



FACOLTÀ DI FILOSOFIA
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Proposal for the Constitution of a BD Course on “Computer Science & Philosophy”

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1 Aims of the Proposal

- The aim of the Computer Science & Philosophy (CSP) Bachelor Degree (BD) study program is threefold:
 1. Endowing philosophy students of a CS background making able them of **programming at a good level** in order that several **new job opportunities open to them** in the growing field of communication technology, of semantic database management, of Artificial Intelligence (AI) applications (automated control systems, autonomous systems, etc.).
 2. Giving students a high-level, **integrated humanistic-scientific education** in which the philosophical component in the CSP study program is not subjected to the Computer Science (CS)/Information Technology (IT) component like, for instance, in the UK similar programs, but has an equal dignity/relevance.
 3. These are all CS fields in which the humanistic skills are highly required on condition that people **are capable of reasoning in a double way**: the **humanistic one** (intensional and modal logics) and the **recursive one** (mathematical logic). This double competence is generally what is lacking today on both sides and this is the **added value** of our CSP Course.
- Of course, the BD program in CSP is only the first step, and it is necessary to integrate it in the very next future with MD and PhD degrees.

1.1 The first aim: endowing humanities students with CS skills

- Having the fortune of seeing at Catholic Universities from the privileged observatory of Rome, I realized that the problem of a **not-integrated Humanistic education with the Scientific one** is a generalized problem, depending on the so-called “separation of the two cultures”, affecting like a tumor the history of modern science and thought.
- **We are thus in a lucky position** because the philosophical/humanistic training of a CSP course **is intrinsically related**, for its own nature, to the “cutting edge” technologies in CS, IT, and AI, as far as **all related to the artificial simulation/integration/support of human conscious behaviors and abilities**.
- Now for this type of research and of jobs, to have a team of researchers/workers in which there are open-minded people coming from a humanistic discipline, but with **an advanced and not amateur competence in CS** is essential, as I realized in thirty years of collaborations in this field. **The original solutions that persons with a similar double training** are able to suggest never can be reached by people with only a scientific training.
- On the other hand, people with a similar double training **must necessarily interact** with people with a specific and specialized CS training.
- What is essential is that **a person with a humanistic education be able to reason and to speak the language of the computer scientist, because generally the opposite cannot hold**. Nobody can require a scientist or an engineer to be a humanist if not in an amateur way: the scientific/engineer training is too engaging for allowing to deepen also humanistic disciplines.
- Also in this sense, therefore, **an adequate complete (BD/MD/PhD) CSP study program** is essential in a wider sense for:

1. Giving a model of “**extravasation**” of the **humanistic culture** into the **technological one** of our XXI cent., for avoiding that the treasures of the venerable philosophical and religious traditions be “ghettoing” in the enclosures of the **cultural folklore** and of the **private religious and ethical practice**, without any relevance for our society, its economy, its politics, its ethics, its culture, and ever its science and technology.
 2. Giving **an essential improvement to the development of high-level hw/sw research institutions and companies in the CS/IT realm**. Indeed it is critical also for our societies having **many professionals educated in the cutting-edge CS/IT, but also Artificial Intelligence (AI) technologies** all related – as the list at the next point emphasizes – to the artificial simulation/integration of human high-level skills and behaviors: linguistic, cognitive, social, ethical, economical...
- See, on this regard, the dossiers that I attached as the **first three attachments** of this document.

