Quick Start to Hardware Simulation

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Outline

- Connect to server
- Basic Linux commands
- Editors
- Lab

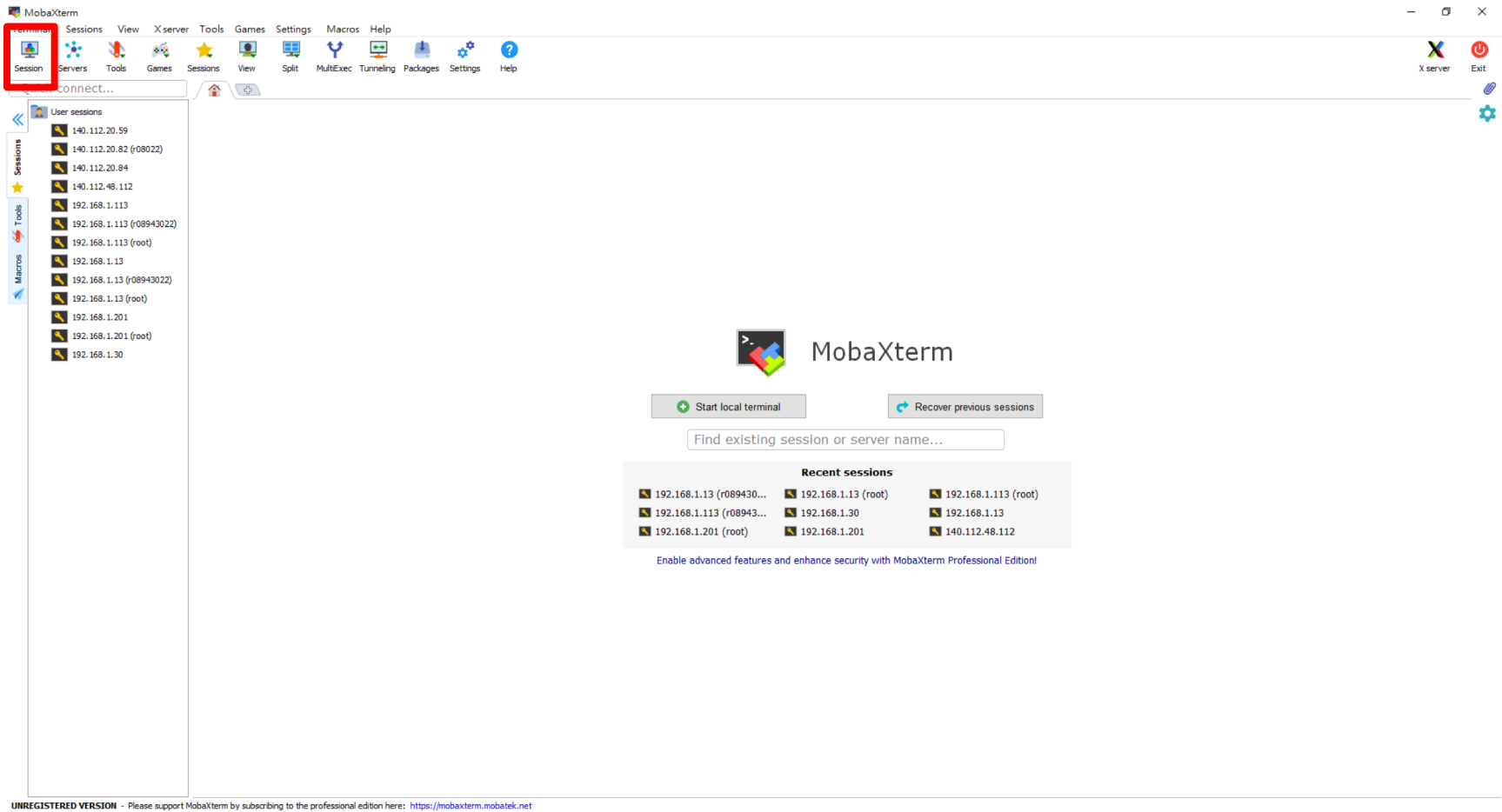
EE2-231 Servers

- http://cad.ee.ntu.edu.tw

* IP	Name	Type	CPU	CPU Clock	Memory	OS
59	cad16	IBM X3500	Intel Xeon 64	1.2 GHz * 24	40 GB	CentOS 6.10
60	cad17	IBM x260	Intel Xeon 64	1.2 GHz * 24	32 GB	CentOS 6.10
64	cad21	DELL R620	Intel Xeon 64	2 GHz * 32	48 GB	CentOS 6.9
66	cad23	DELL R620	Intel Xeon 64	2 GHz * 16	96 GB	CentOS 6.9
70	cad27	DELL R640	Intel Xeon Silver 4110	2.1 GHz * 32	128 GB	CentOS 6.10
~~71~~	~~cad28~~	~~IBM e336~~	~~Intel Xeon 64~~	~~3.2 GHz~~	~~5 GB~~	
72	cad29	Dell R730	Intel Xeon 64	2.3GHz * 40	336 GB	CentOS 6.10
73	cad30		Intel Xeon 64	1.6GHz * 16	12 GB	CentOS 6.9
74	cad31	DELL R620	Intel Xeon 64	2.2 GHz * 32	48 GB	CentOS 6.9
