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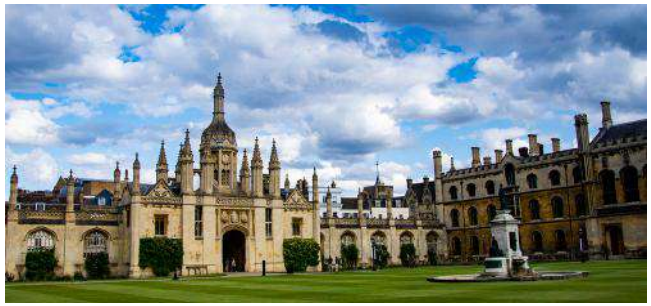


Computer Science

SYLLABUS OVERVIEW 16-18 YEARS OLDS

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About Immerse

Immerse Education is an award-winning academic summer school provider offering programmes for 16-18 year olds in centres of academic prestige.

The aim of these programmes is to provide participants with academically challenging content that develops their understanding of and passion for their chosen discipline. Through 40 hours of academic sessions, the programmes also offer young students unique and valuable insights into what it would be like to study their chosen subject at university.

This Syllabus Overview provides a summary of the topics and subject areas that participants can encounter during their studies with Immerse. It has been carefully created by our expert tutors who are current members of world-leading universities, and who have experience in teaching undergraduate students.

Academic Sessions

The academic sessions at Immerse are arranged into modules to enable participants to explore a broad range of topics over the course of two weeks. The modules included in this syllabus overview are indicative but not prescriptive.

Tutors are encouraged to include their own specialisms and also focus on any particular areas of interest expressed by participants within the class. They may choose to provide further detail on a specific topic, or they may include new material and information that builds on the knowledge already developed during the programme.

Personal Project

Each programme includes an element of individual work, generally termed the 'Personal Project'. This can take many forms but is commonly an essay or presentation delivered on the final day of the programme. Participants will receive feedback on this work which may also be mentioned in the participant evaluation which is provided in writing by the tutor once the programmes have ended.

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Preparatory work

Some tutors may ask participants to complete some preparatory work, such as reading or a series of exercises in advance of the programme. Participants are strongly encouraged to complete this work since it will be included in the opening sessions of the programme. Any preparatory tasks will be provided in advance of the programme directly to the participant.

Academic Difficulty

As all of our programmes are designed to provide a unique introduction to advanced material, the syllabus will be academically challenging at times.

This is something to be excited about and all of our tutors will encourage and support participants throughout the programme. Immerse Education aims to develop every participant regardless of ability, and our tutors will adapt their teaching to individual needs.

Aim of the Computer Science Programme

The Immerse Education Computer Science programme is designed to build upon the foundation of knowledge that participants have already gained in a traditional classroom environment and highlight how this can be used to inspire further study at university. Participants are encouraged to explore new material in-depth and to form independent and considered opinions and ideas based on sound research and practical knowledge. By the end of the programme, participants will have a good understanding, not only of university-level content, but also the variety of degree programmes available in subjects related to computer science. Beyond this, participants also explore the career opportunities available to graduates in this field.

