NIMBioS

Evaluation Data Report

Investigative Workshop: *Mathematical Modeling and Experimental Investigations in Renal Hemodynamics*

August 1-3, 2011

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Background

Introduction

This report contains evaluation data for a NIMBioS Investigative Workshop entitled "*Mathematical Modeling and Experimental Investigations in Renal Hemodynamics*" (Renal workshop), which took place at NIMBioS August 1-3, 2011. NIMBioS Investigative Workshops are relatively large (30-40 participants), focus on a broader topic or a set of related topics than Working Groups, attempt to summarize/synthesize the state of the art and identify future directions, and have potential for leading to one or more future Working Groups. Participants may include post-docs and graduate students with less experience in the particular topic than those participating in Working Groups.

The Renal workshop comprised 35 participants, including co-organizers Anita Layton (Dept. of Mathematics, Duke Univ.), and Leon Moore (Dept. of Physiology & Biophysics, SUNY Health Sciences Center).

Workshop Description

Failure of the kidneys in individuals with hypertension, diabetes, and reduced nephron number begins with deregulation of the renal microvasculature, in the form of vasodilation and reduced autoregulatory reactivity. The resulting vascular hypertrophy and capillary rarefaction give rise to nephron loss and renal microvascular injury, the extent of which depends on arterial pressure and the residual autoregulatory ability. This Investigative Workshop will bring together mathematicians, computational scientists, biologists, nephrologists, and engineers to discuss current achievements and challenges in modeling renal hemodynamics, and to identify key areas in modeling, computing, laboratory experimentation, and clinical diagnosis that could be pursued to improve our understanding of the physiology and pathophysiology of renal autoregulation and its role in the development of progressive renal diseases. The short-term goals of this workshop are to identify and address key physiological questions by facilitating the productive collaboration of interdisciplinary teams, as well as to improve existing mathematical models and generate ideas for new approaches. A long-term goal of this workshop is to integrate key data and concepts into a multi-scale mathematical model of relevant aspects of renal functions that can be used to study how the kidney is involved in, and is impacted by, hypertension and diabetes, and how this leads to progressive renal failure.

The central theme of this workshop is to investigate, by means of modeling techniques, the potential pathogenetic link between progressive renal disease, diabetes, and hypertension. Hypertension and diabetes are epidemic in our society; their frequencies have skyrocketed among the US and overseas population in the recent decades. It is firmly established that the

progression of renal microvascular injury is critically dependent upon arterial blood pressure and the extent to which autoregulatory ability is impaired. Over recent decades, a large body of experimental data has been obtained concerning the physiology and pathophysiology of the renal microvasculature, but little is known about the magnitude of blood pressure transmission into the renal microvasculature in chronic renal diseases. A goal of this workshop is to initiate the process of integrating key data and concepts into multi-scale mathematical models of the renal vasculature and hemodynamic controls, which, in the long term, can be used to study the development of hypertension, diabetes, and other progressive renal diseases.

Organizer Summary Report

This Investigative Workshop brought together mathematicians, computational scientists, biologists, nephrologists and engineers to discuss current achievements and challenges in modeling renal hemodynamics, and to identify key areas in modeling, computing, laboratory experimentation and clinical diagnosis that could be pursued to improve our understanding of the physiology and pathophysiology of renal autoregulation and its role in the development of progressive renal diseases. There were eight talks, four on day one and four on day two, and in addition a poster session on day one. Talks on the first day reviewed recent experimental findings related to progressive renal disease, diabetes and hypertension. Talks on the second day discussed the role of mathematical modeling in understanding renal autoregulatory mechanisms. Those talks were followed by two break-up discussion groups, one in normal renal physiology and the other in pathophysiology, in which workshop participants identified specific questions to be addressed. At the end of each discussion session, summary presentations of group ideas, work in progress and future plans were made by a designated member from each group. Summary reports were written on the third day. New collaborations were formed, and a future plan is to form a Working Group to develop a model that would of kidney oxygen consumption under physiologic and pathophysiologic conditions.

Evaluation Design

Evaluation Questions

The evaluation of the workshop was both formative and summative in nature, in that the data collected from respondents was intended to both gain feedback from respondents about the quality of the current workshop and also to inform future similar meetings. The evaluation framework was guided by Kirkpatrick's Four Levels of Evaluation model for training and learning programs (Kirkpatrick, 1994[1]). Several questions constituted the foundation for the evaluation:

1. Were participants satisfied with the workshop overall?
2. Did the meeting meet participant expectations?
3. Do participants feel the workshop made adequate progress toward its stated goals?
4. Do participants feel they gained knowledge about the main issues related to the research problem?
5. Do participants feel they gained a better understanding of the research across disciplines related to the workshop's research problem?
6. What impact do participants feel the workshop will have on their future research?
7. What changes in accommodations, group format, and/or content would participants like to see at future similar meetings?

