DECIPHer
Development and Evaluation of Complex
Interventions for Public Health Improvement
A UKCRC Public Health Research Centre of Excellence

Challenges of working with a large database of routinely collected health data: Combining *SQL and R*

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HIRU and the SAIL database

- HIRU – the Health Information Research Unit
- SAIL – Secure Anonymous Information Linkage
- Main aim of HIRU is to realise the potential of electronically-held, routinely-collected, person-based data to conduct and support health-related studies
- The SAIL databank already holds over 1.9 billion anonymised and encrypted individual-level records, from a range of sources relevant to health and well-being

Appropriate use of patient and personal information

How can these data be made available for research?

- In accordance with the principles of Information Governance
- To ensure data security, integrity and quality
- To maintain data usefulness

Trusted Third Party

NHS Wales Informatics Service (NWIS)

SAIL does not receive identifiable data

- Handle demographic data
- Matching and anonymisation

Secure data transport

Data security

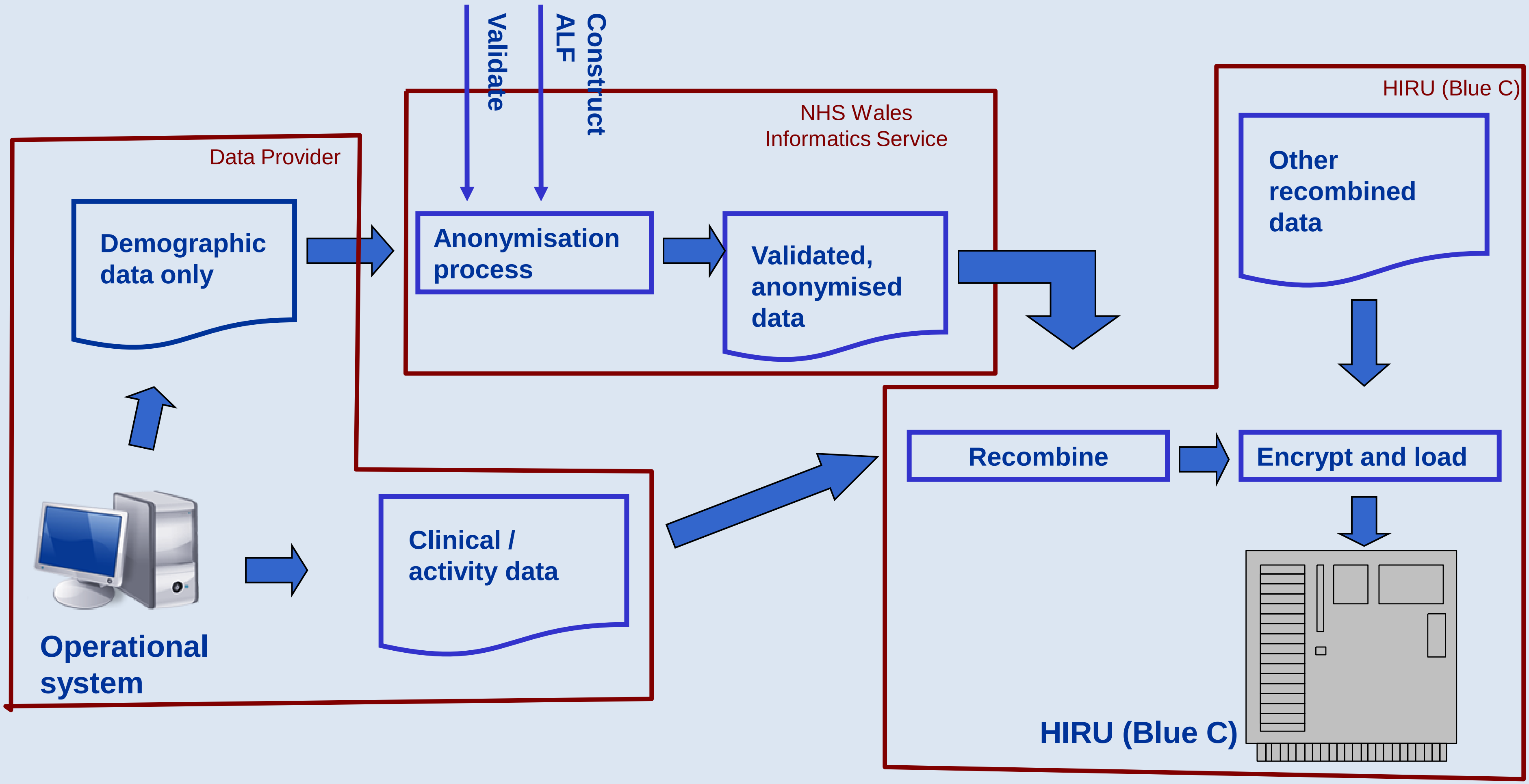
- Disclosure control
- Data access controls
- Scrutiny of data utilisation proposals
- External verification of compliance with IG

SAIL references:

Ford et al. (2009). The SAIL Databank: building a national architecture for e-health research and evaluation. *BMC Health Serv Res, 9*, 157.

