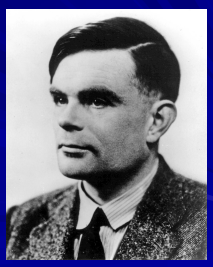
CS&P: The Educational Imperative

Computer Science & Philosophy

The Educational Imperative, and Steps Towards Achieving It



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Brief Personal Introduction

- 1976: Entered Oxford in Mathematics
- 1980: Graduated in Philosophy & Theology
- 1980-3: Postgrad in Philosophy at Oxford
- 1983: Temporary Lecturer at Glasgow
- 1985: Appointed at Leeds University as Lecturer in Computing & Philosophy
  - Created numerous interdisciplinary programmes involving Computing, Philosophy and cognate disciplines
- 2005-: Hertford College, Oxford
  - Fellow and Professor of Philosophy, also CS Faculty
  - Proposed and campaigned for new degree programme in Computer Science & Philosophy, which began 2012

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The Super-Flexible Oxford Course in Computer Science and Philosophy

- Year 1 Functional programming, Imperative programming, Design and analysis of algorithms, Discrete mathematics, Probability, *General philosophy*, Elements of deductive logic, Turing on computability and intelligence
- Year 2 50% Computer Science, *50% Philosophy*
- Year 3 25%-75% Computer Science, *25%-75% Philosophy*
- Year 4 0%-100% Computer Science, *0%-100% Philosophy*

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Why Combine the Disciplines?

1. Society's Perspective
   - Need for young people who *combine* technical understanding of problems with the ability to think critically and imaginatively to come up with solutions.
2. The Student's Perspective
   - Fascinating and varied subjects, great employment opportunities with combination of valuable skills.
3. The Philosopher's Perspective
   - Lots of interesting new problems raised by Computing/AI, and new methods for addressing existing problems.
4. The Computer Scientist's Perspective
   - Exploring deeper problems raised by Computer Science, and facilitating more interdisciplinary work.

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1. Society's Perspective

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A Multitude of Societal Problems

- Consider, for example:
  - Climate change, ecosystem stress, extreme events, potential famine, mass migrations; Cultural conflicts (e.g. racial or religious), political instability, crises of authority, economic instability; Healthcare crises, drug resistance, epidemics.
- Add to these some specific AI risks:
  - Economic polarisation (from monopolistic "big tech", automated financial trading etc.); Political manipulation (from money, targeted advertising, etc.); Widespread unemployment (as people lose out to computers, self-driving cars, and robots etc.). For many other issues in AI Ethics, see https://www.philocomp.net/ethics.htm.

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Not "Business as Usual"

- These new problems require a generation of thinkers who can *both* understand the relevant technologies, *and* think creatively "outside the box" to help find new solutions.
  - Philosophers specialise in this sort of creative, critical thinking about standard assumptions; and much of the modern world has built on their ideas (e.g. moving from the medieval to the scientific world-view, from religious authority and "divine right of kings" to democracy etc.).
  - But modern problems are so complex, that future philosophers will need AI to help solve them!

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2. The Student's Perspective

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An Attractive Degree Programme

- Interesting and varied – a wealth of problems and skills, both technical *and* discursive.
- Nevertheless a natural affinity (logical, systematic thinking, and intellectually creative).
- Flexible – can choose many different directions (in both disciplines) as interests develop.
- Empowering, maximising potential for a rapidly-changing and unpredictable world.
- Economically valuable: excellent employment / startup opportunities, often directly using skills taught, *both* technical and discursive.

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A Brilliant Combination for Both Study and Employment

- Computers are being increasingly applied to almost every new area of study and thought …
  - This requires *intellectual flexibility* and *imagination*, as well as technical skill.
  - Studying Philosophy is ideal for developing the ability to think "outside the box".
- Technical skills are not enough for high-level management positions …
  - Philosophy teaches you to *synthesise written material*, to *argue and present a case*, *understand other points of view*, to *write good reports* etc.

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The Employers' View of *Computer Science and Philosophy*

"We believe that the degree is likely to produce high-value graduates who combine technical and analytical skills with rhetorical and literary skills. These are just the kind of people that industry, and we believe society generally, wants. The degree will produce graduates who can potentially become members of executive boards of companies, where clarity of thinking combined with knowledge of technology issues will be vital. … It will also produce software engineers with the skills to analyse, and intelligently explain and document, complex problems. We believe that the new degree is likely to excite and attract strong, ambitious candidates."

Oxford Computer Science External Advisory Board

(see www.philocomp.net for more)

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3. The Philosopher's Perspective

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New Philosophical Questions

- Here is a cluster of AI-related questions in the area of Mind / Action / Responsibility / Ethics (as mentioned in a recent outreach talk):
  - Could a computer think in the same way that we do?
  - Could a computer be conscious?
  - Could a computer count as a "person", with something like personal identity over time?
  - Could a robot be capable of free action, as we are?
  - Could a robot legitimately be morally assessable (e.g. praised or blamed) for how it behaves?
  - Could a computer or robot be worthy of moral consideration by us (e.g. so we avoid harming it)?