1.2 The second aim: integrating humanistic and scientific education

- The second aim of this proposal consists in giving universities implementing a CSP program a **leadership position** among the other Academic Institutions endowed with Humanistic and Computer Science Engineering (CS) Dept., but not with a study program integrating systematically them.
- Effectively, in the world, examples of this specific type of course and study program (with the identification GV45) exist only in UK, all following the first example of Oxford University (BA-MA, active since 2012: <http://www.ox.ac.uk/admissions/undergraduate/courses-listing/computer-science-and-philosophy>), and then, to quote the more relevant, in the University of York (UCAS) – only BSc, and a MA jointly with the School of Philosophy <https://www.cs.york.ac.uk/undergraduate/ug-courses/bsc-cs-phil/> – and in the University of Edinburgh (School of Informatics) – only BA jointly with the School of Philosophy <http://www.inf.ed.ac.uk/undergraduate/csph.html> – even though it seems that several UK universities are offering courses and joint degrees on this topics (e.g.: Keele, Aberdeen, Hertfordshire, Glasgow, Kent,...), anyway signifying the growing interest for the topics.
- On the contrary, in other European countries, US, and Japan, a specific course and study program on these topics does not exist, but only courses on “philosophy of computer science”, “philosophy of information”, etc. that are completely different topics as to ours, just as “philosophical (modal) logic” is not “the philosophy of logic”.
- However, the worldwide growing interest on our argument is proved by **the growing number of institutes and research groups**, in an impressive number of prestigious universities and academic institutions, all relating **humanities and computer science**, in fields all critical for computer science CS/IT research & development (R&D) such as: **artificial intelligence and robotics, natural language processing, semantic databases, semantic web, artificial cognitive systems, computational epistemology, bioinformatics and theoretical biology, machine ethics, autonomous system ethics, artificial moral ecologies, agent-based social simulation, agent-based computational economics, etc.** (see for an impressive list, continuously updated, of these research centers with the relative web links, the specific page of the web site dedicated to the students of Oxford CSP course: www.philocomp.net/links.htm).

1.3 The third aim: the proper of a CSP Course

- The third aim to be pursued by the CSP Course, consists in giving CSP students a complete, high-level, **integrated humanistic-scientific education in which the philosophical component in the CSP study program is not subjected like in the UK programs to the CS/IT component, but has an equal dignity/relevance.**
- To see this limit in the UK study program of CSP Courses, it is sufficient to start from reading the brochure with the detailed **Oxford study program scheme** of their CSP course, that I inserted as a **fourth attachment** of this document. As you see, in it **the philosophical component is too poor**, not only from the standpoint of a sufficient philosophical formation, but also and overall for a professional training of CS/IT professionals specialized in the simulation/integration of human skills/behaviors in CS/IT/AI end products, that is the proper mission of a CSP course with BD/MD degrees.
- This depends on the fact that the philosophers who prepared this study program **have not generally the richness of the humanistic and metaphysical background** that a Catholic philosopher – but also a philosopher expert in the study of the Religion Traditions, the Indian in our case – generally has.
- This specific competence, if **integrated with a proper understanding of the potentialities of the “philosophical (modal) logic”, and of the “category theory (CT)”** for developing “computational semantics” in automatic systems (either in hw or sw), allow us and, if we work well, our students to generate final products capable of **“pouring”** – for paraphrasing the Gospel – the **“old, good wine”** of our ontological, ethical, anthropological traditions into the **“new containers”** of CS/IT/AI products. For instance, this requires a specific choice of specializing our CSP Course, at the level of a further MTech degree, not discussed in this document, and of its research laboratories, in particular types of applications.
- Having CS/IT/AI professionals well trained in traditional philosophy and able to “translate” it into the formal language of CS is indeed **fundamental for the future of our technology and of our societies.** The automation of a lot of tasks/jobs implies not only a deep revolution of job market (see the first attachment to this document), but also the **necessity of implementing ethical behaviors** in particular autonomous hw/sw systems (e.g., unmanned vehicles, self-driving cars, telemedicine devices, robotized nursing and surgery devices, algorithms for autonomous trading online in finance, game theory models of micro-macro economy behaviors, etc.).
- This is **one of the main challenges of our next future culture and society**, lastly addressed, for instance, by the **Future of Life Institute (FLI)**, whose name and whose motto (and logo) are a program: **“Technology has given life the opportunity to flourish like never before... or to self-destruct”** (<http://futureoflife.org/>) . FLI has become recently world-wide recognized, also for the “open-letter” it addressed during the last weeks to all Governments **for prohibiting the development of autonomous weapons** (probably developed also at some of the Indian DRDO labs), and signed from thousands of scientists all over the world, and that is available on its web site.
- I add as a **fifth attachment the FLI paper-work** with a survey of the short/long-term research questions for making “robust and beneficial” AI, and where the core question is the necessity of implementing **ethics in autonomous systems**. Of course, the problem – not addressed in FLI paper for evident reasons – is **“which ethics?”**.

- On the contrary, this question, of course, **addresses strongly our consciences of Catholic philosophers and computer scientists**, showing the urgency of implementing in Catholic Universities some CSP Courses.

