

Supporting CS Education via Virtualization and Packages

*Tools for Successfully Accommodating Bring-Your-
Own-Device at Scale*

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University of Colorado **Boulder**

The Challenge

Support a

Support a

growing and increasingly diverse student body

Support a

growing and increasingly diverse student body

while also

Support a

growing and increasingly diverse student body

while also

enabling new educational techniques

Support a
range of skills
100s to 1000s
growing and increasingly diverse student body
differing backgrounds

while also
enabling new educational techniques

Support a
range of skills
100s to 1000s
laptops
operating systems
desktops
growing and increasingly diverse student body
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while also
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Support a
range of skills
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laptops
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comp sci music
biology

while also

enabling new educational techniques

Support a
range of skills
100s to 1000s

laptops
operating systems desktops

growing and increasingly diverse student body

differing backgrounds

comp sci music
biology

while also

live coding during lecture

pair programming

enabling new educational techniques

MOOCs

interview grading

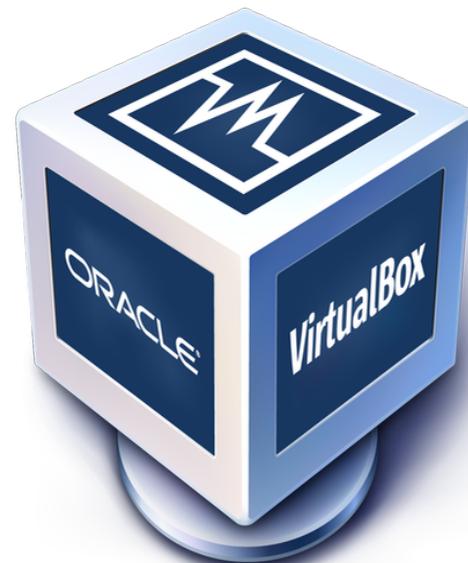