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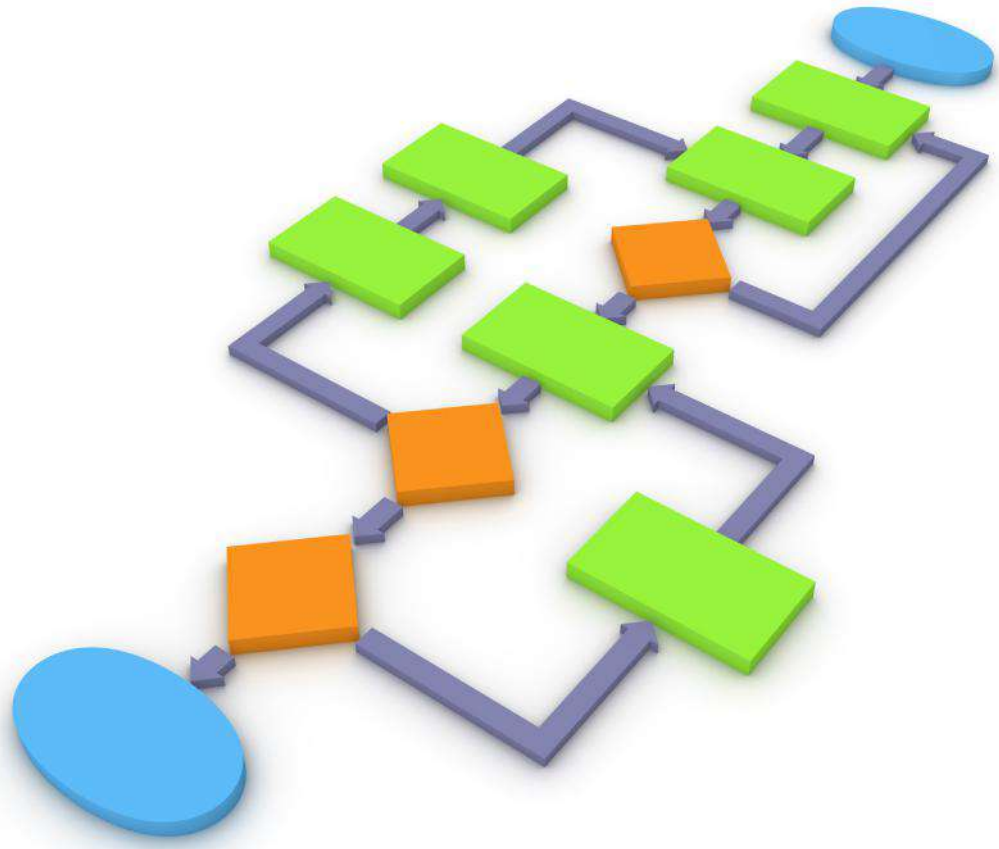
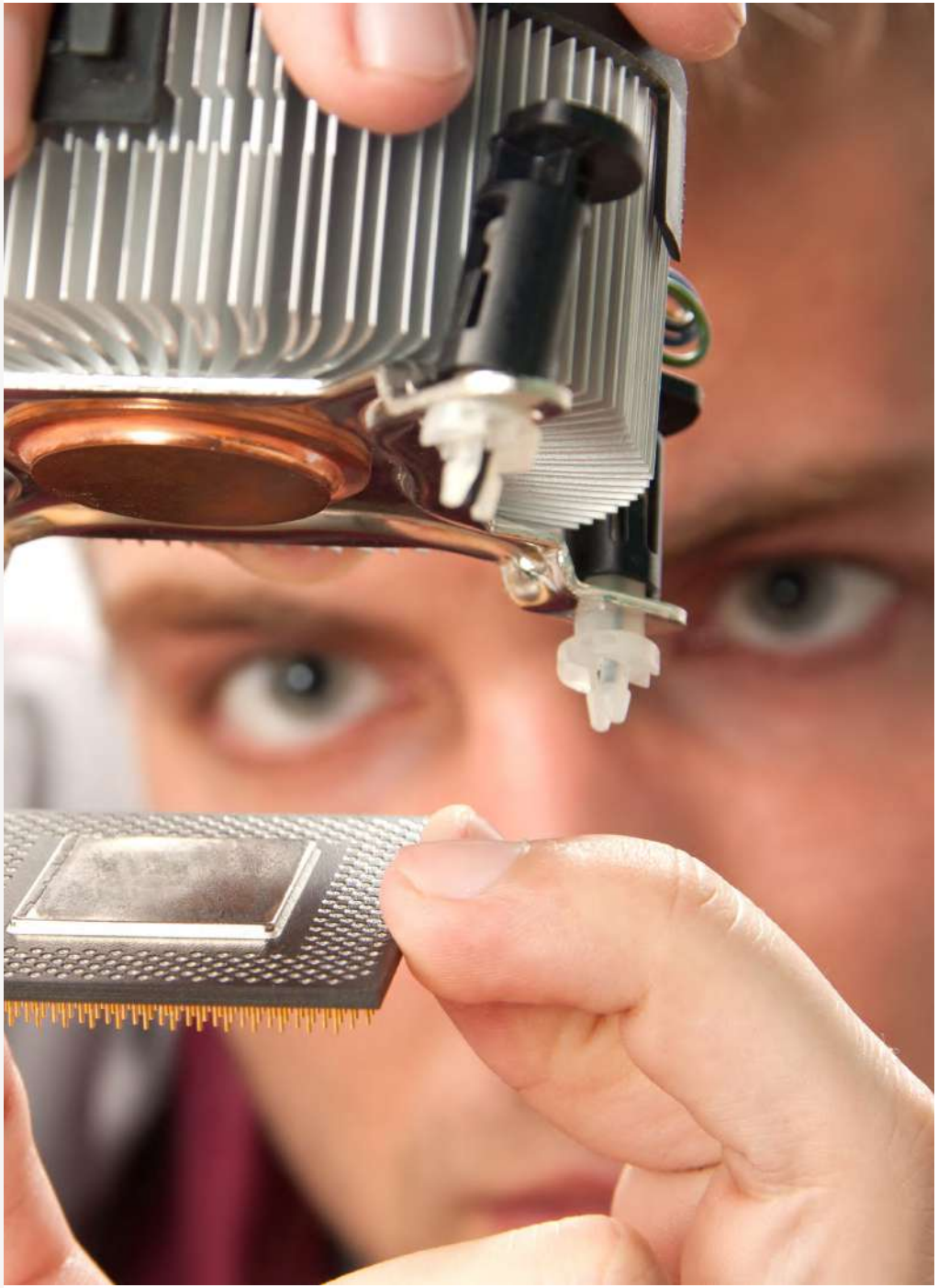
Models of Computation

