Evaluation Report

Tutorial: Optimal Control and Optimization for Biologists

December 15-17, 2009

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National Institute for Mathematical and Biological Synthesis
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Table of Contents

List of Tables

List of Figures

Executive Summary

Brief Synopsis of Event

This report is an evaluation of the NIMBioS Tutorial entitled "Optimal Control and Optimization for Biologists" (Optimal Tutorial), which took place at NIMBioS December 15-17, 2009. NIMBioS Tutorials are relatively large (30-40 participants), and serve as short introductions to particular research methods.

The Optimal Tutorial comprised 37 participants, including co-organizers Suzanne Lenhart (University of Tennessee, Department of Mathematics and NIMBioS Associate Director for Education, Outreach and Diversity) and Michael Bevers (USDA Forest Service, Fort Collins, Colorado). Participants included a diverse collection agricultural scientists, biologists, engineers, health scientists, and mathematicians.

The Tutorial was designed to introduce selected topics in optimal control and optimization with an emphasis on biological applications. Introductory material on optimal control of ordinary differential equations and difference equations, and interactive computer labs were included in sessions led by Dr. Lenhart. Mathematical programming and spatial optimization techniques were demonstrated for managing natural resources under conditions of risk. Lectures and computer lab exercises, led by Dr. Bevers, introduced linear, integer, nonlinear, stochastic and chance-constrained programming methods. Renee Fister of Murray State University gave a lecture on optimal control techniques applied to cancer modeling. Paul Armsworth of the University of Tennessee lectured on applications in conservation and natural resource management.

Evaluation Design

An electronic survey aligned to the following evaluation questions was designed by NIMBioS' Evaluation Coordinator with input from the NIMBioS Director and Deputy Director:

1. Were participants satisfied with the Tutorial overall?
2. Did the Tutorial meet participant expectations?
3. Was the Tutorial appropriate to the participants' levels of expertise?
4. Did participants feel they learned an appropriate amount of information?
5. Were participants satisfied with the amount of content and format of the Tutorial?
6. Were participants satisfied with the accommodations offered by NIMBioS?
7. What changes in accommodations, group format, and/or content would participants like to see at future similar meetings?

The final instrument was hosted online via the University of Tennessee's online survey host mrInterview. Links to the survey were sent to 28 Tutorial participants on December 21, 2009 (Tutorial organizers and seven participants associated with NIMBioS were excluded from the evaluation). Reminder emails were

sent to non-responding participants on January 4 and 11, 2010. By January 18, 2010, 26 participants had given their feedback, for a response rate of 93%.

An electronic demographics survey aligned to the reporting requirements of the National Science Foundation was designed by the NIMBioS Evaluation Coordinator with input from the NIMBioS Director. The final instrument was hosted online via the University of Tennessee's online survey host mrInterview. Links to the survey were sent to the 21 working group participants for whom NIMBioS did not have complete information on November 24, 2009. Reminder emails were sent to non-responding participants on December 1 and 8, 2009. By December 15, 2009, 21 participants had filled out the survey for a response rate of 100%. Demographic questions regarding gender, race, and ethnicity, and disability status were optional (disability status is not reported in this evaluation report). All demographic information is confidential, and results are reported only in the aggregate. When feasible, the evaluator filled in missing demographic data from other sources (e.g. address, institution, field of study). The evaluator did not assume race, ethnicity, or disability status for any participant who did not report this information.

Highlights of Results

- One-hundred percent of respondents either agreed or strongly agreed that they would recommend participating in NIMBioS Tutorials to their colleagues.
- Almost all respondents agreed the Tutorial met their expectations (96%) and was appropriate to their level of expertise (92%).
- All respondents thought the instructors were knowledgeable about their topics, and 92% thought the presentations were useful.
- The majority of participants thought the hands-on exercises were useful (96%), while a smaller majority felt the group discussions were useful (89%).
- Ninety-two percent of respondents agreed that the format of the Tutorial was very effective for achieving its goals.
- The majority of respondents (69%) indicated they felt the amount of content offered during the Tutorial was "just right," while 31% felt there was too much material presented for the allotted time.
- One-hundred percent of participants agreed that they had a better understanding of optimal control of ordinary differential equations and difference equations as a result of attending the Tutorial.
- A smaller majority of participants (58%) agreed that they had a better understanding of linear, integer, nonlinear, stochastic and chance-constrained programming methods as a result of attending the Tutorial.
- A large majority (92%) said they were satisfied with the opportunities provided during the Tutorial to ask questions and/or make comments.
- Overall, respondents reported being satisfied with the travel, housing, and other amenities provided by NIMBioS.