flipped classrooms

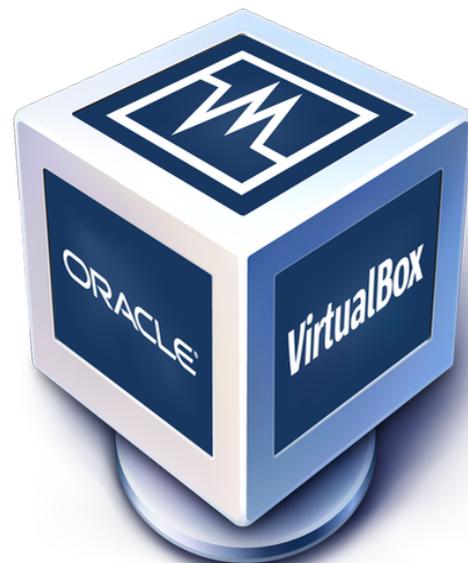
without spending too much money

The Solution









About Us





Department of Computer Science
UNIVERSITY OF COLORADO **BOULDER**

1500 Undergraduates Enrolled per Semester

25 Undergraduate Courses per Semester

400 BS (Engineering) Majors in Program

300 BA (A&S) Majors in Program

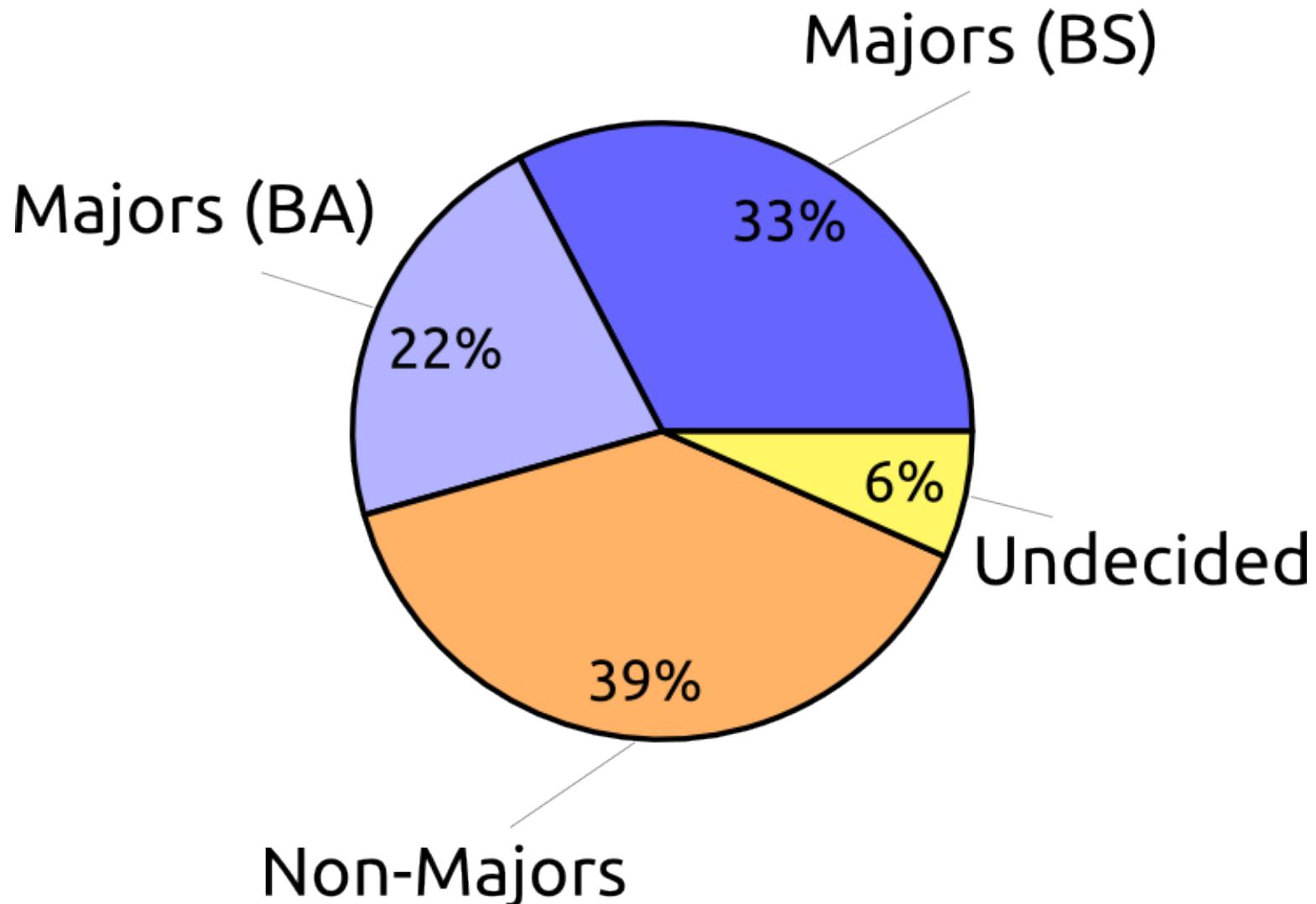
40 Faculty Members in Dept

10 Staff Members in Dept

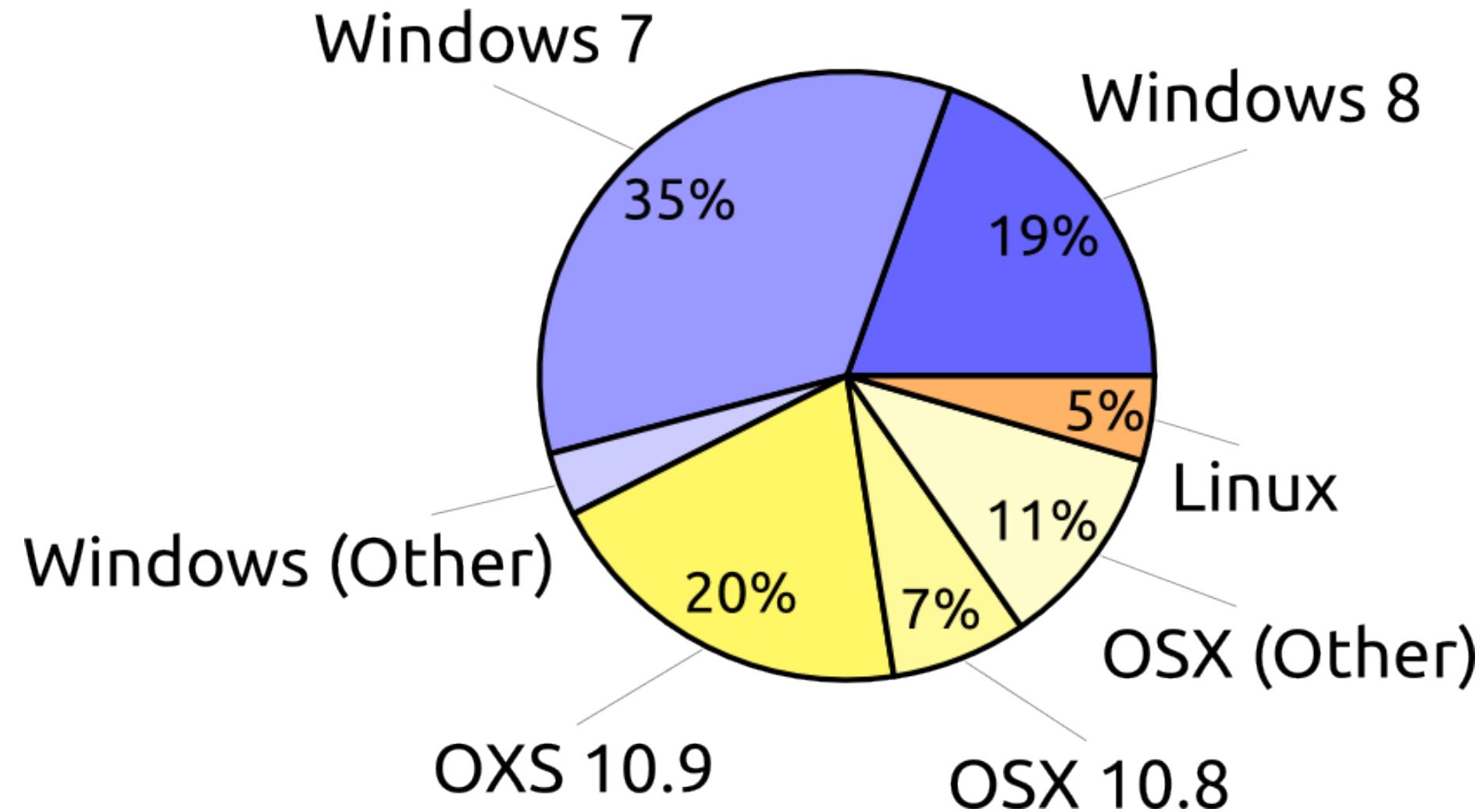
0.5 Ed Tech Staff in Dept

0.5 IT Staff in Dept

User Major



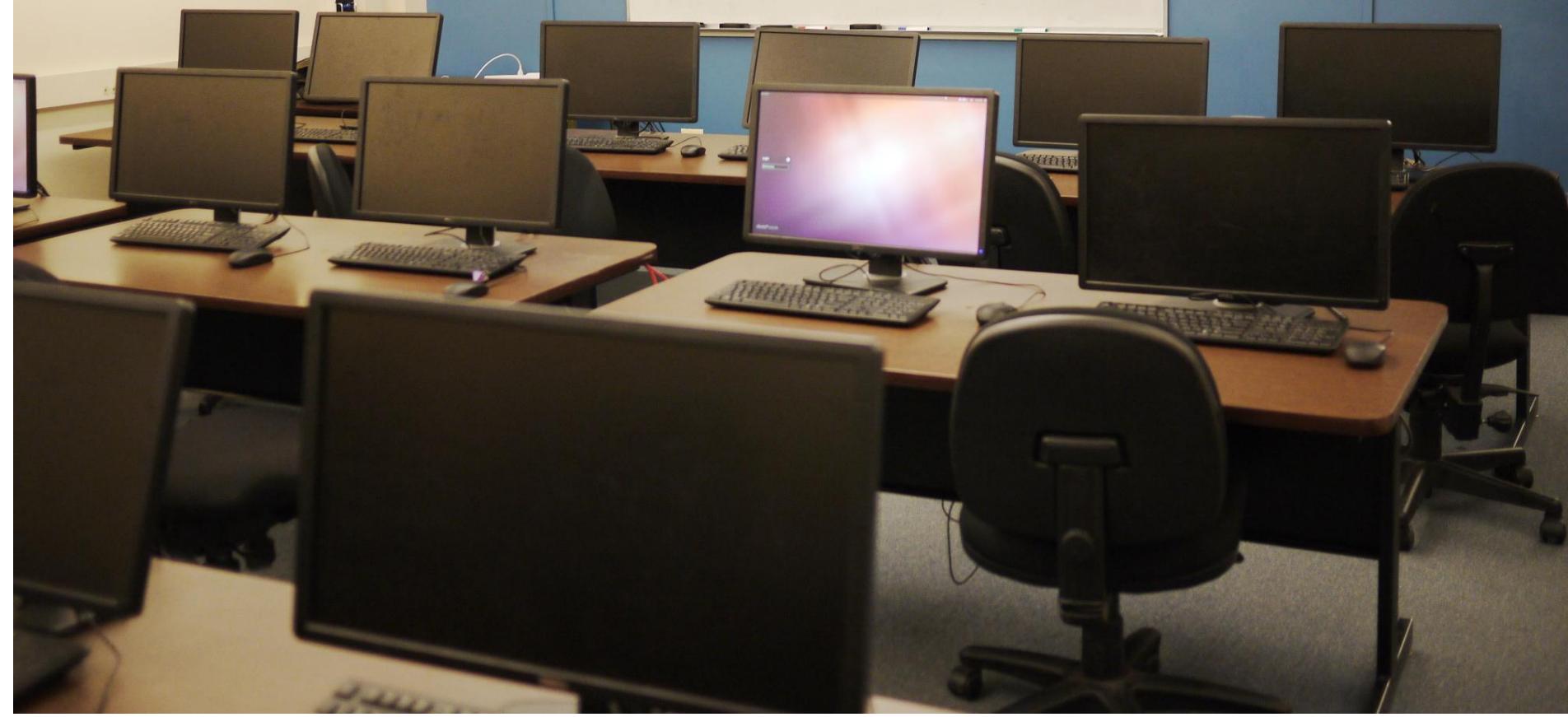
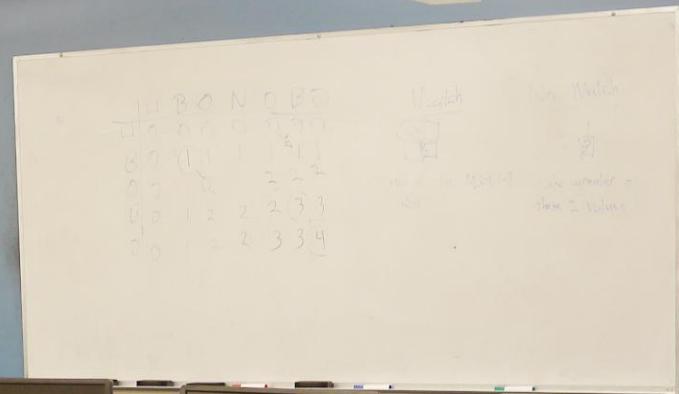
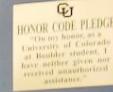
User Host OS



Where do students do CS work?