The cornerstone of computer science is models of computation. In this session we introduce computability theory, and complexity, and show how the building blocks of computer science are based on very simple models, which in turn are very powerful. We will explore various automaton examples, from combinatorial logic through to the Turing machine. Introducing the mathematical syntax for these automaton examples, we can express them, and show how they can also be interpreted graphically. This forms the basis for our later exploration of topics such as algorithms and understanding how technology has developed at such a rapid rate.

Algorithms

Everyday tasks such as sorting a list of numbers may seem trivial to humans, but to computers these are challenges. In this session, we will show how even the simplest of tasks can be tough when we consider an algorithmic approach. When we have two or more algorithms that achieve the same output, how do we pick which is best? For this we will look at time and space complexity, two measures used to assess algorithm performance, and how this relates to one of the great questions in computer science: P versus NP.





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Object-Oriented Programming

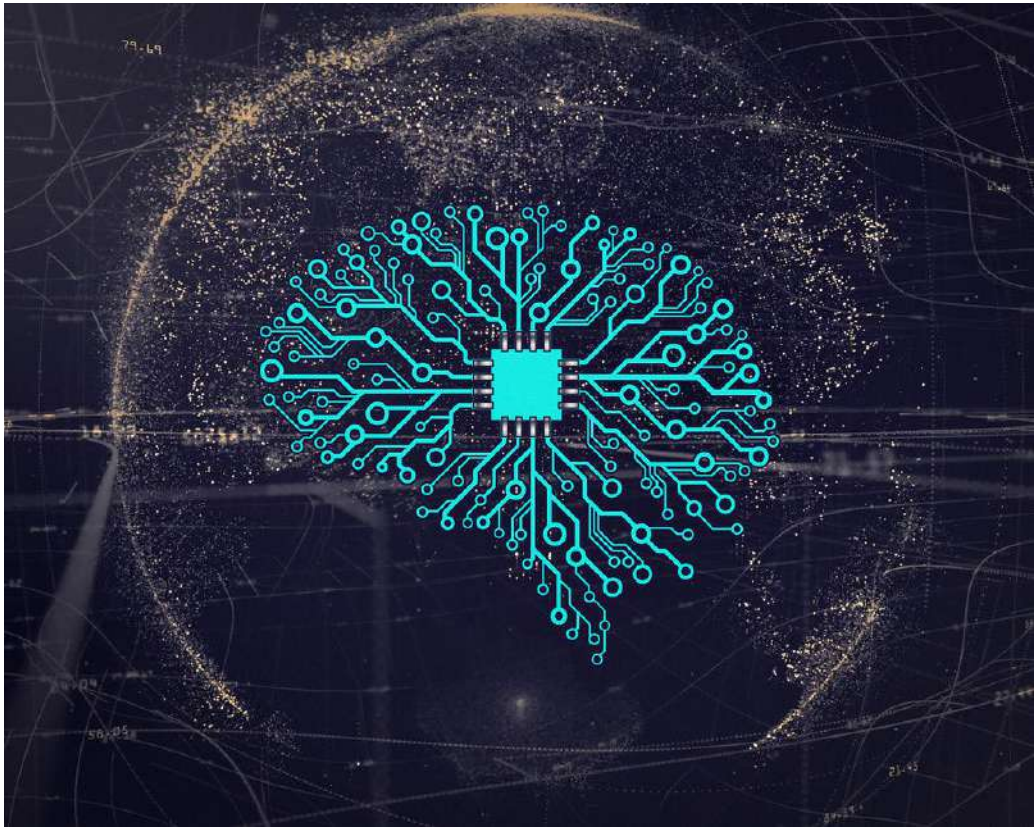
Object orientation or OO, is a design paradigm introduced and used since the late 1950s. Object orientation allows us to express components as objects, packaging what we need to know about a component in a self-contained unit of code, which has its own functionality and state. We can build layers of these objects to create more powerful representations, whilst simultaneously simplifying our code, and promoting the reuse of code. In this topic we will demonstrate how we can achieve this with Python, and the benefits and drawbacks of this paradigm.

