Version Control for Data Analysis

at Sheffield City Council

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Preface

This documentation is at an early stage of development. It includes good practice for using version control for data analysis at Sheffield City Council. In particular, it provides suggestions and requirements on how the data being analysed is handled by version control.

In addition to good practice, the guidance will also provide some pointers on getting started and links to other resources.

If you're reading this from the PDF version you can view the online version here: scc-pi.github.io/version-control.

If you're reading this from the online version you can view the PDF version via the small Adobe Acrobat icon next to the title in index pane on the left, or by using this URL: scc-pi.github.io/version-control/Version-Control-for-Data-Analysis.pdf.

How this guidance is published is detailed in the repository README.md: github.com/scc-pi/version-control#readme

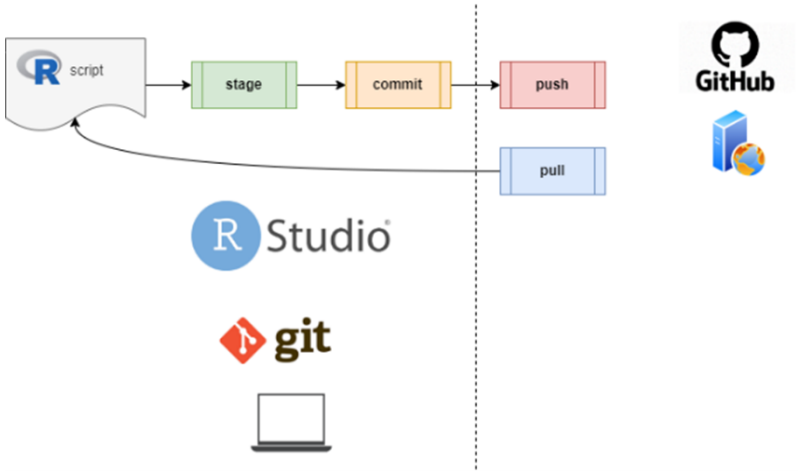
The expectation is that this book, its repository, along with most repositories in scc-pi GitHub organisation, will move to Azure DevOps within the Council's secure Azure Tenant. Establishing the Council Azure DevOps for data analysis is currently on hold whilst a new data platform is established.

1 Introduction

It is good practice to use version control with data analysis scripts, SQL, R, Python etc. It facilitates re-use, collaboration, and better-quality analysis output. Version control is a key principle of the RAP (Reproducible Analytical Pipeline) approach that has been adopted in the last few years by Government and the NHS. The vision in the Government RAP strategy includes: "analytical teams in public sector organisations choose to deliver their analysis using the RAP principles by default".

Git is the industry standard open-source distributed version control system. Azure DevOps and GitHub are two Git-based repository hosting services.

In the diagram on the right, the dashed line indicates where files are shared from a data analyst's laptop to a web service like GitHub. It could be Azure DevOps instead of GitHub. Similarly, it could be a Python script instead of an R script, and a different IDE (Interactive Development Environment) like VS Code instead of RStudio. Stage, commit, push, and pull are all Git commands.