Traditionally

Computer Lab



Today

Bring Your Own Device





**98% own a
Personal Computing Device**

85% Laptops

12% Desktops

2% Other

Goals

Provide a
standardized development environment
for use across
all Computer Science courses
available on
both student and lab hardware

“Lab in a Box”

How?

Industry-Standard Tech

BYOD

BYOD → Virtualization

BYOD → Virtualization

Scalability and Management

BYOD → Virtualization

Scalability and Management → Packages

Virtualization



Hypervisor





Oracle VM VirtualBox Manager

New Settings Start Discard

Details Snapshots (3)

64 CU-CS-VM-Spring14-x64 (v1.1)
Powered Off

CU-CS-VM-Spring14-x32 (v1.1)
Powered Off

General

Name: CU-CS-VM-Spring14-x64
Operating System: Ubuntu (64 bit)

System

Base Memory: 2048 MB
Processors: 2
Boot Order: CD/DVD, Hard Disk
Acceleration: VT-x/AMD-V, Nested Paging

Display

Video Memory: 32 MB
Remote Desktop Server: Disabled
Video Capture: Disabled

Storage

Controller: SATA
SATA Port 0: CU-CS-VM-Spring14-x64.vdi (Normal, 30.00 GB)
SATA Port 1: [CD/DVD] Empty

Audio

Host Driver: PulseAudio
Controller: ICH AC97

Network

Adapter 1: Intel PRO/1000 MT Desktop (NAT)

USB

Device Filters: 0 (0 active)

Shared folders

None

Description

None

Preview

CU-CS-VM-Spring14-x64

Ubuntu Desktop



CU CS Foundation VM
Spring 2014 Version



Default User: user
Default Pass: user



Need Help? New to Linux? Have a question?
Visit <http://foundation.cs.colorado.edu>



Use the icon in the upper right corner to shut down



Use the icon at the top of the launcher to search for programs and files



Save your work to Dropbox to avoid losing data



Some useful commands:



Read command instructions

`man <command name>`

Install Software

`sudo apt-get install <package name>`

Remove Software

`sudo apt-get remove <package name>`

Update Available Software List

`sudo apt-get update`

Upgrade installed software

`sudo apt-get dist-upgrade`



cu-cs-vm-spring14-x64-v1.1.ova

Packages



Software Dependencies



Software Dependencies

Configuration Scripts



Software Dependencies
Configuration Scripts
Files & Executables



Software Dependencies
Configuration Scripts
Files & Executables



cu-cs-csci1300_0.5.1_all.deb

./cu-cs-apt-packages/cu-cs-csci1300/debian/control

Section: extra

Priority: optional

Homepage: apt.cs.colorado.edu

Standards-Version: 3.9.2

Package: cu-cs-csci1300

Maintainer: Andy Sayler (asayler) <andrew.sayler@colorado.edu>

Depends: cu-cs-foundations-base, g++, g++-multilib

python3, python3-dev, python3-doc, python3-tk, python3-numpy, python3-scipy,
python, python-dev, python-doc, python-tk, python-numpy, python-scipy, python-pygame,
openjdk-7-jdk, openjdk-7-jre, openjdk-7-doc, jython, jython-doc

Architecture: all

Copyright: copyright

Changelog: changelog

Postinst: setup.sh

Postrm: remove.sh

Files: ./graphics.py /usr/lib/python3/dist-packages

Description: Packages for University of Colorado CSCI-1300 Course

./cu-cs-apt-packages/cu-cs-csci1300/debian/control

Section: extra

Priority: optional

Homepage: apt.cs.colorado.edu

Standards-Version: 3.9.2

Package: cu-cs-csci1300

Maintainer: Andy Sayler (asayler) <andrew.sayler@colorado.edu>

Depends: cu-cs-foundations-base, g++, g++-multilib

python3, python3-dev, python3-doc, python3-tk, python3-numpy, python3-scipy,
python, python-dev, python-doc, python-tk, python-numpy, python-scipy, python-pygame,
openjdk-7-jdk, openjdk-7-jre, openjdk-7-doc, jython, jython-doc

Architecture: all

Copyright: copyright

Changelog: changelog

Postinst: setup.sh

Postrm: remove.sh

Files: ./graphics.py /usr/lib/python3/dist-packages

Description: Packages for University of Colorado CSCI-1300 Course

```
$ sudo apt-get install cu-cs-csci1300
```