Conclusions and Recommendations

Overall satisfaction with the Tutorial was high among respondents, the majority of whom indicated that the Tutorial met their expectations and was appropriate to their level of expertise. Respondents were also satisfied with the travel, housing, and other amenities offered by NIMBioS.

The majority of respondents thought that the Tutorial format was effective for achieving its goals and were satisfied with the opportunities provided during the Tutorial to ask questions and/or make comments. Many respondents indicated the hands-on lab work was the most useful aspect of the tutorial, while others liked the well-prepared lectures introducing the material.

The majority of respondents felt the amount of content covered during the Tutorial was "just right." When asked what topics they would have liked to have covered in this tutorial if given more time, the most common response was differential equations. Other participants indicated they would be interested in learning more about applications of optimal control in specific fields.

All respondents said they felt that participating in the Tutorial helped them understand optimal control of ordinary differential equations and difference equations, while fewer agreed that they had a better understanding of the programming methods taught during the Tutorial.

Several suggestions were made for improving future tutorials, including breaking into smaller groups more often and having more information available before the Tutorial. Suggestions for breaking into smaller groups centered on the idea that more discussion of individual problems could take place in this format. Other suggestions included focusing more on optimal control and less on linear programming, providing more life sciences applications, and breaking the tutorial into separate groups (mathematicians and biologists) so that more detail could be discussed in these areas.

Based on analysis of participant response data, the recommendations for future Tutorials are as follows:

- Consider making more background research and reading materials available to all participants before the Tutorial. Participant suggestions for materials included copies of Tutorial presentations, handouts, and papers.
- A common request from participants was to break into smaller groups more often to discuss specific problems and work on projects. Consider having smaller groups work on projects and give mini-presentations at the conclusion of the Tutorial about their work.
- While participants indicated high levels of learning about optimal control of ordinary differential equations and difference equations, it was also the topic they were most interested in learning more about. Consider offering another Tutorial in the future related to this topic as interest appears to be high.

Optimal Control and Optimization for Biologists Tutorial Evaluation Report

Background

Introduction

This report is an evaluation of a NIMBioS Tutorial entitled "Optimal Control and Optimization for Biologists" (Optimal Tutorial), which took place at NIMBioS December 15-17, 2009. NIMBioS Tutorials are relatively large (30-40 participants), and serve as short introductions to particular research methods.

The Optimal Tutorial comprised 37 participants, including co-organizers Suzanne Lenhart (University of Tennessee, Department of Mathematics and NIMBioS Associate Director for Education, Outreach and Diversity) and Michael Bevers (USDA Forest Service, Fort Collins, Colorado). Participants included a diverse collection agricultural scientists, biologists, engineers, health scientists, and mathematicians.

The Tutorial was designed to introduce selected topics in optimal control and optimization with an emphasis on biological applications. Introductory material on optimal control of ordinary differential equations and difference equations, and interactive computer labs were included in sessions led by Dr. Lenhart. Mathematical programming and spatial optimization techniques were demonstrated for managing natural resources under conditions of risk. Lectures and computer lab exercises, led by Dr. Bevers, introduced linear, integer, nonlinear, stochastic and chance-constrained programming methods. Renee Fister of Murray State University gave a lecture on optimal control techniques applied to cancer modeling. Paul Armsworth of the University of Tennessee lectured on applications in conservation and natural resource management.

Participant Demographics

The majority of participants were college/university faculty, graduate students, and postdoctoral researchers; however, several participants held other positions (Figure 1). Primary fields of study for the 37 participants included agricultural sciences/natural resources, biological/biomedical sciences, engineering, health sciences, mathematics, and ocean/marine sciences (Table 1).

