



# Banff International Research Station

for Mathematical Innovation and Discovery

## Crossing Numbers Turn Useful Sunday August 21–Friday August 26, 2011

### MEALS

\*Breakfast (Buffet): 7:00–9:30 am, Sally Borden Building, Monday–Friday

\*Lunch (Buffet): 11:30 am–1:30 pm, Sally Borden Building, Monday–Friday

\*Dinner (Buffet): 5:30–7:30 pm, Sally Borden Building, Sunday–Thursday

Coffee Breaks: As per daily schedule, 2nd floor lounge, Corbett Hall

**\*Please remember to scan your meal card at the host/hostess station in the dining room for each meal.**

### MEETING ROOMS

- All lectures will be held in Max Bell 159 (Max Bell Building accessible by walkway on 2nd floor of Corbett Hall). LCD projector, overhead projectors and blackboards are available for presentations. *Note that the meeting space designated for BIRS is the lower level of Max Bell, Rooms 155–159. Please respect that all other space has been contracted to other Banff Centre guests, including any Food and Beverage in those areas.*
- Rooms 158 and 159 (Max Bell Building) will be available for the discussion groups.

### SCHEDULE

#### *Sunday*

- 16:00** Check-in begins (Front Desk - Professional Development Centre - open 24 hours)  
**17:30–19:30** Buffet Dinner, Sally Borden Building  
**20:00** Informal gathering in 2nd floor lounge, Corbett Hall  
Beverages and a small assortment of snacks are available on a cash honor system.

#### *Monday*

- 7:00–8:45** Breakfast  
**8:45** Introduction and Welcome by BIRS Station Manager, Max Bell 159  
**9:00** Introductory 5-minute presentations describing your research (in alphabetical order)  
**10:00** Coffee Break, 2nd floor lounge, Corbett Hall  
**10:30** Continued introductory 5-minute presentations describing your research  
**11:30–13:30** Lunch  
**13:00** Guided Tour of The Banff Centre (1-hour); meet in the 2nd floor lounge, Corbett Hall  
**14:00** Group Photo; meet on the front steps of Corbett Hall  
**14:15** Discussion Groups  
**15:00** Coffee Break, 2nd floor lounge, Corbett Hall  
**15:30** Discussion Groups  
**16:30** Break  
**17:30–19:30** Dinner

## *Tuesday*

<b>7:00–9:00</b>	Breakfast
<b>9:00</b>	Problem Session
<b>10:00</b>	Coffee Break, 2nd floor lounge, Corbett Hall
<b>10:30</b>	Discussion Groups
<b>11:30–13:30</b>	Lunch
<b>13:30</b>	Lectures: Dan Cranston, followed by Peter Hlineny
<b>15:00</b>	Coffee Break, 2nd floor lounge, Corbett Hall
<b>15:30</b>	Discussion Groups
<b>16:30</b>	Break
<b>17:30–19:30</b>	Dinner
<b>19:30</b>	Outing to Banff Hot Springs

## *Wednesday*

<b>7:00–9:00</b>	Breakfast
<b>9:00</b>	Lecture: Eva Czabarka
<b>10:00</b>	Coffee Break, 2nd floor lounge, Corbett Hall
<b>10:30</b>	Lecture: Pedro Ramos
<b>11:30–13:30</b>	Lunch
<b>13:30</b>	Free Afternoon – Enjoy Banff
<b>17:30–19:30</b>	Dinner

## *Thursday*

<b>7:00–9:00</b>	Breakfast
<b>9:00</b>	Open Lecture slot
<b>10:00</b>	Coffee Break, 2nd floor lounge, Corbett Hall
<b>10:30</b>	Open Lecture slot
<b>11:30–13:30</b>	Lunch
<b>13:30</b>	Discussion Groups
<b>15:00</b>	Coffee Break, 2nd floor lounge, Corbett Hall
<b>15:30</b>	Second Problem Session: Ideas that arose during the conference (and solutions to questions from the First Problem Session?)
<b>16:30</b>	Break
<b>17:30–19:30</b>	Dinner

## *Friday*

<b>7:00–9:00</b>	Breakfast
<b>9:00</b>	Discussion groups
<b>10:00</b>	Coffee Break, 2nd floor lounge, Corbett Hall
<b>10:30</b>	Closing Remarks, followed by Informal Discussions
<b>11:30–13:30</b>	Lunch

**Be sure to checkout by 12 noon.** *After checkout participants are welcome to use BIRS facilities (2nd Floor Lounge, Max Bell Meeting Rooms, Reading Room) until 3:00 pm on Friday.*

# Crossing Numbers Turn Useful

## Sunday August 21–Friday August 26, 2011

### ABSTRACTS

(in alphabetic order by speaker surname)

Speaker: **Dan Cranston** (Virginia Commonwealth University)

Title: *Crossings, Colorings, and Cliques*

Abstract: The talk will give some historical background, but also focus on Albertson's conjecture, which states: If  $\chi(G) = r$ , then  $cn(G) \geq cn(K_r)$ . (Here  $\chi$  is the usual chromatic number and  $cn$  is the crossing number.)

Speaker: **Eva Czabarka** (University of South Carolina)

Title: *Orientations give lower bounds on crossing numbers*

Abstract: Orientations give lower bounds on crossing numbers. Leighton- and Euler-type lower bounds for the crossing number are often better for a proper subgraph than on the entire graph. Can one find optimal or at least good lower bounds on the crossing number considering all subgraphs? What is the subgraph that gives an optimal lower bound? This question can be solved for Euler-type lower bounds using a linear programming approach. Considering the dual of this problem we find that finding an optimal Euler-type lower bound is equivalent to finding certain optimal orientations in an appropriately defined multigraph. Consequences of these results include the fact that a planar graph always has an orientation with every indegree being at most 3 (Frasysseix, Ossona de Mendez), and every graph has an orientation where the maximum indegree is at most the ceiling of twice the maximum average degree, where the maximum is taken over all subgraphs (Aichholzer-Aurenhammer-Rote, Venkateshvaran). The orientation problem turns out to be a slight generalization of results by Frank and Gyárfás. This is joint work with M. Bračić, D. Bokal and L.A. Székely.

Speaker: **Petr Hlineny** (Masaryk University)

Title: *Crossing numbers of graphs embedded in surfaces*

Abstract: We introduce "stretch", a new embedding-density parameter related to the face-width and dual edge-width of embedded graphs. This new stretch parameter lower-bounds the (planar) crossing number of the graph, up to a factor depending on the max degree and the genus, and we use it to derive an efficient approximation of the crossing number of graphs embedded on a fixed orientable surface.

This talk is based on a joint work with M. Chimani (SODA 2010), and also on a previous work with G. Salazar (ISAAC 2007).

Speaker: **Pedro Ramos** (Universidad de Alcalá)

Title: *On the rectilinear crossing number of the complete graph*

Abstract: In 2004, Lovasz, Vesztergombi, Wagner, and Welzl, and, independently, Abrego and Fernández-Merchant, found a strong connection between the rectilinear crossing number of the complete graph and the number of ( $\leq k$ )-edges of a set of points in the plane. This relation originated a wealth of research and results on both problems. In this talk, I will survey some of these results.