All Course Software Requests Handled via Packages

VM

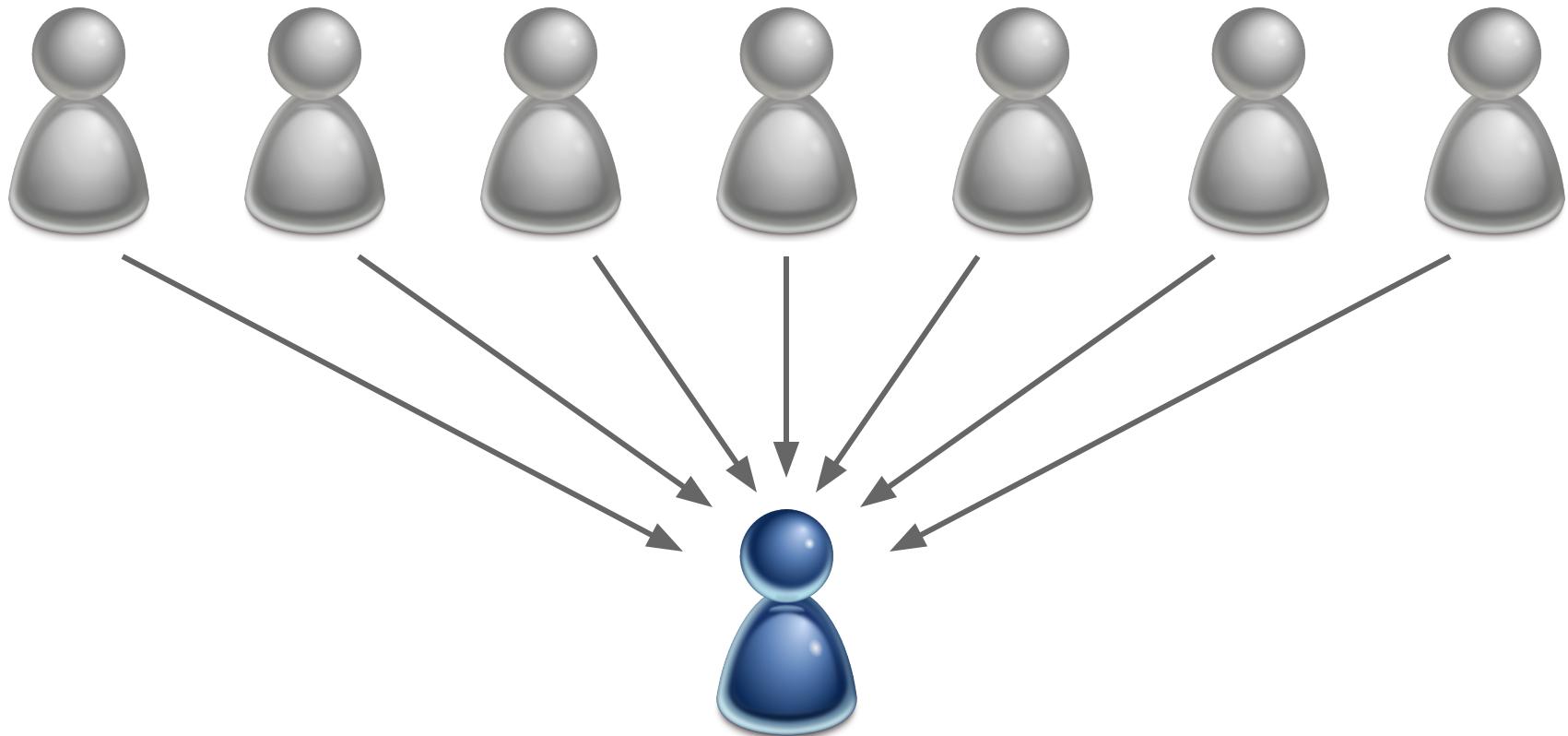
Pre-Installed with Core Course Packages
Elective Course Packages Manually Installed