Computer Hardware

Computer hardware has changed significantly over the last 50 years. We will discuss how models of computation first gave direction to computer hardware, from vacuum valves through to modern NAND-flash storage, and how these advancements have affected computational power. The law concerning expected advances in computational power is Moore's law, in this topic we will look at the background to this law, and how far (or near) we are from it. We will also approach high-performance computing and supercomputing, and how in the modern day, high performance computers are very similar to your everyday computer.

Internet Infrastructure

The development of the internet and the World Wide Web had an enormous impact on nearly all aspects of our lives – a brief internet outage can easily reveal how much we depend on continuous connectivity and instant access to information. Nevertheless, the more one learns about how the internet infrastructure operates, the more amazing it is that it works as well as it does. To explore this feat of human engineering, we will examine the layers of the Internet protocol suite, a great example of modular abstraction and standardisation. We will also look at widely used wireless technologies such as Bluetooth and Wi-Fi.



AI and Machine Learning

The rise of machine learning in the past five years is a great example of the transformative power of computer science: as soon as computational power caught up with the requirements of algorithms formulated many decades ago, the technology revolutionised entire industries and continues to surprise us with achievements that seemed impossible just a few years ago. We will explore the fascinating history of AI research and the initial experiments that seemed promising but ultimately turned out to be dead ends. Then, we'll turn to the probabilistic basis of machine learning and neural networks, demystifying this arcane-sounding technique and its many variations.

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Databases and Big Data

Data science, data mining, big data, these scary-sounding buzzwords have entered the marketing vocabulary of many businesses and tech companies, raising important questions about data privacy and ownership. On the technical side, however, these notions all arose as a result of the enormous amount of data produced by people, and the technological advancements in data storage, retrieval, and analysis. This session explores the relational database model still widely employed in traditional software systems. Then we discuss the rise of data-intensive applications and the NoSQL movement, fuelled by the need for an alternative to relational databases which can handle the huge amounts of unstructured data produced and captured every day.