Lyons et al. (2009). The SAIL databank: linking multiple health and social care datasets. *BMC Med Informat Decis Making, 9*, 3.

HIRU methodology



Validate

Construct ALF

Data Provider

Demographic data only

Operational system

Clinical / activity data

NHS Wales Informatics Service

Anonymisation process

Validated, anonymised data

HIRU (Blue C)

Other recombined data

Recombine

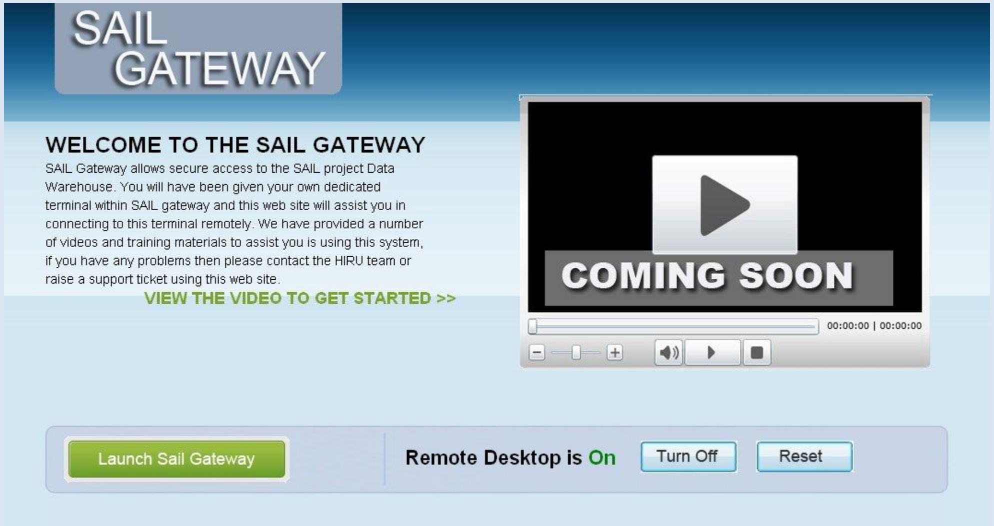
Encrypt and load

HIRU (Blue C)

Working with the SAIL gateway

All analysis is done within the SAIL gateway

- data analysts retrieve data through SQL code from DB2 databank on Blue C replacement servers
- researchers analyse data using SPSS, STATA or R



WELCOME TO THE SAIL GATEWAY

SAIL Gateway allows secure access to the SAIL project Data Warehouse. You will have been given your own dedicated terminal within SAIL gateway and this web site will assist you in connecting to this terminal remotely. We have provided a number of videos and training materials to assist you is using this system, if you have any problems then please contact the HIRU team or raise a support ticket using this web site.

VIEW THE VIDEO TO GET STARTED >>

Files are moved into the gateway using a FTP client

- no internet access within the gateway

Files are requested out of the gateway through a review process

- screening for potentially identifiable data

Why use R?

- Running SQL queries and creating tables
  - users do have restricted command line access to DB2
  - no access to advanced SQL options such as procedures

  ➔Brilliant way to create multiple SQL tables, e.g. `for` loop & `paste` command

- Evaluation and pre-cleaning of raw data
  - no need to create temporary tables in SQL or copy query results into different software package

- Programming heavy analysis
  - biomarkers
  - data mining (RWeka)

Challenges when working with R and SAIL – PART 1

- R packages
  - have to be installed manually in the SAIL gateway

  ➢ Possibility to open a single connection to a CRAN mirror

- Computing power
  - SQL uses computing power of Blue C replacement servers
  - R only has remote desktop properties (equals to 1 core of a Xeon 5550@2.67 GHz processor, with allocated memory of 2GB RAM per user)

  ➢ There are plans to install R on a separate, very powerful server (a server each per statistics package: SPSS, STATA, R)

Connecting to SAIL with RODBC

1) Installation of ODBC driver
2) Installation of package RODBC in R
3) Start RODBC

```
library(RODBC)
```

4) Connect to SAIL (makes table views available)

```
channel <- odbcConnect("PR_SAIL")
```

5) Set up the WORKTMPT environment

```
odbcQuery(channel,"SET CURRENT SCHEMA = WORKTMPT")
```

