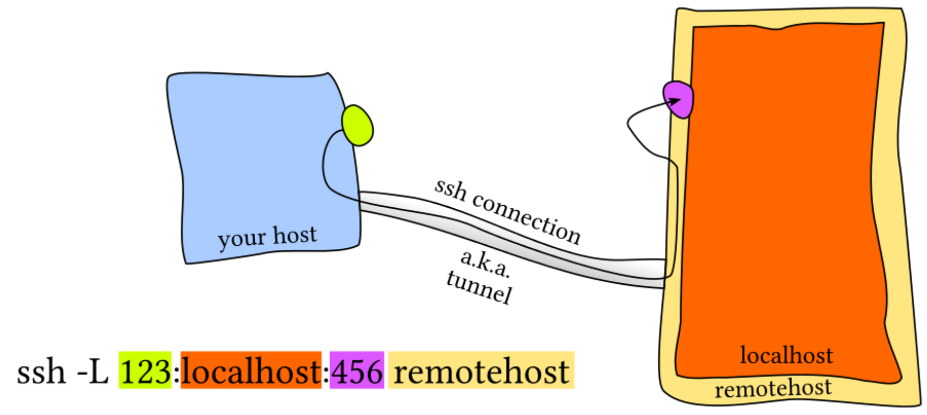
Lecture Agenda and Notes Draft:
Unix Fundamentals: Remote Machine