Figure 1. ***Status of participants (n = 37)***

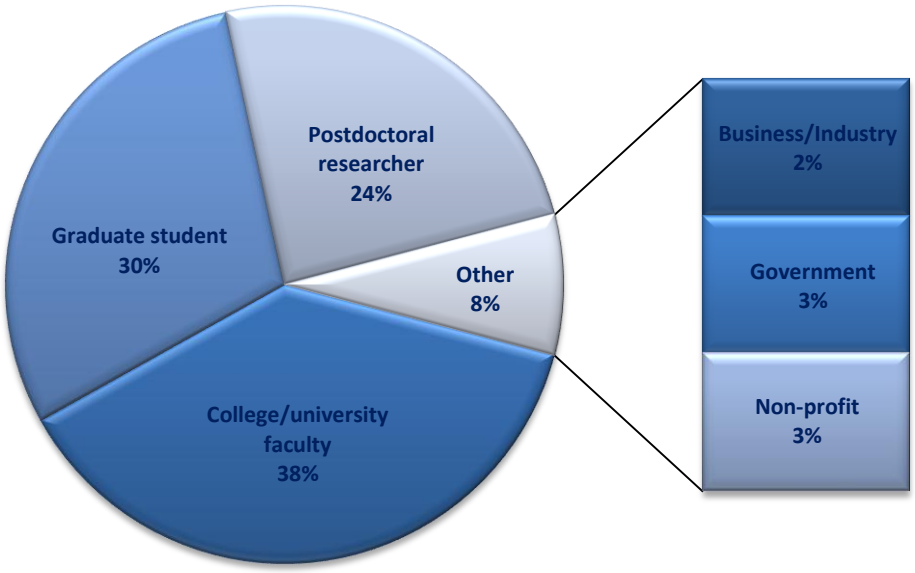
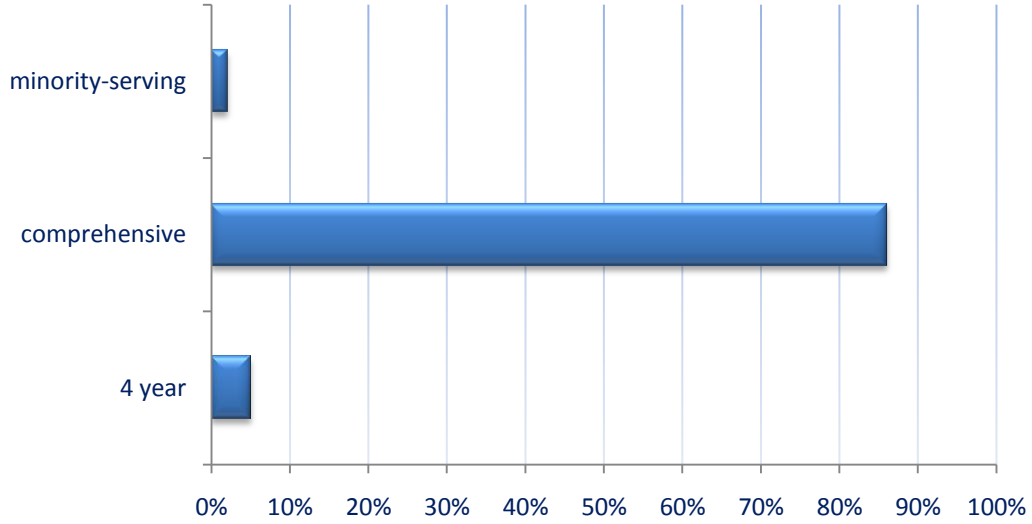


Table 1. ***Participant fields of study and areas of concentration***

Field of Study	Concentration	# Participants
Agricultural Sciences/Natural Resources	Forest/Resources Management	3
Biological/Biomedical Sciences	Ecology	4
	Zoology, Other	1
Engineering	Bioengineering & Biomedical	1
Health Sciences	Not Reported	1
	Public Health	1
Mathematics	Analysis & Functional Analysis	1
	Applied Mathematics	6
	Mathematical Biology	13
	Mathematical Ecology	2
	Not reported	1
Ocean/Marine Sciences	Ocean/Marine, Other	1
Not reported		2

Participants represented 25 different institutions across five countries, including Bangladesh, Canada, Indonesia, Nigeria, and the United States. Within the U.S., 13 different states were represented. Included in the institutions were 1 government institution, 34 colleges/universities, and 1 non-profit and 1 business. Of the 22 *different* colleges/universities, most were classified as comprehensive (having undergraduate and graduate programs) schools (Figure 2).

