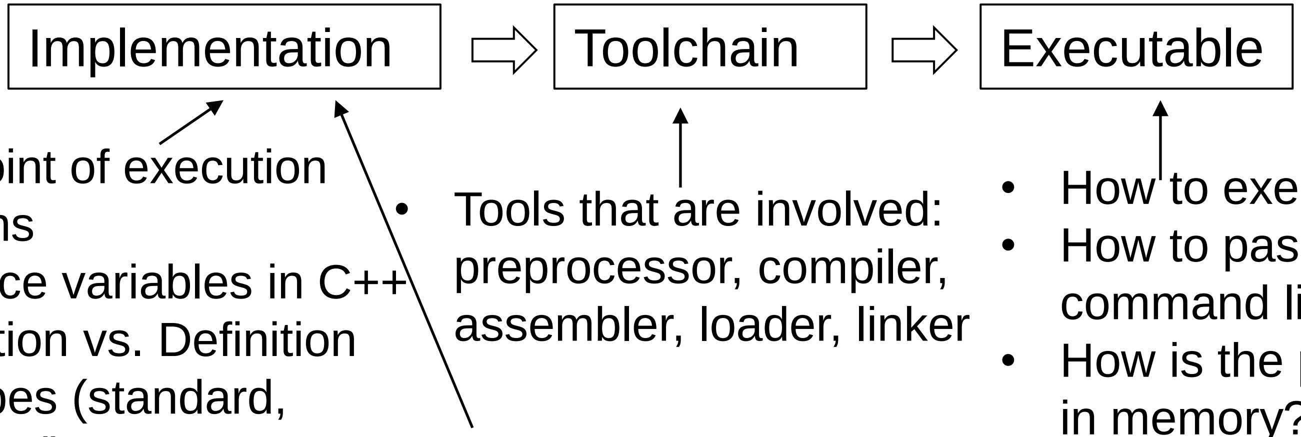
CS601: Software Development for Scientific Computing

Autumn 2022

Week4: Build tool (Make contd.), Version control system (git), Motifs – Matrix Computations with Dense Matrices

So far..

- Overview (scientific software, examples, commonly occurring patterns in scientific computing)
- IEEE-754 Representation
- Creating a program (Program Development Environment)



Implementation ⇨ Toolchain ⇨ Executable

- Entry point of execution
- Functions
- Reference variables in C++
- Declaration vs. Definition
- C++ Types (standard, compound)

- Tools that are involved: preprocessor, compiler, assembler, loader, linker

- How to execute?
- How to pass arguments from command line?
- How is the program laid out in memory?

Towards creating software (`vectorprod_vx.cpp`):
Data types (flexibility, adaptability)
Correctness (exceptions, validating)
Creating modular code

Discussion **`vectorprod_vx.cpp`**

Refer to:

- `vectorprod_v1.cpp`
  - What if `atoi` doesn't provide accurate status about the value returned?
- `vectorprod_v2.cpp`
  - `C++ stringstreams are an option. Is this code modular?`
- `vectorprod_v3.cpp scprod.cpp`
  - `What if there is already built-in function by the same name?`
- `vectorprod_v4.cpp scprod_v4.cpp`
  - `Namespaces`

Make - Recap

`Makefile` or `makefile`

- Is a file, contains instructions for the `make` program to generate a *target* (executable).
- Generating a target involves:
  1. Preprocessing (e.g. strips comments, conditional compilation etc.)
  2. Compiling (.c -> .s files, .s -> .o files)
  3. Linking (e.g. making printf available)
- A `Makefile` typically contains directives on how to do steps 1, 2, and 3.

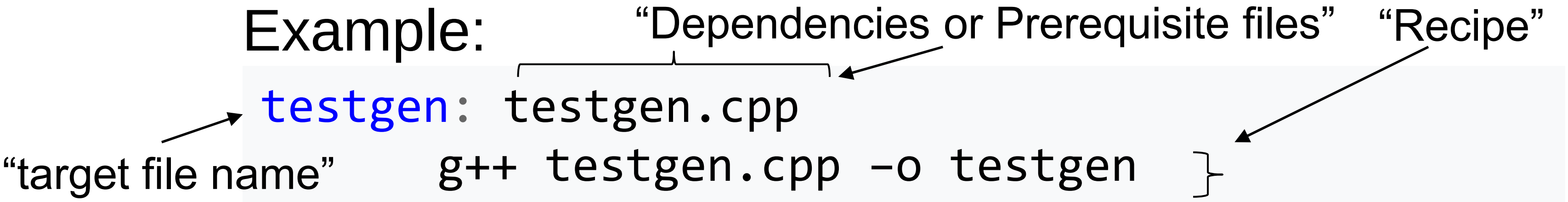
`Makefile` - Format

1. Contains series of ‘rules’-

```
target: dependencies
[TAB]  system command(s)
```

Note that it is important that there be a TAB character before the system command (not spaces).

