

# Supporting CS Education via Virtualization and Packages

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

Andy Sayler  
Dirk Grunwald  
John Black  
Elizabeth White  
Matthew Monaco



University of Colorado **Boulder**

# The Challenge

Provide the **development environment** for a

Provide the development environment for a  
growing and increasingly diverse student body

Provide the development environment for a  
growing and increasingly diverse student body  
while also

Provide the development environment for a  
growing and increasingly diverse student body  
while also  
enabling new educational techniques

Provide the development environment for a  
range of skills

100s to 1000s

**growing and increasingly diverse student body**  
differing backgrounds

while also

enabling new educational techniques

Provide the development environment for a

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100s to 1000s

laptops

operating systems

desktops

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comp sci

music

biology

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Provide the development environment for a

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growing and increasingly diverse student body

differing backgrounds

comp sci

music

biology

while also

live coding during lecture

MOOCs

pair programming

enabling new educational techniques

interview grading

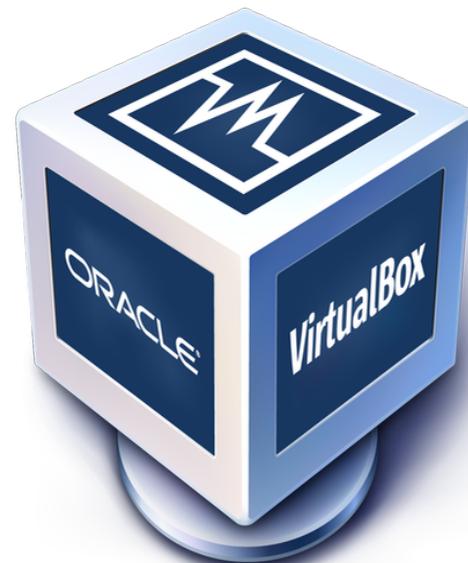
flipped classrooms

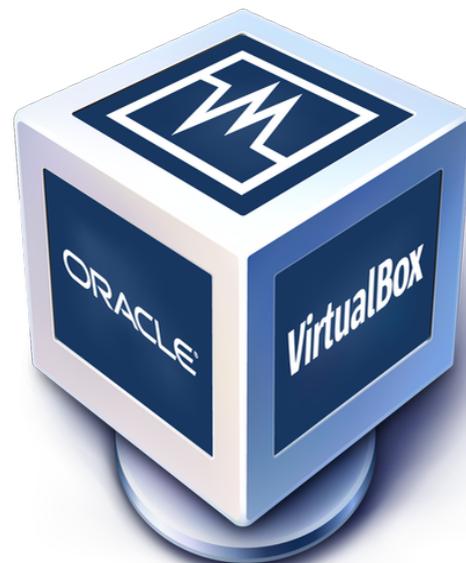
without spending too much money

# 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

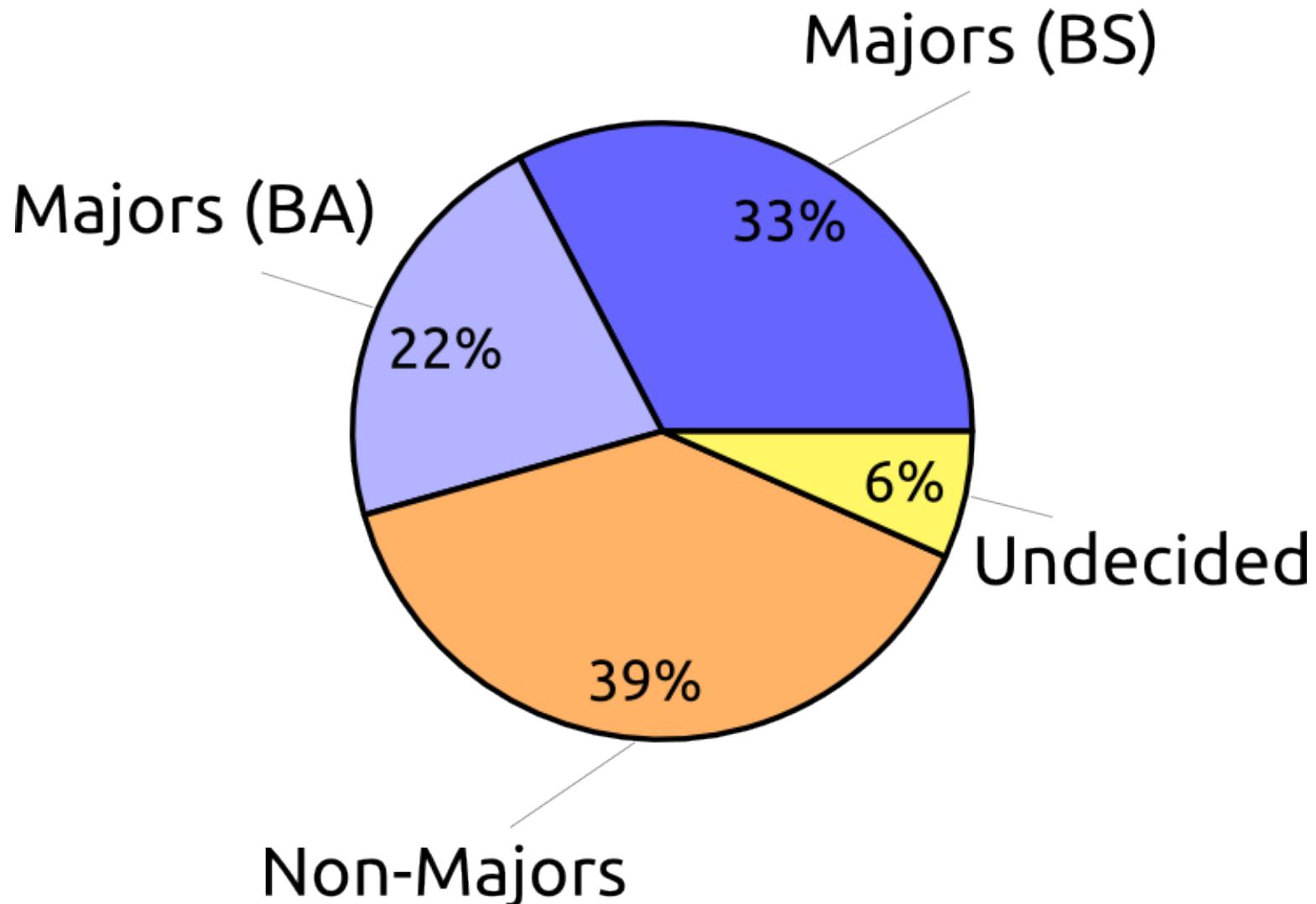
**40** Faculty Members in Dept

**10** Staff Members in Dept

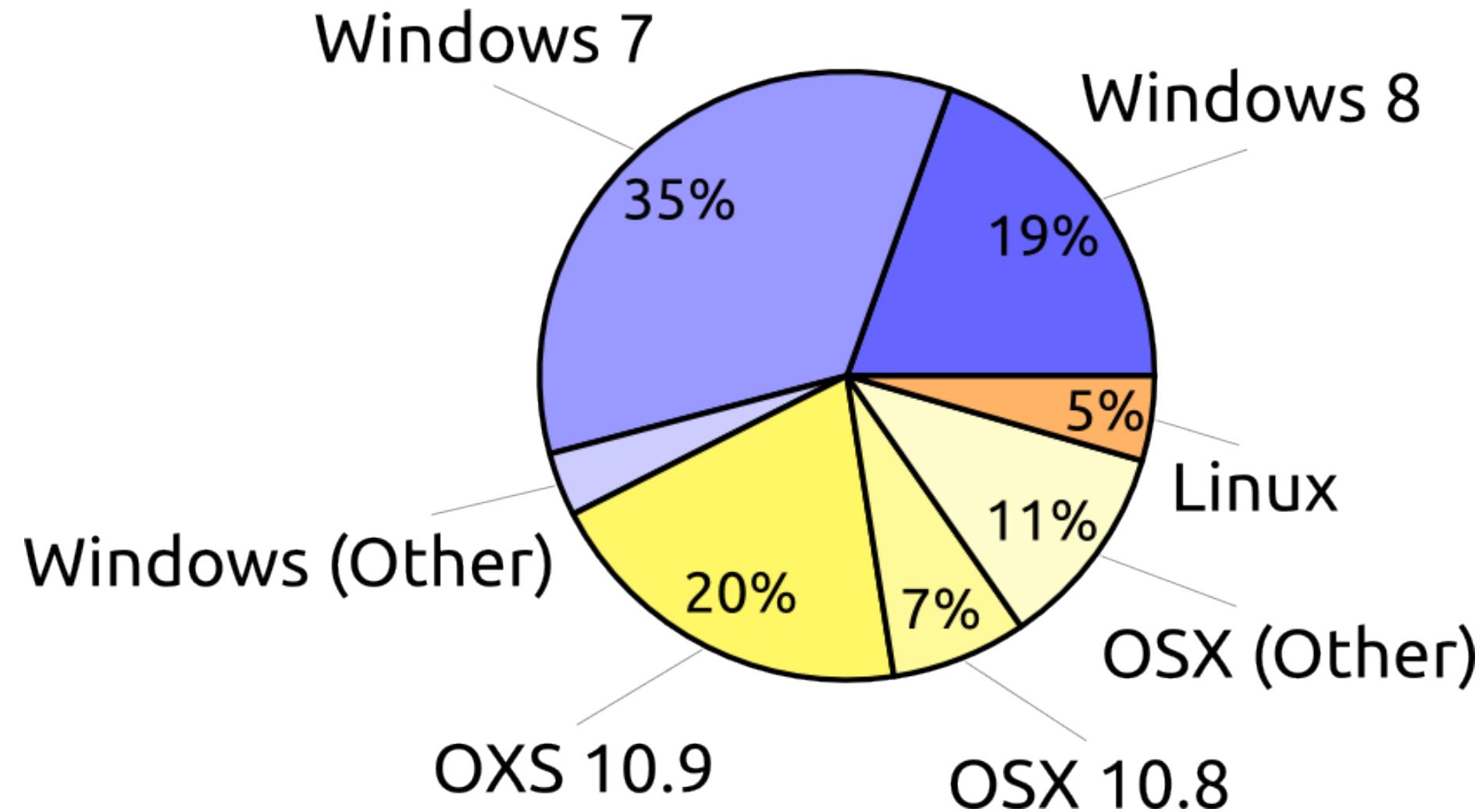
**0.5** Ed Tech Staff in Dept

**0.5** IT Staff in Dept

# User Major



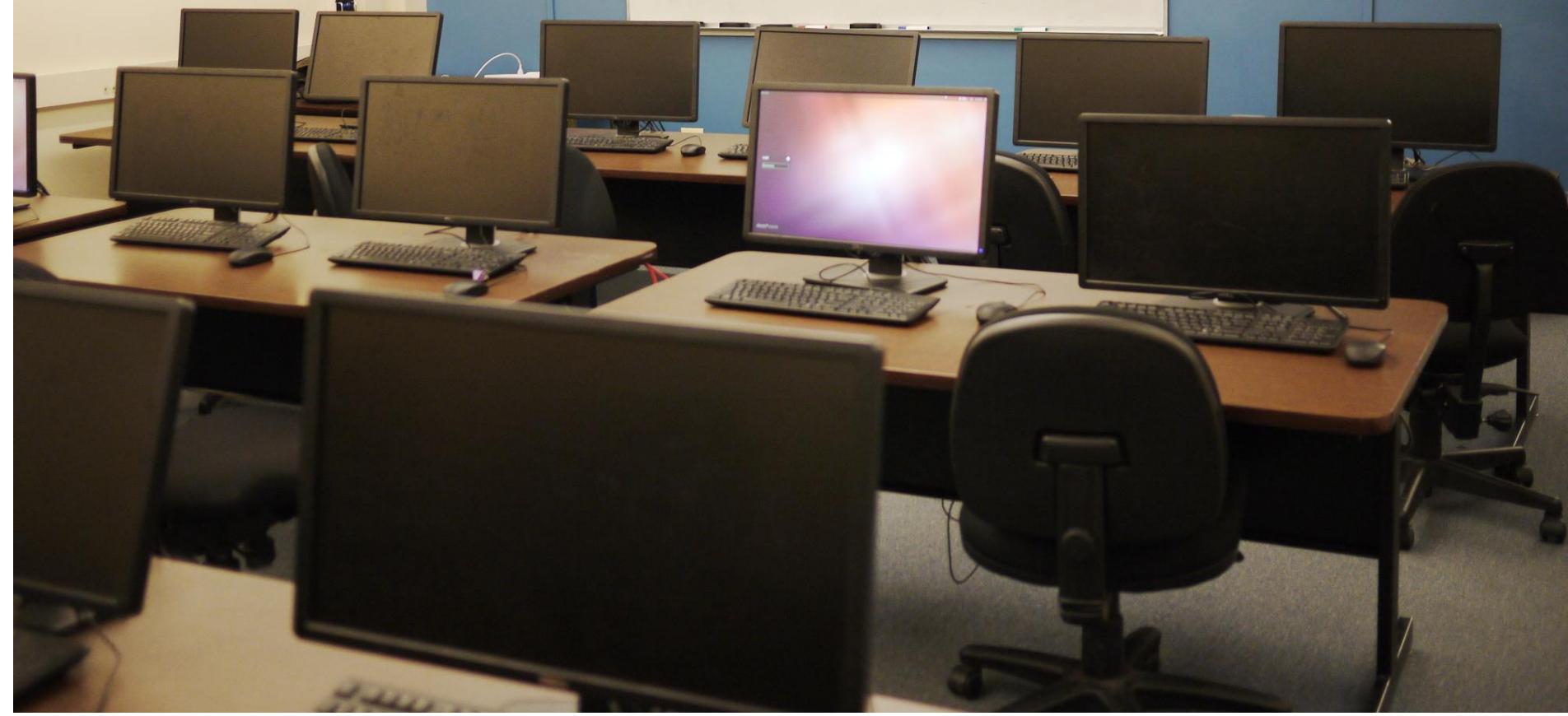
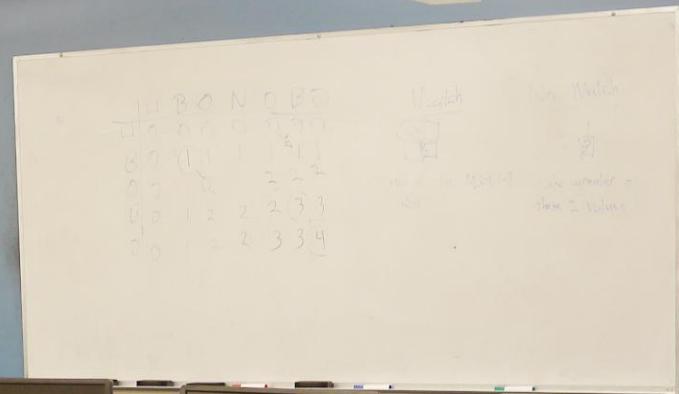
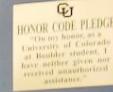
# User Host OS