Figure 2. ***Characteristics of participants' colleges/universities (n=34)***



The 21 females and 16 males (two of whom self-identified as being of Hispanic/Latino ethnicity) primarily self-identified racially as white (Figures 3 & 4).

Figure 3. ***Racial composition of program participants (n=37)***

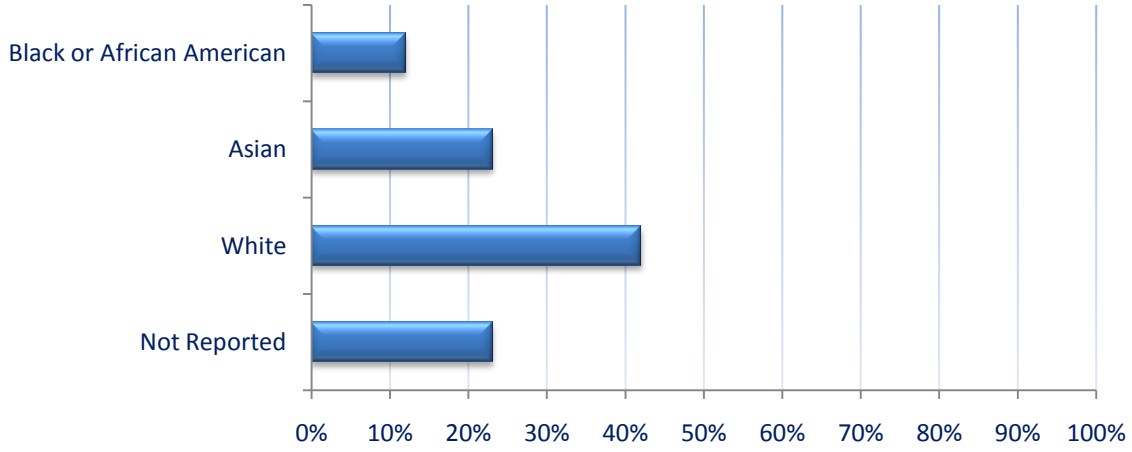
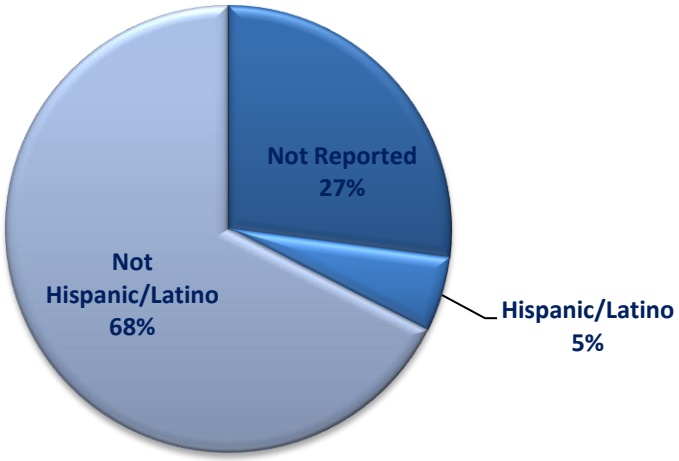


Figure 4. ***Ethnic composition of program participants (n=37)***



Three respondents indicated their work is currently supported by National Science foundation grants (Table 2).

