# Introduction

## COMS10018 - Algorithms

Dr Christian Konrad

## Algorithms?

A procedure that solves a *computational problem*

## Computational Problem?

- How often does "Juliet" appear in Shakespeare's "Romeo And Juliet"? (181 times) (text/strings)
- Sort an array of $n$ numbers (all areas)
- How do we factorize a large number? (crypto)
- Shortest way to travel from Bristol to Glasgow? (graph algorithms)
- How to execute a database query? (databases)
- Is it possible to partition the set $\{17, 8, 4, 22, 9, 28, 2\}$ into two sets s.t. their sums are equal? (scheduling, load balancing)
  $\{8, 9, 28\}$, $\{2, 4, 17, 22\}$

# Brain Behind Your Software


**Algorithms:**

- Fabric that Software is made of
- Inner logic of your Software
- Insufficient computational power $\rightarrow$ Improve your algorithms!

# What we want and how we work

## Efficiency

- The faster the better: **Time complexity**
- Use as little memory as possible: **Space complexity**

## Mathematics

- We will prove that algorithms run fast and use little memory
- We will prove that algorithms are correct
- **Tools:** Induction, algebra, sums, . . . , rigorous arguments

## Theoretical Computer Science

No implementations in this unit!

# What you get out of this unit

**Algorithm 1** Single-pass Semi-Streaming Algorithm for MDS

**Require:** Bipartite input graph $G = (A, B, E)$ with $|A| = |B| = n$

1: Let $D_1, D_2, \ldots, D_{\log n} \leftarrow \{\}$
2: For every $a \in A$: $d(a) \leftarrow 0$
3: $U \leftarrow \varnothing$ {Keep track of dominated nodes ($U \subseteq B$ always holds)}
4: For every $b \in B$: $C(b) \leftarrow \perp$ {Output cover certificate}

**Goals:** First steps towards becoming an algorithms designer

1. Learn techniques that help you design & analyze algorithms
2. Understand a set of well-known algorithms

**Systematic Approach to Problem/Puzzle Solving**

- Study a problem, discover structure, exploit structure and design algorithms
- Useful in all areas of Computer Science
- **Interview Questions:** Google, Facebook, Amazon, etc.

# My Goals

**My Goals**

- Get you excited about Algorithms
- Make you contribute to Algorithms research in Bristol

**Algorithms in Bristol**

- 1st year: OOP + **Algo** (Algorithms 1)
- 2nd year: **Algorithms** and Data (Algorithms 2)
- 3rd year: Advanced Algorithms (Algorithms 3)
- 4th year: Advanced Topics in Theoretical Computer Science (Algorithms 4)

**BSc/MEng Projects, Reading Group, Summer Internships, PhD students**

# Unit Structure

## Teaching Sessions

- **Lectures:** Mondays 10am, Fridays 2pm
- **Problem sheet sessions:** Throughout the week

$$\boxed{\text{Week } X+1 \text{ covers sheet released in Week } X}$$

- **OPTIONAL Drop-in/discussion session:** (Fridays 1pm-2pm) ask questions about the material or other algorithms-related topics
- **OPTIONAL Office hours:** (Monday 11-noon) Ask me anything about the unit

## Assessment

- Exam: Counts 50% towards your final mark in the joint unit "Object-Oriented Programming and Algorithms"
- **Attention:** Algorithms exam is a must-pass component

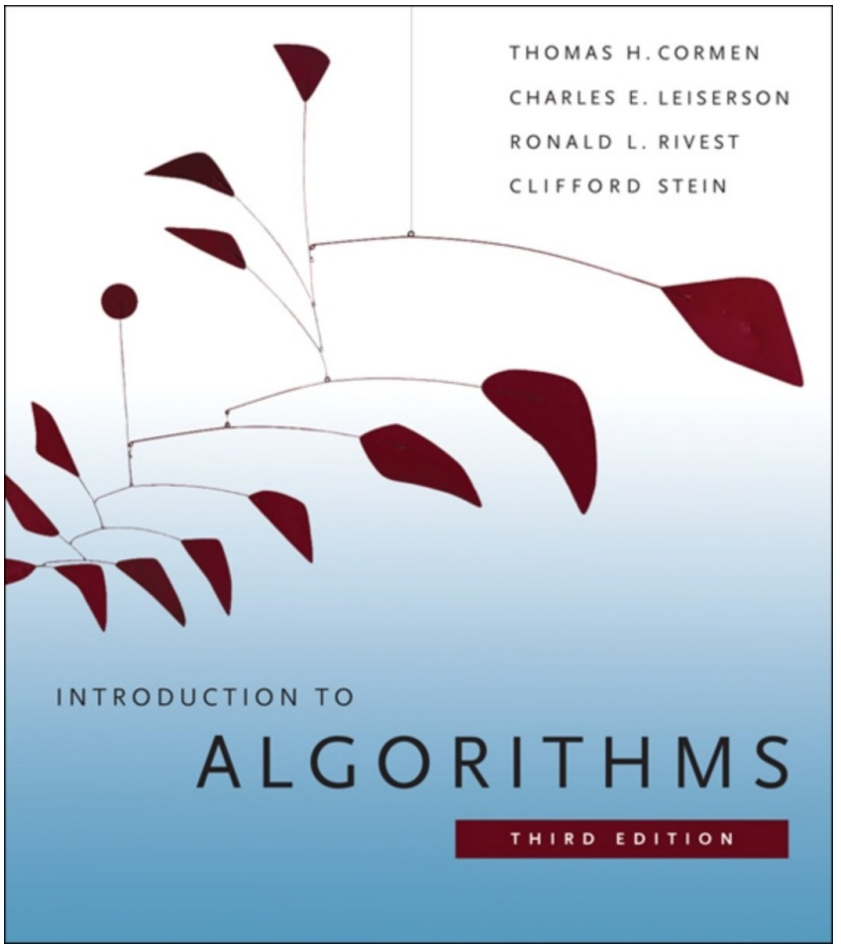
# Teaching Staff

**Teaching Staff**

- **Unit Director:** Dr Christian Konrad (christian.konrad@bristol.ac.uk)
- **Lead TA:** Conor O'Sullivan (c.osullivan@bristol.ac.uk)
- **TAs:** Artem Borisov, Michael Degamo, Amos Holland, Harley Huang, Sophia Izwan, Thomas Parr, Vlad Petre, Kasim Rafiq, Ava Raisian, Archie Walton, Stephen Yang

# Further Reading

- More details on many of the topics discussed in this unit
- However, not all topics can be found in this book
- Unit materials cover everything you need to know



# How to Succeed in this Unit

**How to succeed**

- Make sure you understand the material
- **Work on provided exercises!**
- Use MS Teams channel for discussions and questions
- **Work on provided exercises!!**
- **Work on provided exercises!!!**

**Unit webpage:** Use link on blackboard

`https://bristolalgo.github.io/courses/2025_2026_COMS10018/coms10018.html`

# What's next

**This Week**

- Monday 10am-11am: Lecture (today)
- Friday 2pm-3pm: Lecture

**Next Week** and every subsequent week

- Monday 10am-11am: Lecture
- OPTIONAL Monday 11-noon: Office Hours
- Monday, Tuesday, Thursday: Small-group problem sheet sessions
- Friday 2pm-3pm: Lecture
- OPTIONAL Friday 1pm-2pm: Drop-in Session

**Good luck and enjoy! Questions?**