Lab

Pre-Installed with All Course Packages

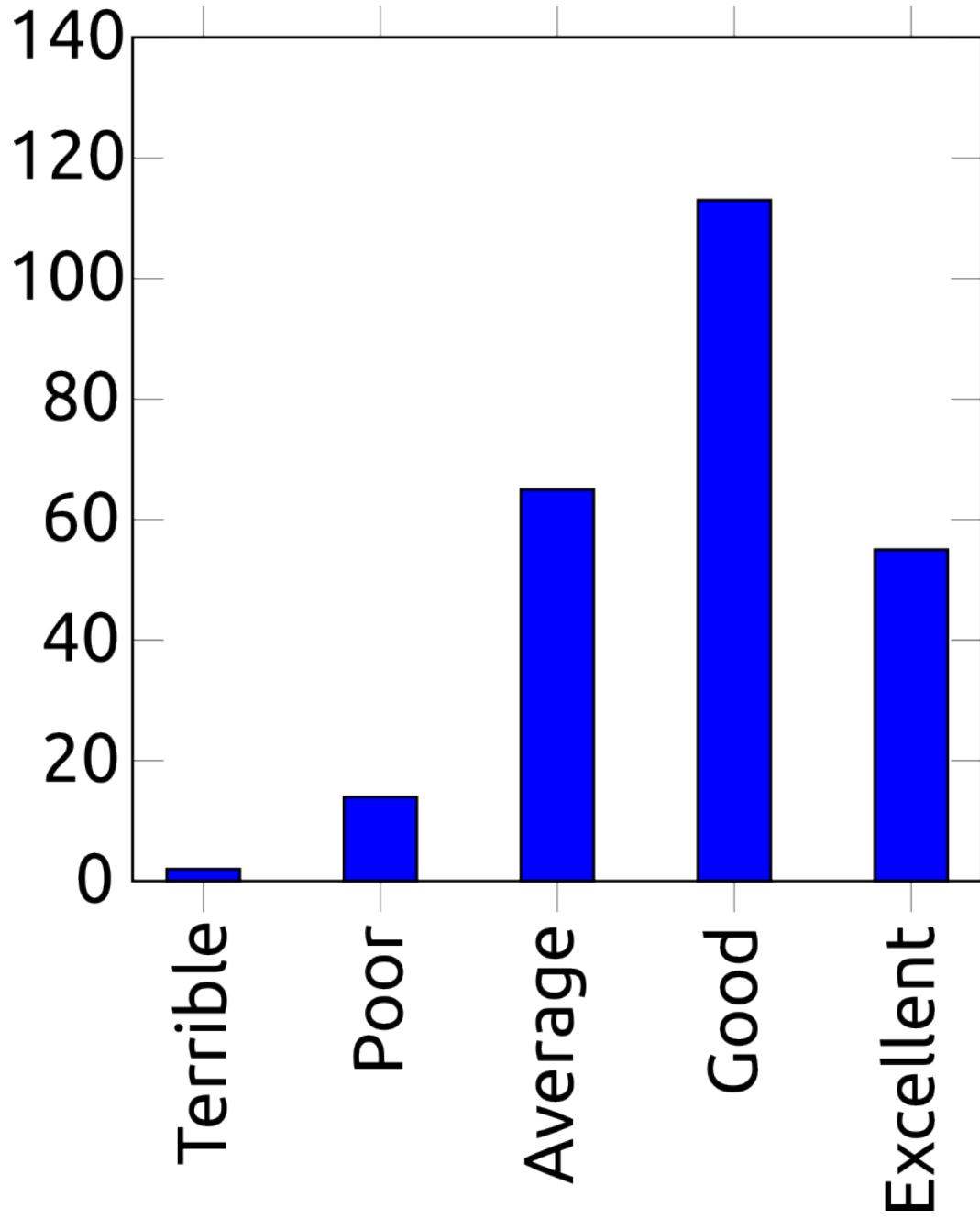
Results

Over One Thousand Users

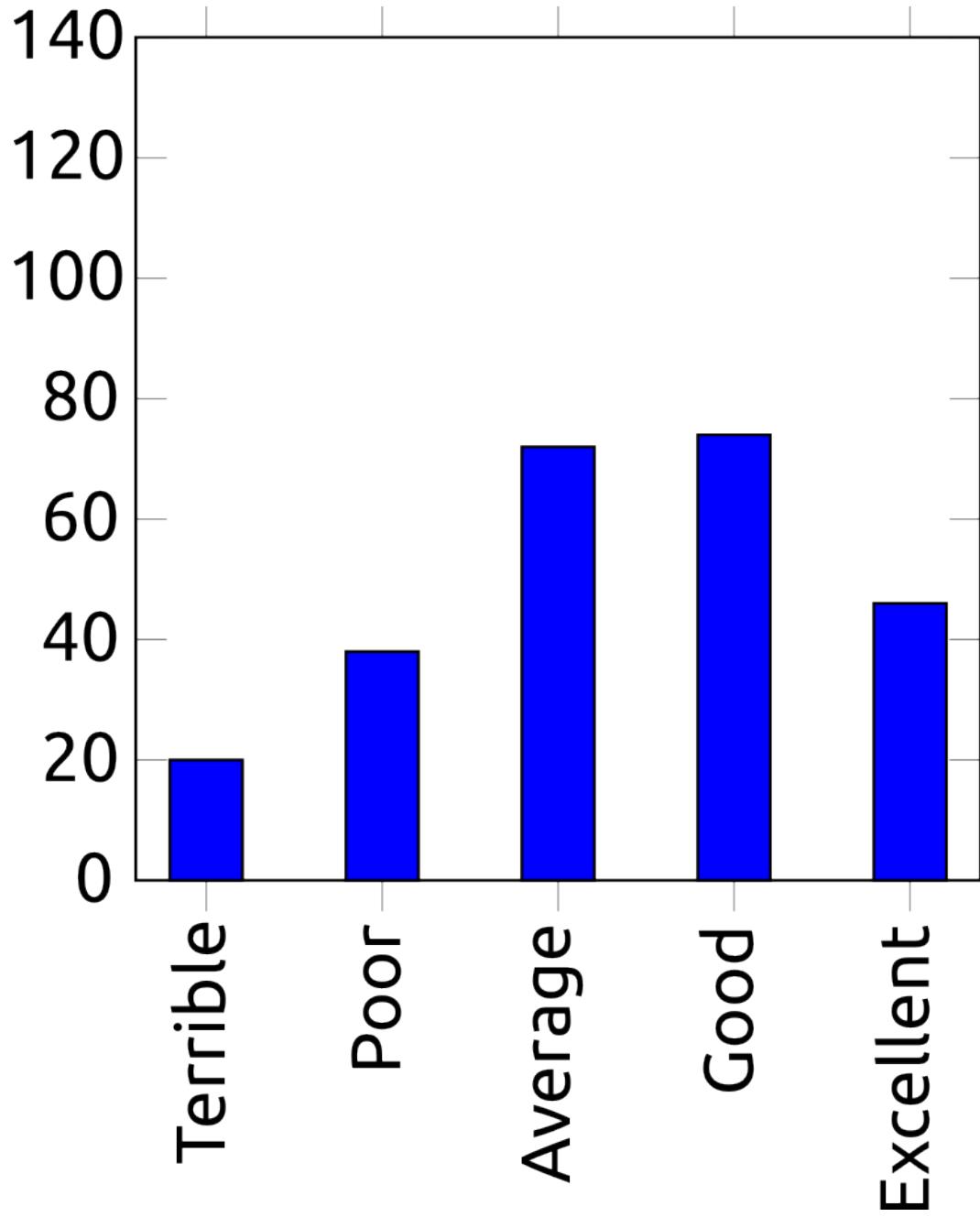


One (Half-Time) Graduate Assistant

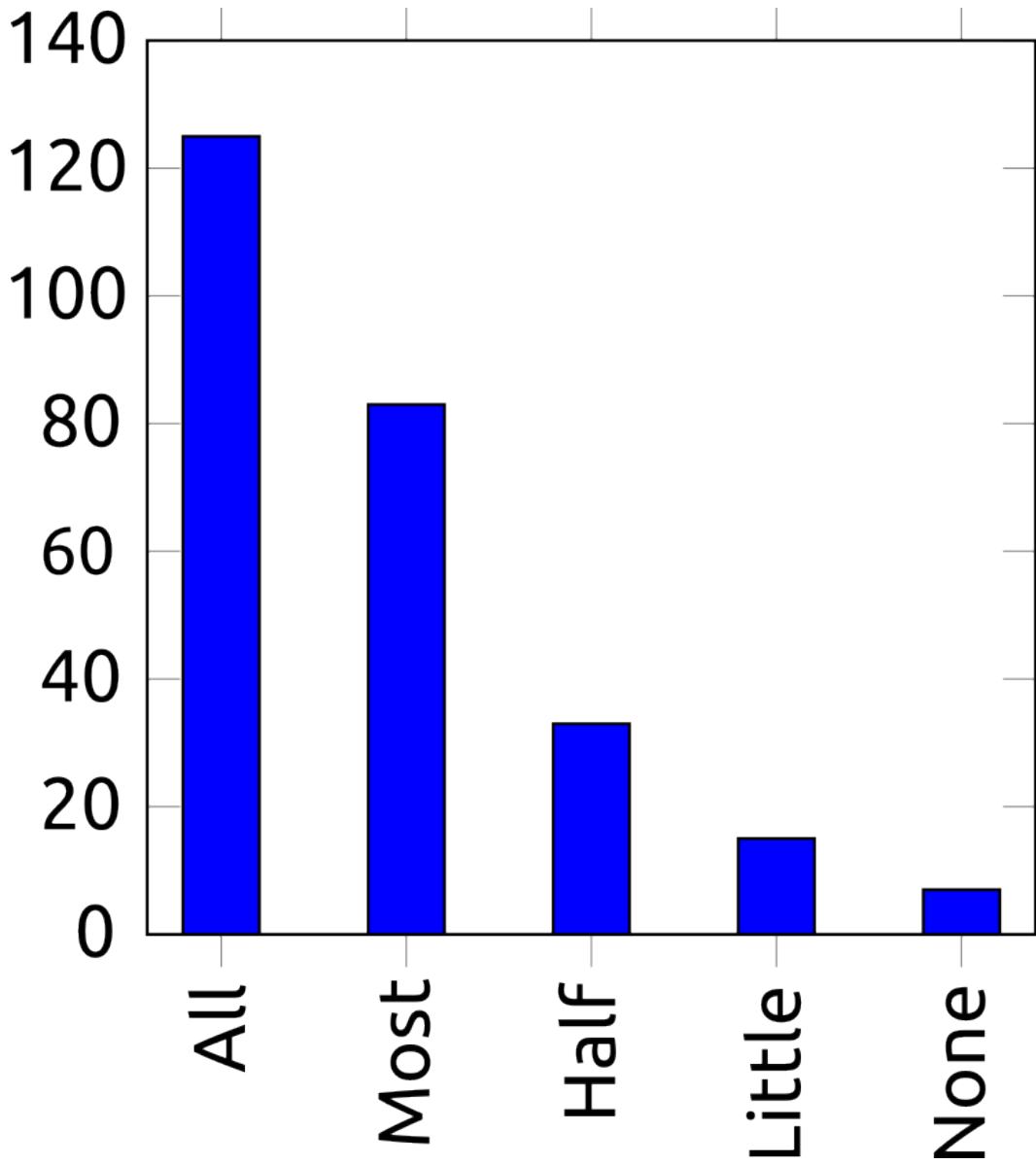
Overall VM Experience



VM Performance



Coursework Completed on VM



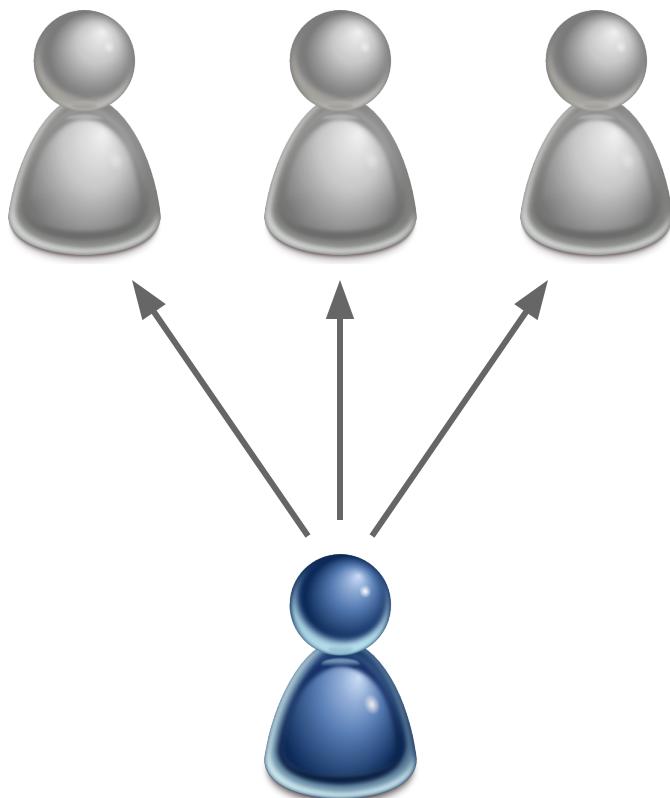
Best Practices

Virtualization Extensions & BIOS Support



64-bit

Install Sessions



Virtualization Extensions & BIOS Support

Download Corruption and Speed Issues

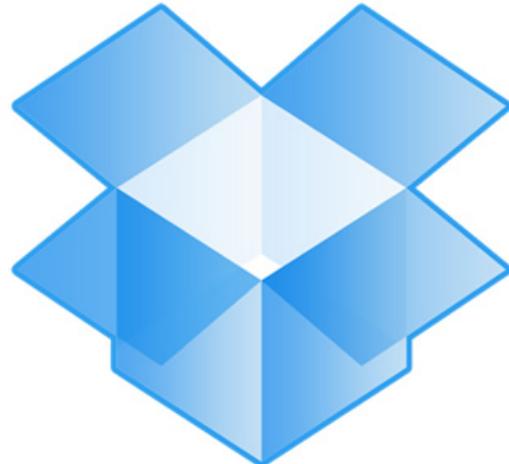


USB Flash Drives

Virtualization Extensions & BIOS Support

Download Corruption and Speed Issues

VM Crashes and Support Issues



Dropbox



GitHub



Office Hours

Virtualization and Packaging

enable us to provide a

standardized development environment

for use across a

range of courses and hardware

for the cost of

one half-time GA

Questions?



Paper + Slides: www.andysayler.com/output