Table 2. ***NSF grants supporting participant research***

Name of grant	Institution at which grant is held
Optimal Control Related to Cholera Studies	Murray State University
NSF Graduate Research Fellowship Program	Massachusetts Institute of Technology
CAREER: Integrated Research and Education in Nonlinear Dynamics in Biological Systems	University of Tennessee, Knoxville

Evaluation Design

Evaluation Questions

The evaluation of the Tutorial was both formative and summative in nature, in that the data collected from participants was intended to both gain feedback from participants about the quality of the current Tutorial and also to inform future meetings. The evaluation framework was guided by Kirkpatrick's Four Levels of Evaluation model for training and learning programs (Kirkpatrick, 1994[1]). The evaluation questions were developed according to level one of the model, participants' reactions, in order to gather information about how participants felt about the content and format of the Tutorial, as well as the accommodations provided by NIMBioS. Several questions constituted the foundation for the evaluation:

1. Were participants satisfied with the Tutorial overall?
2. Did the Tutorial meet participant expectations?
3. Was the Tutorial appropriate to the participants' levels of expertise?
4. Did participants feel they learned an appropriate amount of information?
5. Were participants satisfied with the amount of content and format of the Tutorial?
6. Were participants satisfied with the accommodations offered by NIMBioS?
7. What changes in accommodations, group format, and/or content would participants like to see at future similar meetings?

Evaluation Procedures

The final instrument was hosted online via the University of Tennessee's online survey host mrInterview. Links to the survey were sent to 28 Tutorial participants on December 21, 2009 (Tutorial organizers and seven participants associated with NIMBioS were excluded from the evaluation). Reminder emails were sent to non-responding participants on January 4 and 11, 2010. By January 18, 2010, 26 participants had given their feedback, for a response rate of 93%.

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[1] From Kirkpatrick, D.L. (1994). *Evaluating Training Programs: The Four Levels.* San Francisco, CA: Berrett-Koehler.

the evaluator filled in missing demographic data from other sources (e.g. address, institution, field of study). The evaluator did not assume race, ethnicity, or disability status for any participant who did not report this information.

Data Analysis

Data from the electronic survey included both forced-response and supply-item questions. All data were downloaded from the online survey host into the statistical software package SPSS for analysis. Quantitative data were analyzed using SPSS, while qualitative data were analyzed in SPSS Text Analysis for Surveys. Qualitative responses were categorized by question and analyzed for trends.

Findings

Overall Satisfaction

Overall satisfaction with the Tutorial was high among respondents, the majority of whom indicated they either agreed or strongly agreed that the Tutorial met their expectations (96%) and was appropriate to their level of expertise (92%). Some general participant comments:

> *"This [tutorial] has been a great exposure to different kinds of control and to meet several people working in our related fields. I have gained a lot for my future research. Lectures by Dr. Lenhart, Dr. Fister and others were very encouraging and their scientific pursuit is very inspiring."*

> *"Thanks very much for giving me a chance to learn the valuable materials in this compact [tutorial]. It is very helpful to my research….I appreciate the help from the assistants in the lab study."*

All respondents thought the instructors were knowledgeable about their topics, and 92% thought the presentations were useful. The majority of participants thought the hands-on exercises were useful (96%) as well, while a smaller majority felt the group discussions were useful (88%). Additionally, all respondents either agreed or strongly agreed that they would recommend participating in NIMBioS Tutorials to their colleagues (Table 3).

Table 3. ***Participant satisfaction with various aspects of the Tutorial***

	n	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
This tutorial was appropriate for my level of expertise.	26	58%	35%	4%	4%	0%
The tutorial met my expectations.	26	42%	54%	0%	4%	0%
The hands-on exercises were useful.	26	46%	50%	4%	0%	0%
The presentations were useful.	26	42%	50%	8%	0%	0%
The instructors were very knowledgeable about their topics.	26	86%	12%	0%	0%	0%
The group discussions were useful.	26	42%	46%	12%	0%	0%
I would recommend participating in NIMBioS tutorials to my colleagues.	26	76%	24%	0%	0%	0%

Satisfaction with Accommodations

Overall, respondents reported being satisfied with the travel, housing, and other accommodations provided by NIMBioS during the Workshop. Twenty-four respondents answered questions about their travel accommodations, 23 of whom said they were satisfied with their accommodations, while one indicated feeling "neutral."