Example:



“Dependencies or Prerequisite files”

“Recipe”

“target file name”

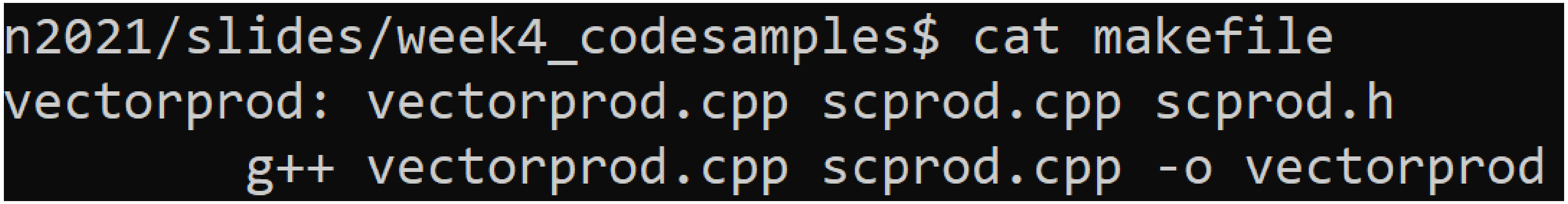
```
testgen: testgen.cpp
         g++ testgen.cpp –o testgen
```

2. And Macro/Variable definitions -

```
CFLAGS = -std=c++11 -g -Wall -Wshadow --pedantic -Wvla –Werror

GCC  = g++
```

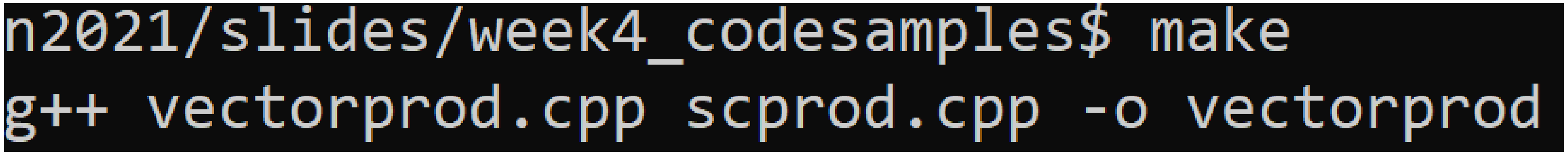
Makefile - Usage

– The ‘make’ command (Assumes that a file by name ‘makefile’ or ‘Makefile’. exists)



```
n2021/slides/week4_codesamples$ cat makefile
vectorprod: vectorprod.cpp scprod.cpp scprod.h
        g++ vectorprod.cpp scprod.cpp -o vectorprod
```

- Run the ‘make’ command



```
n2021/slides/week4_codesamples$ make
g++ vectorprod.cpp scprod.cpp -o vectorprod
```

`Makefile` - Benefits

- Systematic dependency tracking and building for projects
  - Minimal rebuilding of project
  - Rule adding is ‘declarative’ in nature (i.e. more intuitive to read *caveat: make also lets you write equivalent rules that are very concise and non-intuitive.*)
- To know more, please read: https://www.gnu.org/software/make/manual/html_node/index.html#Top