Evaluation Procedures

An electronic survey aligned to the evaluation questions was designed by the NIMBioS Evaluation Coordinator with input from the NIMBioS Director and Deputy Director. The final instrument was hosted online via the University of Tennessee's online survey host mrInterview. Links to the survey were sent to 33 registered workshop participants on August 3, 2011 (co-organizers and NIMBioS affiliates were not included in the evaluation). Reminder emails were sent to non-responding participants on August 10 and 16, 2011. By August 23, 2011, 28 of the participants had given their feedback, for a response rate of 85%.
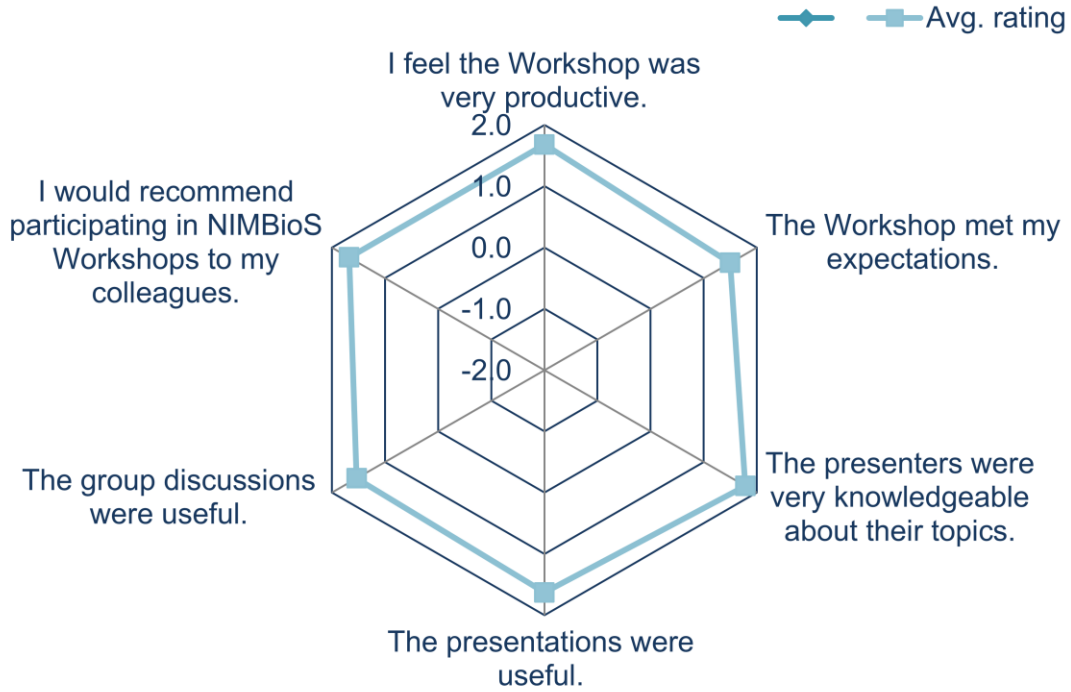
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[1] From Kirkpatrick, D.L. (1994). *Evaluating Training Programs: The Four Levels.* San Francisco, CA: Berrett-Koehler.