~~76~~	~~cad33~~	~~IBM X3400~~	~~Intel Xeon 64~~	~~2.4 GHz * 16~~	~~100 GB~~	~~CentOS 6.9~~
77	cad34	IBM X3650	Intel Xeon 64	1.6 GHz * 16	16 GB	CentOS 6.9
~~78~~	~~cad35~~	~~SUN V20z~~	~~AMD Opteron~~	~~2.4 GHz * 2~~	~~4 GB~~	
~~79~~	~~cad36~~	~~SUN V20z~~	~~AMD Opteron~~	~~2.4 GHz * 2~~	~~4 GB~~	
~~80~~	~~cad37~~	~~SUN V20z~~	~~AMD Opteron~~	~~2.4 GHz * 2~~	~~4 GB~~	
81	cad38	IBM X3650	Intel Xeon 64	2.4 GHz * 16	96 GB	RHEL 5
82	cad39	IBM X3650	Intel Xeon 64	1.2 GHz * 24	40 GB	CentOS 6.9
83	cad40	IBM X3550	Intel Xeon 64	2 GHz * 24	132 GB	CentOS 6.9
84	cad41	IBM X3550	Intel Xeon 64	2.1 GHz * 24	132 GB	CentOS 6
85	cad42	IBM X3500	Intel Xeon 64	2 GHz * 24	32 GB	CentOS 7
86	cad43	IBM X3550	Intel Xeon 64	2.6GHz * 32	148 GB	CentOS 5.11

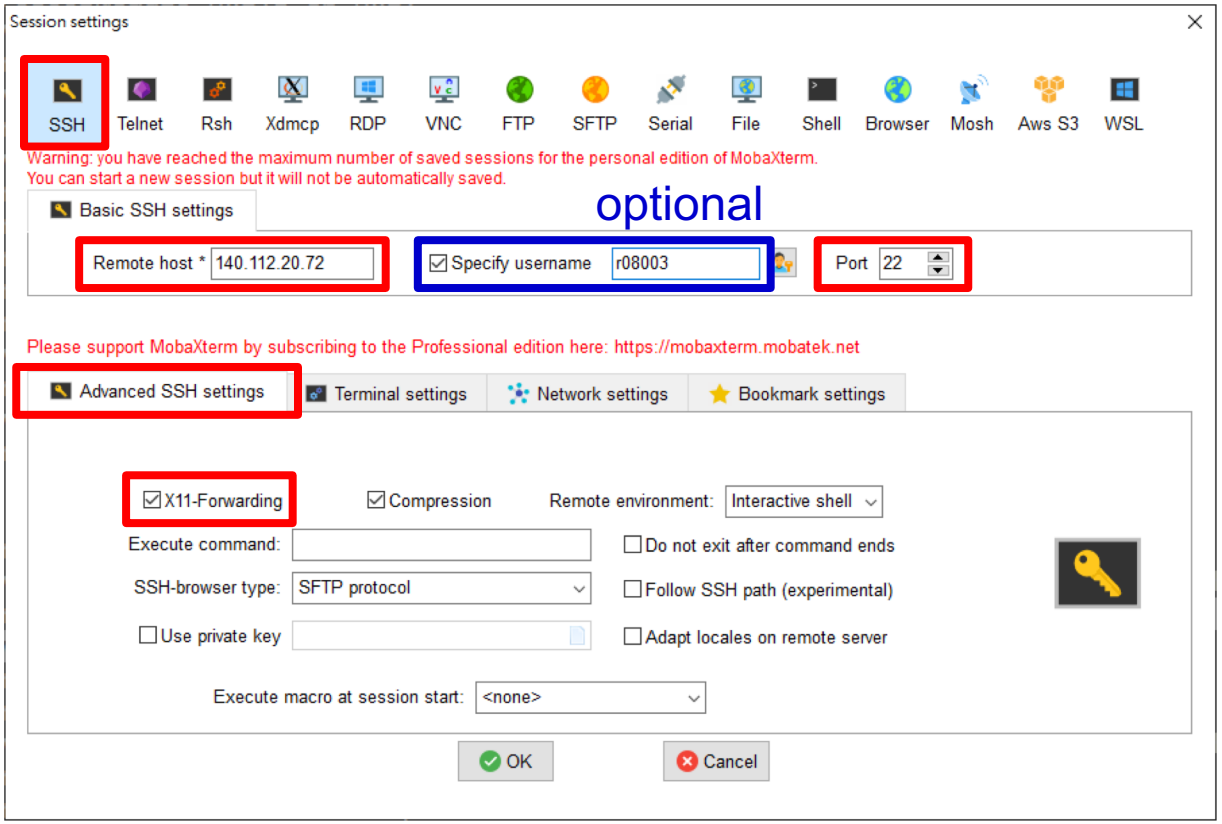
MobaXterm (1/3)

