

After that, each group will explain to the rest of the classmates the scenario received to study, as so as the possible outputs according to different ethical approaches. Finally, they will discuss each scenario in classroom, trying to reach an agreement regarding the output and ethical approach that offers the “better” solution, if possible.

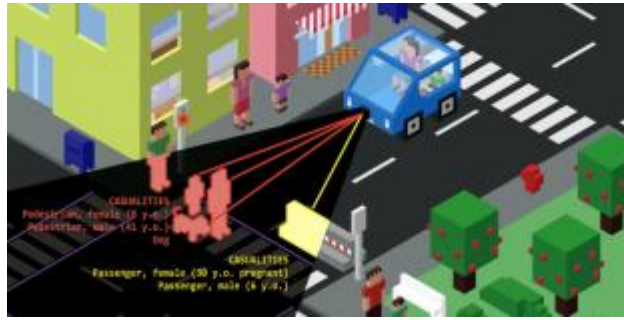


Figure 2. Pre-defined scenario to discuss in classroom
(Iyad Rahwan. <http://www.popularmechanics.com>)

Session 3. Student-designed scenarios (i)

During the third session students will be asked to develop in groups their own scenario data from the matrix in Table 1 and planning the ethical decision making process as in *Ethics Classroom (AV-DMEC)* framework shown in Figure 3. To do so, they involved in the scenario. Then, they will provide the agents with some *properties* on, they will sketch the scene by using a free tool like AccidentSketch.com scene with logical propositions using *connectors* and natural language (“time to avoid collision AND will run over the motorcyclist OR crash if

machine ethical decision making by retrieving the *Autonomous Vehicle - Decision Making* by counting the number and nature of *agents* and verifying the actions to analyse. Later on, they should also describe the road of AV; AV cannot stop in on the sidewalk).

Table 1. Matrix with sample elements

Agents	AV-car, Bus, School bus, Motorcycle, Cyclist, Pedestrian, Obstacle, Traffic light, [...]
Properties	Red/green light, Child, Boy, woman, Old man/woman, Same way, Slower/Faster, helmet, Correctly/Incorrectly, Crash, Stop, Run
Connectors	AND, OR, IF
Ethical approaches	Utilitarian, Deontological

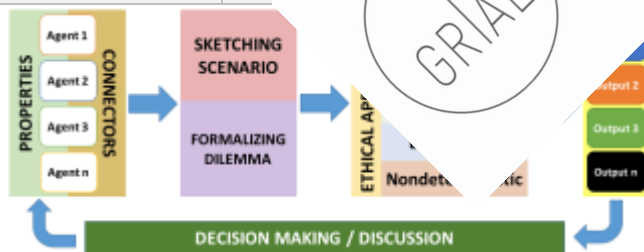


Figure 3. AV-DMEC framework

Session 4. Student-designed scenarios (ii)

After verifying that the sketch and the logical propositions match and clearly describe the scenario, students will be asked to analyse the possible outputs taking into account different *ethical approaches*. After studying and discussing such approaches, they should select the better ethical approach according to the most desirable output and explain their reasons.

Session 5. Discussion and feedback

The last session will be devoted to discuss some issues implied within the results of sessions 3 and 4. For example: is there any ethical approach that is *generally* preferable? Are there scenarios where it should be impossible to determine a “better” output? Are there scenarios where none of the ethical approaches seem to provide with a reasonable solution?

In order to introduce students to complex computational thinking and ethical decision making processes, they will be invited to watch the video *Ethical autonomous vehicles*, <https://vimeo.com/85939744>, where Matthieu Cherubini illustrates two case studies (scenarios) under

three different ethical approaches. Students will be invited to analyse the ethical algorithms and the formal representation, as shown in <http://research.mchrbn.net/eav>.

Finally, students will be asked to participate in a game-based learning competition for assessing what they should have learned using a Kahoot test (<http://kahoot.it>) prepared by the instructor.

3.2.6 Assessment

The aim of evaluating the learning experience is twofold: on the one hand, assessing students' performance in understanding, defining (both visually and linguistically) and ethical decision making regarding this topic. To do so, the instructor will take note of the experiences and outputs, discussions and argumentations by students, and will guide them to better and more accurate logical and ethical reasoning when these are not being carried out properly. On the other hand, it is necessary to assess the satisfaction of students with the learning plan itself, how did they feel and to which extent they improved the capacity to logically analyse moral dilemmas and to apply different ethical approaches to different scenarios they have created. This will be done by a set of questionnaires developed with Kahoot.it! (<http://kahoot.it>) and a group final reflection, followed by a short individual essay to be handed to the instructor. In this way the learning activity itself should be evaluated and improved in subsequent iterations.