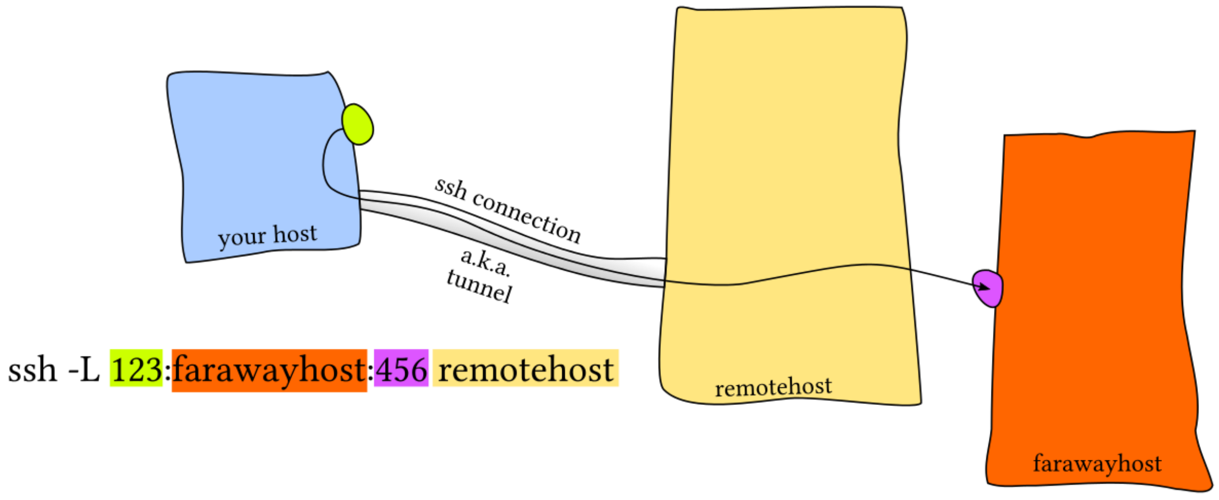
SSH connections

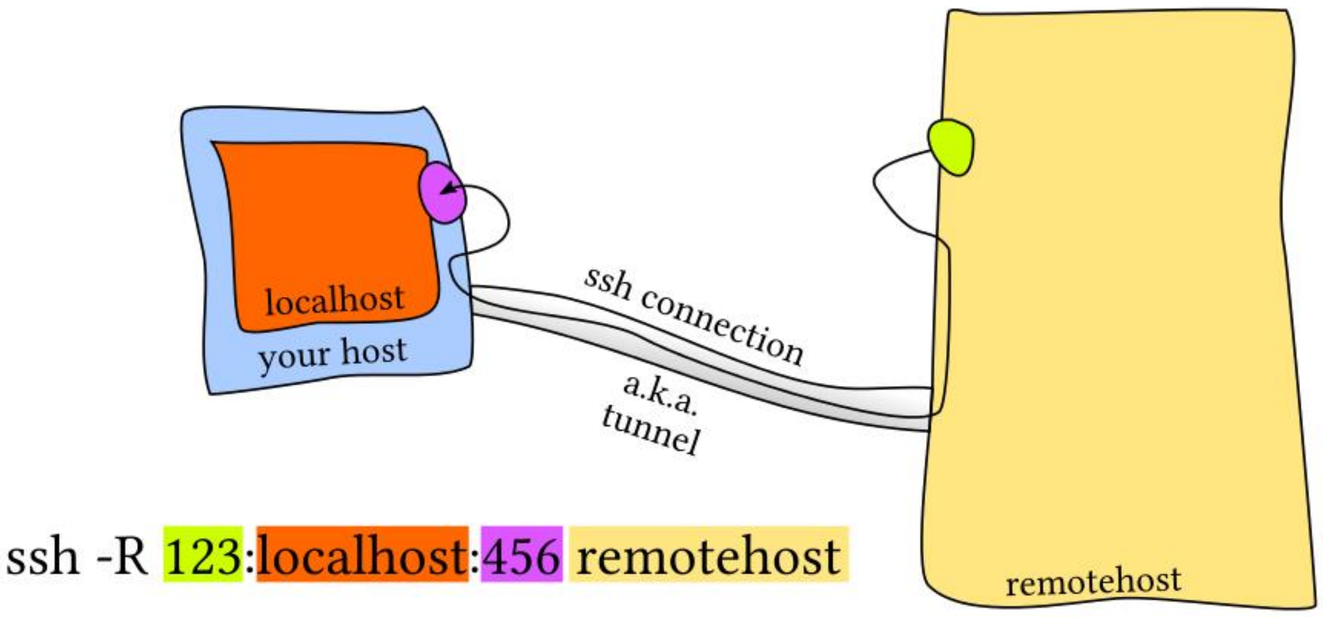
1. Show command *ssh user@machine*
    a. You are in the shell of a remote machine, you can just type commands and do whatever you want
    b. execute *logout* to disconnect
2. Sometimes one doesn't need to connect to a shell, you just need to execute a command. For example *ssh user@machine ls*, it'll output the result of the command on the remote
    a. If you do *ssh user@machine ls | grep -E "Do.*"* then it'll execute first part remotely, second part locally
    b. If you do *ls | ssh user@machine grep -E "Do.*"* then it'll execute first part locally, send results to a remote, and execute second part remotely
3. You needn't always type your credentials when logging into a remote. It is possible to configure your local *ssh.*
    a. Run *ls .ssh* in your home directory to see what's in it
        i. **known_hosts** contains the known keys for remote hosts
        ii. **config** contains user's own configuration file which, where applicable, overrides the settings in the global client configuration
    b. Run *ssh-keygen -t rsa -b 4096* to create a public/private key pair that might be used for authentication on a remote server. You can added the ***public*** key to a server two ways
        i. Manually append it *cat .ssh/id_rsa.pub | ssh user@remote 'cat >> ~/.ssh/authorized_keys'* (cat writes to stdin of remote, remote append it to the keys file)
        ii. Use *ssh-copy-id -i .ssh/id_rsa.pub user@remote*