- Download here: https://mobaxterm.mobatek.net/
- MobaXterm includes SSH, X server, and SFTP
- Click session



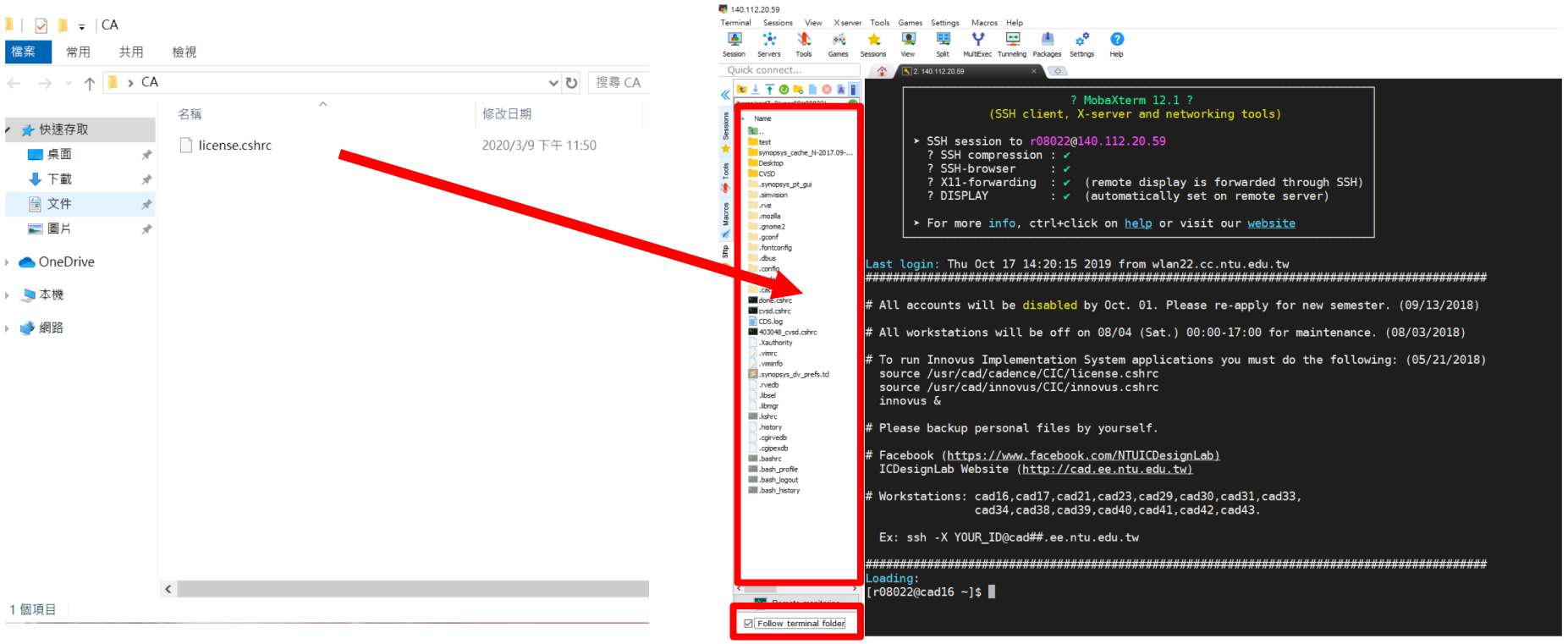
MobaXterm (2/3)

- Choose SSH
- Enter IP: 140.112.20.x and Port: 22
- Enable “X11-Forwarding” in advanced SSH settings



MobaXterm (3/3)

- After login
- Enable “Follow terminal folder”
- Upload license.cshrc to SFTP browser
  - Drag and drop files directly



For OSX User

- For X11, you can use XQuartz: https://www.xquartz.org/
- For FTP, you can use filezilla: https://filezilla-project.org/
  - Alternative: scp command
- To login to server, you may use terminal command:
  `ssh -x <account>@<IP>`

Account Unavailable?