4. DISCUSSION

The models currently available to describe and formalize decision making processes for moral machines are yet too much complicated to be applied in Ethics classroom with young students. Such models focus on how the machine "acts" to gather information from the environment, how its artificial intelligence process this information and how it is capable to perform programmed behaviours (even with ethical approaches). In spite of this, our learning activity is addressed to reflect on the morality of decision itself more than trying to explain how the machine should behave to act ethically. We are mainly interested on *what* should the moral machine do and *why* a self-driving car should behave in a certain way by undertaking certain decisions instead of explaining *how* it will fulfil those tasks, because we play the role of the philosopher, not the computer scientist. Then, students need to be aware of the relevance of formalizing moral dilemmas to be resolved by such moral machines and try to analyse possible outputs under certain ethical approaches.

Platforms like Moral Machine by MIT Media Lab provide us with a very interesting tool to browse and judge pre-defined scenarios, or even to design new situations regarding this issue. Nevertheless, Moral Machine platform has been designed to analyse user attitudes towards moral decisions of self-driving cars and so ethical implications are discovered *a posteriori* as a user set of values in comparison with other users' decisions. On the contrary, for the purpose of this learning experience we need to analyse and make ethical decisions starting from *a priori* ethical approaches, in order to compare different outputs that should be preferred depending on what moral algorithm constitutes the basis of decision making. Besides, Moral Machine tool allow us to judge and define scenarios where only two outputs are possible, which is right for proposing a dilemma, but the experience should become more interesting with other scenarios designed for three or more outputs.

This proposal does not reach the technical complexity of a framework for decision making applicable to artificial intelligence nor (yet) the simplicity of a tool where users can add variables, define outputs and judge them according to different ethical approaches. But it has the virtue of allowing students to define a potentially infinite set of scenarios starting from a finite set of variables, analysing possible outputs by sketching and formalising these scenarios in natural language but with logical structures and connectors, and comparing and discussing the consequences of such outputs according to ethical approaches well known by our students. They put into practice computational thinking skills, decision making processes, philosophical analysis of moral behaviours and other soft skills: teamwork, oral skills, debating skills, etc.

This lesson plan should consequently let students become aware of the relevance of ethical decisions and to which extent the development of artificial intelligence requires the definition of a set of ethical principles (that both philosophers and scientists are far from agreeing) or an ethical framework for decision making by the so called moral machines. The computational thinking approach to Ethics will also help students to understand the need to combine ethical reflection and computing to formalise algorithms capable to perform at least "weak" ethical decisions, as long as technology and science won't be able to develop "real" moral machines.

5. CONCLUSIONS AND FUTURE WORK

Among all the branches of Philosophy, undoubtedly Ethics is currently one of the most challenging and with more and more relevant implications. Apart from the importance itself of teaching students to become ethically skilled as human beings and citizens, ethical approaches permeate sciences and even determine their future development, as this paper has demonstrated in the case of moral machines and artificial intelligence.

Moreover, living in a the 21st century implies the development of a set of skills, still under discussion, among which computational thinking, problem solving, decision making and STEM competencies play a relevant role. Compulsory school should tackle these skills by developing training actions that will help our students acquiring the ability to apply school curricula within these approaches. Computational thinking is not only a matter of computer sciences, as ethical behaviour is not only a matter of philosophical studies.

The development of training actions with a cross-curricular approach, covering subjects as Computer Science, Ethics, Mathematics, Arts & Crafts, Language, etc., will help us to succeed in this goal of preparing our students to cope with their own future as workers and citizens.

This training action allows students to understand and experience the implications of moral decisions, while they put into practice philosophical skills like logical reasoning, resolution of moral dilemmas, etc. Besides, by connecting sciences and humanities they can start understanding human knowledge as a *continuum* instead of perceiving it as a set of "watertight compartments".

The set of activities introduce students to the representation (visually and logically) of ethical implications of machine behaviours, as they are expected to become “moral machines” in the near future. In the meanwhile, students will be able to analyse the implications of programming decision making frameworks and algorithms to these machines and discuss those consequences. Future directions of this study will move forward towards the implication of Computer Sciences subjects, in order to continue this work in Ethics classroom by representing different moral scenarios with programming languages usually studied in these subjects. These scenarios could be perfectly programmed in Arduino, Scratch or any other language that could also be inserted to virtual or real robots, in order to both improve computational thinking abilities and check the algorithms and decision making processes in “real” scenarios, so trying the meaning of roboethics in real robots.

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