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**

# Goal

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**

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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

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**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

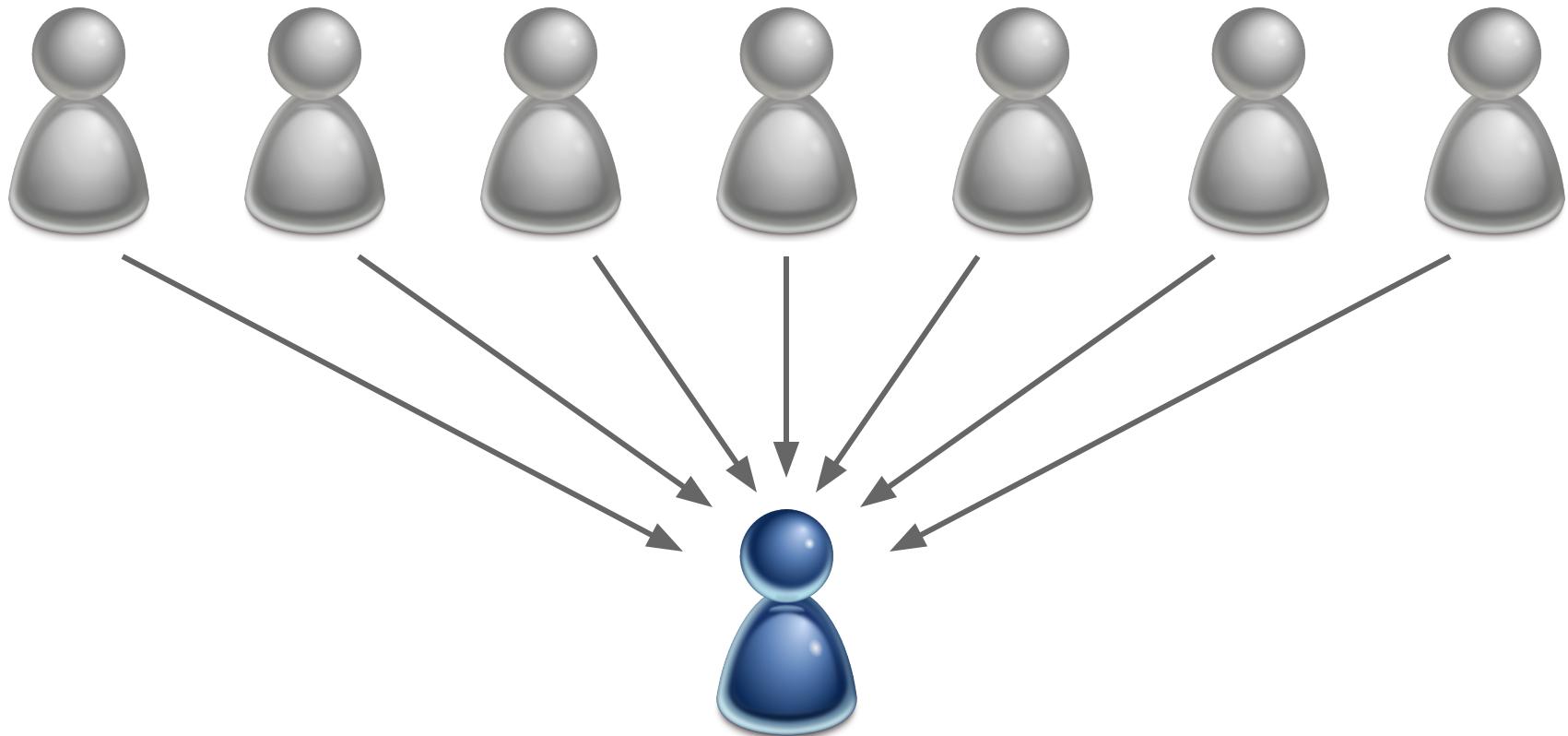
Pre-Installed with Core Course Packages  
Elective Course Packages Manually Installed