- Email TA: d10943014@ntu.edu.tw
  - In order to confirm your identity, only NTU mail is allowed
  - Please report your problem about the account ASAP
- Your email must include
  - Course name
  - Student ID
  - Name

Basic Linux Commands (1/6)

For files

- `$ ls`: list your files
- `$ ls -l`: list your files in long format
- `$ ls -a`: list all the files, including the hidden files
- `$ cp <src-filename> <dest-filename>`: copy the file
- `$ mv <src-filename> <dest-filename>`: move and rename the file
- `$ rm <filename>`: delete the file
- `$ more <filename>`: show the content of the file

Basic Linux Commands (2/6)

For directory

- `$ mkdir <dirname>`: make a new directory
- `$ cd <dirname>`: change directory
- `$ cd ..`: go up one directory level
- `$ cd ~`: go to home directory
- `$ rm -r <dirname>`: remove directory and all the files inside
- Some special symbol
  - ~ means home directory
  - . means current directory
  - .. means up one directory level directory
  - / means root directory (users cannot edit anything)

Basic Linux Commands (3/6)

- Let's see some examples
- Change filename from a.v into b.v
  - `$ mv a.v b.v`
- Create folder called CA_HW
  - `$ mkdir CA_HW`
- Copy a.v into folder CA_HW
  - `$ cp ./a.v ./CA_HW/`
- Delete a.v
  - `$ rm a.v`
- Delete the folder CA_HW
  - `$ rm -r CA_HW`

Basic Linux Commands (4/6)

- Compress
  - $ zip -r <zip_filename> <folder>
- Decompress
  - $ unzip <zip_filename>

Basic Linux Commands (5/6)

- Processes
  - `$ Ctrl+C`: kill current process (only for the process is into infinite loop or cannot stop via other methods)
  - `$ <command> &`: run the command in background
  - `$ jobs`: list every process in background
  - `$ Ctrl+Z`: suspend and put the process in background
  - `$ bg %<number>`: let the number of process run background
  - `$ fg %<number>`: move the number of process to front ground
- Logout
  - `$ exit`
  - `$ Ctrl+D` (EOF)

Basic Linux Commands (6/6)

- To understand a command, use “man”
  - “man” command is abbreviation of manual
- For example: if you want to know how to use “ls” and its parameters
  - `$ man ls`
  - `$ q` to exit

