris Mainey  
Intelligence Analyst  
University Hospitals Birmingham  
NHS Foundation Trust

[chris.maine@uhb.nhs.uk](mailto:chris.maine@uhb.nhs.uk)

[@chrismainey](https://twitter.com/chrismainey)



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## University Hospitals Birmingham NHS FT

- Second largest acute hospital trust in England
- Four hospital sites seeing approx. 440,000 in-patients per year
- Large informatics team(s):
  - Core Information
  - Analytics
  - SQL engineers/ Dashboard developers
  - Research
  - Commercial

*So we're all R-wielding data ninjas, right?*



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# Healthcare Evaluation Data (HED)

[www.hed.nhs.uk](http://www.hed.nhs.uk)

- Online hospital benchmarking system
- Statistical models and analysis tools
- Activity, Mortality, Readmissions, Length-of-Stay, Marketshare etc.
- Used by ~60 NHS and other organisations
- Training and support
- **Using national NHS data**



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## Data analysis tools in the NHS

- Excel and Access were baseline 10-years ago
- Variable reliance on IT departments and external suppliers
- Huge differences in skills across, and within, organisations
- Increasing use of Qlik, PowerBI and Tableau

### UHB:

- Recruited SQL devs and slowly moved whole department
- Excel, SSRS and TIBCO Spotfire used for outputs

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## Keenies...

- R was used only for rare 'statistical' calculations
- A few keen researchers or medical students
- Similar at other Trusts
- Also the case in our team
- **But...**

## One keen user...



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## Allowed space to develop:

- PhD project, funded by UHB
- Developed statistical, visualisation and data wrangling skills
- Chose to use R from the outset, rather than SAS or Stata.
- Python training harder to find when I started

## Took a risk

- Moved some HED models to R, from SAS
- Supported other team members to use it
- This generated a demand for basic training

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## Followed established patterns:

- Set up a local user group
- Trained senior team
- Encouraged new starters to use R
- External relationships:
  - Twitter has been key
  - NHS-R Community: <https://nhsrcommunity.com/>
  - External R user groups
  - Regional relationships: Other Trusts, PHE, City Council
  - Advice from Mango, RStudio and others
- ***Demonstrated ROI !!!***

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## Barriers

- **Open Source fears:** IT teams sometimes reluctant to install
- **Wrestling with default settings:**
  - Mapped user folders that aren't writable
  - Can't write to package library, or download temp files
- **Poor hardware**
  - Cheap desktops, low on disk space with minimal RAM
- **Lack of understanding of fundamentals:**
  - Networking/file locations
  - Suspensions around security
  - R coding, or its application to problems

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# Solutions

- **Permissions:** *Explicitly identify, and change, default settings*
  - Set a folders: `R_libs_user` or `.Renviron` file
- **Hardware:**
  - Make the case for more RAM! It doesn't cost much
  - Consider server approaches: VMs or 'Desktop' on a 'Server'
  - RStudio Server / RStudio Connect
- **Skill/Awareness:**
  - Protect time
  - Windows users often don't know file paths, SSH etc.
  - Central guidance on R/Python implementation

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# How do we use it?

1. Regression, and related models (`mgcv`, `lme4`, `glmmTMB`, `glmnet`)
2. Machine Learning technique (`caret`, `randomForest`, `gbm`)
3. Optimisation problems (solving equations using `nloptr`)
4. Summary stats and Exploration
5. Data Visualisation (`ggplot2`, `FunnelPlotR`)
6. `RMarkdown` Reports and Presentations
7. API interaction (NHS ODS service, CQC registered organisations)

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# Initial adoption:

```

74 base_table_1718[,PROC003:=as.factor(PROC003)]
75 base_table_1718[,donl_dtag_chap:=as.factor(donl_dtag_chap)]
76 base_table_1718[,LOS_PQ:=as.factor(ifelse(LOS==4, 'LOS_3_plus', paste0("LOS_",LOS)))]
77
78 #use this to claim back memory
79 gc()
80
81
82
83 # 4. this code sets up the parallel structures.
84 ## If doing this on a PC, don't run section 5, and comment out the
85 ## set up cluster and register with 'doparallel', an implicit parallel function.
86 ## If doing this in Microsoft R open (R60), run all 'mkl' commands. Who parallelises silently and gets confused
87 ## explicitly parallelised like we are here. I.e. on four cores, you want 4 single threads, not 4 x 4 threaded s.
88 ## If doing this in 'regular' R, skip over or comment out the 'mkl' commands.
89
90 getMkLthreads() #do not use in 'regular' R, use if running Microsoft R open (faster version)
91 setMkLthreads() #do not use in 'regular' R, use if running Microsoft R open (faster version)
92
93 #make an register clusters
94 cl<-makeCluster(3)
95 registerDoParallel(cl)
96
97 #set clusters to single thread each if required
98 clusterEvalQ(cl, setMkLthreads()) #do not use in 'regular' R, use if running Microsoft R open (faster version).
99 clusterEvalQ(cl, getMkLthreads()) #do not use in 'regular' R, use if running Microsoft R open (faster version)
100
101 #garbage collect on cluster
102 clusterEvalQ(cl, gc())
103
104
105
106 # 5. work out HRG4_chapters for iteration
107 chapters<-distinct(base_table_1718,HRG4c_LETTER) %>% as.data.frame()
108 chapters<-t(chapters) %>% as.vector()
109
110
111 #6. set up blank data frame for AUC data
112 AUC_gans<-data.frame(HRG4c_LETTER=NULL, AUC=NULL)
113
114
115
116 #7. set start time and run loop iterating through
117 start<-sys.time()
118
119 #start of loop
120
121
122