2 A proposal of CSP Programme

2.1 CSP Programme Presentation¹

- The Computer Science and Philosophy (CSP) degree allows studying fascinating topics, stimulating the creativity since the beginning, because they represent the cutting edge of the contemporary computer and information technology.
- The main topics, where the two disciplines today meet, include semantic data storage and mining, semantic web applications, knowledge representation and ontology, artificial intelligence, bioinformatics and artificial life modelling, information and machine ethics, mathematical and philosophical logic, robotics and virtual reality.
- The two disciplines indeed share a broad range of common interests, from the representation of information and of rational inference, to the cognition, intelligence, language, and decision making processes in humans (philosophy), and their possible simulation/integration in the machine behaviors (computer science).
- The novelty of these technologies, and of their broad and till largely unexpressed potentialities, requires a growing number of professionals well trained in both the disciplines, for responsibly inventing, projecting, realizing, and managing new applications.
- Indeed, on one side, the computer science education gives the necessary notions and skills for designing and developing these new technologies. On the other side, a professional and open-minded philosophical education, because expressing a millennial wisdom, not only suggests new (or forgotten) ideas to be computationally implemented. It also gives the computer scientist a wide and multifarious awareness of the moral and social responsibilities that the development of these powerful technologies implies.
- The specificity of the CSP Course and degree at Catholic Universities is that it spreads at the intersection between ancient and venerable philosophical traditions, and the contemporary mathematical and computer science culture. It is aimed thus at “pouring the old wine” of these wisdoms into the “new containers” of advanced computer technologies.

2.2 CSP Programme Objectives and Outcomes²

2.2.1 CSP Programme Objectives

1. The graduates of our program will apply the critical and logical rigor and their ability to think globally through the consequences of novel ideas and their implementations, derived from their Philosophy training, to identify complex engineering problems, and to solve them through their knowledge of Mathematics, Engineering, and Computer Science, across a broad range of application areas.
2. Their professional, intercultural, Humanistic education will allow them to identify new usages of computer-based solutions in several areas, so to apply their knowledge and skills of Computer Science and Engineering for inventing, designing and developing new applications.

¹ It follows Oxford CSP Presentations with many changes and integrations.

² I used essentially the objectives and the outcomes of your CS/IT Depts. with some integrations/corrections.

3. Their double training will allow them to apply in a specific human-oriented way their knowledge and skills of Computer Science and Engineering, with a proper understanding both of their ethical and of their realistic constraints.
4. They will be specifically prepared to work and to communicate in an inter-disciplinary, inter-cultural environment, either independently or in a team, so to be helped to demonstrate significant leadership qualities.
5. They will engage in life-long learning and professional development through self-study, continuing education or graduate and professional studies.

2.2.2 CSP Programme Outcomes

1. A specific ability to apply knowledge of computing and mathematical science appropriate to integrate or simulate human behaviors.
2. A specific ability to analyze in an inter-disciplinary and inter-cultural fashion a problem, for identifying and defining the computing requirements appropriate to its solution.
3. A specific ability to design, implement and evaluate a computer-based system, or program to meet desired human and technological needs.
4. A specific ability of teamwork with people with different humanistic and scientific expertise in order to accomplish a common goal.
5. A specific ability to communicate with a wide range of audiences, because of their inter-cultural inter-disciplinary education.
6. A specific ability to integrate logical, anthropological and social knowledge with the expertise in mathematical foundations, algorithmic principles and computer science theory in modelling and designing computer-based systems.
7. A deep understanding of anthropological, professional, ethical, legal and social issues and responsibilities.

2.3 A possible scheme of the CSP Btech Degree in 8 semesters

2.3.1 A premise

- As a premise of this Subsection, if the first one was only a proposed “techno-dream” to be shared, corrected and integrated by your knowledge and experience, much more this Second Section.
 - One **essential key-point** must be clear, however, at the beginning.
- **The theoretical but also the practical bridge** between the two halves of the CSP Course is constituted by the **formal logic courses** that must be at least **three**, like already it is in the BA study program in Philosophy at PUL, but it is not actually in the Oxford CSP program, where the CT logic is actually completely lacking, despite they have at Oxford CS Dept., one

of the world leaders of CT, professor Samson Abramsky³, whose illuminating paper I propose as **sixth attachment**, because conceived precisely in this “bridging” way. The **seventh attachment** is on the contrary about the CS application of CT logic. So the three key-courses of logic are about: a) **classical and mathematical logic**; 2) **modal and intensional logics**, the core of the “philosophical logic”; 3) **CT logic**, as the common formal framework among mathematical, and computational logic, on the one side, and the modal (philosophical) logic, on the other side.