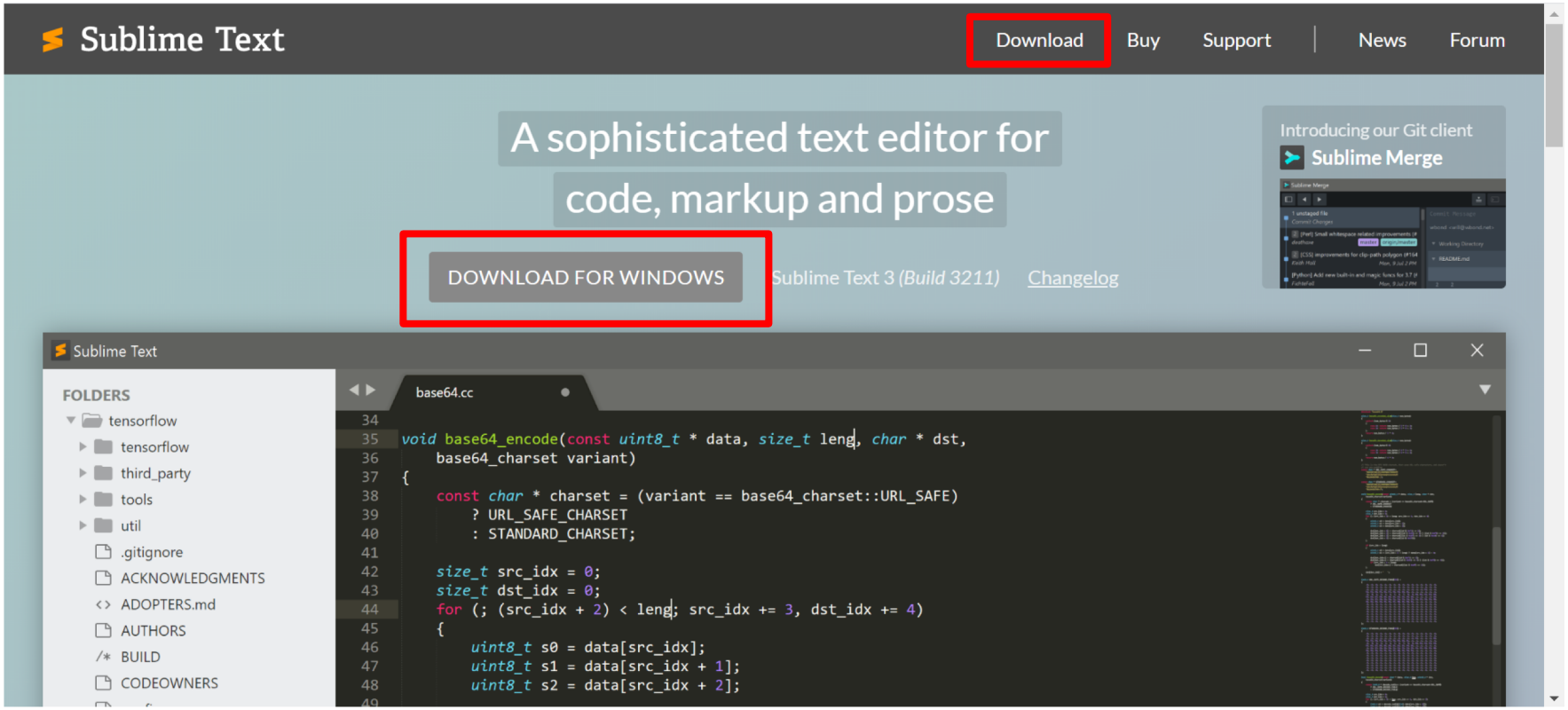
```
LS(1)                          User Commands                          LS(1)

NAME
       ls - list directory contents

SYNOPSIS
       ls [OPTION]... [FILE]...

DESCRIPTION
       List  information about the FILEs (the current directory by default).  Sort entries alphabetically if none
       of -cftuvSUX nor --sort.

       Mandatory arguments to long options are mandatory for short options too.

       -a, --all
              do not ignore entries starting with .

       -A, --almost-all
              do not list implied . and ..

       --author
              with -l, print the author of each file

       -b, --escape
              print octal escapes for nongraphic characters

       --block-size=SIZE
              use SIZE-byte blocks.  See SIZE format below

       -B, --ignore-backups
              do not list implied entries ending with ~
```

Editors

- There are so many powerful editors
  - Sublime text
  - Notepad++
  - Visual studio code
  - Vim
  - gedit
- If you already have a favorite editor, just use it
- If not?
  - Recommendation: Sublime Text

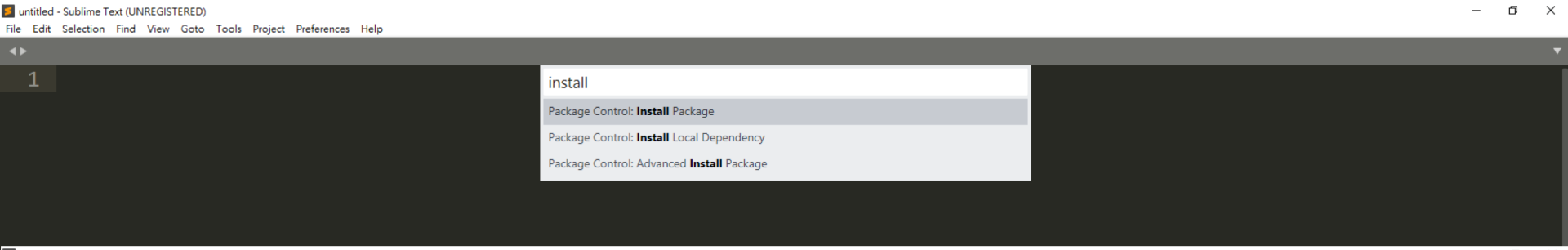
Introduction to Sublime Text (1/5)

- Sublime Text is a shareware cross-platform source code editor supports free-software licenses plugins
- Download here: https://www.sublimetext.com/
- Click “Download” to find the OSX version