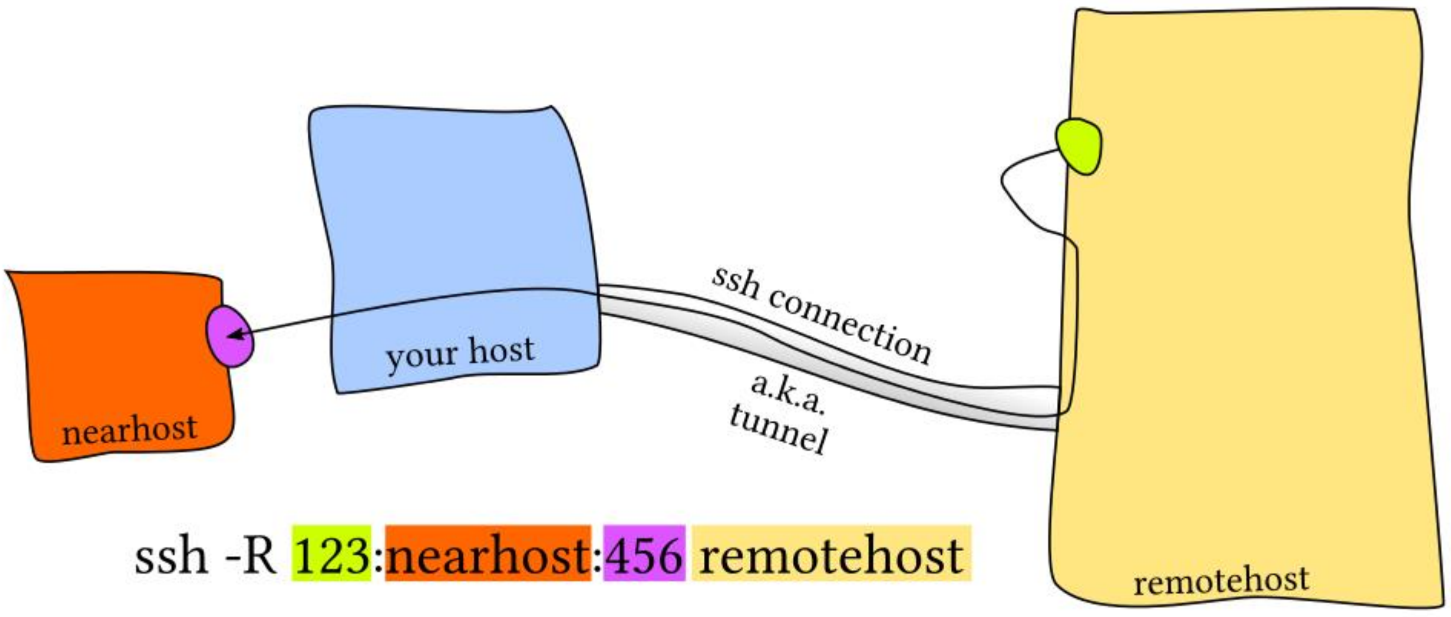
SSH Forwarding

1. Any service that you run on the machine is assigned to a port. For example when you start a jupyter notebook it by default uses port 8888 of your localhost. It is possible to start a service on the remote and access locally using port forwarding.









a. Most of the time, you need to access the remote service on port 456 locally on port 123 run *ssh -L 8888:localhost:9999 remotehost.*
    i. Example 1:
        1. connect to a remote with this command,
        2. run jupyter notebook on a port 9999,
        3. then open locally on your browser localhost:8888
    ii. Example 2
        1. connect to a remote with this command,
        2. run *nc -l 9999* remotely (start listening on port)
        3. run *curl localhost:8888* locally

2. Another type of forwarding is graphics forwarding. This allows you to run GUI based programs on the server and interact with its user interface locally.

a. For this to work server must have these lines present

   X11Forwarding yes; X11DisplayOffset 10

   inside file */etc/ssh/sshd_config*

b. To forward graphics run *ssh -X user@remote*, then run *gedit* (if present) to check

Configure the SSH using .ssh/config

1. One can create aliases for the remote machine available by modifying the .ssh/config file
    a.
    ```
    Host my_machine
            User my_user # <user> in the ssh <user>@my_machine command
            HostName 172.16.174.141 # the name of a remote machine
            Port 22 # port to connect via SSH (22 is default)
            IdentityFile ~/.ssh/id_rsa # which key to use when authenticate
            RemoteForward 9999 localhost:8888 # which port always forward

    # Configs can also take wildcards
    Host *.skoltech.ru # connect any machine within the domain with same user
            User foobaz
    ```

Copying and Downloading Data

1. Similar to how you'd copy on a local with *cp folder1 folder2*, one could do *scp folder1 user@remote:folder2*, to copy local to the remote. This tool is very handy
    a. add -r flag to do it recursively
2. One can use the more reliable tool *rsync.* rsync improves upon scp by detecting identical files in local and remote and preventing copying them again. It also provides more fine grained control over symlinks, permissions and has extra features like the --partial flag that can resume from a previously interrupted copy.
    a. use *rsync -avP folder1 user@remote:folder2* to copy local folder to the remote showing progress and don't send files if they are already there
3. RClone is used for cloning from drives such as (google drive, dropbox)
4. wget is used to fetch data by URL

