COMP5048
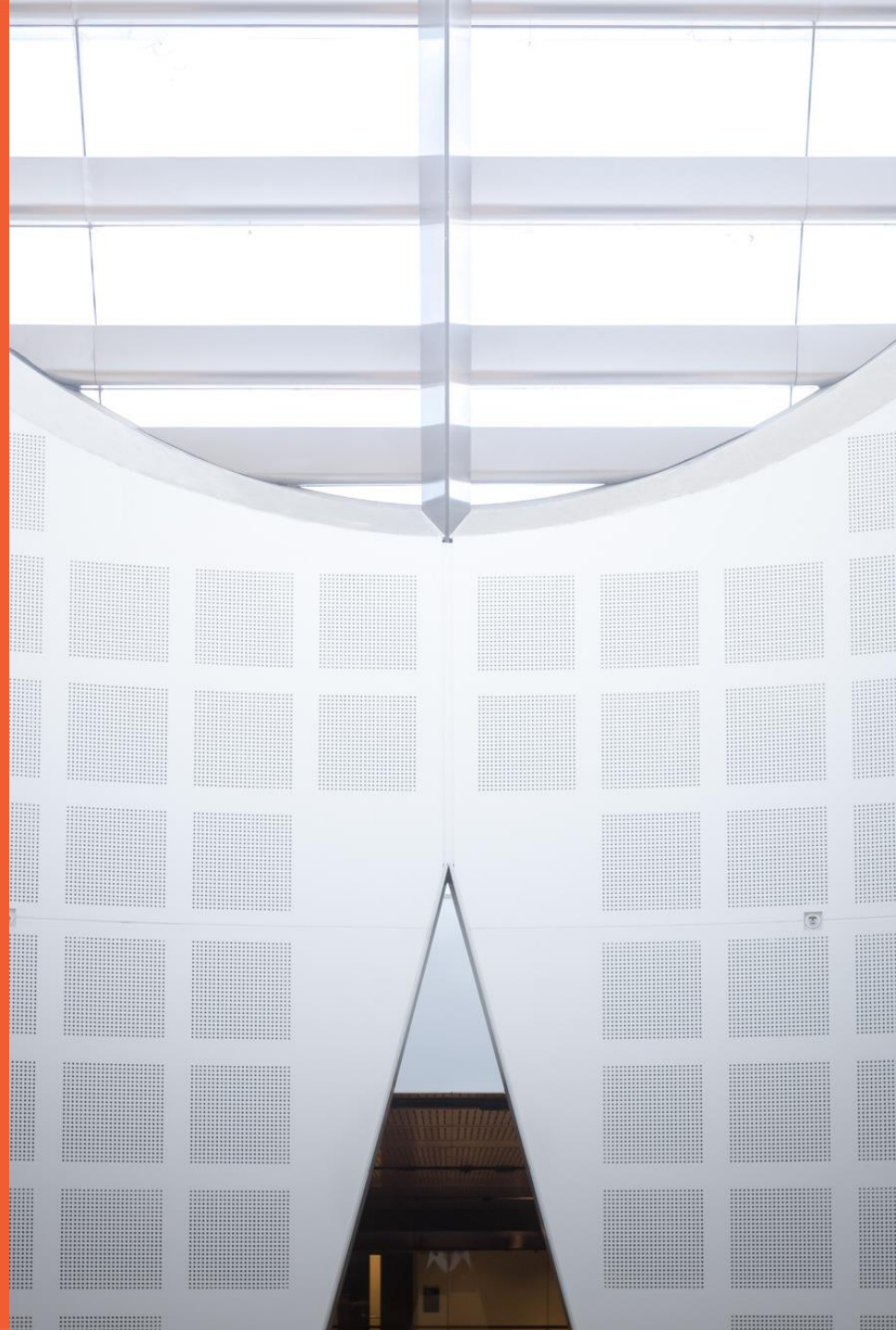# Visual Analytics

Week 12: Review

Professor Seokhee Hong

School of Computer Science

THE UNIVERSITY OF
SYDNEY

Copyright warning

Content:

1. Review

2. Exam

3. Reminder

4. Example: Academic research

Appendix: ProctorU Review+ Exam

1. Review

COMP5048 Visual Analytics

- *Visual Analytics* aims to facilitate the data analytics process using Information Visualisation.

- **Information Visualisation** aims to make good pictures of <u>abstract information</u>, such as stock prices, health data, social networks, and software diagrams.

- The **challenge** for Visual Analytics is to **design and implement effective Visualisation methods** that produce geometric representation of complex data so that data analysts can carry out critical decision making.

- ***This unit will provide Visualisation techniques and fundamental algorithms to achieve good visualisation of abstract information.***

- It will also provide opportunities for **academic research** and developing new methods for Visual Analytic methods.

Learning Outcomes

- ***knowledge of basic concepts, techniques and algorithms to produce good visualization of abstract data*** effectively and efficiently

- ***understanding* of geometric algorithms and visualization methods**

- ***use* of geometric algorithms and visualisation methods** to **solve new problems**

- be able to ***apply and modify* visualisation methods** for **application** area such as social networks and biological networks

- experience ***academic research*** in Visual Analytics and Information Visualisation

- **Assumed Knowledge**: **Data Structures, Algorithms, Programming**

Week 2: Complex Data Visualisation

1. **<u>Multi-dimensional/Multi-variate Data</u>**
    - Multiple attributes: ordinal, nominal, categorical, image

2. **<u>Spatial Data</u>**
    - Data with geometry (map, longitude/latitude)

3. **<u>Temporal/Dynamic Data</u>**
    - Data with time stamps: changing over time

4. **<u>Relational Data with Constraints</u>** (Week 2-4)
    - ***<u>Tree (Hierarchical Relational Data</u>***): Week 2
        A. Tidier Tree Drawing
        B. Radial Tree Drawing
        C. HV Tree Drawing

Week 3: Visualisation of Network Data

1. Force directed methods (spring algorithm)

2. Barycenter method

3. Stress minimization method

4. Magnetic spring algorithm

5. Energy Function

6. Constraints

7. Fast spring algorithm

Week 4: Visualisation of Directed Graphs

Sugiyama Method:

step1. ***Cycle removal*****:** make acyclic digraph

step2. ***Layer assignment*****:** assign y-coordinates

step3. ***Crossing reduction*****:** determine the order of vertices in each layer

step4. ***Horizontal coordinate assignment***: assign x-coordinates (Straighten the long edges)

Week 5: Visualisation of Big Data

1. Cluster the data

2. Multi-level approach

3. Use 3 dimensions

4. Reduce Visual Complexity

5. Integration with Analysis

6. Integration with Interaction

Week 6: Visualisation of Complex Data

1. **Multi-dimensional/Multi-variate Data (Table data)**
   - Multiple attributes: ordinal, nominal, categorical, image etc

2. **Spatial Data**
   - Data with geometry (map, longitude/latitude)

3. **Temporal/Dynamic Data**
   - Data with time stamps: changing over time

4. **Data with Constraints** (Week 2-4)
   - Relations, Hierarchy, Clusters, Directions

5. **Multi-relational Data**
   - *Multiple clusters, multiple relationships etc*

Week 7: Perception/Color

1. **Human Perception System**

2. **Gestalt principles**

   - Figure/ground relationships
   - Grouping: Proximity, Similarity, Continuity, Closure
   - Goodness of figures

3. **Color**

   - Categorical vs Ordered color(maps)
   - Hue, Saturation, Luminance
   - Colormaps

Week 8: Evaluation Methods

Quantitative Evaluation: Quality Metrics

Qualitative Evaluation (HCI Evaluation methods)

1. Survey:
   A. Interview
   B. Questionnaire
   C. Focused group
2. Analytic inspection:
   A. Heuristic Evaluation
   B. Cognitive walkthroughs
3. Empirical evaluation:
   A. Observational experiment
   B. Controlled Experiment

Assessment

1. **Homework (10 marks)** : individual work
   - Tutorial: 7 weeks (7 marks)
   - Peer review: 3 marks