Lab

Pre-Installed with All Course Packages

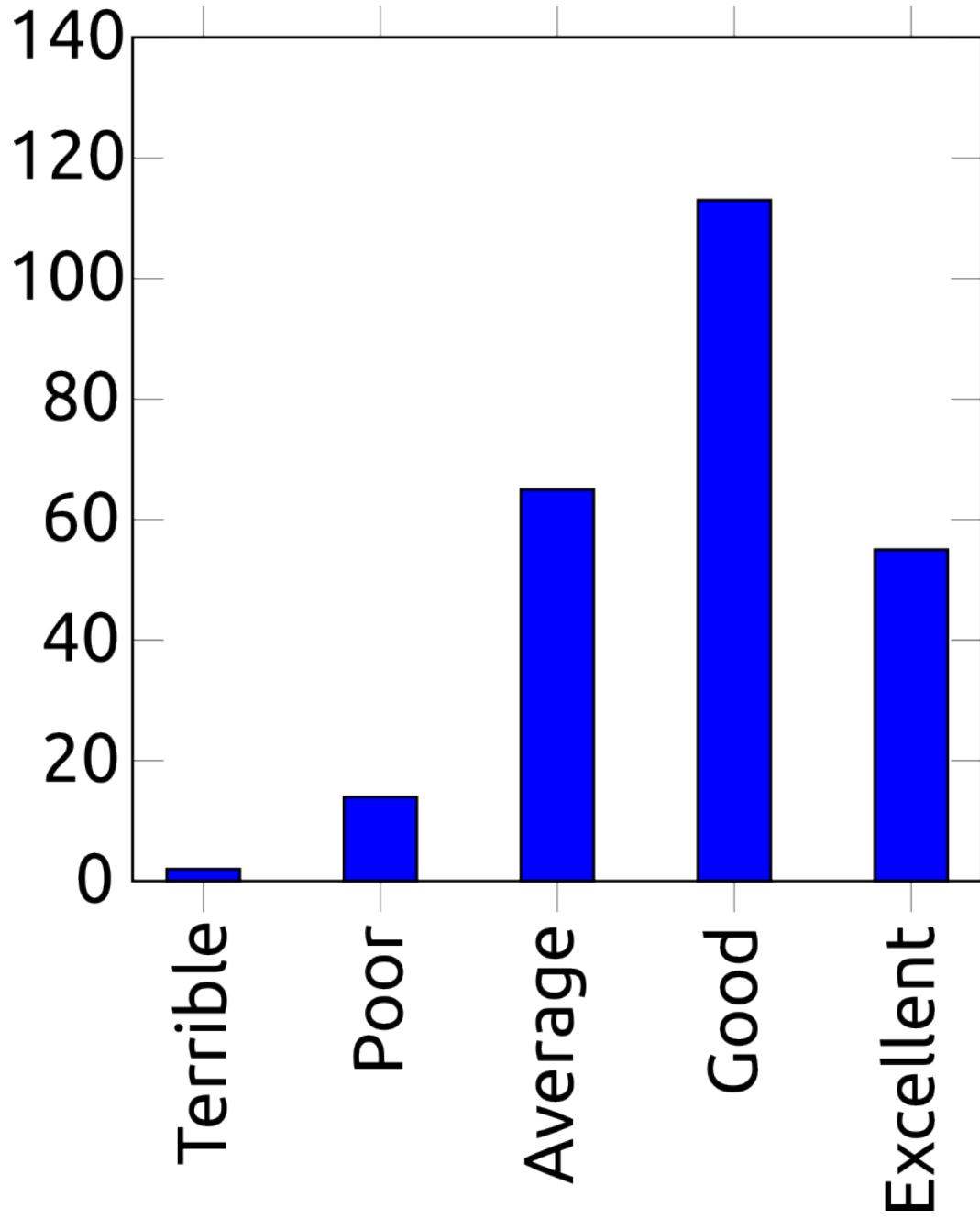
# Results

# Over One Thousand Users

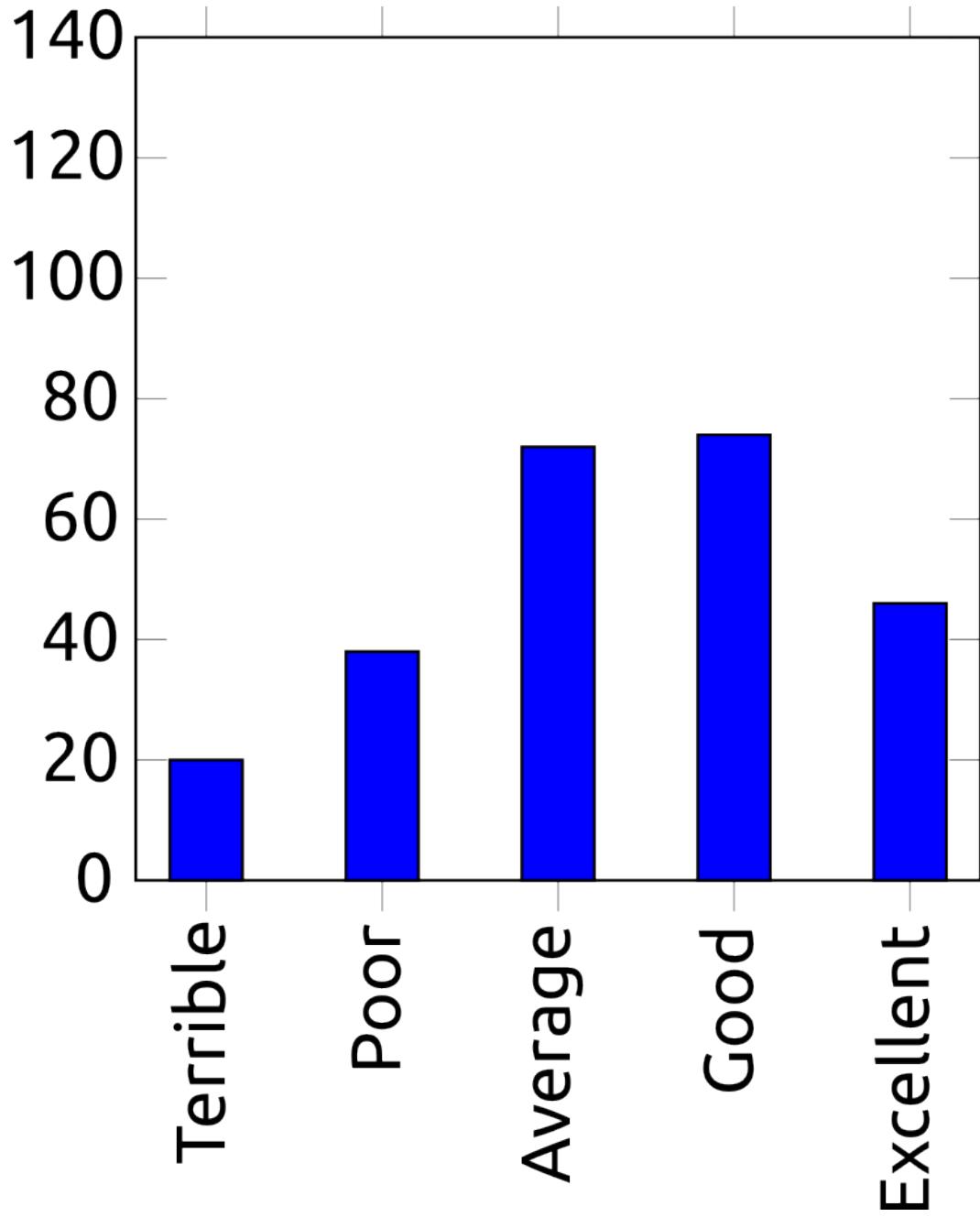


One (Half-Time) Graduate Assistant

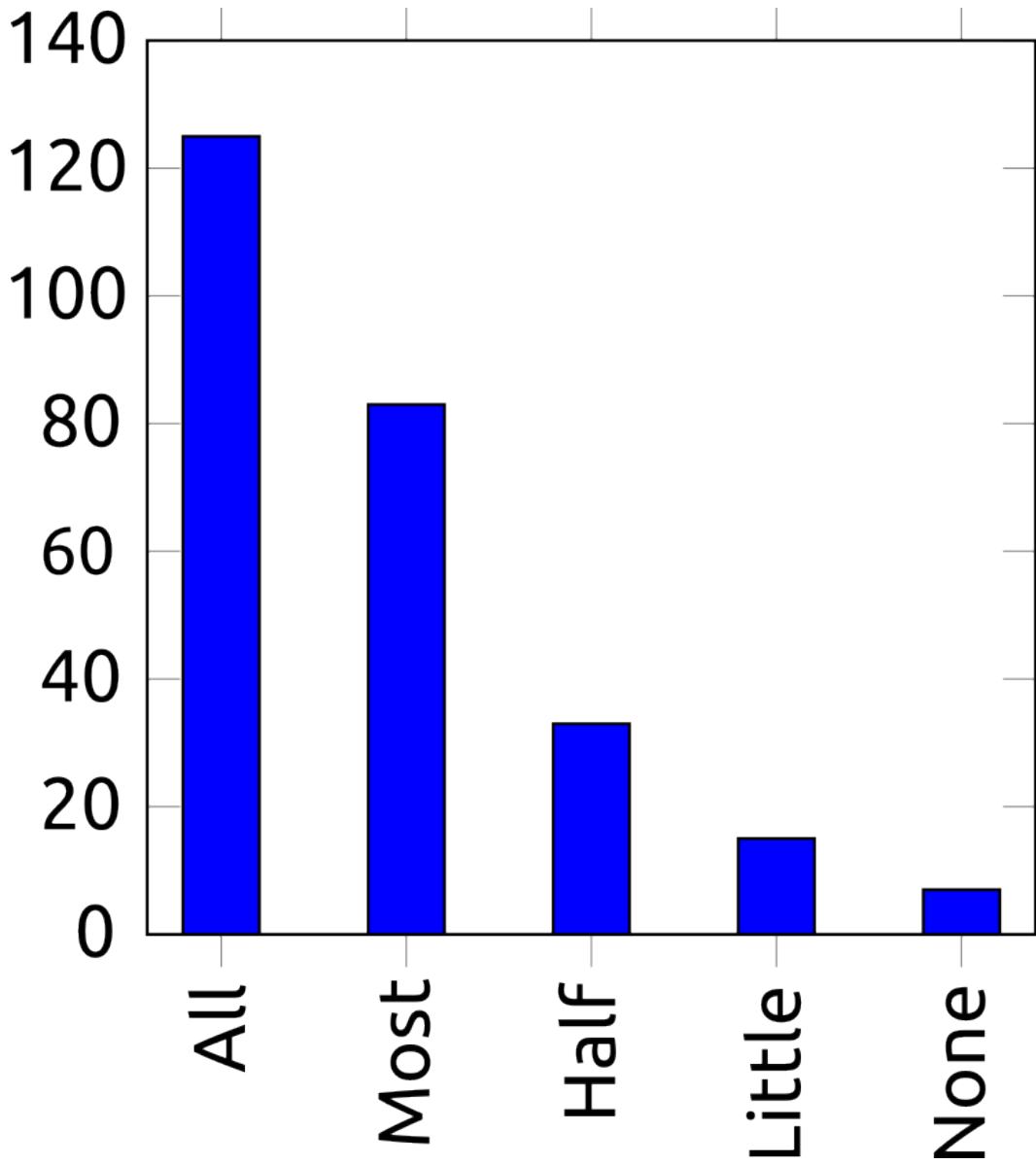
# Overall VM Experience



# VM Performance



# Coursework Completed on VM



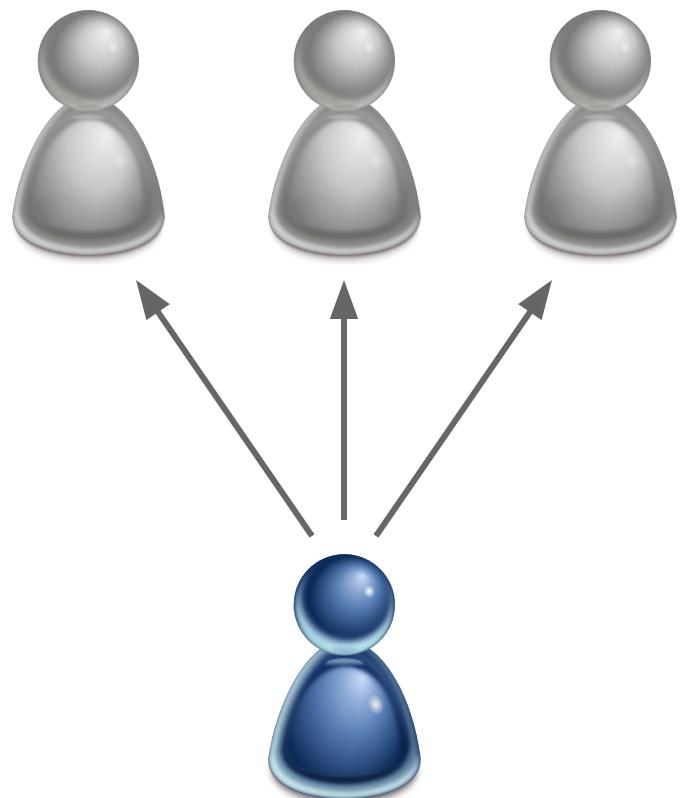
# Best Practices

# **Virtualization Extensions & BIOS Support**