Table 4. ***Participant satisfaction with Tutorial accommodations***

Please indicate your level of satisfaction with the Tutorial accommodations:	*n*	Very satisfied	Satisfied	Neutral	Dissatisfied	Strongly dissatisfied
Comfort of the facility in which the Tutorial took place	26	69%	27%	4%	0%	0%
Resources of the facility in which the Tutorial took place	26	72%	28%	0%	0%	0%
Travel arranged by NIMBioS	24	88%	8%	4%	0%	0%
Housing arranged by NIMBioS	24	92%	4%	4%	0%	0%

Tutorial Content and Format

Format

The majority of respondents (92%) thought that the Tutorial format was effective for achieving its goals, and were also satisfied with the opportunities provided during the Tutorial to ask questions and/or make comments. Many respondents indicated the hands-on lab work was the most useful aspect of the tutorial, while others liked the well-prepared lectures introducing the material:

> *"The teaching lectures by Dr. Lenhart and Dr. Bevers were the most useful to me. They did an excellent job covering the basic content in such a short time."*

> *"[The most useful aspects were the] lectures by faculty. Not only did it cover a lot of useful background information, but it also gave us insight into their thinking styles and projects."*

Yet another participant felt the group discussions were the most useful aspect of the Tutorial:

> *"Seeing several examples of optimal control problems was very useful, but I think the most helpful part was breaking into the groups. I was able to see how we can work through how to best set up a control problem."*

Regarding content, 69% of respondents felt the amount of content covered during the Tutorial was "just right," while 19% felt there was too much content for the allotted time. When asked what topics they would have liked to have covered in this tutorial if given more time, the most common response was differential equations. Participant comments:

> *"Optimal control on complicated ODE and some PDE models. More examples of different kinds of control applications and construction of related objective functions."*

> *"More details on the optimal control of ordinary differential equations and difference equations."*

> *"Different numerical techniques for solving differential equations on Matlab*."

Other participants indicated they would be interested in learning more about applications of optimal control in specific fields:

> *"[M]ore applications in life sciences research."*

> *"I would suggest a special topic: Optimal control for epidemiological (infectious disease) models in human and animal population based on both ODEs and Markov Chain Models."*

> *"[O]ptimal control of ordinary differential equations and difference equations with applications in epidemiology."*

> *"Natural Resource Management and Fisheries Modeling*."

Participant Learning

All respondents said they felt that participating in the Tutorial helped them understand optimal control of ordinary differential equations and difference equations, while 59% agreed that they had a better understanding of the programming methods taught during the Tutorial (Table 5). One participant who disagreed he/she gained a better understanding of programming methods had this to say:

> *"The second half (programming, linear & variants) needs to be more explicitly written out. We had to read what the instructor typed on screen and type it ourselves, and do it, without error to get the same results. If each example, with inputs and necessary editing were written out, it would be easier to think about what we were doing."*

Table 5. ***Participant self-reports of learning***

As a result of participating in this Tutorial, I have a better understanding of:	*n*	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Optimal control of ordinary differential equations and difference equations	26	69%	31%	0%	0%	0%
Linear, integer, nonlinear, stochastic, and chance-constrained programming methods	26	17%	42%	25%	13%	4%

Suggestions for Future Tutorials

Respondents were asked for suggestions for improving future Tutorials. Several themes emerged from analysis of participant responses, including breaking into smaller groups more often and having more information available before the Tutorial. Suggestions for breaking into smaller groups centered on the idea that more discussion of individual problems could take place in this format:

> *"More time or chance in break-up group discussion or putting the people on the same topic in small group."*

> *"[Break into] small groups working on small representative projects, such as those covered in the lab, where a short group presentation is required at the end of the tutorial."*

Some respondents suggested it would also be useful to make more background information available to participants before the Tutorial so they would feel more prepared:

> *"I would have liked to have Paul's papers in advance. While the use of one example to illustrate the different methods was educative, it also made the practicum of Paul's part more tedious. The use of different examples from his research would have made it more interesting."*

> *"[L]inear, integer, nonlinear, stochastic and chance-constrained programming methods. I followed it but it was difficult since the programs were not very user friendly. Having a handout prior to the session might have helped on the numbers to input and so on."*

"Provide the participants ahead of time with all the slides (ppt) and documents of the presentations and talks. It makes it easier to read in advance about the topic and write extra notes on the printed ppt or document presentations. In addition, it would help to have group presentations at the end of the tutorial where groups composed by the participants would work on some of the covered projects in the tutorial, such as the project in the labs."