2. **Assignment 1 (15 marks)**: individual work

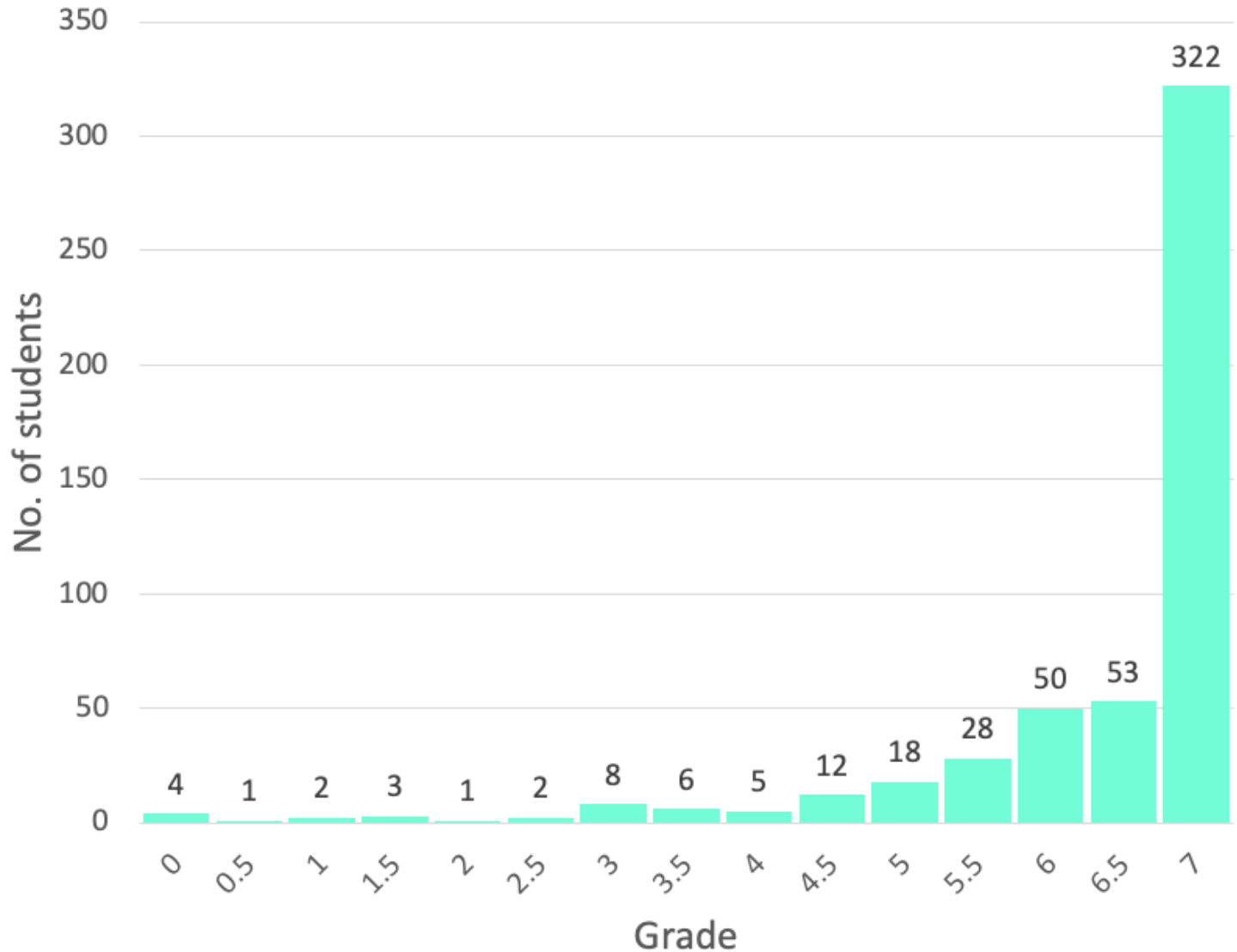3. **Assignment 2 (25 marks):** group work
   1. Presentation (10)
   2. Final report (10)
   3. Individual mark (5)

4. **Exam (50 marks)**
   - **Dec 1 Tuesday 5pm: ProctorU Review+ Exam**
   - student must achieve **at least 40%** in the written examination
   - Fail **(45):** fail to pass the Exam barrier (not prac mark+exam mark)
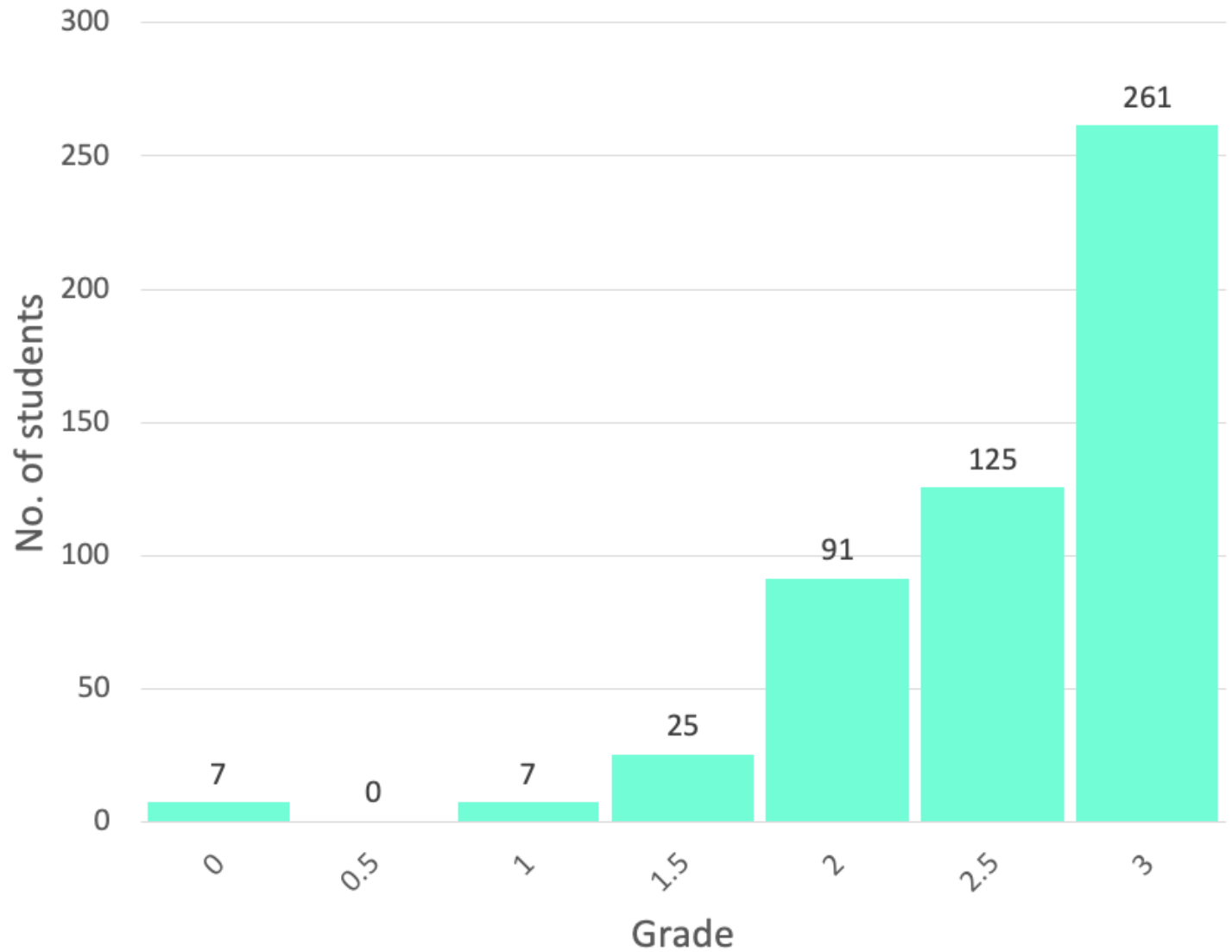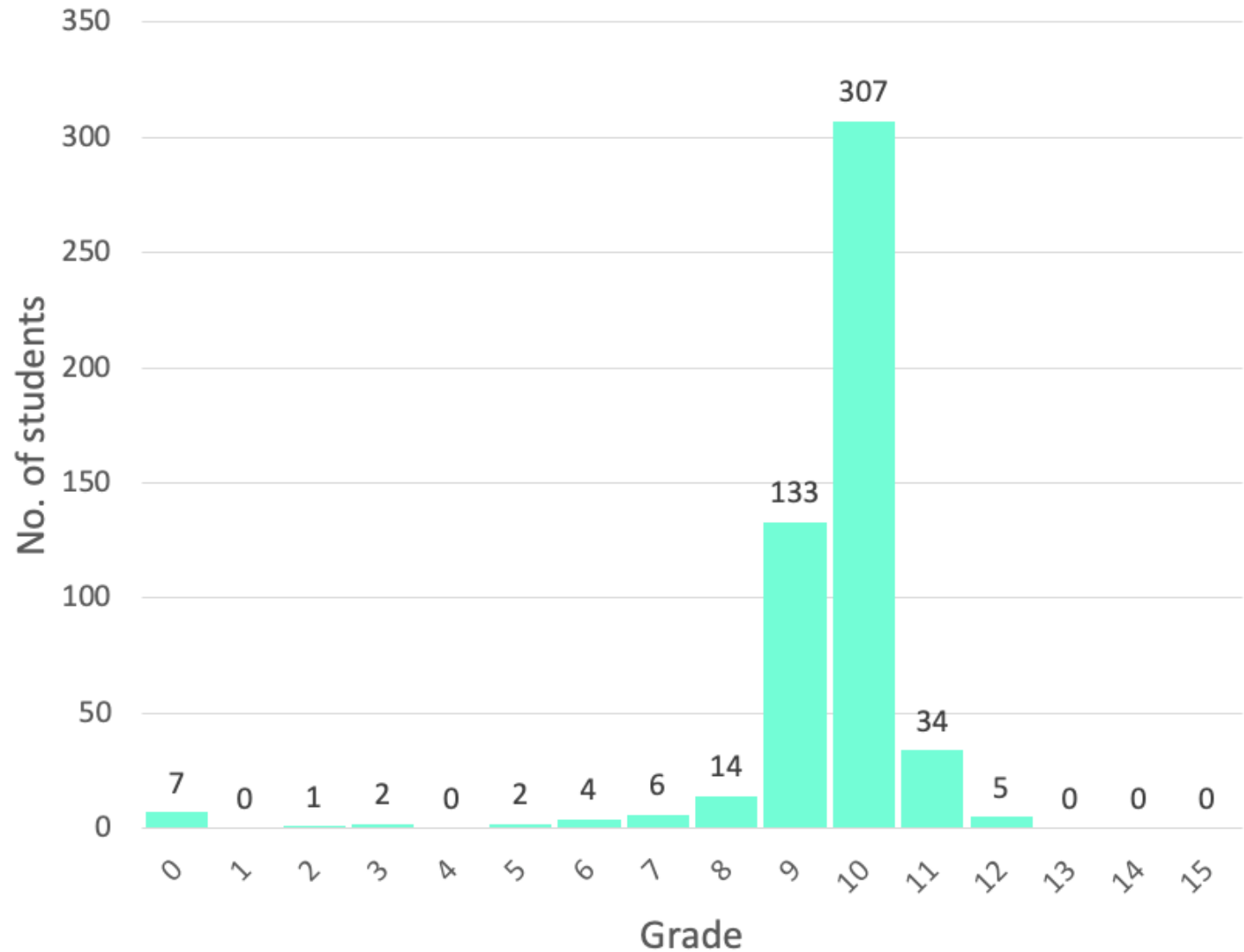
Homework