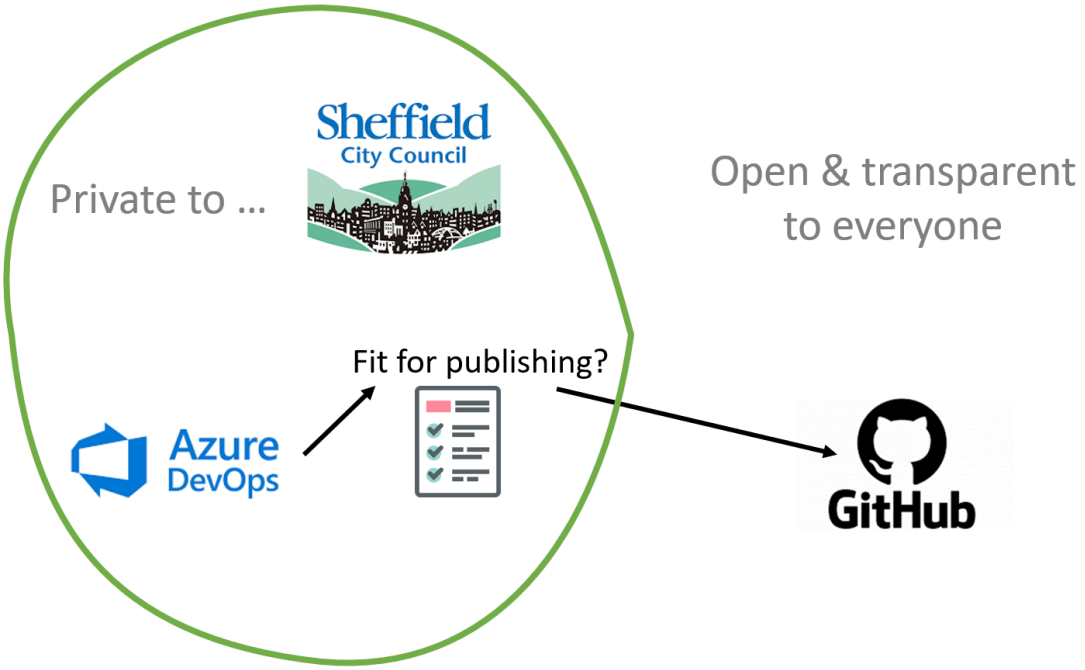


A Show and Tell of version control was provided for data analysts at Sheffield City Council in August 2023. A recording and the slide deck is available from the Council's Data Network Sharepoint Site.

1.1 Council setup

The intention is for Azure DevOps to be our default for hosting version control repositories. This will enable us to securely share code with data analysts across the Council. Our

adoption of Azure DevOps is on hold whilst a new data platform is established.



The diagram on the left is an illustration of the Council's planned version control setup once both the Data Platform and Azure DevOps are established. It is based on the NHS Digital setup, but they use GitLab in place of Azure DevOps:
How to publish your code in the open - RAP Community of Practice (nhsdigital.github.io)

Making code open and transparent to everyone, not just other Council Officers, is considered best practice. The Government's Digital Service Standard 12th principle states that all publicly funded code should be open, reusable, and available under appropriate licences. The main benefits of publishing your code are increased transparency, collaboration and knowledge sharing across local authorities, external users, and analysts. Knowing that code will be published will lead to overall code health increasing as analysts will take greater care in ensuring that best coding practices and standards are applied.

Making a repository publicly available will be done by publishing it on GitHub, but only if it passes a fit for publishing checklist.

To understand both the benefits of sharing code and how to manage the risks, we'll be leaning heavily on resources from:
NHS RAP Community of Practice Government Analysis Function Guidance Hub

1.2 ToDo

- Some form of "Getting Started", so subsequent content makes sense. Links to other resources and training?

- Once this guidance is moved to Azure DevOps, include Show & Tell URL.
- Re-write chapter when Azure DevOps available.

2 Data protection

Using version control for data analysis requires data protection to be front and centre of your considerations, as it has to be with any form of data handling. That said, a lot of the risk mitigation will be undertaken as part of an unobtrusive version control workflow, once the workflow is established and well practised. Our procedures will also prompt for particular data protection considerations at different stages:

1. Project initiation and repository creation.

2. Code reviews with a colleague.

3. Fit for publishing checklist.

2.1 Confidentiality risk

The principal data protection risk is confidentiality. Confidentiality is defined as unauthorised disclosure of, or access to, personal data.

Version control for data analysis has three types of confidentiality risk. These relate to what a data analyst may inadvertently include in a **public** version control repository:

1. Data file (e.g. a spreadsheet) with personal data.

2. Some personal data in data analysis output or a script.

3. Secret (e.g. a password) in a script that compromises the security of, for example, a database containing personal data.

These risks are less relevant for SQL scripts than for R and Python scripts, and SQL scripts are more likely for new Council users of version control.

Our Azure DevOps repositories will not be public. Only our GitHub repositories will be public, so the GitHub repositories are the main risk.

2.2 Information Management notes

Once we move to Azure DevOps we may take advantage of the project management tools. However, for now we'll keep track of actions on this page.

Preliminary discussions with the Council's Information Management team have been held. Below are notes of (italicised) questions raised and (bulleted) actions agreed.

1. Are there retention schedules for scripts (and their versions)?
No. Current housekeeping is to periodically (maybe every 6 month) review the list of GitHub repos (repositories) and archive what's no longer in use.

- Formalise and document proposed housekeeping, including retention schedules.
- Extend periodic reviews of repos to include what should be archived, and what should be deleted from the archive.

2. When you publish your data analyses do you indicate anything about the script, its version and a plain English statement?
Each repository includes, as a minimum, a README.md file with a plain English statement. It will also often include further documentation about the data analysis pipeline. The current version and previous versions are an intrinsic aspect of GitHub and Azure DevOps.