Introduction to Sublime Text (2/5)

- Changes font size
  - Ctrl + scroll
- Install Verilog syntax
  - Ctrl+Shift+P opens command line
  - Type “Package Control: Install Package”
  - Type “Verilog” to install Verilog syntax
  - Type “Verilog” to set syntax as Verilog

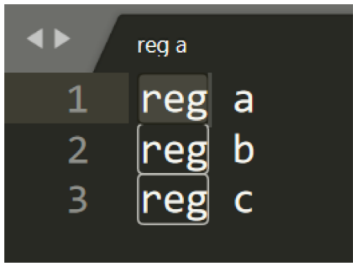


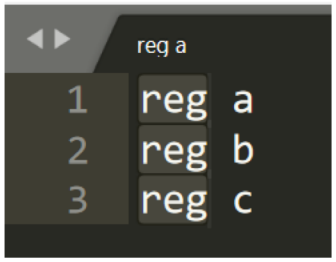
Introduction to Sublime Text (3/5)

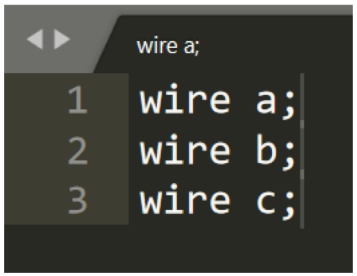
- Want a different theme?
  - Ctrl+Shift+P opens command line
  - Type “Package Control: Install Package
  - Type “theme”
  - Try to pick one

Introduction to Sublime Text (4/5)

- Why sublime text?
  - Free
  - Cool
  - Convenient
- Example: need to change “reg” into “wire” and add semicolon for each line?
  - Select one “reg”
  - Ctrl+D to select all “reg”
  - Just modify them simultaneously
- Other tips?
  - Discover it or google it by yourself