Min	0
Max	7.0
Average	6.3
Mode	7.0

Peer Review

Min	0.0
Max	3.0
Average	2.6
Mode	3.0

Assignment1

Min	0
Max	12.8
Average	10.0
Mode	10.2

Assignment 2: Presentation

Min	5.7
Max	8.7
Average	6.8
Mode	6.7
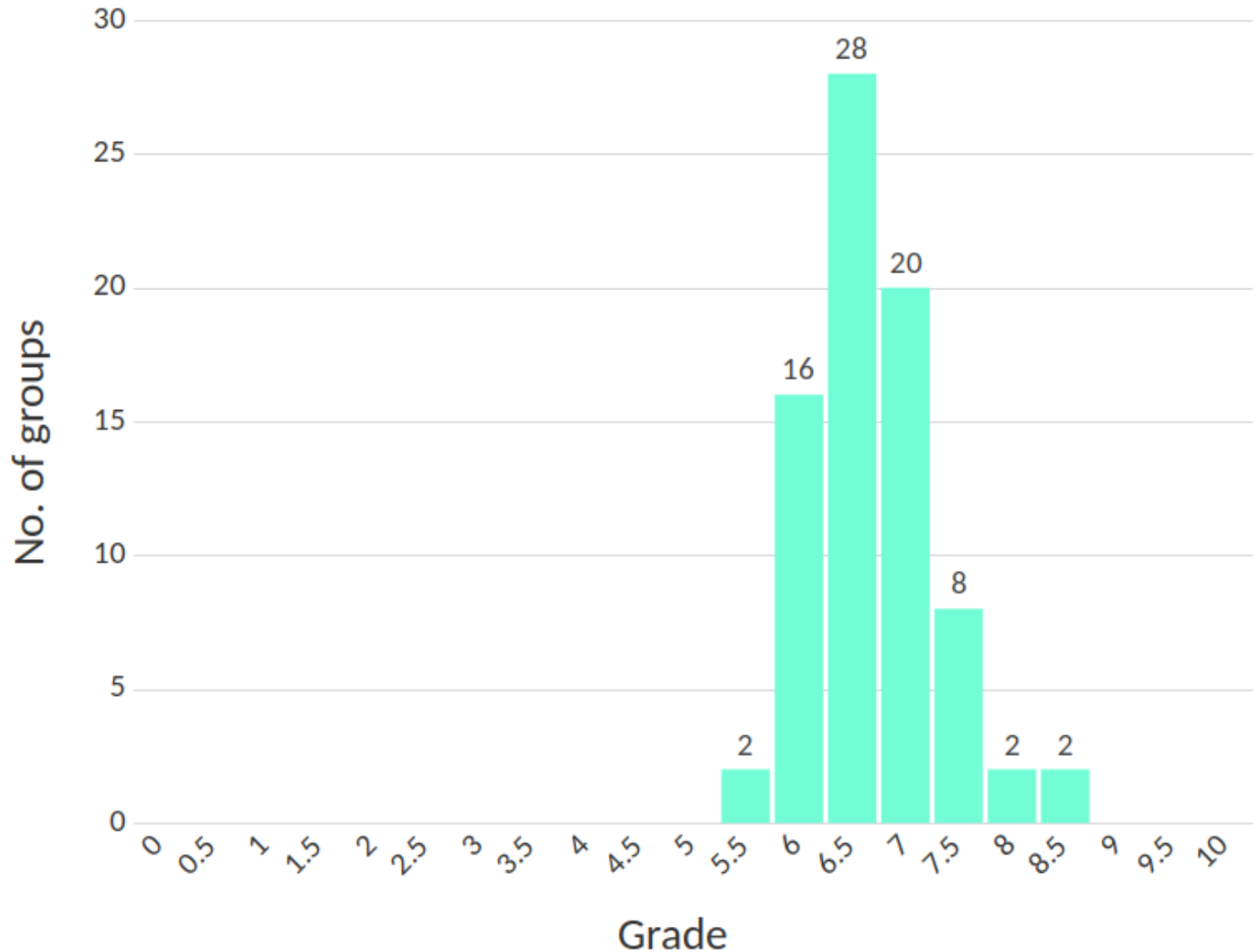
2. Exam

Exam

- **<u>Closed book, ProctorReview+ exam</u>**
- **<u>Scope: lectures notes (week 2-8)</u>**

- **Two hours** writing plus 10 minutes reading at the start
- **No calculators, No handout/memo**

- ***<u>Answer 16 questions</u>*** worth in total **80 marks**
  - Some question contains ***subquestions***
  - Each subquestion has different marks

Exam Questions: Scope

- (10 marks) Week 2: Visualisation of Complex Data I
- (20 marks) Week 3: Visualisation of Network Data
- (12 marks) Week 4: Visualisation of Directed Graphs
- (18 marks)
  - Week 5: Visualisation of Big Data
  - Week 6: Visualisation of Complex Data II
- (20 marks)
  - Week 7: Perception/Color
  - Week 8: Evaluation Methods

