Set01 - Data Management

STAT 401 (Engineering) - Iowa State University

January 11, 2017

Duke Breast Cancer Clinical Trial Fraud

`http://cancerletter.com/articles/20150522_1/`:

> *...fraudulent data...irregularities in handling of the data...problems with the data*

`http://www.nature.com/nm/journal/v13/n11/full/nm1107-1276b.html`

> *We report here our inability to reproduce their findings.*
>
> 1. *We cannot reproduce their selection of cell lines.*
> 2. *lists of genes ... are wrong because of an 'off-by-one' indexing error*
> 3. *Using their software and lists of cell lines, we [could not reproduce their findings] ...*
> 4. *For docetaxel, their software yields only 31 of their 50 reported genes... We do not know how these 19 can be obtained from the training data, and we suspect that they were included by mistake.*
> 5. *Their software does not maintain the independence of training and test sets ...*
> 6. *suggesting that most labels are reversed. If the labels are reversed, the model suggests administering the drug only to the patients it would not benefit.*
> 7. *When we apply the same methods but maintain the separation of training and test sets, predictions are poor*
>
> *We believe that this situation may be improved by an approach that allows a complete, auditable trail of data handling and statistical analysis.*

KISS Data Management

Create a process and stick to it!

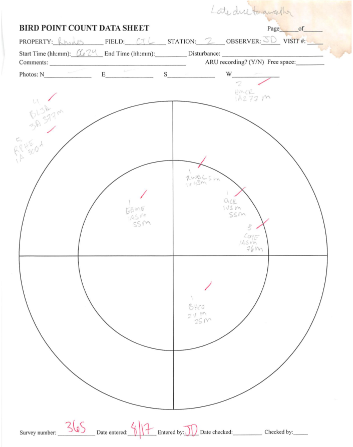
Suggested process

- Take a picture/scan/etc
- Digitize data
- Back it up
- Use scripts to tidy it
- Use scripts to analyze it

Take a picture/scan/etc

To make sure you always have access to the actual raw data (when it is not digital), take a picture/scan/etc and save it wherever you will be saving the digitized version.

For example,



Late due to weather

BIRD POINT COUNT DATA SHEET Page_____of_____

PROPERTY: Rhodes FIELD: CTL STATION: 2 OBSERVER: JD VISIT #: _____

Start Time (hh:mm): 0624 End Time (hh:mm): _________ Disturbance: __________________

Comments: ________________________ ARU recording? (Y/N) Free space: ________

Photos: N____________ E____________ S____________ W____________

2
AMCR
1A 277 m
4
BLJA
3A 377m
5
RPHE
1A 300+
1
RWBL 5m
1V 43m
1
GBME
1A5m
55m
1
DICK
1V5m
55m
3
COYE
1A5m
76m
1
BHCO
2V m
25m

Survey number: 365 Date entered: 8/17 Entered by: JD Date checked: _________ Checked by: _____

KISS Digitize data

Either

- your data is already digital or
- you need to make it digital.

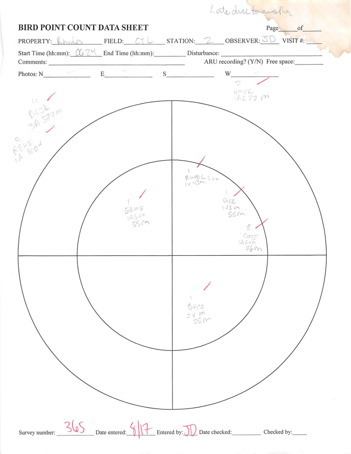
When making it digital, BE CONSISTENT!

- Directory structure
- File names
- Data file structure
- Column names in data file

It is okay if it isn't perfect. Once it is digital, you can change it later. As long as you were consistent.

KISS Digitize data - example

bpc/2015/06/25/JD/0624.pdf:



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Comments: ____________________________ ARU recording? (Y/N) Free space:________

Photos: N____________ E____________ S____________ W____________

2
HMCR
1A 277 m
4
BLJA
3A 377m
5
RPHE
1A 300+
1
RWBL 5m
1V 43m
1
DICK
1VSm
55m
1
EAME
1ASm
55m
3
COYE
1ASm
76m
1
BHCO
2V m
25m

Survey number: 365 Date entered: 8/17 Entered by: JD Date checked:_________ Checked by:_____

bpc/2015/06/25/JD/0624.csv:

```
read.csv("0624.csv")
```

```
  minute species code distance angle
1      1    RWBL 1VSM       43    15
2      2    HMCR   1A      277    35
3      1    DICK 1VSM       55    45
4      3    COYE 1ASM       76    75
5      1    BHCO  2VM       25   170
6      5    RPHE   1A      300   315
7      1    EAME 1ASM       55   320
8      4    BLJA   3A      377   325
```

Backup raw data

Definition

The photo/scan/etc and the digital version are your raw data.