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- There are also many others, in many different areas:
  - *Logic*: At the core of both disciplines, with numerous issues of interest to both computer scientists and philosophers.
  - *Ethics of AI*: Many important issues such as algorithmic bias, automation and unemployment, data security, deep fakery, privacy, propaganda, robot ethics, safety, superintelligence.
  - *Philosophy of Science*: How far should computer models (e.g. of global warming) be trusted?
  - *Philosophy of Social Science*: Can computer models revolutionise the study of Economics and Politics?
  - *Philosophy of Mathematics*: Should we accept computer-generated proofs we cannot fully grasp?
  - *Aesthetics*: Can a computer create genuine art?
  - *New Philosophical Fields*: Philosophy of Artificial Intelligence, Philosophy of Artificial Life, Philosophy of Computation, Philosophy of Information, ...

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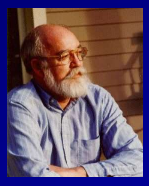
A New Paradigm of Explanation

- Aristotle: conscious purpose (even falling stones!)
- Galileo, Descartes, Boyle: mechanism and inertia
- Newton: mathematical instrumentalism
- Hume: naturalist animal psychology
- Darwin, Wallace: evolution
- Einstein: curvature of space-time
- Bohr, Heisenberg: interactive wave functions
- Turing: algorithms – quasi-purposive, but also automatic: no need of consciousness to achieve outcomes defined in terms of information. Hence *information processing* without *phenomenology*.

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A New Tool for Thought-Experiments

- Daniel Dennett celebrates how philosophers with computing abilities have a wonderful tool for extending their minds, through …



"the creation of prosthetically controlled thought experiments of indefinite complexity … kept honest by requirements that could never be imposed on the naked mind of a human thinker acting alone. … This is a great way of confirming or disconfirming many of the intuitions or hunches that otherwise have to pass as data … Philosophers who see this opportunity will want to leap into the field, at whatever level of abstraction suits their interests, and gird their conceptual loins with the simulational virtuosity of computers."

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An Inductive Humean Perspective

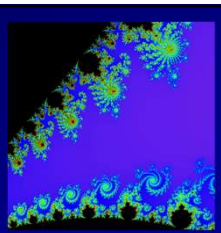


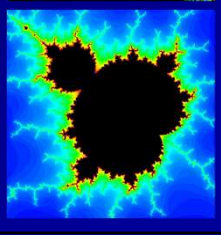
- Our reasoning faculty is very fallible and subject to all sorts of biases.
- Even when reasoning in a narrow and precisely defined domain (e.g. writing programs), we are apt to make errors which, once revealed, look obvious.
- Hence complex abstract reasoning in less precise domains (such as would-be a priori metaphysics) is even more likely to err.
- Our reasoning is most reliable in domains where we can rigorously check results as we go, correct our errors, and learn from experience. Thus we acquire inductive "understanding" of new phenomena.

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Exploring Chaos

- "Chaos" only came to light through computer models, but plays a major role in lots of natural phenomena.
  - Even the very simple "logistic equation" is chaotic.
  - Explore this, and fascinating mathematical objects such as the Mandelbrot Set, though our online programs;
  - Create "self-similar" patterns of great beauty ...





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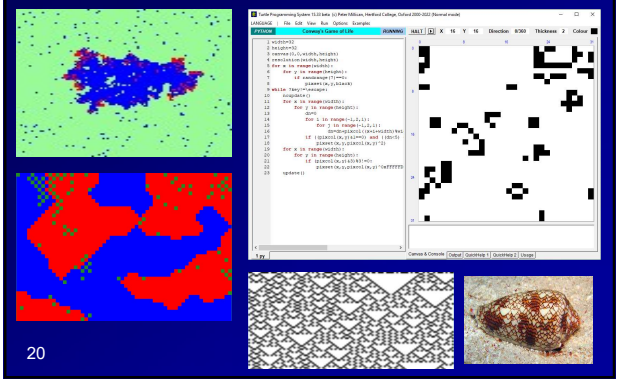
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Programs Built Into *Turtle System* and at www.turtle.ox.ac.uk/csac

- Comprehensible programs (in simple Python, BASIC and Pascal) to illustrate:
  - Animation (e.g. motion under gravity);
  - Rocket dynamics and shooting for orbit;
  - Cellular automata: "Life", epidemics, shells;
  - Chemistry: diffusion, Brownian motion;
  - Biology: evolution, co-evolution, flocking;
  - Physics: waves, quantum interference;
  - Games: knight's tour, nim, tic-tac-toe.
  - Chaos and iterated function systems ...