Learning Outcomes

- ***knowledge of basic concepts, techniques and algorithms* to *produce good visualization of abstract data*** effectively and efficiently

- ***understanding* of geometric algorithms and visualisation methods**

- ***use* of geometric algorithms and visualisation methods** to **solve new problems**

- be able to ***apply and modify* visualisation methods** for **application** area such as social networks and biological networks

- experience ***academic research*** in Visual Analytics and Information Visualisation

- **Assumed Knowledge**: **Data Structures, Algorithms, Programming**

Exam Questions and Answers

Describe/Explain Concepts/Algorithms/Methods: Tutorial Exercise Q

1. Describe methods to visualise XXXX data.

2. Explain Algorithm/methods XXXX in details.

3. Explain XXXX in detail.

How to Write Exam Answers

1. Be *precise (concise)*.

2. Use *technical concepts and terminology* based on the lecture notes.

3. Provide *technical details:* formula, pseudo-code, technical description

Exam technique

- **Plan how you will allocate time (wisely)**
  - Use "reading time" to check your understanding

- **Answer everything (get the "easy marks")**
  - Show that you have some relevant knowledge

- **Write clearly and efficiently**
  - Start with **outline/bullet points**, then expand

Pragmatic Advice

- Have your **student id ready**

- Switch off mobile phone

- Illness and misadventure: Special consideration

Good Luck!

3. Reminder

Reminder

1. Ready for **ProctorU Review+ Test**

2. Fill out **Online Unit of Study Survey**
   - *Constructive* feedback: how to improve this unit

3. **University's Expectation of Students**

University's Expectation of Students

University of Sydney Student Charter

University's Expectation of Students:

https://www.sydney.edu.au/policies/showdoc.aspx?recnum=PDOC2011/215&RendNum=0

8 (1)(c) avoid engaging in <u>bullying, harassment or discriminatory behaviour</u>, including on <u>social media</u>;

8 (1)(d) maintain a <u>cooperative and collaborative approach to relationships with staff, affiliates and students</u>;

Please be mindful when you do **public postings.**

The discussion board is for sharing and discussing course content related issues.

4. Example of Academic Research

- **Extreme-scale Visual Analytics Big networks**

- **Faithful Visual Analytics for Complex networks**
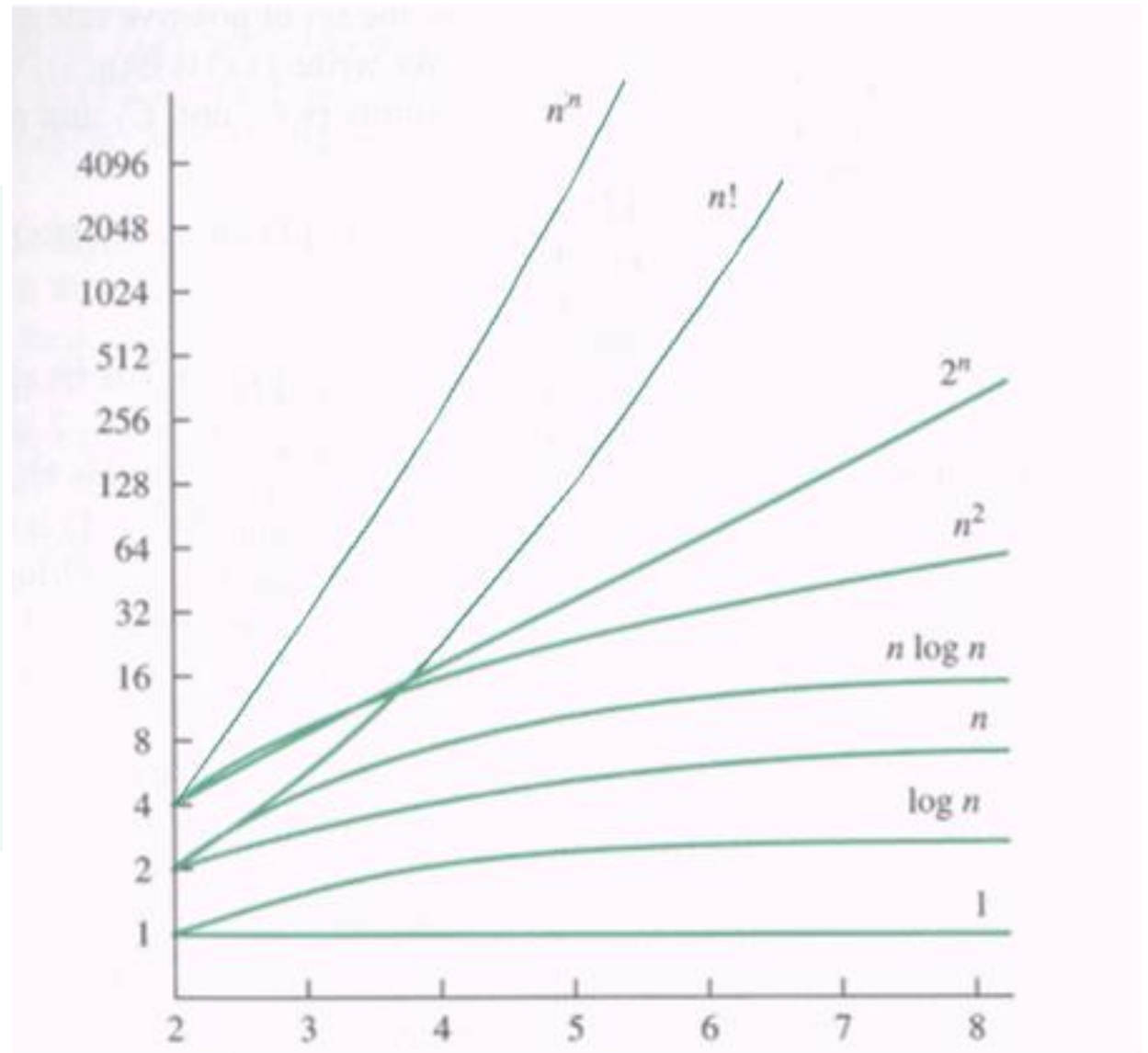
The Scientific Challenge in IT

1. ***Scalability***
   Efficiency
   Runtime

2. ***Complexity***
   Effectiveness
   Quality

Algorithmics for Extreme-scale Big Complex Network Visualization

1. Graph Sampling

- **Topology/Connectivity-based sampling**
  - **BC Tree** decomposition: connected graph into biconnected components
  - **SPQR Tree** decomposition: biconnected graph into triconnected component
- **Spectral Sparsification [Spielman & Teng 2008]**
  - Sparsify dense graphs to **O(nlogn)** edges, preserving the structure of graphs

2. Parallel (Cloud) Computing

- **Topology/Connectivity-based partitioning**
  - BC tree, SPQR tree

- [GD 2017] Eades et al., [IEEE PacificVis 2018] Hong et al.
- [IEEE LDAV 2019] Meidiana et al., [CN 2020] Hu et al.