Querying SAIL from R

Run a Query

```
hw.table <- sqlQuery(channel, "
      SELECT DISTINCT a.ALF_E
      , a.GNDR_CD
      , b.EXAM_DT
      , TIMESTAMPDIFF(256, CHAR(TIMESTAMP_ISO(b.EXAM_DT) - TIMESTAMP_ISO(a.WOB)))
      as AGE_YRS
      , TIMESTAMPDIFF(64, CHAR(TIMESTAMP_ISO(b.EXAM_DT) - TIMESTAMP_ISO(a.WOB)))
      as AGE_MNTH
      , b.HEIGHT_CM
      , b.WEIGHT_KG
      FROM WORKTMPT.JD_WECC_SUBSET_2 a
      JOIN SAILCHDHV.EXAM b
      ON a.CHILD_ID_E = b.CHILD_ID_E
      WHERE TIMESTAMPDIFF(64, CHAR(TIMESTAMP_ISO(b.EXAM_DT) -
      TIMESTAMP_ISO(a.WOB))) >= 0
      AND (HEIGHT_CM IS NOT NULL AND WEIGHT_KG IS NOT NULL)
      AND GNDR_CD IN ('1','2')
      ORDER BY a.ALF_E, b.EXAM_DT;
 ")
```

Data retrieval: R: 1:26 min, *DB2 command line: 0:41 min*, *WinSQL: 3:32 min*
1,842,820 rows, 7 columns → 602,975 individual children

Querying SAIL from SQL script in R

All SQL scripts have to be reviewed before data can be requested out of the gateway. It therefore makes sense to keep SQL scripts as separate files.

Run a query from an SQL script

```
con <- file("hwcode.sql")
sql <- readLines(con)
sqlQuery(channel, paste(sql, collapse=" "))
close(con)
unlink("hwcode.sql")
```

Create table in SAIL using SQL

Create table

```
> sqlQuery(channel, "
CREATE TABLE WORKTMPT.JD_HW
 (ALF_E BIGINT
, GNDR_CD CHAR(1)
, EXAM_DT DATE
, AGE_YRS SMALLINT
, AGE_MNTH SMALLINT
, HEIGHT_CM DECIMAL(31,8)
, WEIGHT_KG DECIMAL(31,8)
 )
DISTRIBUTE BY HASH(ALF_E);
")
```

Create and populate table:

R: 30 sec, *WinSQL: 11 sec*

Populate table

```
> sqlQuery(channel, "
INSERT INTO WORKTMPT.JD_HW (
SELECT DISTINCT a.ALF_E
        , a.GNDR_CD
        , b.EXAM_DT
        , TIMESTAMPDIFF(256,
CHAR(TIMESTAMP_ISO(b.EXAM_DT) -
TIMESTAMP_ISO(a.WOB))) as AGE_YRS
        , TIMESTAMPDIFF(64,
CHAR(TIMESTAMP_ISO(b.EXAM_DT) -
TIMESTAMP_ISO(a.WOB))) as AGE_MNTH
        , b.HEIGHT_CM
        , b.WEIGHT_KG
        FROM WORKTMPT.JD_WECC_SUBSET_2 a
        JOIN SAILCHDHV.EXAM b
        ON a.CHILD_ID_E = b.CHILD_ID_E
        WHERE TIMESTAMPDIFF(64,
CHAR(TIMESTAMP_ISO(b.EXAM_DT) -
        TIMESTAMP_ISO(a.WOB))) >= 0
        AND (HEIGHT_CM IS NOT NULL AND WEIGHT_KG
IS NOT NULL)
        AND GNDR_CD IN ('1','2')
        ORDER BY a.ALF_E, b.EXAM_DT;
")
```

Append data to SAIL table

```
sqlQuery(channel, "CREATE INDEX WORKTMPT.JD_HW1_01 ON
WORKTMPT.JD_HW (ALF_E)")
sqlQuery(channel, "ALTER TABLE WORKTMPT.JD_HW ADD COLUMN
TEST CHAR(1)")
```

DB2 commands, which restructure the table (such as `reorg table`, `runstats`) will have to be run separately.

```
system("db2 connect to PR_SAIL user xxx using xxx")
system("db2 reorg table WORKTMPT.JD_HW")
system("db2 runstats on table WORKTMPT.JD_HW with distribution
   and detailed indexes all")
system("db2 quit")
```