Website: foundation.cs.colorado.edu

Git: github.com/asayler/cu-cs-apt-packages

Student Requirements

Easy to (Install | Use | Maintain)

Runnable on (Any | All | My) Hardware

Consistent across (Courses | Semesters | Hardware)

Instructor Requirements

Keep Students **Happy**

Minimize Instructor IT Overhead

Provide **Consistent** Experiences for
(**Students** | **Graders** | **Instructors**)

Provide Necessary Course Software and **Settings**

Allow **Updates** Throughout Semester

Management Requirements

Keep Students **Happy**

Keep Instructors **Happy**

Easy to (Deploy | Manage | Support)

Unify Lab and BYOD Environments

Minimize (Personnel | Cost | Etc) Requirements

Package Repository

apt.cs.colorado.edu



Index of /ubuntu/pool/main/c

Name	Last modified	Size Description
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 [Parent Directory](#)

cu-cs-csci1300/	09-Jan-2014 21:01	-
cu-cs-csci2270/	09-Jan-2014 21:01	-
cu-cs-csci2400/	09-Jan-2014 21:01	-
cu-cs-csci3155-apt/	12-Feb-2014 21:02	-
cu-cs-csci3155/	12-Feb-2014 21:02	-
cu-cs-csci3202/	11-Sep-2013 17:09	-
cu-cs-csci3308/	25-Aug-2013 12:40	-
cu-cs-csci3753/	17-Jan-2013 18:08	-
cu-cs-csci4229/	25-Sep-2013 14:45	-
cu-cs-csci4273/	16-Sep-2013 21:07	-
cu-cs-csci4753/	16-Jan-2013 22:32	-
cu-cs-csci4830-advrobo-rosrepo/	11-Sep-2013 10:47	-
cu-cs-csci4830-advrobo/	30-Sep-2013 20:22	-
cu-cs-csci5535/	11-Sep-2013 10:47	-
cu-cs-csci5654/	11-Sep-2013 10:47	-
cu-cs-foundations-apt/	10-Jan-2014 23:42	-
cu-cs-foundations-base/	25-Sep-2013 14:42	-
cu-cs-foundations-core/	23-Aug-2013 11:58	-
cu-cs-foundations-csel/	25-Sep-2013 14:42	-
cu-cs-foundations-current-vm-virtualbox/	23-Aug-2013 11:58	-
cu-cs-foundations-editors/	09-Jan-2014 21:01	-
cu-cs-foundations-vm-grub/	14-Oct-2013 22:54	-
cu-cs-foundations-vm-virtualbox/	27-May-2013 00:12	-
cu-cs-foundations-vm/	11-Jan-2014 21:16	-
cu-cs-keyring/	09-Jan-2014 21:01	-