Evaluation Findings

Overall Satisfaction

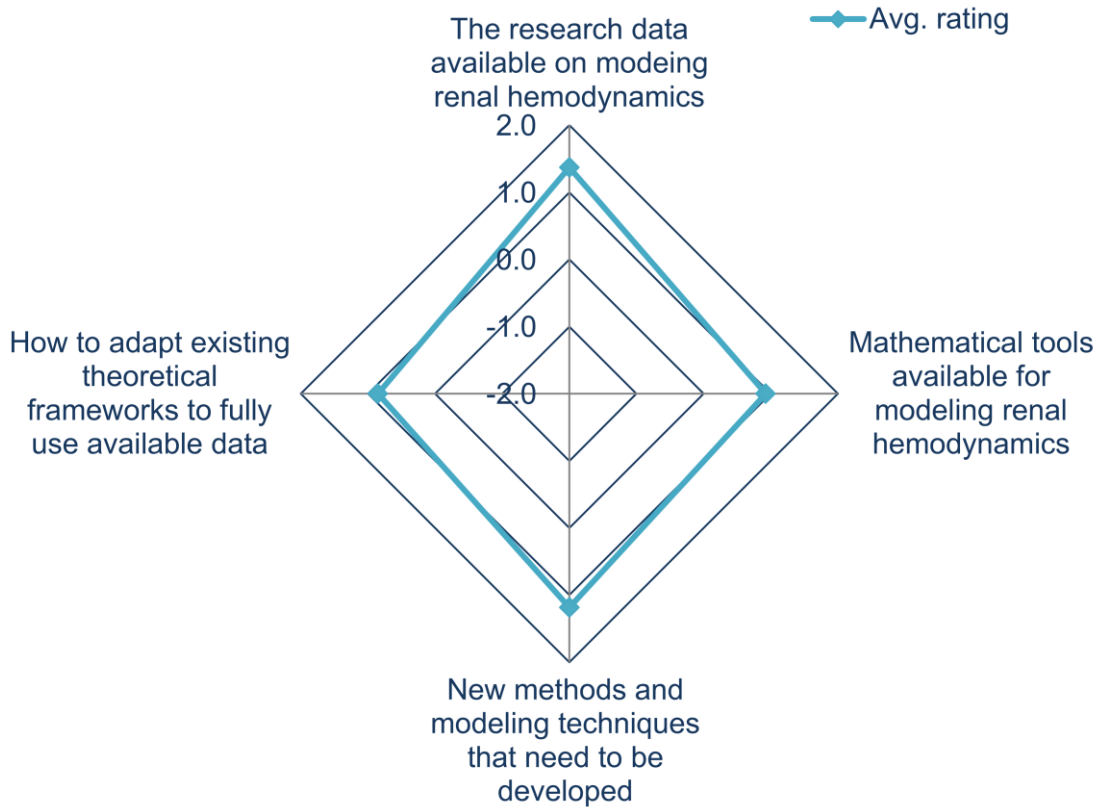**Figure 1. Satisfaction with various aspects of the workshop**

Scored on a 5-point Likert scale from -2 to 2 for "strongly disagree" to "strongly agree"

Workshop Content and Format

Participant Learning

Figure 2. Participant learning

As a result of attending this workshop, I have a better understanding of:

Scored on a 5-point Likert scale from -2 to 2 for "strongly disagree" to "strongly agree"

Figure 3. Do you feel that participating in the workshop helped you better understand the research going on in disciplines other than your own regarding modeling renal hemodynamics?
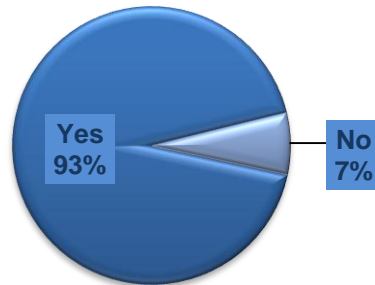
Comments

I was an invited speaker. I already have extensive knowledge of the renal hemodynamics literature, other mathematical biology literature, nonlinear dynamics, and numerical methods. Many of those in attendance had been my students, and I was familiar with their work.

The mixture of people that were present, and the variety of talks and discussions that occurred, certainly gave me a much richer appreciation of the variety of work that is being conducted.

In particular I got a better understanding of research related with myogenic responses in the afferent arteriole. That aspect of renal hemodynamics was to certain extent foreign to me.

The interesting and lively discussions in the breakout groups certainly enhanced my overall experience of the Workshop.

Lacking expertise in the area of renal hemodynamics was a major barrier. I felt like the presenters were mainly presenting to each other, as several presentations appeared to be somewhat inaccessible to many members of the audience. Also, it appeared that much of the mathematics was swept under the rug, and as an individual whose background is primary mathematical, I don't feel as though I got a good grasp for specific mathematical techniques that were being used in the modeling process.

Yes, I learned a lot about current research related to renal physiology and renal pathophysiology that I had previously not known about. Also I learned about current modeling work being conducted by other renal modelers.

I had worked a little in the area in the past but had never been to a meeting with the community. It was a great experience for me. The community was very

welcoming. The talks were very good. There were not too many. The extra time gave time to talk about things that were discussed. NIMBioS really took care of us. I would come back. They were a class act. I am more motivated to learn in more and try to really more in the area. I hope that there is a follow-up summary.