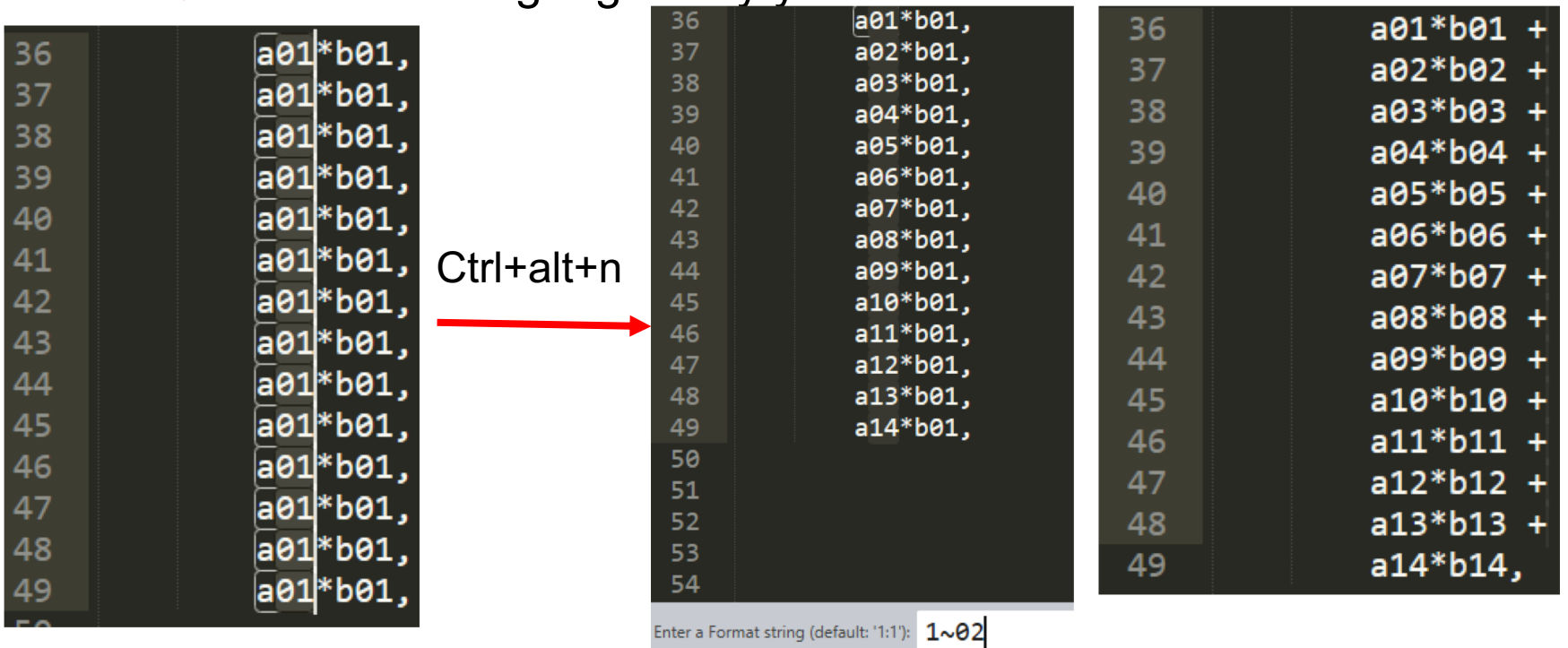






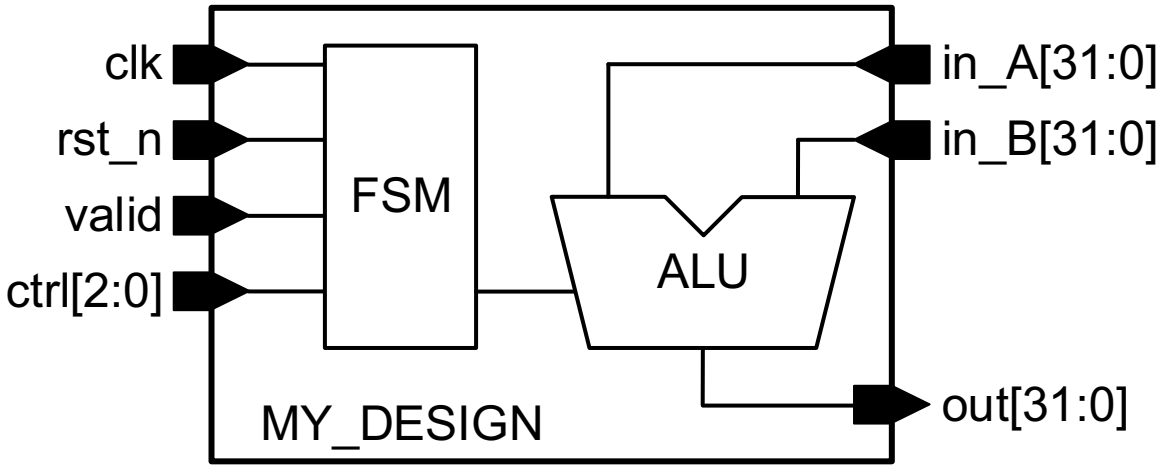
Introduction to Sublime Text (5/5)

- Need to create some codes including a increasing number?
  - Install “insertNums” via package control
  - https://packagecontrol.io/packages/Insert%20Nums
- Other tips?
  - Discover it or google it by yourself



Lab (1/6)

- FSM and ALU
- Specification



Name	I/O	Width	Description
clk	I	1	Positive edge-triggered clock
rst_n	I	1	Asynchronous negative edge reset
valid	I	1	Update state if valid = 1
ctrl[2:0]	I	3	Input to modify state
in_A[31:0]	I	32	Input A
in_B[31:0]	I	32	Input B
out[31:0]	O	32	Output

Lab (2/6)

- State description (all signed computation)

State	Function	Description
3'd0	ADD	out = in_A + in_B (neglect overflow)
3'd1	SUB	out = in_A − in_B (neglect overflow)
3'd2	SLL	out = Logical left shift in_A by in_B bits (0 ≤ in_B ≤ 31)
3'd3	XOR	out = in_A XOR in_B (bitwise)
3'd4	SRL	out = Logical right shift in_A by in_B bits (0 ≤ in_B ≤ 31)
3'd5	SRA	out = Arithmetic right shift in_A by in_B bits (0 ≤ in_B ≤ 31)
3'd6	OR	out = in_A OR in_B (bitwise)
3'd7	AND	out = in_A AND in_B (bitwise)

Lab (3/6)

- Top module
  - Instantiate relating sub-modules
  - Connect them

```
module MY_DESIGN(
    clk,
    rst_n,
    valid,
    ctrl,
    in_A,
    in_B,
    out
);
    // Port list
    input          clk, rst_n, valid;
    input  [ 2:0] ctrl;
    input  [31:0] in_A, in_B;
    output [31:0] out;
    // Wire and reg
    wire   [ 2:0] FSM_ctrl, ALU_ctrl;
```

```
    // Instantiate sub-modules
    FSM FSM_INST(
        .clk(clk),
        .rst_n(rst_n),
        .valid(valid),
        .FSM_ctrl(FSM_ctrl),
        .ALU_ctrl(ALU_ctrl)
    );
    ALU ALU_INST(
        .ctrl(ALU_ctrl),
        .in_A(in_A),
        .in_B(in_B),
        .out(out)
    );
    // Continuous assignment
    assign FSM_ctrl = ctrl;
endmodule
```