- Include the README.md and documentation requirements in the version control housekeeping documentation.

3. When you publish to GitHub (in future) is it checked? attributed to SCC? and come with a disclaimer?

- Unit tests and code reviews are RAP (Reproducible Analytical Pipeline) practices that we're considering adopting.
- Our GitHub repos are held under the scc-pi GitHub organisation and are clearly attributable to SCC.
- Need to consider the different licenses that can be applied to published repos and whether this would cover the disclaimer.

Main action from meeting Information Management:

- Complete mini 2-page DPIA and make MW aware. It might sit under the full DPIA of the new Data Platform.

Other actions:

- Move GitHub repos to Azure DevOps.
- Draft a fit-to-publish (publically on GitHub) checklist.

- pre-commit checks (scripts) or "hooks" that screen for CSVs, PID, {secrets} (e.g. passwords) etc.
- Code review by another analyst will also lessen the risk of inadvertently including data.
- Publish guidance and tools for annonymising datasets for data analysis to encourage working with PID as only by exception.
- Protocols in case of a data breach from incorrect use of version control.

2.3 Other ToDos

- Replace readme with quarto doc and outline quarto book and github actions??
- ~~Move version control content from pinsheff~~
- Link to related unmoved pinsheff content
- ~~Note Version Control Show & Tell e.g. .gitignore /data~~

2.4 ToDo

- What are the connotations of personal data being available to someone in the Council who doesn't need access to it? For example, via Azure DevOps?
- Once this guidance is moved to Azure DevOps, include mini-DPIA PDF download URL.

3 IDEs & Git

Whichever IDE (Interactive Development Environment) you use to make it easier to write your code, it will probably have some integration with Git.

Broadly speaking, you'll need to install Git and link it to GitHub or Azure DevOps via your IDE.

3.1 RStudio & GitHub

Our experience is mainly with RStudio and GitHub, and we've relied on Happy Git with R by Jenny Bryan. In particular we recommend following these chapters:

- 9 Personal access token for HTTPS
- 11 Connect to GitHub
- 12 Connect RStudio to Git and GitHub

Chapters 15, 16 and 17 of Happy Git with R cover different ways of setting up a local RStudio project connected to GitHub. So far, we've stuck with Chapter 15 New project, GitHub first.

There's also a GitHub with RStudio cheatsheet.

3.2 Proxy server

When out of the office and connected via AlwaysOn VPN, both the HTTPS and SSH connection methods for GitHub and Azure DevOps should work. However, SSH will never work when in the office because the Council's proxy server doesn't support SSH. It works when out of the office because when connected via AlwaysOn VPN, not all traffic is routed via the Council and its proxy server.

Git needs to be configured to use the Council's proxy server.

From the Git CMD app you need to run the Git command immediately below. First though, you need to substitute in the command your Council (not your GitHub) username and password, plus the proxy server IP address.

```
git config --global http.proxy http://SCC\username:password@proxyip:8080
```

Note: when you update your Council password you'll need to rerun the command with your new password.

3.3 RStudio workspace

To encourage reproducible R scripts, Hadley Wickham recommends not preserving your workspace between sessions. This entails deselecting a couple of options to save and restore .Rdata (see chapter 8 Workflow: projects in Hadley's R4DS book).

Hadley's recommendation also reduces the chances of inadvertently sharing PID in a GitHub repository. However, `.Rdata` should also be included in the `.gitignore` file and the repository set to private (see the section on GitHub security & data protection).

3.4 ToDo

- Update *Proxy server* section this side of Cloud Proxy
- Azure DevOps
- VS Code
- SSMS & Azure Data Studio
- GitKraken

4 Training

Version control is not especially difficult, but the risks will be greatest when someone is new to it. The low number of potential users of version control for data analysis means that bespoke Go Learn style training is not justified. Instead, there should be some training from an existing Council user of GitHub. This is in addition to personal responsibility for reading the Council guidance and undertaking specified, openly available, introductory training courses on Git and GitHub.

4.1 GitHub

Introduction to GitHub and GitHub Skills are good places to get started and become familiar with some initial concepts:
github.com/skills/introduction-to-github
skills.github.com

Version Control with Git and SVN, Posit Support
Ch.4 Version control with Git, Building reproducible analytical pipelines with R, by Bruno Rodrigues

4.2 ToDo

5 Code reviews

Code reviews by a colleague are best practice that we should adopt. Another pair of eyes will reduce the risk of publishing personal data. Other benefits of code reviews include code health and knowledge sharing. We could look at defining some basic questions to cover as a part of a code review and include data protection considerations. The Government's Duck Book is a good place to start.