```

- Collections of R scripts saved to directory
- Required lead analyst to write
- Required team skills to run and/or debug
- Constant debugging:
  - Data changing
  - Littered with comments, hard to decipher

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# Creating a local package

Wrapped functions in to an R package structure

- Built binary package and saved to shared folders
- Used roxygen2 to write support material

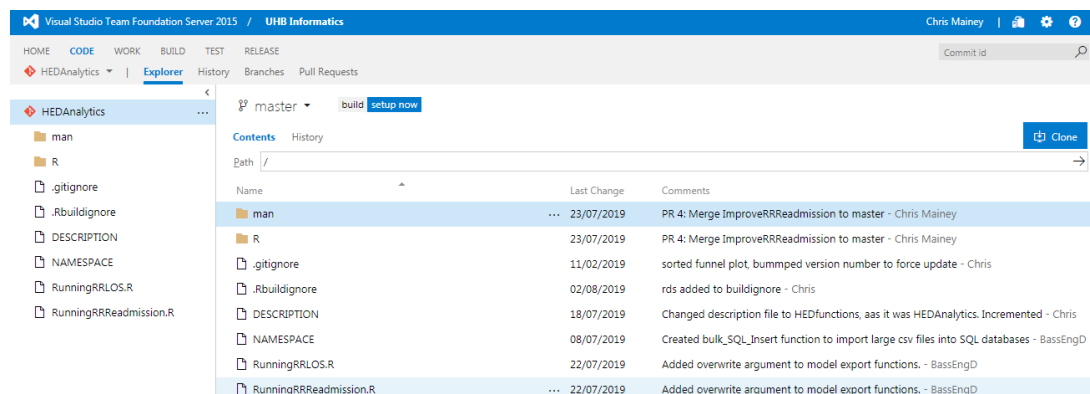
```

41 # Vref(https://onlinelibrary.wiley.com/doi/10.1002/sim.1970) Funnel plots for comparing institutional perfor
42 # Vref(https://onlinelibrary.wiley.com/doi/10.1002/sim.1970) Handling over-dispersion of performance indicators.
43 #
44 # @importFrom scales comma
45 # @importFrom ggplot2 geom_text_repel
46 # @importFrom dplyr select filter arrange mutate summarise group_by %>% n
47 # @importFrom stats predict qchisq quantile sd
48 # @import ggplot2
49
50
51 Funnel_plot <- function(predictions, observed, group, title, label,outliers = 99,
52                          poisson_limits = FALSE, QQ_Fact2 = TRUE, method = "SWt", winsorize_by = 0.1,
53                          multiplier = 1, x_label = "Expected", y_label = "Standardised Ratio") {
54
55
56
57 # build initial dataframe of obs/predicted, with error message caught here in 'try'
58
59 if (missing(predictions)) {
60   stop("need to specify model predictions")
61 }
62 if (missing(observed)) {
63   stop("need to supply observed")
64 }
65 if (missing(title)) {
66   title <- "(untitled Funnel plot)"
67 }
68 if (missing(outliers)) {
69   stop("need to supply the column name for observed events")
70 }
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# Source control

- Moved to source control
  - Install git for windows
  - Git learning curve
  - Happy Git with R!
    - <https://happygitwithr.com/>
- Git repo on TFS
  - Figure out https connections
  - Steph Locke's tfsr
    - <https://github.com/lockedata/tfsR>



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# NHS-R community

- Promote R use in NHS
- Led by Prof. MA Mohammed
- Funded by grant from the Health Foundation
- Training provision
- Blog posts
- Share best practice
- Development of tools
- National Conference: 4th & 5th November



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## What's next?

- Continuing to develop analyst skills in R
- Spreading to different teams: control charts, Rmarkdown
- Contributing to, or building, Open Source tools with NHS-R community:
  - `FunnelPlotR`
  - `NHSRdatasets`
- Pushing further into ML techniques for prediction
  - Improving current models: Ensemble techniques etc.
  - Unsupervised techniques for cluster analysis.

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## Thanks for your time!

✉ [chris.maine@uhb.nhs.uk](mailto:chris.maine@uhb.nhs.uk)

🌐 <http://www.hed.nhs.uk>

🐦 [@chrismainey](https://twitter.com/chrismainey)

🐙 [chrismainey](https://github.com/chrismainey)

🌐 <http://www.mainard.co.uk>



`FunnelPlotR`  now available on CRAN!

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