Topology-based Graph Sampling
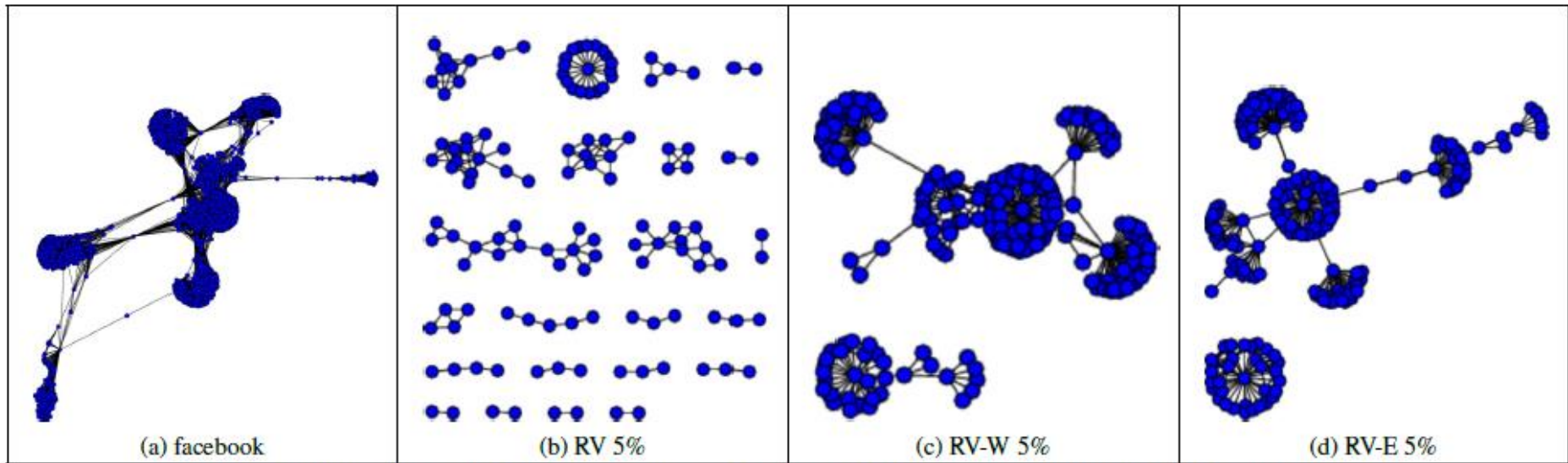
Figure 6: Comparison of proxy graphs of *facebook* graph with 5% sampling ratio, computed by RV, RV-W and RV-E.
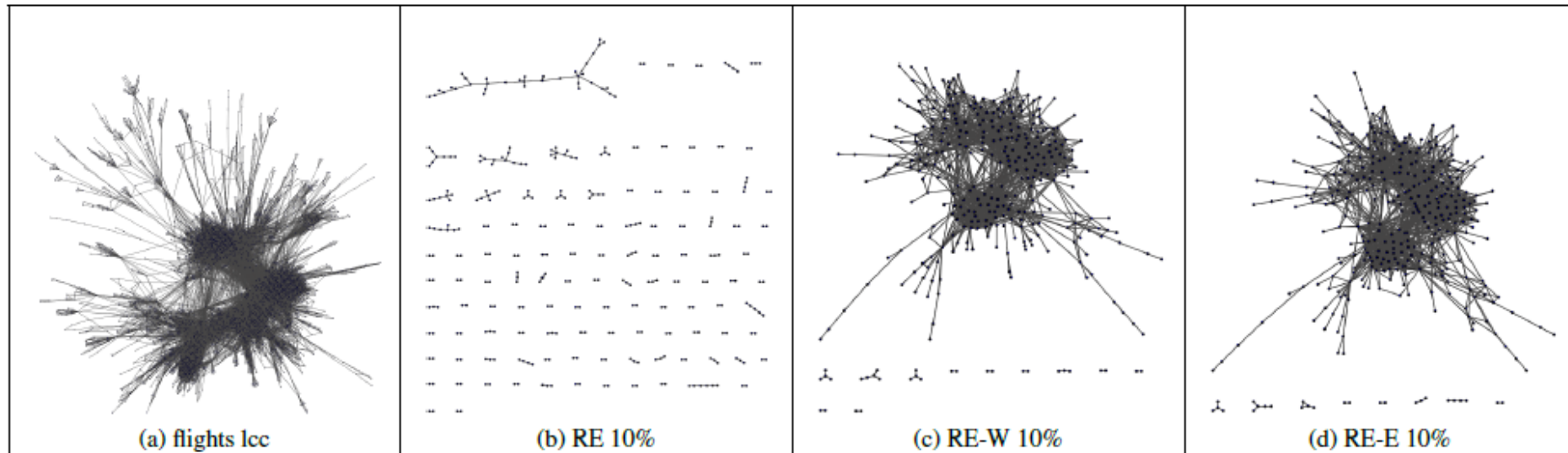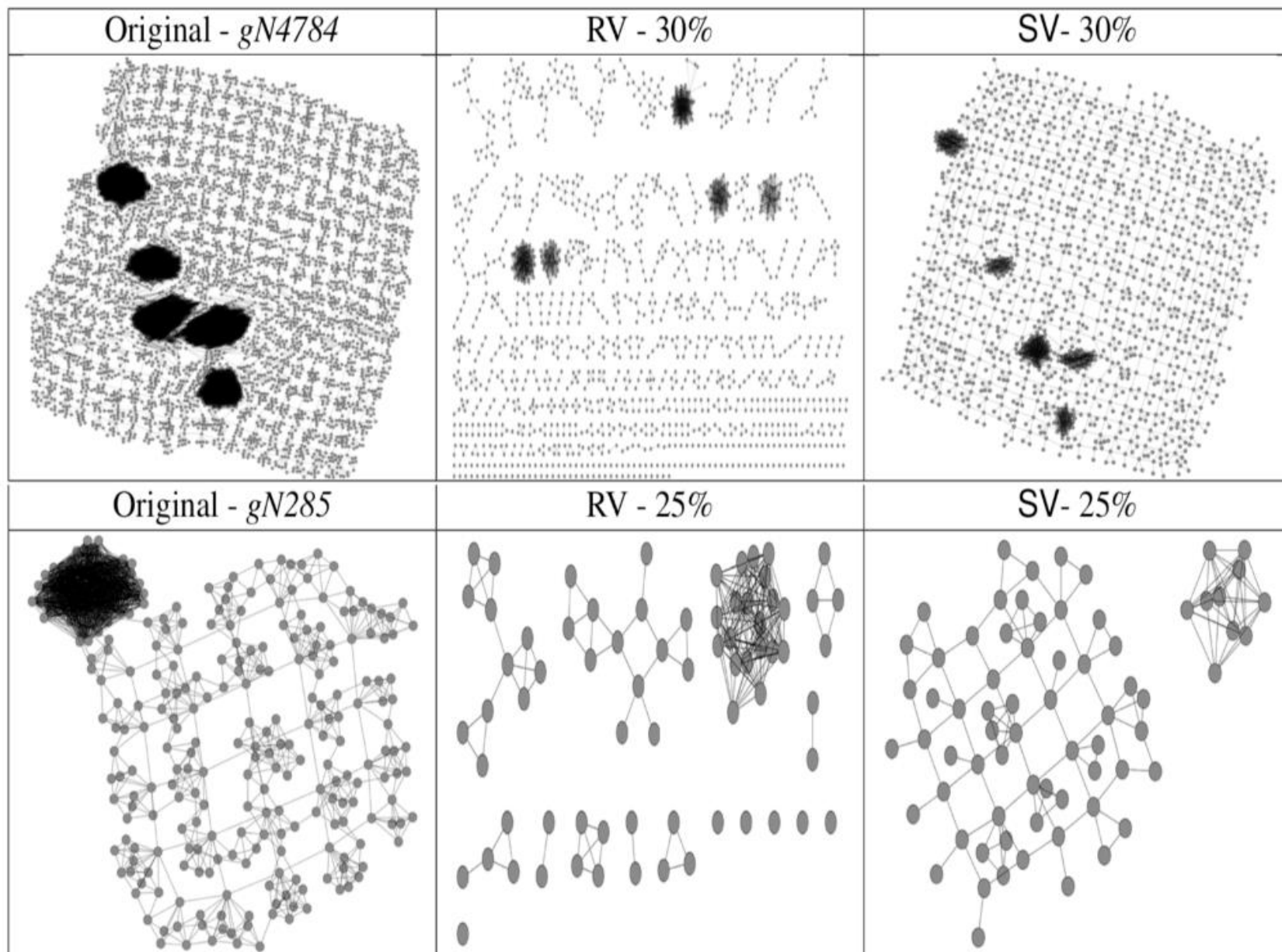
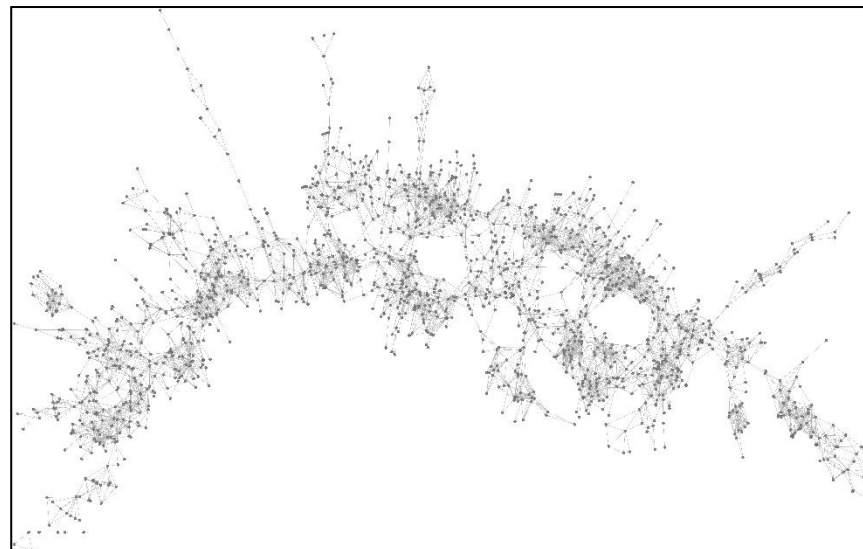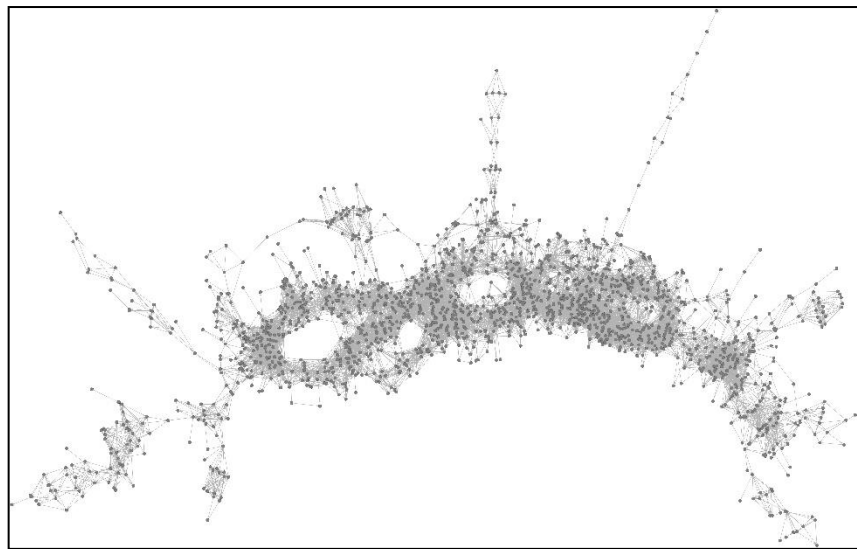(a) facebook (b) RV 5% (c) RV-W 5% (d) RV-E 5%