Investigating raw data

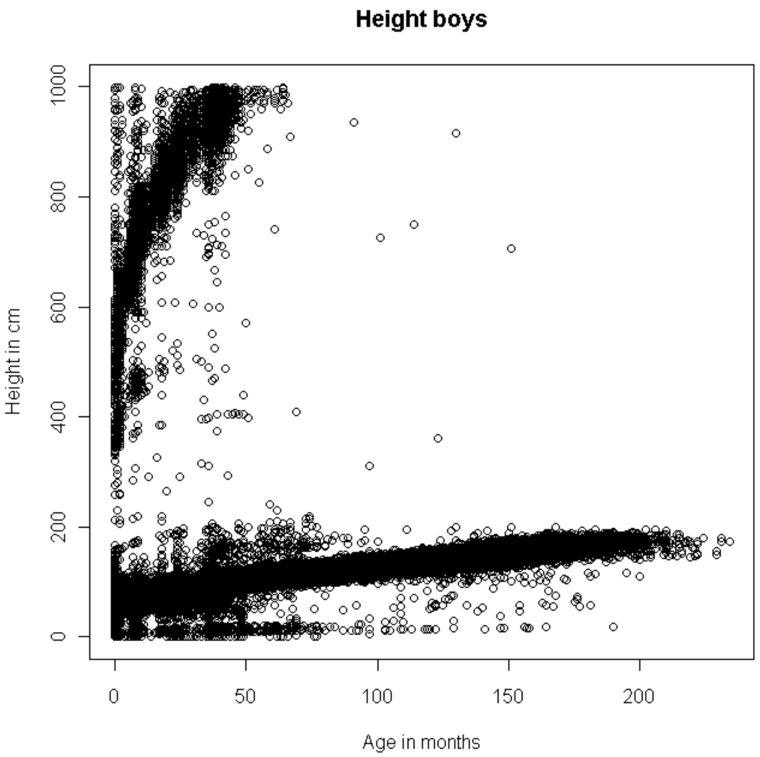
```
hw.table <- sqlFetch(channel, "JD_HW")
```

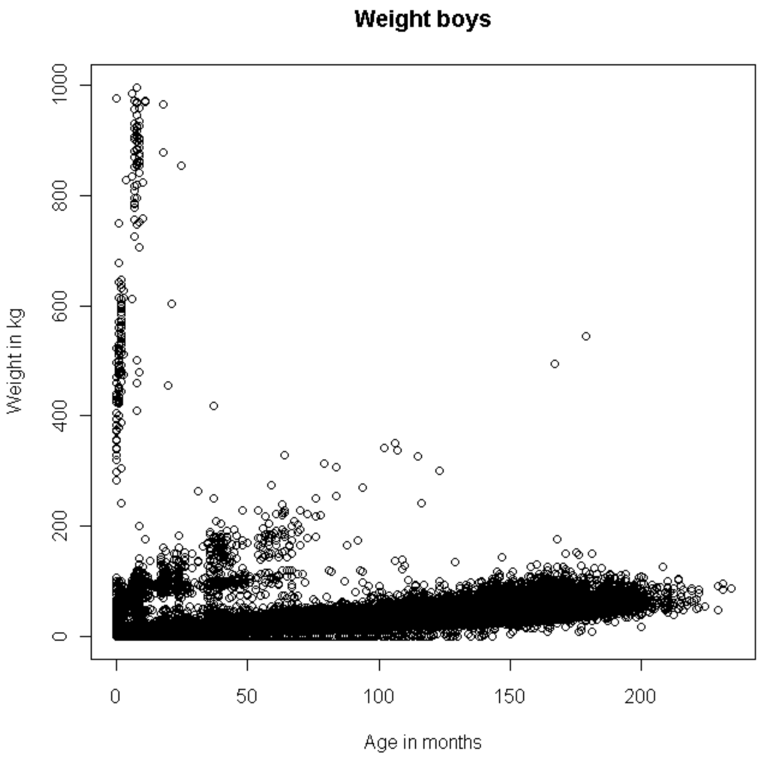
< 1 min

OR

```
hw.table <- sqlQuery(channel, "SELECT * FROM
WORKTMPT.JD_HW")
```

< 50 sec





<u>Possible problems:</u>

- typing errors
- wrong units (inches, feet / pounds, stones)
- serious congenital diseases (e.g. Dwarfism)