Very well organized. Pleasant environment. Excellent participants with diverse interests and expertise.

Workshop Format

Figure 4. Effectiveness of workshop format
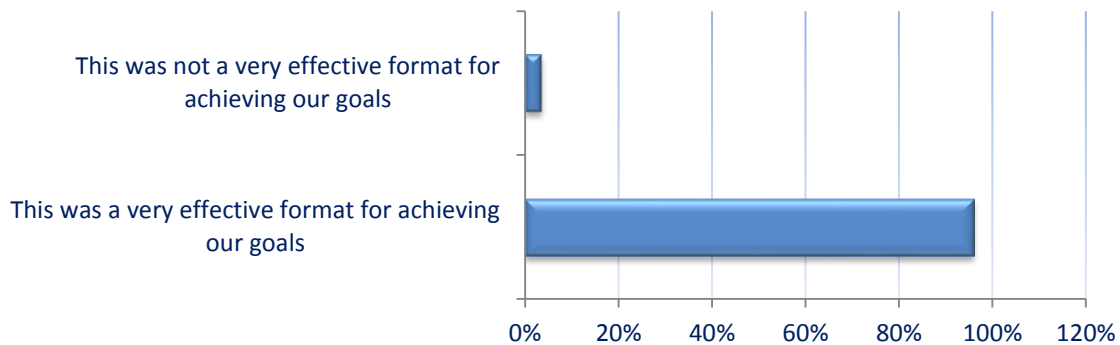
Format could be improved if:

No comments

Most Useful Aspects of Workshop

We obtained a broad view of the most relevant issues in renal hemodynamics from the main researchers in the area. We also learned the kind of models that different groups are developing.

I think the combination of presentations and discussion groups was a good approach. While I did not completely understand everything in the presentations, I did get enough out of them to understand some of what was being discussed in the discussion groups.

The dividing the talks in modeling and experiments were a good idea for organizing.

The combination between the lecture and the working group was the most useful for me.

Lectures and FIRST series of discussions on Monday

Discussion with experimentalists.

The discussion groups and the summary discussions were quite useful and not part of most other meetings.

Discussions about what needed to be done in modeling renal regulation.

The group sessions. Since they provide a good setting for the free exchange of ideas.

The discussion groups.

It was useful to discuss what kind of questions should be addressed and focused in order to take the next step. Interesting enough, but undiscovered yet problems have been discussed.

Discussion among experts on technical details of hemodynamics and conflicting ideas.

The focused discussions.

Break-out discussion sessions

Discussions finding the middle ground between modelers and experimentalists.

Small group and group discussions on specific topics

The most useful aspect of the workshop was probably that opportunity to discuss ideas with other attendees, and to receive feedback on what might be the most interesting and relevant problems to investigate.

The many discussions, both formal and informal, among modelers (including graduate students and postdocs), physiologists, and physiologist-clinicians.

Good choice of participants with a mix of theoreticians and experimentalists.

The most useful aspect was the main purpose it was designed to serve of putting physiologists and modelers in the same room together.

Mixing mathematical modelers with pathologists, who told us what important clinical problems we should focus on.

Great feel of community, broad aspects of hemodialysis research covered, best specialist participated
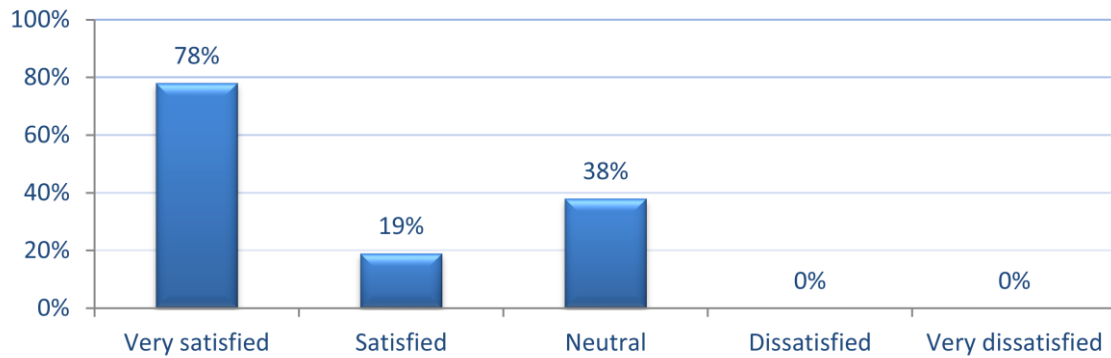
Networking.

