

# Learning a (programming) language from mistakes

## Applicants

Eligible proposals must have two (and only two) applicants from different disciplines within the Network Institute.

Supervisor Name	Department/Group	Faculty
1. Natalia Silvis-Cividjian	Computer Science/Computers systems and security	Science
2. Monique Lamers	Applied linguistics	Humanities

## Project description

Provide a brief description of the project (max. 300 words) word counts: 298

Although making mistakes is usually associated with negative emotions, making mistakes is by no means “evidence of failure to learn”.<sup>1</sup> Actually, making mistakes may enhance the learning process and might even be essential for an effective learning process.<sup>2,3</sup>

This project focusses on learning from mistakes a new language, be it a foreign human natural or a programming one. Although there are many differences between these two types of languages, both are characterised by sets of rules that constrain the use of certain expressions or forms. Not being familiar with all the rules, learners will make mistakes. The projects sets out to explore possibilities to develop an efficient automatic training system to assist students in learning a new (programming) language. The system uses a more refined manner of assessing students’ knowledge and understanding, that extends beyond traditional assessment tools, with the ultimate goal to turn mistakes into positive learning events.

To realize this, we will apply state-of-the-art technology using time sensitive registration of brain activity and eye movement, in combination with key stroke logging. We want to identify the markers of students’ cognitive states while making mistakes, when they are aware of making them, and when they detect and correct them during learning. This information will enable an adaptive feedback mechanism that will enhance students’ learning from mistakes. In its turn, this system might be used to train software testers in efficient fault detection during inspections.

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<sup>1</sup> Davis, P. & Pearse, E. (2000) *Success in English Teaching*. Oxford: Oxford University Press.

<sup>2</sup> Frank, M.J., Woroch, B.S. & Curran T. (2005) Error –related negativity predicts reinforcement learning and conflict biases. *Neuron* 2005. Aug 18:47(4):495-501.

<sup>3</sup> Richland, L. E.; Kornell, N.; Kao, L. S. (2009) The pretesting effect: Do unsuccessful retrieval attempts enhance learning? *Journal of Experimental Psychology*, Vol 15(3), Sep 2009, 243-257

## **Project Organization**

*Each proposal requests two Academy Assistants from different disciplines. Describe their roles and describe the skills and expertise required from them. (max. 300 words) word counts: 295*

For the comparison between learning a programming language and a foreign one, the two assistants will set up tasks, each in their language learning domain, that will either elicit the making of mistakes, or let the learner notice these mistakes and correct them. These tasks will be developed such that they enable the beforehand mentioned technologies to collect information about the behavior of the learners. For the next phase of the project, one or two markers that both types of language learning have in common will be selected. These markers will be used as input for the feedback system of which a prototype will be developed.

AA1 (Computer Science):

Tasks: Get familiarized with various sensing equipment (EEG, eye tracker). Read literature on how to build a tutoring system. Design the GUI, create a data base with questions and fill this data base with examples containing typical programming mistakes. Build the feedback system. Test the system anytime when needed. Report the findings and write user manuals and a paper.

Skills and interests: Programming skills in Matlab, Python or Java. Interest in working with technical equipment, learning and teaching.

AA2. (Psycholinguistics or Psychology):

Tasks: Study relevant literature on learning by mistakes in psycholinguistics and cognitive psychology. Design tasks for experiments to attest the handling of mistakes in language learning. Collect information on effective feedback forms for the automatic system to point out and resolve mistakes in both types of language learning. Assist testing the system.

Skills and interests: Interest and some basic knowledge of human behavior in language learning processes. Knowledge about experimental research.

Both assistants will develop and perform the experiments with students in the process of learning a language in their own domain and analyse and compare the data from to two language learning domains.

## **Collaboration**

*Describe how your research improves collaboration and cross-pollination between the disciplines involved (max. 300 words) word counts: 291*

A recurrent problem in our CS education practice is that despite all our teaching efforts, many students still struggle to learn imperative programming languages, such as Java and Python. Some graduates continue to make mistakes later in their role as software developers. The result is poor quality software.

In the linguistic department at the VU, a similar situation takes place: students still struggle to learn a foreign language. In both departments there is a need for good computer-based automatic training tools, that offer a good feedback and helps the teacher to understand what a student has understood and what not yet and guide the students in gaining proficiency.

We both believe that the learning process of our students may improve by making effective use of their failing. Developing a tool that takes into account the cognitive state while learning does not only provide

both faculties with new insights on language learning and teaching, but will also improve our teaching. In order to realize the development a tool that implement our proposed paradigm of learning from mistakes, expertise from both departments is needed. At Computer Science department we have experience in teaching programming languages and we have many students who we are learning how to program. We have the skills of acquiring data from EEG brain headsets and know how to develop software and design graphical user interfaces.

At the Applied Linguistics Department we have experience in designing psychological experiments, insights in the learning processes, individual differences between learners (e.g. learning styles). There is ample experience in the development of language teaching tasks and knowledge about effects of different forms of feedback and instruction. In conclusion this project needs expertise from both departments and both departments will benefit from its final product.

### **Deliverables**

*Enumerate intended project results: papers, research proposals or otherwise. (max 200 words)*

For one, the project will lead to an inventory of markers that characterize learning processes in learning a new language, may it be a programming language or a human natural language. Additionally, both departments will enhance their language teaching with a computer-based tool. The results will be presented in a joint paper at a computer science / linguistics education conference. Moreover, software industry, where testing is an activity of paramount importance that unfortunately never gets the budget and time it deserves, will profit from our guidelines to more effectively perform inspection, that implies less testing in later development phases. A joint paper on a software engineering conference is possible.

## Planning

*Provide a breakdown of the project into phases with tentative timing (max 150 words)*

Phase	Period	AA1(Computer Science)	AA2(Applied linguistics)
1	Sept	Familiarization with sensors (EEG, eye tracker)	Read about the psychology of handling and learning from mistakes (make, detect, correct)
2	Oct	Read about tutoring systems. Design a simple GUI for our learning environment	Read about tutoring systems and different forms of feedback.
3	Nov	Design tasks to collect information about cognitive states including examples of code with seeded programming faults	Design examples with typical mistakes in language learning and design writing tasks
4	Dec-Jan	Test on CS students learning programming in Python/Java. Observe behavior with various sensors during writing and reading code	Test on LING students learning English/Dutch. Observe behavior with various sensors during reading and writing text.
5	Febr	Interpret the data and identify the markers of students' cognitive states while making mistakes	
6	March-April	Build the adaptive feedback system	Provide information for effective feedback and instructions for the feedback system
7	May	Test the final product, draw conclusions and report	
8	June	Formulate guidelines for language teachers, developers and testers and write a paper	

*Please respect the word count limits: proposals that exceed the stated limits will not be eligible.*