5.1 ToDo

6 Anonymise

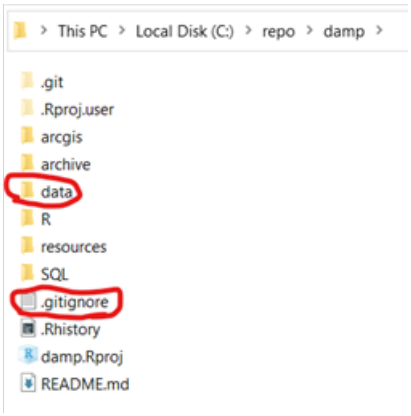
Where possible the data being analysed should have personal data removed or anonymised. We could better support this with written examples, functions, and packages, that all make it as convenient as possible to anonymise personal data.

The best way of removing the risk of leaking personal data is not to include it in the data analysis process in the first place. If you're extracting data from a database, don't select the personal data attributes unless it's necessary. If someone is providing a data extract for you, ask them to omit personal data unless it's necessary.

6.1 ToDo

7 .gitignore

For data files with personal data, the simplest way to ensure they're not published in a public repository is to store all data files in a `/data` sub-folder in the project directory and then exclude the data sub-folder from the Git repository. This is done by specifying the data sub-folder in the `.gitignore` file.



The `.gitignore` file specifies the folders and files you want to exclude from the repository i.e. it lists what you want to ignore. Holding any file based data (e.g. CSV files), whether they're original or transformed, in a `/data` sub-folder, makes it simple to exclude data from the repository by adding the following to the `.gitignore` file:

```
# data directory
/data/
```

As an additional precaution, any projects involving confidential information should be held in a private repository and `.Rdata` should also be included in the `.gitignore` file (see the section on RStudio security & data protection):

```
# Session Data files
.RData
```

7.1 ToDo

8 Repository template

We could create an SCC repository template to make consistent project folder structures and `.gitignore` exclusions more convenient.

8.1 ToDo

- Consider excluding initial data exploration and data engineering aspects from publishing.

9 Git hooks

Git hooks are scripts that can be set to run locally at specific points in your Git workflow, such as pre-commit. So, we can automate some checks for potential secret or personal data leaks by writing Git hook scripts to scan the contents of files in our version control repository.

9.1 ToDo

10 Secrets

The best way to avoid leaking secrets is to store them in local files. These can then be excluded from Git tracking with a `.gitignore` file. More likely and safer still, they will be stored within an IDE's folder structure (e.g. `.Renviron`) so that they are available across projects and are not exposed to specific project directories and version control.

10.1 Passwords & RStudio

It's poor practice to include login details in code. One option is using the `.Renviron` file for securing credentials. `usethis::edit_r_environ()` will open your user `.Renviron`.

If you're sharing the script, you can anticipate that the environment variable might not be set and use the RStudio API to prompt for credentials. For example:

```
# Connect to OSCAR database via ODBC DSN
oscar_con <- DBI::dbConnect(
  odbc::odbc(),
  dsn = "OSCAR",
  UID = if (Sys.getenv("oscar_userid") == "") {
    rstudioapi::askForPassword("OSCAR User ID")
  } else {
    Sys.getenv("oscar_userid")
  },
  PWD = if (Sys.getenv("oscar_pwd") == "") {
    rstudioapi::askForPassword("OSCAR Password")
  } else {
    Sys.getenv("oscar_pwd")
  },
  timeout = 10
)
```

Note that including all the connection logic within a single statement works well with the RStudio *Connections* tab.

10.2 ToDo

11 Fit for publishing checklist

We should adopt something similar to the NHS fit for publishing checklist, which includes data protection checks.

11.1 ToDo

12 GitHub roles

12.1 ToDo

- https://docs.github.com/en/organizations/managing-peoples-access-to-your-organization-with-roles/roles-in-an-organization
- https://docs.github.com/en/code-security/getting-started/best-practices-for-preventing-data-leaks-in-your-organization
- Retention schedules for repositories.
- Type of license?

13 Breach protocol

1. Delete the published repository, having first downloaded the repository to secure Council storage, for example ??

2. Report to ??

13.1 ToDo

References