Lab (4/6)

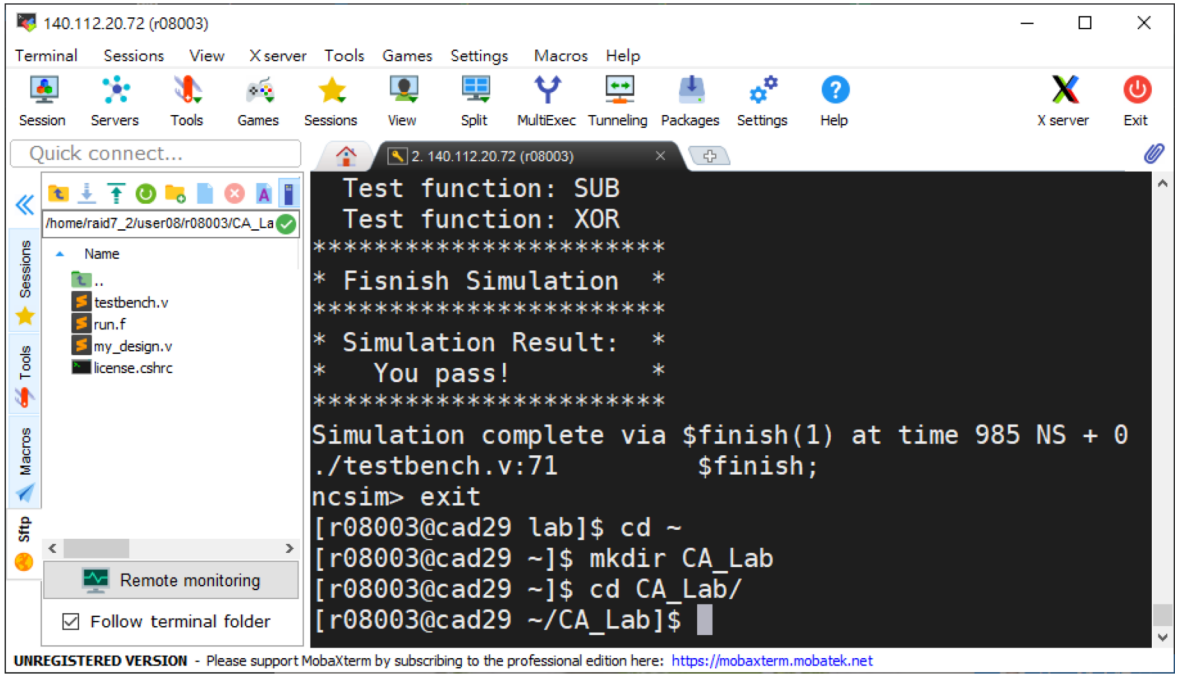
- There are some mistakes in my_design.v
  - Only in module ALU
- Revise it!

```
// Combinational block
always @(*) begin
    case(ctrl)
        // Todo: Complete ALU
        3'd0: out = in_A + in_B;
        3'd1: out = in_A + in_B;
        3'd2: out = in_A + in_B;
        3'd3: out = in_A + in_B;
        3'd4: out = in_A + in_B;
        3'd5: out = in_A + in_B;
        3'd6: out = in_A + in_B;
        3'd7: out = in_A + in_B;
        // Full-case, neglect default case
    endcase
end
```

Wrong!

Lab (5/6)

- Simulation
- Create directory: CA_Lab
  - `$ mkdir CA_Lab`
  - `$ cd CA_Lab/`
- Upload related files to CA_Lab/
  - license.cshrc
  - run.f
  - testbench.v
  - my_design.v



Lab (6/6)

- Source
  - `$ source license.cshrc`
- Simulation
  - `$ ncverilog -f run.f`
- Debug
  - `$ nWave &`

```
************************
* Begin Simulation... *
************************
  Test function: ADD
  Test function: AND
  Test function: OR
  Test function: SLL
  Test function: SRA
  Test function: SRL
  Test function: SUB
  Test function: XOR
************************
* Fisnish Simulation  *
************************
* Simulation Result:  *
*    You pass!        *
************************
```