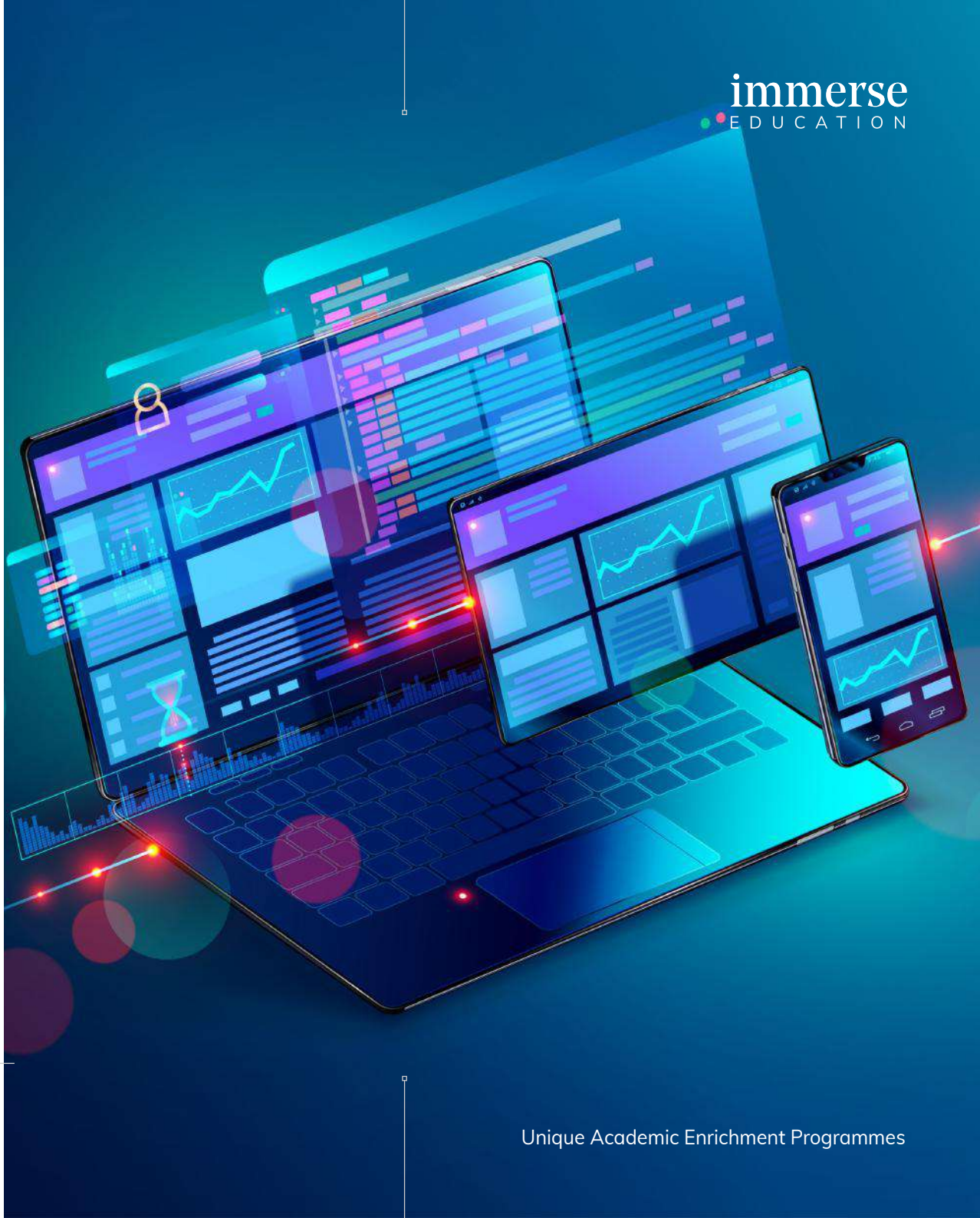
Playing Games

In the 1990s IBM successfully defeated chess grandmaster, Garry Kasparov, a feat which shocked the world. IBM's machine, Deep Blue, employed artificial intelligence to defeat Kasparov. But what is artificial intelligence? What does it mean to be rational? And how does this tie in with playing games? Further, why do we need artificial intelligence, and what does it provide us with? A commonly misunderstood question. In this topic, we will consider algorithms such as MiniMax, simulated annealing, genetic algorithms, and Monte Carlo methods, and how they can be used for optimisation problems.

TOPICS LIST

Web Development

Developing a website from a blank page and bringing style to your website hasn't been easier. After developing the structure of the website using HTML, we experiment with different styling options and how best to incorporate them over entire websites using CSS. While the name may suggest that JavaScript is like Java, they are completely different – it is one of the main programming languages for the Web. We will explore how we can bring our site to life with a touch of JavaScript, as it allows us to create more responsive sites, that allow you to add action and responses when the user interacts with your website.



Personal Project

Throughout the fortnight, participants will be working on their own personal project. Having been provided with a brief, participants should research and prepare a presentation for their peers. This will build upon an aspect of the theory that they have learnt over the course of the programme and is also an opportunity to showcase the practical skills they have developed. The presentation is followed by questions from the audience and wider class discussion of particular points of interest. The tutor may also include feedback about the presentation in the written evaluation which is sent to participants after the programme has ended.

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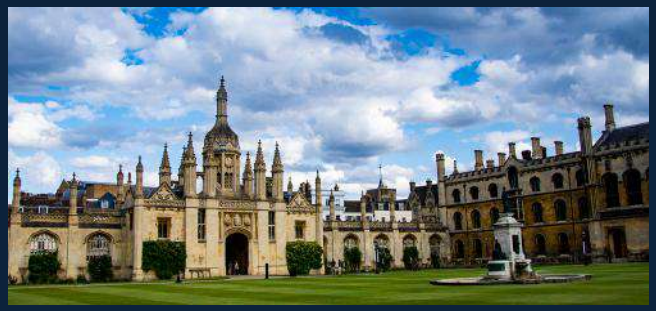


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THE QUEEN'S AWARDS FOR ENTERPRISE 2018

BAC ACCREDITED

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