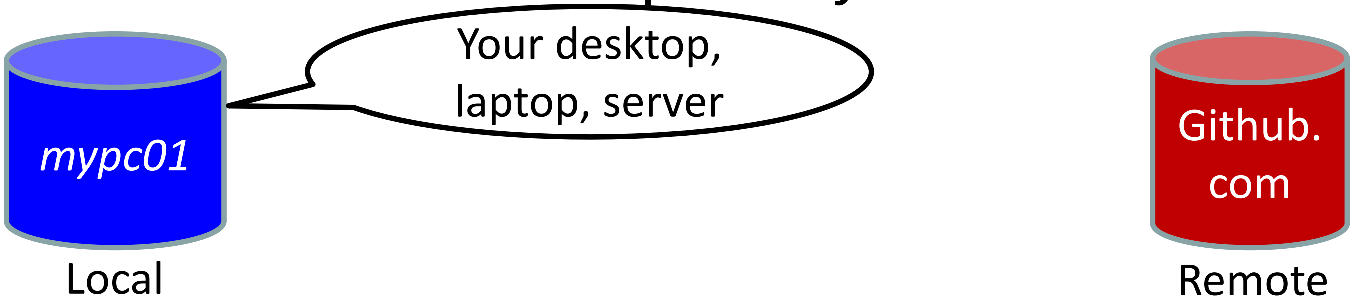
`make` - Demo

- Minimal build
  - What if only `scprod.cpp` changes?
- Special targets (`.phony`)
  - E.g. explicit request to `clean` executes the associated recipe. What if there is a file named `clean`?
- Organizing into folders
  - Use of variables (built-in (`CXX, CFLAGS`) and automatic (`$@, $^, $<`))

refer to week3_codesamples

Git

- Example of a Version Control System
  - Manage versions of your code – access to different versions when needed
  - Lets you collaborate
- ‘Repository’ – term used to represent storage
  - *Local* and *Remote* Repository



mypc01

Your desktop, laptop, server

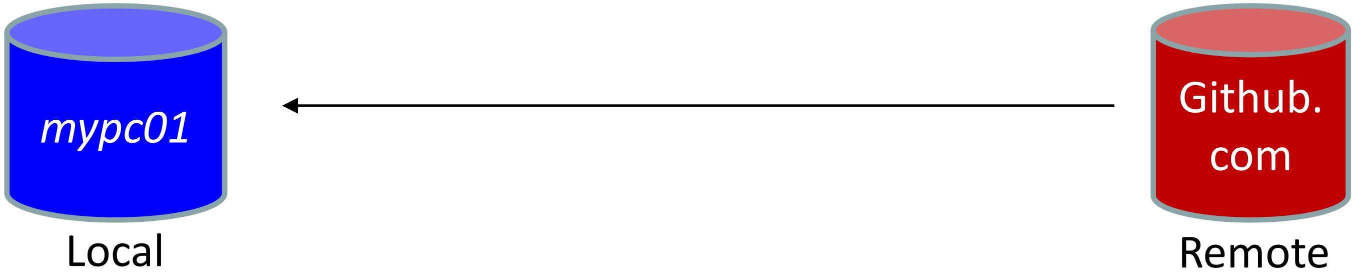
Local

Github.com

Remote

Git – Creating Repositories

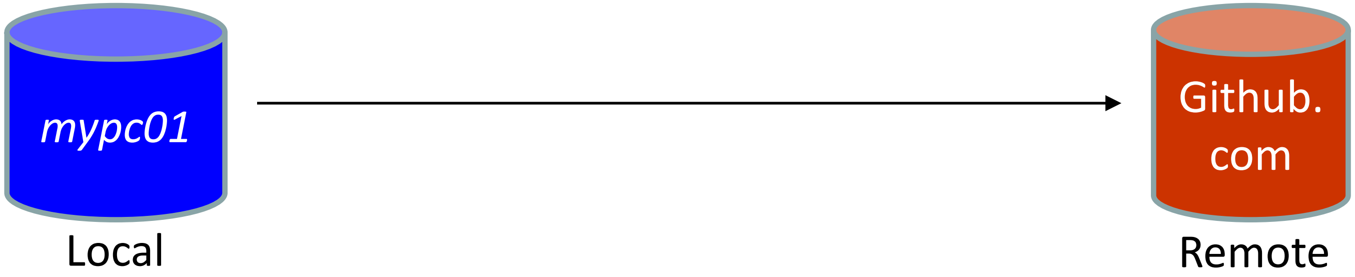
- Two methods:
  1. ‘Clone’ / Download an *existing* repository from GitHub