- Another premise is that in the following scheme, I indicated generally courses that for me **are fundamental** and are indicated with an (*).
- As to the **Philosophy part of the program**, I indicated the course title according to the **idioms used generally in the Catholic faculties of philosophy**.

³ According to me, he has to be one of the key-professor to invite at our CSP Course, if he accepts. Another one, from Oxford, could be professor Luciano Floridi, who teaches “ethics of information”. He is also a friend of mine...

2.3.2 CSP BD Course Scheme

CSP COURSE TABLE		
	Philosophy	CS/IT
First Year	History of Ancient Philosophy	Engineering Mathematics I (Calculus and Mathematical Anal.)
	History of Middle Age Philosophy	Engineering Physics
	History of Modern Philosophy	Foundations of Computing and Programming in C
	Logic I (Classical and Mathematical)	Communicative English and Technical Writing
	Turing Computability and Turing Test in AI (*)	Programming Lab
Second Year	Epistemology	Engineering Mathematics II (Numerical Calculus and Discrete Mathematics)
	Logic II (Philosophical: Modal and Intensional)(°)	
	Anthropology	Engineering Mathematics III: Probability, Random Processes and Numerical Techniques
	Ethics I	Data Structures and Algorithms
	Cognitive Science and Neuroscience (°)	Database Design
		Formal Languages and Automata Theory
	Data Structures Lab	
Third Year	Ontology & Metaphysics	Engineering Mathematics IV
	Formal Ontology and Knowledge Management(°)	Principles of Programming Languages
	Ethics II	Principles of Quantum Computing
	Philosophy of Nature and of Science	Advanced Database Management Systems
	Logic III (Category Theory: mathematics, logic, computer science) ((*): Abramsky)	Object Oriented Design and JAVA Programming
		System Software Lab
Fourth Year	Ethics of Information and Machine Ethics ((*): Floridi)	Artificial Intelligence
	Deontic Logics in Formal Ethics and Law (°)	Neural Computing
	The Issue of Foundations in Mathematics, Logic, and CS (°)	Distributed Systems
	Eastern Thought & Religions	Soft & Fuzzy Computing
	Islamic Thought & Traditions	Advanced Data Mining Techniques
	Ebrew Thought & Tradirions	Cryptography
		Mobile Computing

3 Career Prospects

- Examples of career prospects are those listed in the attached CSP Course at Oxford that I report here for your convenience.

Our graduate and postgraduate employment rates are exceptional. Computer scientists from the University of Oxford have the highest graduate salaries of any UK course, according to a 2014 *Sunday Times* report, earning an average of £43,895 six months after leaving university.

All of our degrees allow graduates to enter into technical, managerial, academic, financial or commercial posts, both in the UK and abroad. In recent years, our graduates have progressed to careers in many fields that need an understanding of computer systems, what such systems can (and cannot) do, and how to design them.

Recent employers of our graduates include IBM, Google, Amazon, Palantir Technologies, Cisco, Morgan Stanley, and Goldman Sachs, with jobs such as senior software engineers and developers, analysts, chief technology officers, games programmers, and technical leads. We have also seen students going into teaching, government and policy organizations, management consultancy and law. Others have continued onto PhDs and academic or research careers, or started up their own companies.

4 Attachments to this document

4.1 The economic and social impact of next automation (*The Economist*)

4.2 Main commercial lines of the actual CS/IT/AI development (*The Economist*)

4.3 Main trends of the actual CS/IT/AI development (*Science*)

4.4 Brochure of the CSP Course at Oxford (2015-16)

4.5 A survey of research questions for robust and beneficial AI (FLI Institute)

4.6 Category Theory in mathematics, logic and CS (Abramsky)

4.7 Universal Coalgebra as a general theory of dynamic systems (Rutten)