The experimentalist participant was highly experienced.

Open-ended problems. Willingness for collaboration among participants.

Communication

Figure 5. How satisfied were you with the opportunities provided during workshop presentations and discussions to ask questions and/or make comments?
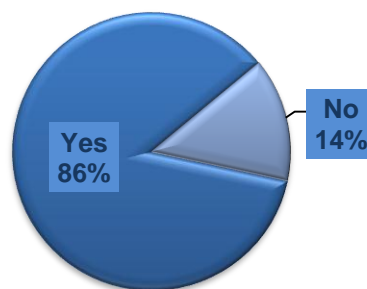

Comments

Power points being available online might be useful.

I can't improve on facilitating communication. The workshop was very, very well set up for the communication.

I gained from this experience, mainly by having opportunity to gather all together with a group of physiologists who share my interest in abstract reasoning and whom I have known for years, but seldom have the opportunity to sit down with. I am interested to know what the younger mathematicians thought of the meeting, since they did little of the talking.

Progress Toward Goals

Figure 6. Do you feel the workshop made adequate progress toward finding a common language across disciplines for research on the workshop's topic?

Comments

Progress was certainly made in defining areas of research, their relationship to each other, and areas needing additional work.

More young emerging modelers than experimentalists attended. Next meeting needs to recruit more physiologists who can conduct the necessary experiments to advance modeling and next generation of predictions.

This will require ongoing dialogue.

See my comments to the previous question. On the other hand, I did feel like progress was made (within the "experts" group) as to some future directions the research in renal dynamics could and should take. However, the "experts" group seemed to already know each other and speak a similar language, but somewhat excluded those outside of the "experts" group.

Common language seems not quite right. What is more to the point is a more complete common understanding among modelers, physiologists, and clinicians who do research in physiology but who also treat (or used to treat) patients that have renal disease.

Yes experimentalists were communicating with modelers closely.

Impact on Future Research Plans

Figure 7. Do you feel that the exchange of ideas that took place during the workshop will influence your future research?
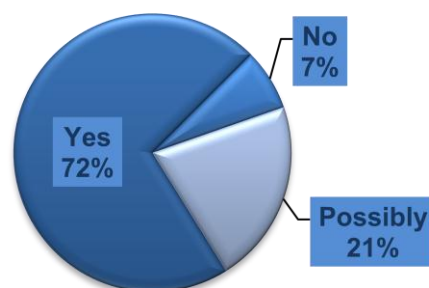
Comments

I have a better understanding of how I can apply my mathematical models to address open and interesting questions.

Since I'm not already involved in renal hemodynamics research, my experience with this workshop left me with very little directions that I would be able to take.

As I have stated previously, I got the sense that some clear directions have been established, but since I'm not already directly involved, these directions seem inaccessible to me.

That was how learning occurred. It worked.

*I may apply some of our theories of flow regulation to the renal circulation.*

Absolutely. It has strengthened my resolve to move into modeling questions that relate to renal pathologies.

So far as I could tell, a close collaborator and I are the only individuals working on our subject.

Based on this I will focus on this area.

Impact on Future Collaborations

Figure 8. Did you develop plans for collaborative research with other workshop participants?
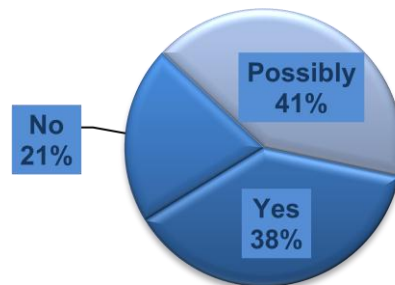
Comments

I will be meeting and collaborating with one of participants early in the fall semester.

Unfortunately, I ultimately had very little interaction with anyone at the Workshop. I felt like I was basically the only person attending the Workshop who was not directly associated with any of the other attendees, so I generally felt like I was on the outside looking in.

There is presently an initiative to establish one or more working groups to address some of the issues that were raised at the workshop.

An area has been identified that would allow the dovetailing of modeling with experimental evidence in an area not been previously done before the results of

which will be helpful in understanding the pathogenesis of rather complex and progressive human renal disease conditions.

I tentatively did with one person. That may or may not work. However I feel that I have made connections to people that I would feel comfortable in contacting later.

I made contacts to collaborate with other professor in some projects

This workshop was the first opportunity that I've had to meet with many of the attendees. Several conversations did lead to suggestions of potential collaborative efforts, although at this stage it is too early for me to say whether they will go ahead.