Git – Creating Repositories

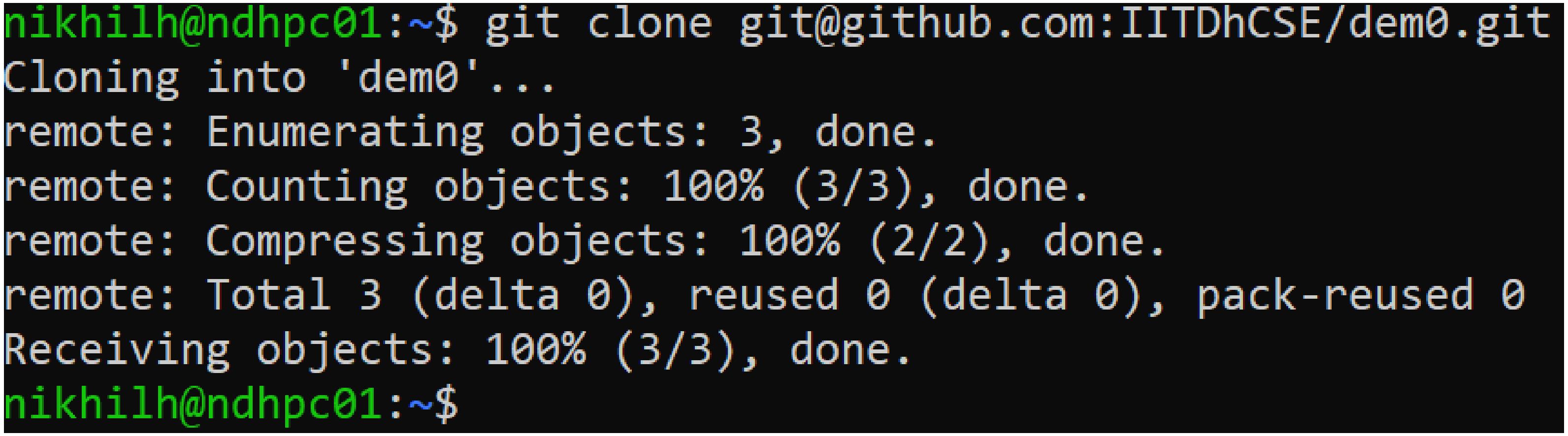
- Two methods:

  2. Create local repository first and then make it available on GitHub



Method 1: `git clone` for creating local working copy

- ‘Clone’ / Download an existing repository from GitHub – get your own copy of source code
  - `git clone` (when a remote repository on GitHub.com exists)



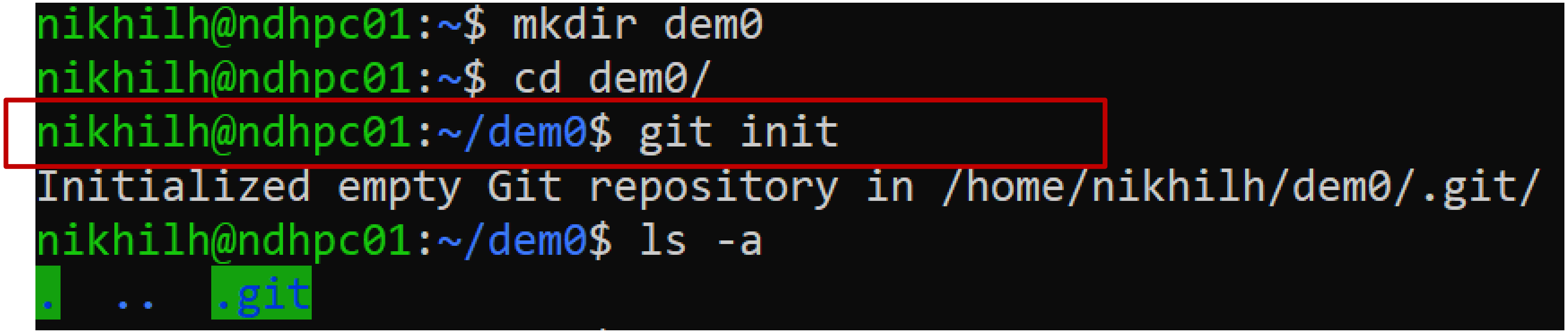
```
nikhilh@ndhpc01:~$ git clone git@github.com:IITDhCSE/dem0.git
Cloning into 'dem0'...
remote: Enumerating objects: 3, done.
remote: Counting objects: 100% (3/3), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 3 (delta 0), reused 0 (delta 0), pack-reused 0
Receiving objects: 100% (3/3), done.
nikhilh@ndhpc01:~$
```