Running command on a remote, terminal multiplexing

1. If you run a command that takes a really long time on a remote e.g. *sleep 1000*, it'll stop if the connection between your local and remote is lost. Even if you send it to the background using *sleep 1000 &*, it'll have the same effect. To prevent command from stopping while on the remote one can use nohup + background, *nohup sleep 1000 &*
    a. Run *nohup sleep 1000 &*
    b. Disconnect from the remote
    c. Connect and *run ps aux | grep sleep,* you'll see that it's still running
2. Or for example you can run interactive commands such as *top.* The *top* will stop when you disconnect. To prevent it one can use *screen or tmux,* these both convenient for interactive shell sessions
    a. Screen
        i. Run *screen*, then run *top*
        ii. Press *Ctrl* + *a* followed by *d* to detach
        iii. Disconnect from the remote then connect
        iv. Run *screen -r* to reattach
    b. More interesting tool is *tmux* (тимукс). In it you can open multiple windows or tabs, split them side to side, detach and attach to a group of theses tabs
        i. To start session *run tmux*
        ii. To detach session run *Ctrl+b, d*
        iii. To attach a session run *tmux a -d*
        iv. To create a window inside tmux run *Ctrl+b, c*; to switch between windows run *Ctrl+b, <some_number>*
        v. To split current window on panes use
            1. *Ctrl+b, %* to split vertically
            2. *Ctrl+b, “* to split horizontally
            3. To jump between them use Ctrl+b, <arrows>

Problem sheet:
Unix Fundamentals: Remote Machine

Part 1. SSH Connect (2 tasks)

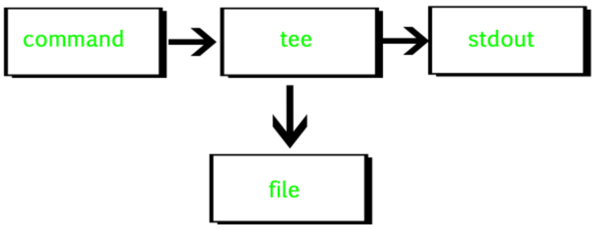
If there's no remote, try to use https://labs.play-with-docker.com/

1. ssh-keygen
    a. Generate a **ed25519** key with 1024 bits and store it to files with **new_key_ed25519** prefix
    b. Change the passphrase of this key
2. ssh-copy-id
    a. Do a dry-run of writing the new ssh key to a remote
    b. Run copy id on the remote

Part 2 (2 tasks)

3. Use the nohup program to run a long computation (for example use "sleep 100; echo complete").
    a. Enter the remote CLI and set up a program to write logs to a file
    b. Disconnect from the remote server immediately without waiting for the computation to complete, but not interrupting its work and saving the output and error logs.

4. Working with `stdout` and `stderr`
    a. Redirect standard output stream to standard error, and echo to standard error stream. You can choose any program to generate messages, for example `ls -lh`
    b. Now, the more complex task. Write a command that:
        i. displays the output and error streams as is and
        ii. redirect them into separate respective files (that means it prints error message to the *stderr* and to a file, and prints other outputs to *stdout* and to a file)
    c. Use the *tee* program (it reads from the standard input and writes to both standard output and one or



more files at the same time)
    d. Use Process Substitution (https://tldp.org/LDP/abs/html/process-sub.html)
    (it creates a FIFO and lets tee listen on it. Then, it uses `>` (file redirection) to redirect the `stdout` of command to the FIFO that your first tee is listening on)

Part 3. Copying and Downloading Data (3 tasks)

5. Copy all files from some local `*/directory_local*` to the remote `/directory_remote` only if their size is between 10MB and 20MB. And show the progress
6. Copy all files from some local `*/directory_local*` to the remote `/directory_remote` only if their names don't start with *"a"* and don't end with *"z"*. And show the progress
7. Copy the directory structure without copying files from a local `*/directory_local*` to the remote `/directory_remote`. Hint: use -f flag and regular expression pattern

Part 4.

Use SSH to resolve the following problems on the remote and retrieve results locally:

8. From the files in logs.tar.xz output the top 3 most frequent IP addresses that performed the GET method from 10 to 17 hours 2015-01-13.
The answer for this task will be the top 3 most frequent IP addresses and their frequencies. And commands that you've used to obtain it

9. In the same archive find a list of all files with the .tsv extension that are larger than 5 MB and start archiving in the background.

The answer for this task will be the number of items (.tsv files) an archive contains. And commands that you've used to obtain it

10. The data_for_science.tar.xz directory contains files of the following format: target class, tab, comma-separated list of keywords. Your task is to find unique words for the *bad* class, which are contained in the three largest files. Remember, *DOG* and *dog* are the same word.

The answer for this task will be 10,11 and 12 entries in a sorted set of unique words. And commands that you've used to obtain it