**64-bit**

## Install Sessions



Virtualization Extensions & BIOS Support

Download Corruption and Speed Issues

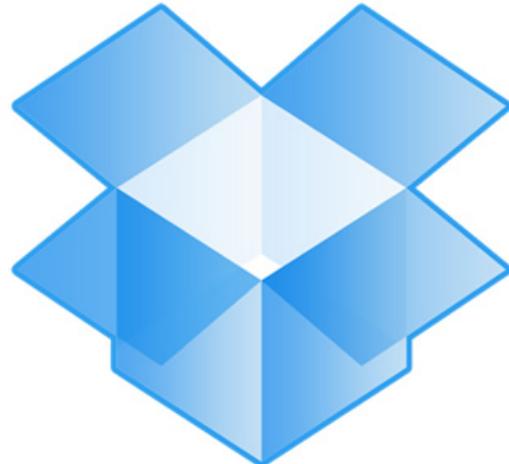


USB Flash Drives

**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](http://www.andysayler.com/output)

Website: [foundation.cs.colorado.edu](http://foundation.cs.colorado.edu)

Git: [github.com/asayler/cu-cs-apt-packages](https://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](#)

<a href="#">cu-cs-csci1300/</a>	09-Jan-2014 21:01	-
<a href="#">cu-cs-csci2270/</a>	09-Jan-2014 21:01	-
<a href="#">cu-cs-csci2400/</a>	09-Jan-2014 21:01	-
<a href="#">cu-cs-csci3155-apt/</a>	12-Feb-2014 21:02	-
<a href="#">cu-cs-csci3155/</a>	12-Feb-2014 21:02	-
<a href="#">cu-cs-csci3202/</a>	11-Sep-2013 17:09	-
<a href="#">cu-cs-csci3308/</a>	25-Aug-2013 12:40	-
<a href="#">cu-cs-csci3753/</a>	17-Jan-2013 18:08	-
<a href="#">cu-cs-csci4229/</a>	25-Sep-2013 14:45	-
<a href="#">cu-cs-csci4273/</a>	16-Sep-2013 21:07	-
<a href="#">cu-cs-csci4753/</a>	16-Jan-2013 22:32	-
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<a href="#">cu-cs-csci5535/</a>	11-Sep-2013 10:47	-
<a href="#">cu-cs-csci5654/</a>	11-Sep-2013 10:47	-
<a href="#">cu-cs-foundations-apt/</a>	10-Jan-2014 23:42	-
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