Other suggestions included focusing more on optimal control and less on linear programming, providing more life sciences applications, and breaking the tutorial into separate groups (mathematicians and biologists) so that more detail could be discussed in these areas.

Conclusions and Recommendations

Overall satisfaction with the Tutorial was high among respondents, the majority of whom indicated that the Tutorial met their expectations and was appropriate to their level of expertise. Respondents were also satisfied with the travel, housing, and other amenities offered by NIMBioS.

The majority of respondents thought that the Tutorial format was effective for achieving its goals and were satisfied with the opportunities provided during the Tutorial to ask questions and/or make comments. Many respondents indicated the hands-on lab work was the most useful aspect of the tutorial, while others liked the well-prepared lectures introducing the material.

The majority of respondents felt the amount of content covered during the Tutorial was "just right." When asked what topics they would have liked to have covered in this tutorial if given more time, the most common response was differential equations. Other participants indicated they would be interested in learning more about applications of optimal control in specific fields.

All respondents said they felt that participating in the Tutorial helped them understand optimal control of ordinary differential equations and difference equations, while fewer agreed that they had a better understanding of the programming methods taught during the Tutorial.

Several suggestions were made for improving future tutorials, including breaking into smaller groups more often and having more information available before the Tutorial. Suggestions for breaking into smaller groups centered on the idea that more discussion of individual problems could take place in this format. Other suggestions included focusing more on optimal control and less on linear programming, providing more life sciences applications, and breaking the tutorial into separate groups (mathematicians and biologists) so that more detail could be discussed in these areas.

Based on analysis of participant response data, the recommendations for future Tutorials are as follows:

- Consider making more background research and reading materials available to all participants before the Tutorial. Participant suggestions included having copies of Tutorial presentations, handouts, and papers used during the Tutorial available beforehand.

- A common request from participants was to break into smaller groups more often to discuss specific problems and work on projects. Consider having smaller groups work on projects and give mini-presentations at the conclusion of the Tutorial about their work.
- While participants indicated high levels of learning about optimal control of ordinary differential equations and difference equations, it was also the topic they were most interested in learning more about. Consider offering another Tutorial in the future related to this topic as interest appears to be high.

Appendix A: List of Participants

Participants

Last name	First name	Institution
Abdelrazec	Ahmed	York University, Toronto
Agusto	Folashade	NIMBioS
Armsworth	Paul	University of Tennessee, Knoxville
Beckage	Brian	University of Vermont
Benitez-Gucciardi	Barbara	Houston Baptist University
*Bevers	Michael (Guy)	United States Forest Service
Bewick	Sharon	NIMBioS
Bodine	Erin	University of Tennessee, Knoxville
Bourouiba	Lydia	Massachusetts Institute of Technology
Cho	Eungchun	Kentucky State University
Debroy	Swati	University of Florida
Fister	Renee	Murray State University
Hughes	Joe	University of Tennessee, Knoxville
Khan	Mohammad Safayet	Building Resources Across Communities
Lanzas	Cristina	Cornell University
Lawson	Darunee	University of Tennessee Medical Center
Leander	Rachel	University of Tennessee, Knoxville
Lee	Namyong	Minnesota State University, Mankato
Leite	Maria	University of Oklahoma
Leng	Kung (Justine)	State University of New York, Buffalo
*Lenhart	Suzanne	NIMBioS
Lu	Zhao	Cornell University
Mao	Yi	NIMBioS
Masarie	Alex	Colorado State University

McCowen	Erin	Colorado State University

Last name	First name	Institution
Miller	Curtis	University of Kansas, Natural History Museum
Moeller	Holly	Massachusetts Institute of Technology
Prosper	Olivia	University of Florida
Rios-Soto	Karen	University of Puerto Rico, Mayaguez
Robert	Michael	North Carolina State University
Tchuenche	Jean	University of Guelph
Teboh-Ewungkem	Miranda	Lafayette College
Toews	Carl	Duquesne University
Wang	Jiafeng	York University, Toronto
Wiraningsih	Eti Dwi	Jakarta State University
Yahdi	Mohammed	Ursinus College
Zhao	Xiaopeng	University of Tennessee, Knoxville

*** Organizer of Tutorial**

Appendix B: Optimal Control and Optimization for Biologists Tutorial Survey

Optimal Control and Optimization for Biologists Tutorial Survey

Thank you for taking a moment to complete this survey. Your responses will be used to improve the Tutorials 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 Tutorial: (Very satisfied, Satisfied, Neutral, Dissatisfied, Very dissatisfied)

The Tutorial was appropriate to my level of expertise.
The Tutorial met my expectations.
The hands-on exercises were useful.
The presentations were useful.
The instructors were very knowledgeable about their topics.
I would recommend participating in NIMBioS Tutorials to my colleagues.

