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Russian-Dutch double-degree Master's programme in computational science in the age of global education

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ABSTRACT

We present a new double-degree graduate (Master's) programme developed together by the ITMO University, Russia and University of Amsterdam, The Netherlands. First, we look into the global aspects of integration of different educational systems and list some funding opportunities. Then, we describe our double-degree program curriculum, suggest the timeline of enrollment and studies, and give some examples of student research topics. Finally, we discuss the issues of joint programs with Russia and suggest possible solutions, analyze the results of the first three student intakes and reflect on the lessons learnt, and share our thoughts and experiences that could be of interest to the international community expanding the educational markets to the vast countries like Russia, China or India. The paper is written for education professionals and contains useful information for potential students. This is an extended version of a conference paper (http://dx.doi.org/10.1016/j.procs.2014.05.130) invited to this special issue of the Journal of Computational Science.

1. Introduction: Why computational science? Why now?

In the past decade, computational science has become an indispensable tool in all fields of human life: from traditional physics and engineering to biology, medicine, economics, arts, sociology and more exotic fields like fashion or criminology. The world turns progressively more digitized and interconnected, with smart phones and smart homes continuously computing something for us, smart systems controlling transportation and production, and early warning and decision support systems protecting our safety and well-being.

Progress in these smart technologies requires a growing pool of new-wave professionals who can develop models, algorithms and software tools, and then efficiently harness computational resources available in a multitude of hardware and middleware environments (from smartphones and laptops to high-performance clusters, supercomputers, Grids and Clouds). Experts in computational science are highly valued in all research institutions and industrial sectors, but until recently only few universities provided complete coherent educational programmes in computational science, e.g. [1–3].

The University of Amsterdam pioneered this field by establishing the Computational Science group [4] in 1990 and a Master's program [3] in 2005, first as a track in Computer Science and Grid Computing programs. The computational science group led by Prof. Peter Sloot has been collaborating with several Russian research institutes within international projects. These strong ties resulted in a special award from the Russian government for setting up an Advanced Computing Lab [5] at the ITMO University, St. Petersburg, within the Leading Scientist Programme [6]. One of the goals of this program was the development of joint educational and research programs [7].

A great initiative taken by the organizers of the Workshop on Teaching Computational Science [8], held in conjunction with the International Conference on Computational Science [9], brings together researchers and educators to push forward this challenging and exciting branch of science. Joint efforts and strong

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incentives from high-tech industries helped to promptly establish several new educational programmes in computational science around the world [2], [10], but the curricula and educational methods were often inherited from the existing programmes in computer science and applied mathematics and physics. Establishing an internationally recognized benchmark in computational science curriculum could be one of the goals in this workshop.

This is an extended version of a conference paper [11] invited to the special issue of the Journal of Computational Science. In this paper, we present a new double-degree Master's programme developed together by the ITMO University, Russia and University of Amsterdam, The Netherlands. First, we look into the global aspects of integration of different educational systems and list some funding opportunities from European foundations (Chapter 2). Then we describe our double-degree program curriculum, suggest the timeline of enrollment and studies, and give some examples of student research topics (Chapter 3). This information may be useful to the prospective students. Finally, we discuss the issues of joint programs with Russia and suggest possible solutions, analyze the results of the first three student intakes and reflect on the lessons learnt, and share our thoughts and experiences that could be of interest to the international community expanding the educational markets to the vast countries like Russia, China or India (Chapter 4).

2. Global integration of educational systems: Why and How?

2.1. Past, present and future of global education

Globalization and amalgamation of world economies, with strong interdependencies between the countries, have led to gradual integration of the educational systems. The first wave came with the Age of Enlightenment in 17–18th centuries, which defined the school of thought in Western Europe[1] and spread out to Southern and Eastern Europe, Russia, European colonies in Africa, Asia and America. In the next two centuries, the educational systems developed consistent and compatible programs for primary and secondary education, and started to form the basis of a global higher education. Alas, the two World Wars and the Cold War of the 20th century disrupted the integration process and essentially separated the educational systems of the Western Bloc and the Eastern Bloc. The only positive side of this separation was the extreme competition that boosted higher education (although largely inclined towards the military-driven engineering).