Method 2: `git init` for initializing local repository

- Create local repository first and then make it available on GitHub

  1. `git init`

  converts a directory to Git local repo

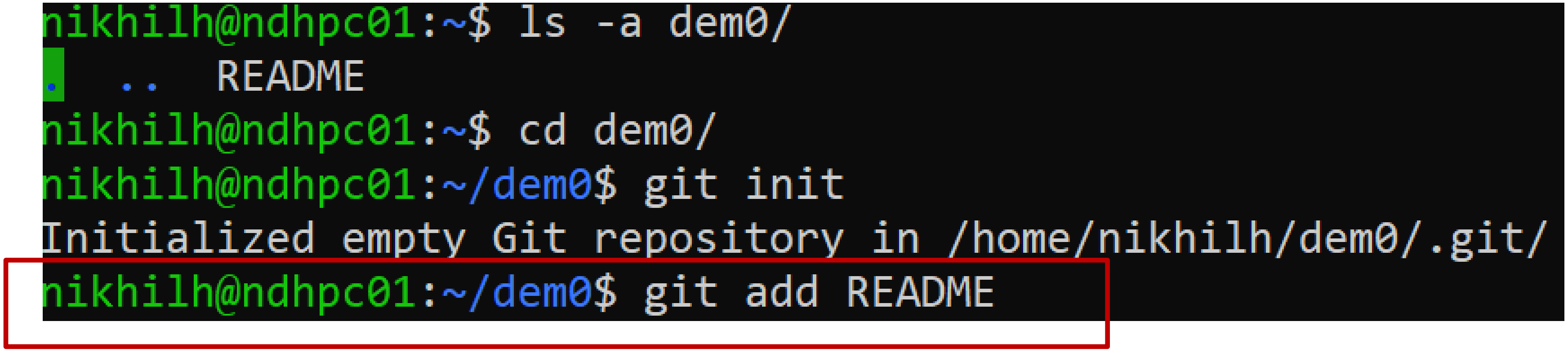


```
nikhilh@ndhpc01:~$ mkdir dem0
nikhilh@ndhpc01:~$ cd dem0/
nikhilh@ndhpc01:~/dem0$ git init
Initialized empty Git repository in /home/nikhilh/dem0/.git/
nikhilh@ndhpc01:~/dem0$ ls -a
.  ..  .git
```

git add for staging files

2. `git add`

‘stage’ a file i.e. prepare for saving the file on local repository



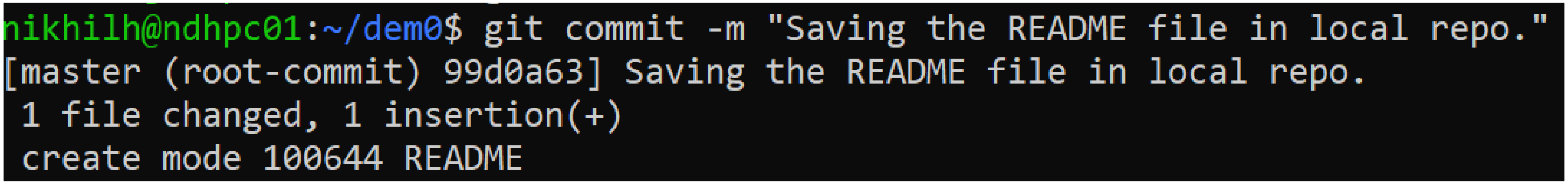
```
nikhilh@ndhpc01:~$ ls -a dem0/
.   ..   README
nikhilh@ndhpc01:~$ cd dem0/
nikhilh@ndhpc01:~/dem0$ git init
Initialized empty Git repository in /home/nikhilh/dem0/.git/
nikhilh@ndhpc01:~/dem0$ git add README
```

Note that creating a file, say, README2 in dem0 directory does not *automatically* make it part of the local repository

`git commit` for saving changes in local repository

3. `git commit`

‘commit’ changes i.e. save all the changes (adding a new file in this example) in the local repository



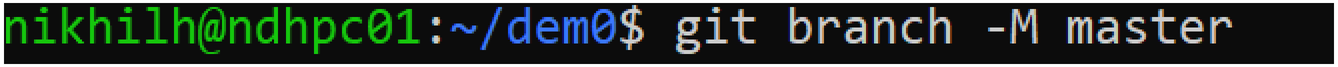
```
nikhilh@ndhpc01:~/dem0$ git commit -m "Saving the README file in local repo."
[master (root-commit) 99d0a63] Saving the README file in local repo.
 1 file changed, 1 insertion(+)
 create mode 100644 README
```

How to save changes done when you must overwrite an existing file?