Removing impossible values

Combined heights

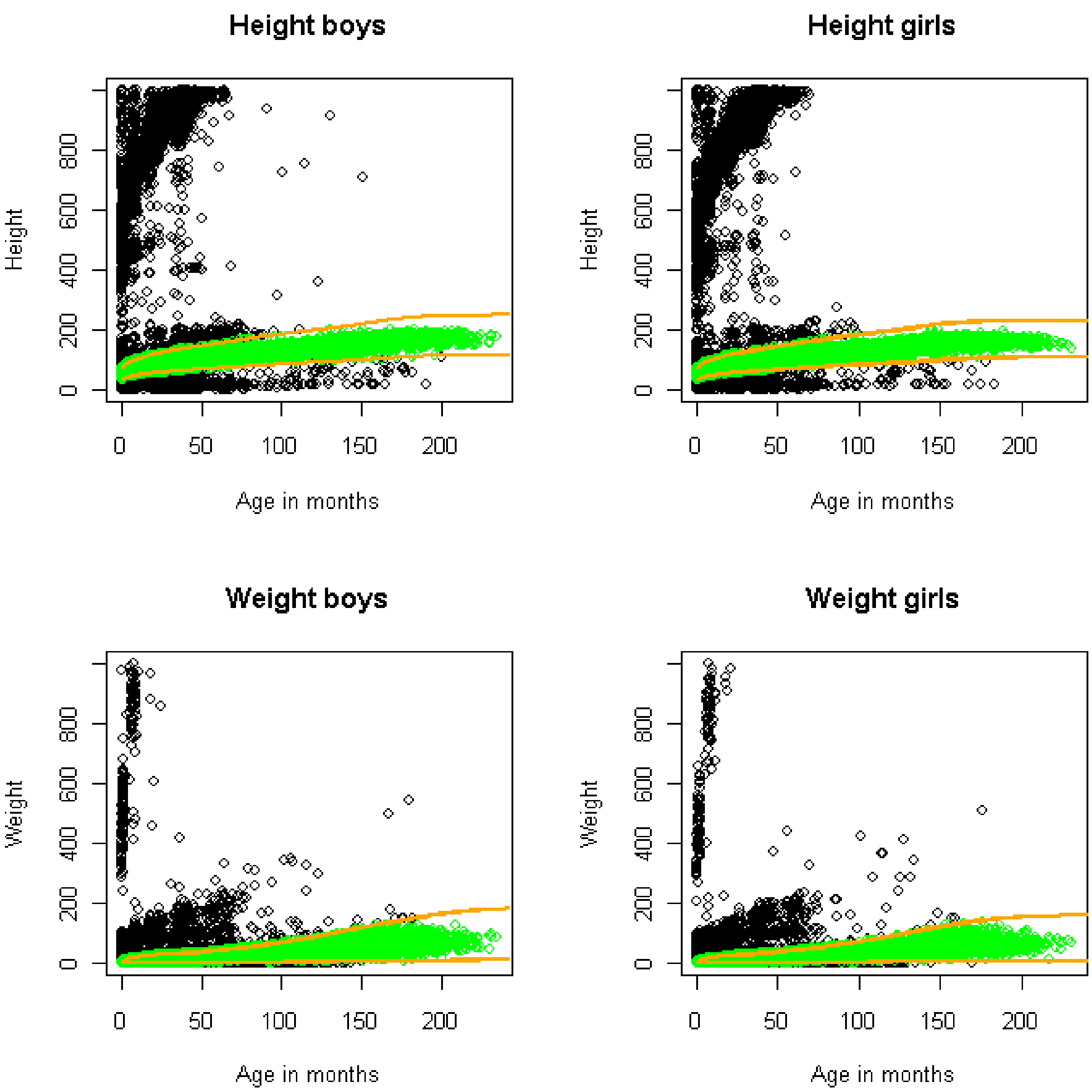
before	after
1,842,820	1,795,606

Both height & weights
1,764,728 (96% of data)

Combined weights

before	after
1,842,820	1,792,063

Filtering data against height and weight limits in R can be very time consuming
BUT will be very fast in SQL on the supercomputer.



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Challenges when working with R and SAIL – PART 2

- Saving data back to SAIL (`sqlSave`)
  - can be slow
    - ➢ saving 1.7 million rows of data takes 2.5 hours (`fast=T` is 14 minutes quicker)
  - might need special attention for very large tables
    - ➢ running out of internal memory or connection is timing out
  - might need special attention to formatting of columns (e.g. `,varTypes=c(EXAM_DT="Date"),` decimals will be saved as double)
- Best option to adhere with SAIL formatting conventions
  - *`create table`* with `sqlQuery` and then use `sqlSave(..., rownames=F, fast=T, append=T)`

Conclusions

- R can successfully be used as a effective data processing & querying tool with SAIL

- R has added benefits, such as
  - evaluating data in the same application
  - automating queries
  - running DB2 commands over the command line

- When importing data from SAIL into the gateway the performance is dramatically reduced (need for separate, more powerful server)

Craig Cerrig-gleisiad, Brecon Beacons, South Wales
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Thank you!

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