| Guide de « Brainstorming » (bloc 1 et bloc 2) | |
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| **Questions pour vous guider** | **Vos Réponses** |
| **Quel est le problème ?** | It is extremely difficult to program robots for specific end-user applications ranging from manufacturing environments to personal homes. There are many companies that are robot resistant as they do not have the trained personnel to fully exploit the robots, and non-expert users cannot program the robots.<br>The problem that we address is **how can a non-expert user program a robot**. |
| **Dans quels contextes se pose le problème ? quand ? où ?** | This problem arises in many small- to medium industrial/manufacturing environment when deploying a robot, but also in general settings where a robot has to be programmed by a non-expert user. |
| **D'où émane la demande ?** | In general it comes from end-users without robot programming knowledge who want to customise their robot for specific tasks, e.g. manufacturing industries, supermarket stores, etc. |
| **Qui est concerné par le problème ?** | end-users without robot programming knowledge who want to customise their robot for specific tasks |
| **Comment pouvez vous résoudre le problème ?** | create an intuitive robot programming framework for non-experts that allows teaching it new actions by kinesthetic demonstration and interaction with a graphical interface, and the use of automated planning |
| **Pourquoi est-il important de résoudre ce problème au niveau académique ?** | proof of concept to show that this is a feasible robot programming approach for non-experts |
| **Quel est l'intérêt de répondre à ce problème par rapport aux attentes de la société ?** | companies hesitate to use robots because of the lack of programming experts, allowing non-experts to program robots would increase productivity, allow untrained personnel to work with robots and therefore open a market to program robots without needing to write code |
| **Quels sont les auteurs ou références bibliographiques à utiliser ?** | [1] A. Billard, S. Calinon, R. Dillmann, and S. Schaal. Robot programming by demonstration. In Springer Handbook of Robotics, pages 1371–1394. Springer, 2008<br>[2] Argall, B. D., Chernova, S., Veloso, M., & Browning, B. (2009). A survey of robot learning from demonstration. *Robotics and autonomous systems*, *57*(5), 469-483.<br>[3] Abdo, N., Kretzschmar, H., Spinello, L. and Stachniss, C. Learning manipulation actions from a few demonstrations. In 2013 IEEE International Conference on Robotics and Automation (ICRA), (pp. 1268-1275). IEEE. |

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| | [4] M. Ghallab, D. Nau, and P. Traverso. Automated planning: theory & practice. Elsevier, 2004<br>[5] Alexandrova, S., Cakmak, M., Hsiao, K., & Takayama, L. (2014, July). Robot Programming by Demonstration with Interactive Action Visualizations. In *Robotics: science and systems*.<br>[6] M.Stenmark,M.Haage,and E.A.Topp,"Simplified programming of re-usable skills on a safe industrial robot: Prototype and evaluation," in Intl. Conf. on Human-Robot Interaction. ACM, 2017, pp. 463–472. |
| **Qu'est ce qui a été fait dans le domaine académique pour résoudre le problème ?** | Programming by demonstration [1,2] has been commonly applied to allow end-users to teach robots task goals or policies by demonstration. Recent work has focused on industrial manipulators [6] and mobile manipulators [5]. Most closely related to our work are Alexandrova et al. [5], who created an end-user programming framework with an interactive action visualisation but without task planning; and Abdo et al. [3] that teach manipulation actions from few demonstrations and a symbolic planner is used to achieve goals, but does not provide an graphical interface for end-users to set their own goals. |
| **Quelles sont les méthodologies présentes dans les publications ? Comment la construction et l'évaluation ont été réalisées ?** | Abdo et al. [3] takes multiple demonstrations and uses k-means and entropy to deduce action conditions from demonstrations. They evaluated their system with experiments on teaching the robot to stack blocks, pour from a bottle and to open a door programmed.<br><br>Alexandrova et al. [5] interactive action visualization to program the robot and evaluates the system on 12 benchmark tasks as well as a user study (N=10) for box closing tasks, stacking cups, and putting objects into a box.<br><br>Stenmark et al. [6] uses assembly tasks to pick and stack lego blocks and compares the performance of non-experts with reusable tasks (N=3x7 participants). |
| **Quelles sont les avancées technologiques sur le sujet ?** | dynamic activable tool in the form of a software prototype |
| **Qu'est ce qui a été fait dans le domaine technique pour résoudre le problème ?** | The main motivation for my thesis is to allow end-users to program robots, without writing explicit code. We implemented a system for teaching robots atomic actions with conditions that can be used by symbolic planners to solve more complex problems. Using the system, the user interacts with the graphical interface to customise the taught action and its conditions, to activate the robot's perception to |

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| | detect objects on the table, to teach it a new action by kinesthetic manipulation of its arms, and to activate the robot's action condition generation.<br>The robot's learning algorithm generalises the actions to different environments and reuses them to autonomously generate solutions to problems that go beyond the learned actions. The user can create a new problem with a goal to achieve (e.g. stacking objects) and execute the actions on the robot. |
| **Par rapport au problème posé, quels sont les manques ? Que reste-t-il à résoudre ?** | The state of the art in Programming by Demonstration uses demonstrations to teach robots whole action sequences to reach a goal. When the goal changes, a new action sequence needs to be taught. This can be very time consuming.<br>This is why we want to teach the robot atomic actions and their conditions, which together can be combined with a task planner to achieve a variety of different goals.<br>Now that we have created a system that addresses this problem, we need to evaluate its **usability** in terms of end-user experiments as a proof of concept. |
| **A quoi ces résultats vont-ils servir ? et à qui ?** | The results from the user study in the form of human-robot experiments will contribute to the evaluation of this proposed framework and the proof of concept. |
| **Quelle valeur ajoutée allez vous apporter ?** | Rédiger ce que votre recherche ajoutera à la connaissance scientifique actuelle.<br><br>The implemented real-world system to be used for robot programming by non-experts together with its user study will contribute to the robotics research community to compare with state-of-the-art end-user robot programming frameworks and show that it is possible for end-users without programming knowledge to teach robots new actions for complex tasks. |