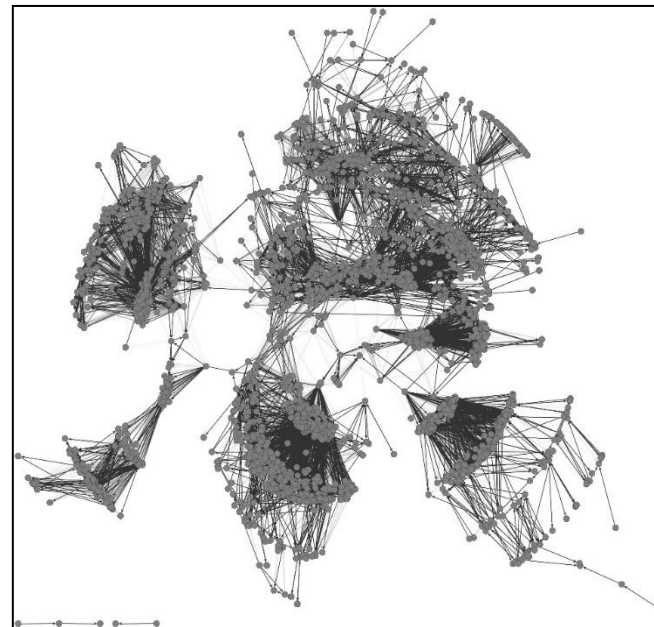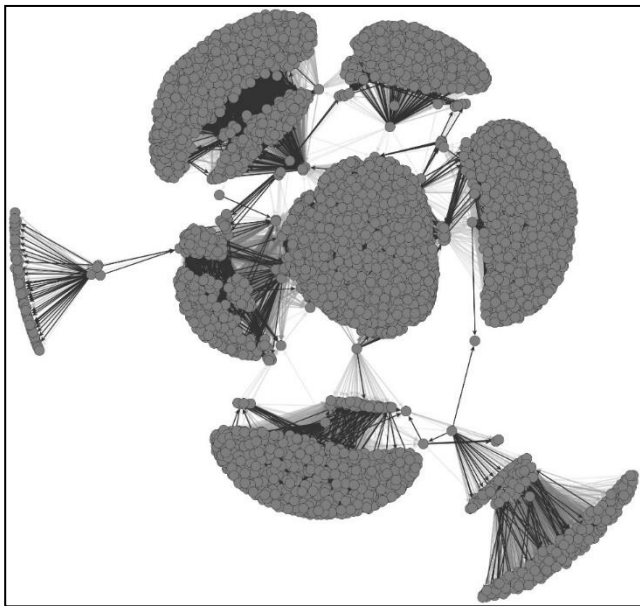Figure 7: Comparison of proxy graphs of *flights_lcc* graph with 10% sampling ratio, computed by RE, RE-W and RE-E.

(a) flights lcc (b) RE 10% (c) RE-W 10% (d) RE-E 10%

Spectral Sparsification

| Original - *gN4784* | RV - 30% | SV- 30% |
| Original - *gN285* | RV - 25% | SV- 25% |

Spectral Sparsification

Sublinear Time Force Computation for Big Complex Network Visualization

Amyra Meidiana, Seok-Hee Hong,
Marni Torkel, Shijun Cai, Peter Eades

IEEE Eurovis 2020

Force-Directed Algorithms

- Force-directed algorithms **[Eades 1984]:** most popular graph layout

  - Compute **_repulsion forces_** on each pair of vertices: $O(|V|^2)$ **time**

  - Compute *attraction forces* on each edge: $O(|E|)$ time

- **Multi-level algorithms: $O(n \log n)$ runtime** in practice

  - FADE [Quigley & Eades 2000]

  - FM³ [Hachul & Junger 2004]

- **RVS [Gove, 2019]: $O(n)$ runtime** for repulsion force computation

  - Computes repulsion force: $|U|^{0.75}$ **x** $|S|^{0.25}$

  - **_U_ (update set):** use *sliding window* on array of randomly-ordered vertices

  - **_S_ (sample set):** use *random sampling*
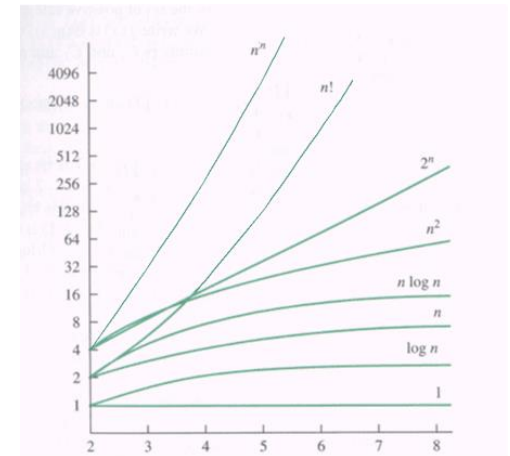
SubLinear Time Force Computation Framework

1. <u>Analysis</u>: BFS tree T rooted at center of the graph

2. <u>Initialization</u>: radial tree drawing [Eades 1991]

3. <u>Force computation</u>: computes repulsion and attraction forces

- **SL** algorithms reduce the sizes of U and S to obtain a sublinear runtime

- Versions of **SL**:

  - **0702: $|U| = |V|^{0.7}$, $|S| = |V|^{0.2}$, $O(n^{0.9})$ runtime**

  - **0602**: **$|U| = |V|^{0.6}$, $|S| = |V|^{0.2}$, $O(n^{0.8})$ runtime**

  - **0502**: **$|U| = |V|^{0.5}$, $|S| = |V|^{0.2}$, $O(n^{0.7})$ runtime**

- Variations of **SL** with different sampling method

  - **SLR** (Sublinear Random): use random sampling

  - **SLG** (Sublinear Geometric): use geometric sampling

  - **SLC** (Sublinear Combinatorial): use combinatorial sampling
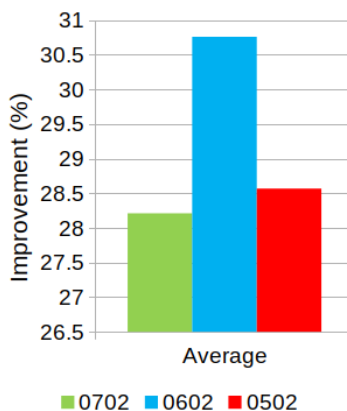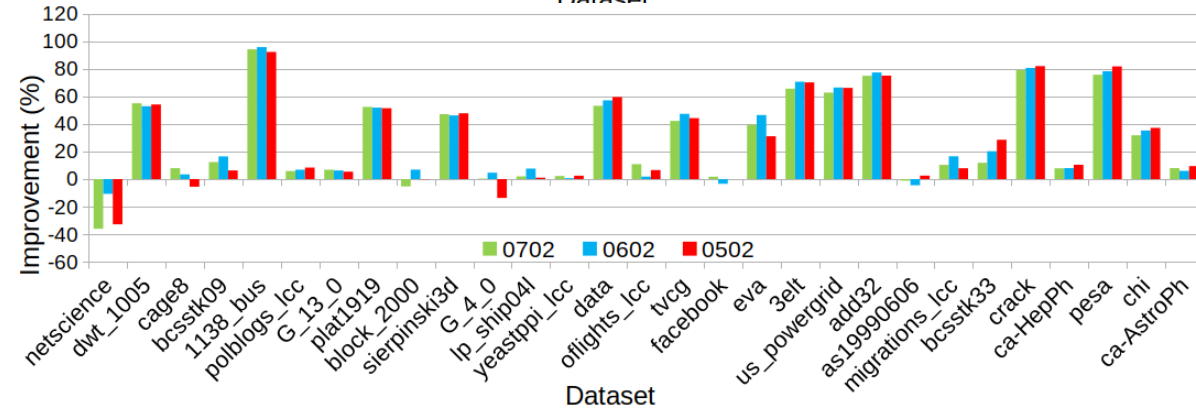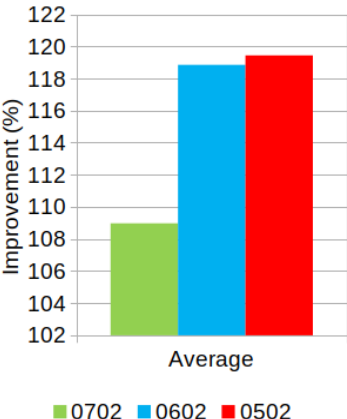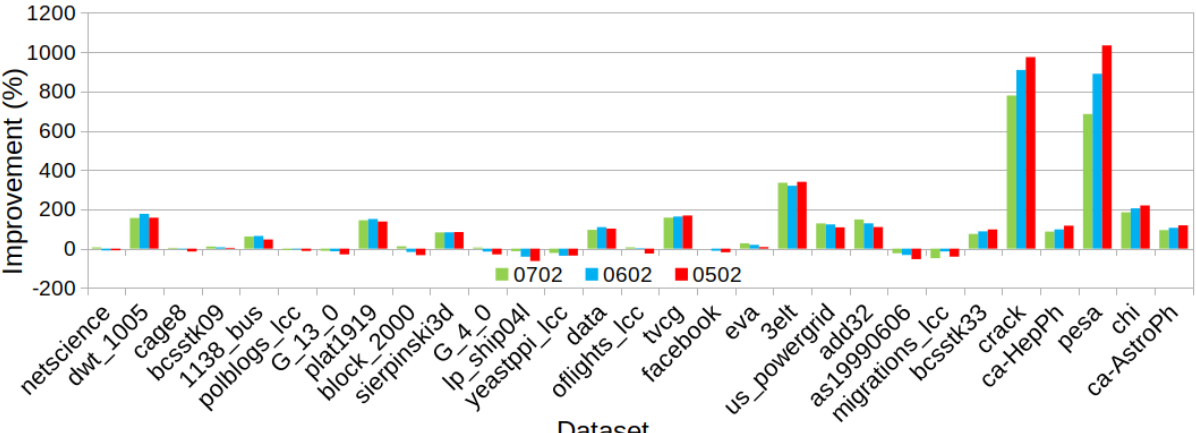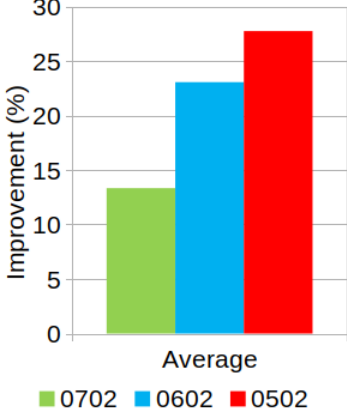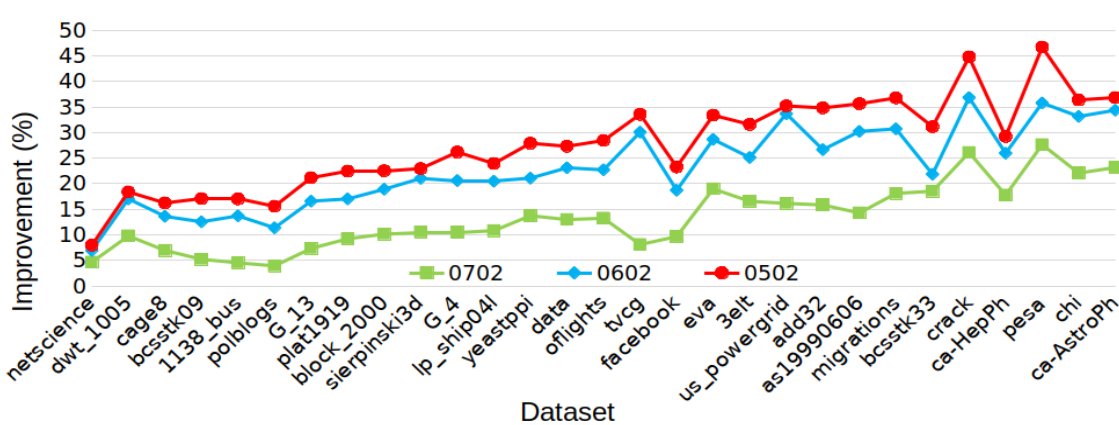
Visual Comparison: SLR, SLG, SLC vs RVS
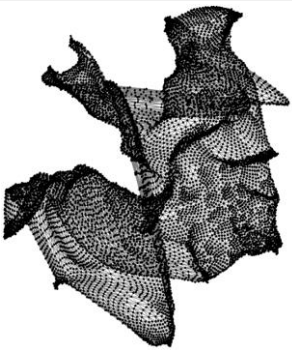
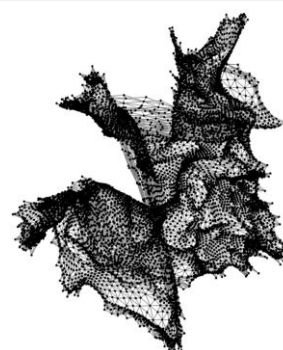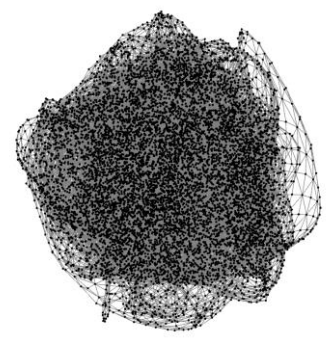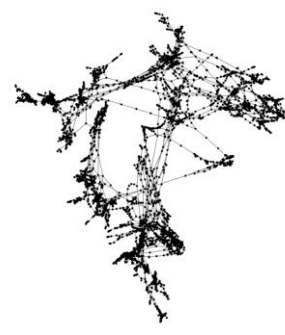| crack_SLR | crack_SLG | crack_SLC | crack_RVS |
| us_powergrid_SLR | us_powergrid_SLG | us_powergrid_SLC | us_powergrid_RVS |
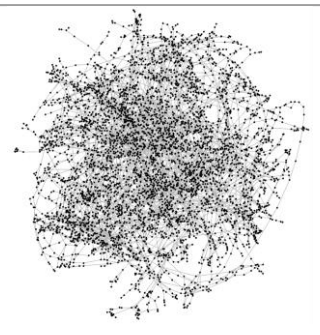
Appendix:
ProctorU Review+ Exam

Preparation for final exam

Taking online exam

1. **ProctorU Review+ practice tests**

2. **Things to do 2 weeks before your exam**

3. **Things to do 5 days before your exam**

4. **During the final exam**

1. ProctorU Review+ practice tests

1. **Enrol in this Canvas site - <u>Self Enrol Here</u>**
If you see a message that says 'This quiz is currently locked' when you try to take the test, you must repeat this step. You can un-enrol as soon as you are finished using the site.