New plans with existing collab. Possibly new collab.

I plan to write a review paper in collaboration with other participants.

Discussion about preparation of a review article with 2 other participants.

Suggestions for Future workshops

There was not much accomplished the final morning of the meeting-- could be combined with the day prior.

Include more topics, more discussions on future needs of the field, unanswered questions in the field.

It was not clear to me the mathematical or computational tools that are needed by the renal hemodynamics modelers. I understand that the models involve different scales and have large numbers of parameters but it was missing in the discussions some thoughts about how mathematicians, statisticians, and computer scientists can work to develop tools to help with the analysis of the models.

I think the first two days of the workshop needed to be structured slightly differently. Each day probably should have had a mix of experimental and modeling talks, rather than each day being more focused on one of the two. I also felt like the mathematical aspects did not receive adequate attention, as I've mentioned previously.

Perhaps, more time.

It could have been a bit longer, maybe a four day-long workshop.

Excellent. Hard to do much better. Quality of people was outstanding.

The workshop would be hard to improve on. The pacing was very good. Keeping the number of talks small was good. Having lots of time to talk among the participants, lots of good food, and lots of coffee, made a super environment for fruitful interactions and discussions.

I might give some preliminary readings. I looked at the speakers and Googled articles but more guidance could be nice.

Shorter breaks.

It would be better to set up the subject of discussion session in prior to the workshop in order to focus on the problems that we think are important to be asked.

More specific questions for the workshops.

Additional Comments

I enjoyed the Workshop very much.

You are doing and excellent work at NIMBioS.

The organizers did an outstanding job and should be commended.

I found the workshop to be incredibly useful. The talks were all very interesting, and clarified various issues that I had not fully understood or appreciated. The discussions and resulting summaries were great to listen to, particularly for the way in which ideas were bounced around between people with clinical, experimental and modeling backgrounds. The workshop was also invaluable for the opportunity to meet so many of the attendees (mostly for the first time) and to benefit from their expertise. In addition, several questions I had concerning the tubulo-vascular organization (answers to which I had been unable to find in the literature) were comprehensively answered during the coffee-breaks.

Appendix

Mathematical Modeling and Experimental Investigations in Renal Hemodynamics Workshop Evaluation Survey

Mathematical Modeling and Experimental Investigations in Renal Hemodynamics Workshop Survey

Thank you for taking a moment to complete this survey. Your responses will be used to improve the workshops hosted by the National Institute for Mathematical and Biological Synthesis. Information supplied on the survey will be confidential, and results will be reported only in the aggregate.

Please check the appropriate box to indicate your level of agreement with the following statements about this workshop: (Very satisfied, Satisfied, Neutral, Dissatisfied, Very dissatisfied)

> I feel the workshop was very productive.
> The workshop met my expectations.
> The presenters were very knowledgeable about their topics.
> The presentations were useful.
> The group discussions were useful
> I would recommend participating in NIMBioS workshops to my colleagues.

Please check the appropriate box to indicate your level of agreement with the following statements. As a result of participating in this workshop, I have a better understanding of: (Strongly agree, Agree, Neutral, Disagree, Strongly disagree)

> The research data available on renal hemodynamics
> Mathematical tools available for modeling renal hemodynamics
> New methods and modeling techniques that need to be developed
> How to adapt existing theoretical frameworks to fully use available data

Do you feel participating in the workshop helped you better understand the research going on in disciplines other than your own?

> Yes
> No
> Comments:

Do you feel the workshop made adequate progress toward finding a common language across disciplines for research on the workshop's topic?

> Yes
> No
> Comments:

Do you feel that the exchange of ideas that took place during the workshop will influence your future research?

        Yes
        No
        Possibly
        Comments:

Did you develop unanticipated plans for collaborative research with other workshop participants?

        Yes
        No
        Possibly
        Comments:

What do you feel was the most useful aspect of the workshop?

What would you have changed about the workshop?

How do you feel about the format of the workshop?

        This was a very effective format for achieving our goals
        This was not a very effective format for achieving our goals ->
                The workshop format would have been more effective if:

How satisfied were you with the opportunities provided during workshop presentations and discussions to ask questions and/or make comments?

        Very satisfied
        Satisfied
        Neutral
        Dissatisfied
        Very Dissatisfied

Please indicate any suggestions you have for facilitating communication among participants during the workshop:

Please use this space for additional comments: