

## **Report:**

### **Recent Developments in the Adaptive Solution of PDEs**

The CRM-AARMS Workshop title "Recent Developments in the Adaptive Solution of PDEs", organized by the AARMS Atlantic Collaborative Research Group in Numerical Analysis and Scientific Computing, was held at Memorial University of Newfoundland, St. John's, Newfoundland, Aug. 17-22, 2014.

The workshop was well attended with approximately 45 participants involved, including BSc, MSc, PhD students and researchers from Canada, the United States, China, the United Kingdom and Columbia. There were 11 faculty members, 3 post-docs, 4 plenary speakers and 27 undergraduate and graduate students. 32 of these participants were from outside the province.

This workshop consisted of three primary parts. The first part was a two day short course on adaptive methods for PDEs, given by Dr. Weizhang Huang of the University of Kansas, a leading expert in this area. This short course outlined PDE based adaptive mesh generation and concluded with research level questions concerning anisotropic mesh generation. Each day included approximately 5 hours of lectures given by Dr. Huang, and concluded with a hands-on computer lab session, led by Dr. Lennard Kamenski (Weierstrass Institute for Applied Analysis and Stochastic (WIAS), in which participants got an opportunity to learn about software implementations (primarily in Matlab) of some of the algorithms discussed in the lectures. An important feature of the short course and computer lab sessions was the degree of interaction between the instructors and the participants; questions were frequent and often added important insight into the material being presented.

The second part of the workshop consisted of 4 plenary research level talks given by Mark Ainsworth (Brown) "A Synthesis of A Posteriori Error Estimation Techniques for Conforming, Non-Conforming, Mixed and Discontinuous Galerkin Finite Element Methods", Chris Budd (Bath) "Anisotropic mesh generation using optimal transport methods with applications to meteorology", Lennard Kamenski (WIAS) "How a non-convergent Hessian recovery works in mesh adaptation", and Weizhang Huang "Adaptive and structure-preserving computation of anisotropic eigenvalue problems". These 4 talks were at very well prepared - it was a real treat to get a summary of the latest results in the field by 4 of our adaptivity experts.

The workshop then transitioned to its third part with 4 applied problem presentations from Colin Farquharson (MUN) "Exploration geophysics and synthesizing electromagnetic fields in the Earth", David Iron (Dalhousie) "Parabolic systems with multiple spatial and temporal scales", Scott MacLachlan (MUN) "Robust methods for singularly perturbed reaction-diffusion equations", and Hongmei Zhu (York) "Challenges with medical image de-noising and segmentation". These speakers nicely outlined problems in their primary research area which would benefit from the use of adaptive numerical technique. The last day and a half of the workshop included breakout sessions which partnered applied problem presenters, adaptivity experts and other workshop participants, as well as several contributed talks in which participants talked about applications in which adaptive methods for PDEs were employed. The breakout sessions that brought together applications experts and adaptivity experts represented a novel part of the workshop and were very well received. Although no papers were written in the last day and a half of the workshop, the sessions were quite successful in forging future collaborations and introducing potential MSc and PhD students to researchers at the forefront of their fields.

A workshop on Domain Decomposition Methods - with a similar format - will be organized by the AARMS Atlantic Collaborative Research Group in Numerical Analysis and Scientific Computing in Halifax, Nova Scotia, during the early part of August, 2015.

Final Budget Numbers:

A full list of revenues and expenses, prepared by our administrative assistant Ms. Ros English is attached. The workshop came in slightly under budget due some last minute unexpected funding from the NSF in the United States that was used to pay expenses for participants from the US. A decision had to be made to divide expenses amongst the funding agencies which included the CRM, the AARMS conference fund and the MUN conference fund. The AARMS conference fund is being invoiced for \$3500 for the plenary speaker travel and expenses.

In the proposal we budgeted for \$8100 for plenary speakers of which \$7446.10 was actually spent (and \$3500 was invoiced to AARMS). We had originally proposed spending \$2000 for a welcome reception and coffee breaks, \$1862.56 was actually spent and indicated as ARAMARK catering on the report of expenses. \$5600 was budgeted for student travel, \$4200 was spent. Additional student travel from US participants was charged to the NSF funding. On the income side of the equation registration fees collected were much higher than expected. We received \$3805 versus the \$1500 indicated on the proposal. We also received \$6000 from the MUN conference fund versus \$5000 expected. And due to the unexpected NSF funding we will use less than the \$5000 proposed from the AARMS CRG funds.

**ADAPTIVE METHODS WORKSHOP**  
**DEPT. MATHEMATICS AND STATISTICS, MEMORIAL UNIVERSITY OF NEWFOUNDLAND**  
**August 17-22, 2014**

	REVENUE	EXPENSES	BALANCE
REVENUE - CRM	\$ 4,200.00		
REVENUE - AARMS Conference Fund	\$ 3,500.00		
REVENUE - REGISTRATION FEES	\$ 3,805.00		
REVENUE - MUN Conference Fund	<u>\$ 6,000.00</u>		
<b>TOTAL REVENUE:</b>			<b>\$ 17,505.00</b>
<b><u>EXPENSES</u></b>			
<b>MATERIALS/SUPPLIES</b>			
Tote bags - MUN Bookstore		\$ 54.28	\$ 17,450.72
<b>TRAVEL - PLENARY SPEAKERS</b>			
W. Huang		\$ 2,480.32	\$ 14,970.40
C.J. Budd		\$ 2,271.61	\$ 12,698.79
L. Kamenski		\$ 2,694.17	\$ 10,004.62
		<u>7,446.10</u>	
<b>TRAVEL - STUDENTS</b>			
Total Travel - Students		\$ 3,600.00	\$ 6,404.62
+ Carlos Acosta Medina (\$600)		\$ 600.00	\$ 5,804.62
<b>TRAVEL - Taxi/Parking</b>		\$ 19.66	\$ 5,784.96
<b>HOSTING</b>			
ARAMARK Catering		\$ 1,862.56	\$ 3,922.40
Reim. - Haynes		\$ 1,782.67	\$ 2,139.73
Reim - Bihlo		\$ 173.76	\$ 1,965.97
<b>Conference Services Expense</b>		\$ 1,025.93	\$ 940.04

\* AARMS invoiced \$3500 of this amount.