Only the last years of the 20th century resumed the integration process by the Lisbon Recognition Convention[2] (1997) and the Bologna Process (1999), which created the European Research Area (2000) and European Higher Education Area (2010)[3]. With these new rules and standards, joint-degree and double-degree programs are becoming very popular in higher education. The universities benefit from this model because they can introduce new educational programmes without hiring extra staff, instead offering some courses in partner-universities. The students find it very attractive because they can learn from the best teachers in the field and gain a unique international experience while studying in different countries. Recognizing these benefits, European foundations offer a variety of granting opportunities through Tempus[4], Marie Curie[5], Erasmus and Erasmus Mundus programme[6]. A review of the progress made in international student mobility can be found in [12].

2.2. Focus on Russia and BRICS: Why is EU & USA interested?

All successfully developing countries (e.g., BRICS countries) reach a point when they need to adopt the top technologies to progress further. That requires more than just a few highly skilled experts imported from the technologically developed countries; it requires a mass education. In the past decade, China and Russia have entered this phase; now India and Brazil are joining the race. At the same time, Western Europe is aging and outsourcing most industries to other countries, instead concentrating on banking, management and research. These two factors shrink the supply of local students enrolled in the hard-science (STEM) programs.

This is a happy point where the demand for top-quality education in developing countries meets the supply of professors and educational programs in the developed world. China was only partly successful in sending their students to top universities (mostly in the United States), under the condition that they come back to work in China: most students did not return. Of course, the high-tech companies where they land are happy with this fact, but for the Chinese government this method is questionable[7]. Another way to make both parties satisfied is establishing joint educational programs. This is the way we are exploring in the University of Amsterdam, the Netherlands and ITMO University, Russia.

Russian education has been traditionally very strong in hard sciences: mathematics, physics, chemistry, engineering, and informatics. This important tradition from the Soviet times comes together with the highest in the world ratio of highly educated people: 54% of the Russian labor force has attained a tertiary (college) education, according to a 2008 World Bank statistic http://goo.gl/1KcMUr With this excellent background and a tradition of working hard,[8] Russian students are well prepared to take even the most challenging courses in top world universities, that is, if they manage to learn the foreign language (more on that in Section 2.3).

In 2012, Russia decided to promote 15 Russian universities to the TOP-200, out of which 5 universities should land in the TOP-100 of the world's leading universities according to the QS World

[1] Curiously British coffeehouses (not to be confused with the modern Dutch coffeeshops for smoking marijuana) played a crucial role in scientific exchange and educational reform discussions.

[2] Lisbon Convention on the Recognition of Qualifications concerning Higher Education in the European Region is an international convention of the Council of Europe elaborated together with the UNESCO, ratified by all 47 member states of the Council of Europe. It was also signed by Canada and United States, but not ratified yet.

[3] The Bologna Process strengthened the competitiveness of the European higher education and fostered student mobility and employability. It includes all 47 member states of the Council of Europe. The European Higher Education Area was created to ensure more comparable, compatible and coherent systems of higher education in Europe http://www.EHEA.info.

[4] Tempus (Trans-European Mobility Programme for University Studies) is the European Union's programme which supports the modernisation of higher education in the Partner Countries of Eastern Europe, Central Asia, the Western Balkans and the Mediterranean region, mainly through university cooperation projects http://eacea.ec.europa.eu/tempus./.

[5] Marie Curie Fellowships are European research grants available to researchers regardless of their nationality or field of research. Scientists have the possibility to complete their training with competences or disciplines useful for their careers. http://ec.europa.eu/research/mariecurieactions/.

[6] Erasmus Programme (European Community Action Scheme for the Mobility of University Students) is a European Union (EU) student exchange programme. From 2014, Erasmus+ took over, a new European programme for Education and Training, 2014–2020 http://ec.europa.eu/education/opportunities/index_en.htm.

[7] As we were finishing this paper, Russian government declared a similar program, fully covering education of 3000 Russian students in top 200 universities http://en.itar-tass.com/opinions/1643 under the condition of coming back to work in Russia. There is one important question though: Does this project still make sense if very few students actually return? Chinese experience shows that the imposed fine cannot solve the problem.

[8] Russian high schools and most universities had a workload of 40 contact hours per week in the class plus up to 20 h homework per week. This load is now reducing, after Russia joined the Bologna Process limiting the program workload.