Your raw data should be

- in 2 physically different locations and, separately,
- routinely given to your PI.

`http://researchdata.wisc.edu/storing-data/top-5-data-management-tips-for-undergraduates/`:

> *This may be hard as a student with limited resources for storage. But if you can, try to practice 3-2-1. 3 copies of your data, in 2 different locations, on more than 1 type of storage hardware. This may seem excessive, but it can help protect you from the perfect storm of hardware malfunctions or physical accidents like flooding. UW offers Box and a number of other storage options depending on whether you are storing personal data or university data.*

`http://researchdata.wisc.edu/news/top-5-data-management-tips-for-graduate-students/`

> *Lets add on to that. 3-2-1-0. 0 USBs used as a form of storage hardware. A USB is easy to lose, misplace, and drop - it happens all the time. A USB is simply not a good form of backup.*

Backup raw data - options

IASTATE file storage: `https://www.it.iastate.edu/services/storage`

- CyBox `https://www.it.iastate.edu/services/storage/cybox`
- myfiles `https://www.it.iastate.edu/services/storage/myfiles`
- ResearchFiles `https://www.it.iastate.edu/services/storage/researchfiles`

Git/GitHub.com: Have the same repository (set of files) in multiple places.
Backup GitHub.com: `https://addyosmani.com/blog/backing-up-a-github-account/`

Use scripts to create tidy data

Definition

Tidy data are raw data that have been

- cleaned/munged/wrangled
- collated/joined/processed

so that the data are ready for statistical analyses, e.g. making

- figures
- tables
- reports

Use scripts to create tidy data - example

Use this gist: https://gist.github.com/jarad/8f3b79b33489828ab8244e82a4a0c5b3:

Then for a particular set of files:

```
source("https://gist.githubusercontent.com/jarad/8f3b79b33489828ab8244e82a4a0c5b3/raw/494db9bffb10ed6d1928c1d13

bpc = read_dir(path = "../raw/bpc/2015",
             pattern = "*.csv",
             into = c(
               "blank",
               "raw",
               "bpc",
               "year",
               "month",
               "day",
               "observer",
               "property",
               "field",
               "station",
               "start_time",
               "extension")) %>%
  dplyr::select(-blank,-raw,-bpc,-extension)

readr::write_csv(bpc, path="bpc.csv")
```

Use scripts to perform analyses

The scripts should use the tidy data to create

- figures,
- tables,
- reports, and/or
- manuscripts.

Use scripts to perform analyses - example

```
library(dplyr)

d <- read.csv("bpc.csv")

d %>%
  group_by(species) %>%
  summarize(count = n()) %>%
  arrange(-count)

# # A tibble: 21 x 2
#    species count
#     <fctr> <int>
# 1     DICK    11
# 2     RWBL     9
# 3     EAME     7
# 4     KILL     6
# 5     AMRO     4
# 6     COYE     4
# 7     RPHE     4
# 8     BHCO     2
# 9     INBU     2
# 10    NOCA     2
# # ... with 11 more rows
```

An iterative process

Although presented as a series of steps, data management is an iterative process. This usually only comes to light once you start doing (basic) statistical analyses. At that point you might need to

- fix errors in raw non-digital data (if you can)
- fix errors in raw digital data
- fix errors in tidying scripts
- fix errors analysis scripts
- update the raw non-digital format
- update the tidying scripts
- update the analysis scripts
- ⋮

You should also plan time to

- document your process
- review (annually) your process and make improvements.

Examples

STRIPS project:

- `https://github.com/ISU-STRIPS/STRIPS`
- `https://github.com/ISU-STRIPS/STRIPSMeta`
- `https://github.com/ISU-STRIPS/STRIPSONeal`
- `https://github.com/ISU-STRIPS/STRIPSLiebman`
- `https://github.com/ISU-STRIPS/STRIPSSchulte/blob/master/tests/testthat/test-counts.R`
- `https://github.com/ISU-STRIPS/STRIPSSchulte/blob/master/R/data.R`

Gas mileage:

- `https://github.com/jarad/ToyotaSiennaGasMileage`

Flash card data:

- `https://github.com/jarad/flashcardData`