2. **Follow the instructions <u>in this site</u> to prepare for your test.**
This is a ProctorU Review+ test so scheduling is not required, but it's important you create a <u>ProctorU account.</u>

3. **If you haven't done so already you must install the ProctorU browser extension in order to take this test.**
Please download it <u>here</u> for Chrome browser or <u>here</u> for Firefox.

4. **MacOS X Catalina users need to take an additional step.**
Please follow the instructions on <u>this site</u>. You can change these settings back after your test.
Find out which version of MacOS X your computer is running <u>here</u>.

1. ProctorU Review+ practice tests

5. When you're ready to start the practice test, ensure the ProctorU extension is logged in
Click the ProctorU logo in the top right of your browser to login.

6. Begin your practice test: Review+ Practice Test
This test uses **Review+** and is password protected. The ProctorU browser extension will unlock it automatically if you have followed the steps above.

If you have any issues, **do not contact teaching team**,
contact ProctorU via the chat window on the bottom right of your screen to troubleshoot. More information about how to get help during your test can be **found here**.

2. Things to do **2 weeks** before your exam

1. **Create a ProctorU account**

COMP5048 Exam time: 01/12/2020 (5:00 PM - 7:10 PM)

2. Book your exam time.

Just log in to your **special Canvas exam site** (which you'll see in your Canvas dashboard **5 days before the exam**) named **'Final Exam for: COMP5048**' at the time noted in your exam timetable.

(COMP5048 is **Review+ exams**, which **do not require** you to book an exam session.)

3. Create a separate profile or account on your computer.

This will contain the programs you need for the exam. Some of the steps below involve downloads, so set up this separate profile first.

2. Things to do 2 weeks before your exam

4. Download the VPN (for students in China and other offshore students with slow internet only).

- If you are taking your exam in China you will need to download and install this special VPN solution, following instructions for either Windows or MacOS.

- If you are taking the exam somewhere else other than China or Australia and are having access issues, download the regular Sydney VPN

5. Download the ProctorU browser extension.

It is only available for Google Chrome and Mozilla Firefox, so you must use one of these to take your exam. You can delete the extension after your online exam.

6. Check your computer's technical specifications.

• check your upload speed through Speedtest.

The following devices cannot be used to take your exam:

• Google Chromebooks
• **Tablets** (Nexus, iPad, Note, Tab, etc.)
• **Smartphones**
• Devices with a Linux operating system
• Windows 10 in S mode, or Surface RT

Minimum and recommended computer specifications:

Type	Minimum	Recommended
Webcam	640 x 480 resolution	1280 x 720 resolution
PC Operating System	Windows Vista	Windows 10 (S mode not supported)
Mac Operating System	OS X 10.5 or higher	OS X 10.13 High Sierra
Internet Download Speed	0.768 Mbps	1.5 Mbps
Internet Upload Speed	0.384 Mbps	1 Mbps
RAM	1024 MB	2 GB

2. Things to do 2 weeks before your exam

7. Take a practice test.

Take a ProctorU Review+ practice test.

Do this now, at least one week in advance of your real exam.

If you have any problem, **do not contact the teaching team**, **contact the ProctorU support**.

8. Contact the help centre if you need extra help.

- **Disability Services**
- Common test or exam adjustments converted for online delivery
- Special consideration

9. Plan your exam environment.

You need to be in a **quiet room by yourself** that isn't too dark and where you won't be interrupted at the time of the exam.

10. For students who are in Australia, you can take the exam at the University by Booking to sit a Review+ exam on campus

If you want to book to take your Review+ exam on campus, select **COMP5048 Exam time: 01/12/2020 (5:00 PM - 7:10 PM)** from the list, and then click the booking link.

We strongly recommend students with poor internet connection or technical issues take the exam at the University.

On-campus exam spots are limited, you should book ASAP.

If you are registered with **Disability Services** and have exam adjustments in place, submit an online enquiry. Please quote **'on-campus registration'** in the body of your enquiry. The Exams Office will be in touch to make the appropriate arrangements for you.

For students who sit a Review+ exam on campus,

- You will do the **online exam**.
- The computer will be ready to go. You will just need to log into **Canvas** and access the exam.
- You will be **using a computer provided by the University**.
- You are expected to arrive **30 minutes before** the exam start time. The front doors will be open so that you can enter and get ready for your exam.
- Remember to bring your **student card, Australian driver's license or passport**.
- The final exam of COMP5048 is a **closed book exam**, there is no approved exam materials. You are **not allowed** to use any notes during the final exam.

If you have any further **questions of the on-campus exam**,
ask questions about exams or results by submitting an online enquiry.

3. Things to do 5 days before your exam

1. Read through the instructions on your exam Canvas site.

Exams will be hosted in **separate Canvas sites** (which you'll see in your Canvas dashboard **5 days** before the exam) identified by unit code, named **'Exam for: COMP5048**'.

Read through this site for specific instructions for preparing for, and starting your exam.

2. Prepare your computer.

Check for any program updates you might need to run before taking your exam, and restart your computer. Computers running Mac OSX Catalina will need to follow some extra steps to prepare.

If you use a **Bluetooth keyboard and mouse**, check **battery level** and charge them if necessary. **Close other programs**, turn off pop-up notifications, and clear your browser's cache. Remember, you must use **Google Chrome or Mozilla Firefox** to take your exam.

- Google Chrome instructions for clearing your cache
- Mozilla Firefox instructions for clearing your cache

3. Things to do **5 days** before your exam

3. Prepare your exam space.

The room you take the exam in should be like an exam room:

- **Put away any books, take down post-it notes on your walls or ceiling, clear your desk**, and make sure the area is as tidy as possible and if the room is dark, make sure you have a lamp

- **You won't be able to wear headphones**, and your **webcam** must be set up so that **your face is in full view** as you complete your exam

- **For a Review+ exam, unpermitted resources (lecture notes, mobile phone, tablet, cheat sheet, calculator) are flagged as part of the review process.** For more information see Additional rules for ProctorU exams.

- if you are registered with **Disability Services** and have an academic plan, carefully read through the advice on what additional resources you can have with you during your exam.

4. Get your University of Sydney student card or government-issued ID.

This will be used to verify your identity. International students should use their passport or student card. Domestic students can use their passport, driver license, proof of age card, or student card.

During the identity checks, students who wear full-face veils can request a live proctor of a specific gender. Use the 'chat now' button to do so.

5. Remind your housemates or family not to interrupt you.

Remind your friends, family, or flatmates that you will need to have good bandwidth while you take your exam. **They should stay off the internet, and avoid streaming movies or tv or playing games**.

6. Go to the bathroom beforehand.

The action of leaving the room will be recorded and reviewed.

3. Things to do 5 days before your exam

7. Start your exam by logging in to your exam Canvas site.

Navigate to your unit with the online exam and be ready to go **at least 10 minutes** before your exam, but the exam will not begin until the set time.

It will take about **10 minutes** to connect and work through the pre-exam checks, so most students will officially begin the exam about ten minutes after the scheduled start time.

The time it takes to set up will not impact the available exam time.

4. During the **final exam**

If you face **ProctorU issues**, contact: **ProctorU support**

- **Live chat within your student account (click on the chat box marked with the blue owl** **)**

- Call them on **1800 957 152**

- Email them on support@proctoru.com

University systems support

If you need help with **USYD systems**, like **Canvas or the VPN**, contact Student IT.

- Phone: **02 9351 2000** (option **2** for ICT) between 8am and 9pm.

- Email: ict.support@sydney.edu.au

Other help: https://canvas.sydney.edu.au/courses/23380/pages/help-centre

Do not contact the teaching team!

Questions?