Method 2 only: `git branch` for branch management

4. `git branch –M master`

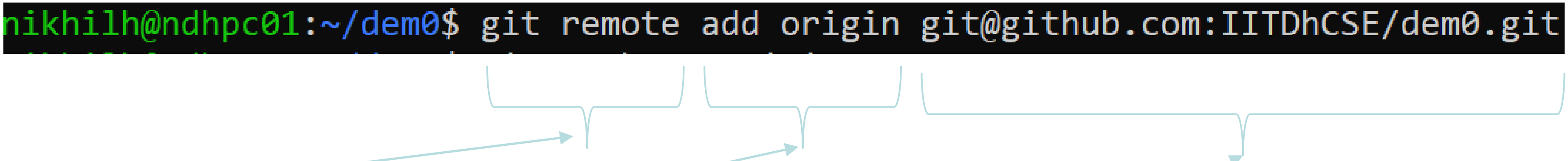
rename the current as ‘`master`’ (-M for force rename even if a branch by that name already exists)



```
nikhilh@ndhpc01:~/dem0$ git branch -M master
```

Method 2 only: `git remote add`

5. `git remote add origin git@github.com:IITDhCSE/dem0.git` – prepare the local repository to be managed as a tracked repository



```
nikhilh@ndhpc01:~/dem0$ git remote add origin git@github.com:IITDhCSE/dem0.git
```

command to manage remote repo.

associates a name ‘origin’ with the remote repo’s URL

The URL of the repository on GitHub.com.

- This URL can be that of any other user’s or server’s address.
- uses SSH protocol
  - HTTP protocol is an alternative. Looks like: https://github.com/IITDhCSE/dem0.git

Method 2 only: GitHub Repository Creation

5.a) Create an empty repository on GitHub.com

(name must be same as the one mentioned previously – `dem0`)

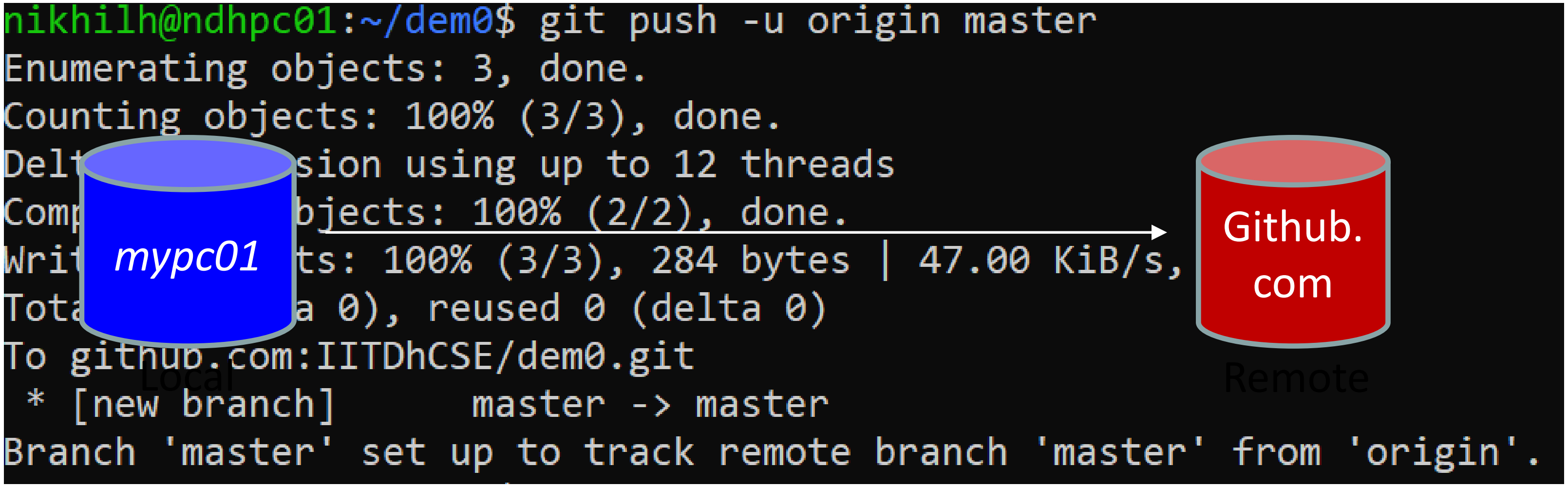
Remote

git push for saving changes in remote repo

6. git push –u origin master

‘push’ or save all the changes done to the ‘master’ branch in local repo to remote repo. *(necessary for guarding against deletes to local repository)*