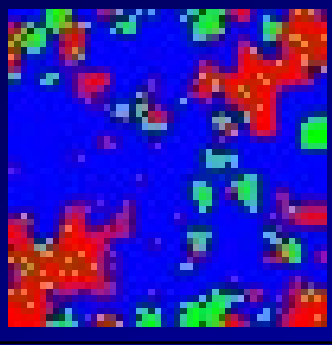
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Cellular Models and Automata



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Snapshot of an IPD: Evolving Morality?



Every cell has a sequence of 10 interactions with each of its 8 neighbours. Then the most successful strategy in the neighbourhood "wins the cell". Most were initially naïve cooperators (RED), but the nasty defectors (BLUE) have ruthlessly taken advantage of them. Small groups of tit-for-tats (GREEN) survive, because they support each other and don't allow the defectors to exploit them beyond the first turn. Before long, the greens will dominate and the blues disappear.

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Tentative Conclusions From a Recent Outreach Talk

- Causal determinism doesn't imply predictability, and nor does it conflict in any way with behaviour that is purposive and/or rational. Perhaps it's less relevant to "free will" than commonly thought?
- Evolution can explain not only how our bodies work, but also how we think: giving us desires and feelings that concern others as well as ourselves.
- These could include "moral" feelings (e.g. of guilt, blame, or gratitude), adapting us to fit into human society, and perhaps so "hard-wired" into us that they are unaffected by theoretical considerations.

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4. The Computer Scientist's Perspective

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Interdisciplinary Computer Science

- A huge amount of work in Computer Science is now interdisciplinary, requiring the ability to talk and think with those of other disciplines:
  - Technical research across many scientific areas, from astronomy to earth and environmental sciences, to medical sciences and zoology.
  - Data collection and analysis across many economic and social domains, often relevant to policy development by politicians, lawyers etc., and raising significant ethical issues.
  - The technical and analytical often combine, perhaps most obviously in healthcare.

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Incorporating Bright Ideas

- Many computing developments have been inspired by philosophical thinking, and many computing pioneers have taken a major interest in Philosophy.
  - Philosophers developed logic and logical systems before the computer even existed.
  - The invention of the Turing machine was plausibly inspired by Turing's interest in Richard's paradox of definable numbers.
  - Computer science quite often stumbles over problems already identified by philosophers.

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Diversity, Ethics, and Influence

- Many bright young people – especially those who are repelled by the "nerdy" caricature – are more likely to be attracted to Computer Science if it is combined with Philosophy.
  - Combined Computing & Humanities degrees have a higher proportion of women (in the UK).
  - Computer Science benefits from including people with varied perspectives, especially those able to critique it (e.g. from an ethical point of view).
  - Influence in public and commercial policy requires skills in presentation, discussion and persuasion, at least as much as technical understanding.

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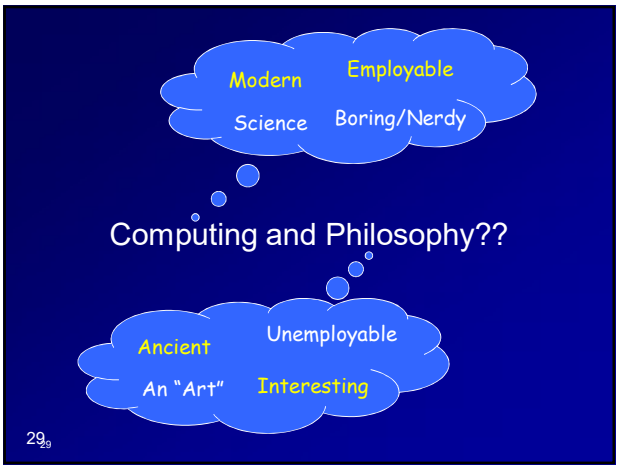
5. The Problem

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School Indoctrination

- Arts/Humanities and Sciences
  - In the UK (where just 3 subjects are typically done at A-level), students tend to be channelled into "Arts" and "Science" streams (by social assumption or timetabling).
- Essays are Torture
  - Mathematically inclined students are often repelled by the idea of writing essays, owing to school experiences.
- Philosophy ≈ Religious Studies
  - Philosophy is seen as closely allied to Religious Studies (e.g. the course on "Philosophy of Religion and Ethics").
- Philosophy Isn't "Useful"
  - It conveys neither technical skills nor useful "knowledge"; and is associated with some very negative stereotypes!

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The Outreach Effort

- www.philocomp.net
  Devoted to links between the disciplines, including to software (notably *The Turtle System*, the *Elizabeth*), videos and other resources.
- www.turtle.ox.ac.uk
  The Oxford *Turtle Project*, providing user-friendly resources for learning programming, including programs of philosophical interest.
- https://www.bebras.uk/
- https://oucc.uk/
  Mass-entry computational thinking competitions (Bebras UK now over 300,000 per year; 10% invited into OUCC)

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