syntax: git push <remotename> <branchname>



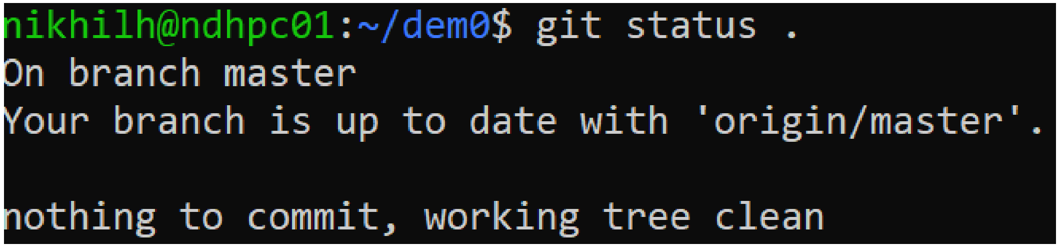
```
nikhilh@ndhpc01:~/dem0$ git push -u origin master
Enumerating objects: 3, done.
Counting objects: 100% (3/3), done.
Delt          sion using up to 12 threads
Comp          bjects: 100% (2/2), done.
Writ          ts: 100% (3/3), 284 bytes | 47.00 KiB/s,
Tota          a 0), reused 0 (delta 0)
To github.com:IITDhCSE/dem0.git
 * [new branch]      master -> master
Branch 'master' set up to track remote branch 'master' from 'origin'.
```

what does the –u option do?

Git – Releasing Code

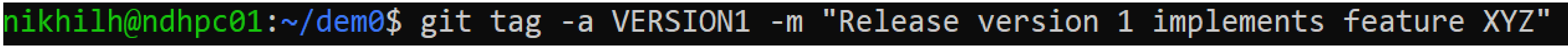
- Tagging

1. Check for unsaved changes in local repository.



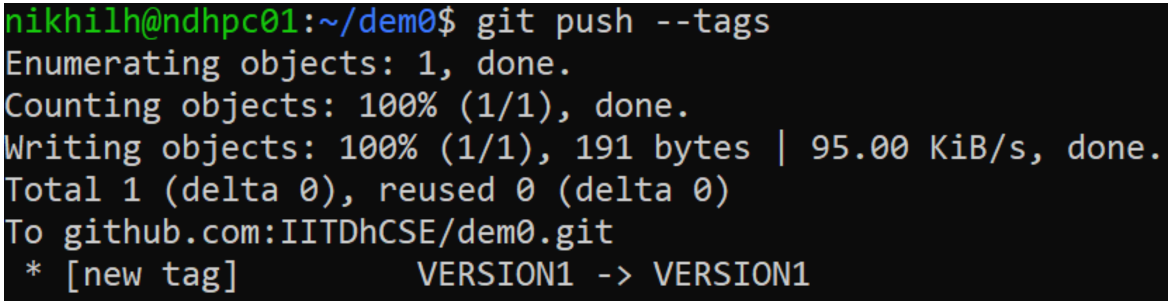
```
nikhilh@ndhpc01:~/dem0$ git status .
On branch master
Your branch is up to date with 'origin/master'.

nothing to commit, working tree clean
```

1. Create a tag and associate a comment with that tag



```
nikhilh@ndhpc01:~/dem0$ git tag -a VERSION1 -m "Release version 1 implements feature XYZ"
```

2. Save tags in remote repository



```
nikhilh@ndhpc01:~/dem0$ git push --tags
Enumerating objects: 1, done.
Counting objects: 100% (1/1), done.
Writing objects: 100% (1/1), 191 bytes | 95.00 KiB/s, done.
Total 1 (delta 0), reused 0 (delta 0)
To github.com:IITDhCSE/dem0.git
 * [new tag]         VERSION1 -> VERSION1
```

Git – Recap..

```
1. git clone (creating a local working copy)
2. git add (staging the modified local copy)
3. git commit (saving local working copy)
4. git push (saving to remote repository)
5. git tag (Naming the release with a label)
6. git push --tags (saving the label to remote)
```

- Note that commands 2, 3, and 4 are common to Method 1 and Method 2.
- Please read https://git-scm.com/book/en/v2 for details

For git download on Windows: https://git-scm.com/download/win