How do you feel about the amount of content offered during the tutorial?

Too little for the allotted time
Too much for the allotted time
Amount of content was just right

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

optimal control of ordinary differential equations and difference equations.
linear, integer, nonlinear, stochastic and chance-constrained programming methods.

What topics would you have liked to have covered in this tutorial if given more time?

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

What would you change about the Tutorial?

How do you feel about the format of the Tutorial?
This was a very effective format
This was not a very effective format
The Tutorial format would have been more effective if:

Please indicate your level of satisfaction with the Tutorial accommodations:
(Very satisfied, Satisfied, Neutral, Dissatisfied, Very dissatisfied, Not applicable)

Travel arranged by NIMBioS
Housing arranged by NIMBioS
Comfort of the facility in which the Tutorial took place
Resources of the facility in which the Tutorial took place

If your work is currently supported by an NSF grant, please indicate the name of the grant:

Institution(s) at which NSF-funded research is being carried out (this will likely be your home institution):

Communications Evaluation

NIMBioS is currently exploring innovative avenues for communication among its Tutorial participants. Your responses to the following questions will allow us to better understand the communication needs of our scientific communities.

How satisfied were you with the opportunities provided during Tutorial 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 Tutorial:

If you maintain a blog about your research and would like a link posted on the NIMBioS website, please provide the URL here, along with a brief description of the blog:

Please provide any additional comments about your overall experience with the Tutorial:

Appendix C: Open-ended Survey Responses

What do you feel was the most useful aspect of the tutorial? (n=20)

Hands-on experience (8)

Doing in-hand lab practical's

Hands-on experience

Hands-on lab sessions and lectures.

The lab work. It is really helpful to understand the lecture.

hands on exercises

the lab work

General overview of methods, Matlab tutorial exercise

The Labs on Optimal Control, The Intro Tutorial on Optimal Control

Well-prepared lectures introducing material (6)

lectures

the theoretical introduction of control theory

1. Reading relevant materials/papers in advance; 2. Well prepared lectures; 3. Carefully selected hands-on exercises with user-friendly interface.

The teaching lectures by Dr. Lenhart and Dr. Bevers were the most useful to me. They did an excellent job covering the basic content in such a short time.

Lectures by faculty. Not only did it cover a lot of useful background information, but it also gave us insight into their thinking styles and projects.

Optimal control talks and labs

Applications for optimal control (5)

Optimal control of ordinary differential equations and difference equations.

optimal control of discrete equations

Optimal control of ODE models. Both quick survey and examples were great!

The first half, on optimal control.

optimal control of ordinary differential equations and difference equations

Group discussions(2)

Presenting of the different examples of application of control to ODE. Group discussion.

Seeing several examples of optimal control problems was very useful, but I think the most helpful part was breaking into the groups. I was able to see how we can work through how to best set up a control problem.

What would you change about the tutorial? (n=14)

Miscellaneous (7)

I would have preferred to spend more time on the optimal control portion and less on the linear programming, however, perhaps if we had gone more thoroughly and slowly through the theory behind linear programming as we did with the control section, I would have gotten more out of the last 1.5 days.

I would have liked to have seen more theoretical aspects of the linear programming problems. It was too computer oriented for me. I would have liked to have explored the nuts and bolts.

more life sciences applications

I like to focus more on optimal control topic (such as optimal control for PDEs model and stochastic equations).

less discussion of software-specific applications

Since the participants came from a variety of backgrounds it was difficult to address any issue in depth. I think if there could be separate groups for more mathematical people and another for the biologists, we could go deeper into details and benefit more.

The second half (programming, linear & variants) needs to be more explicitly written out., We had to read what the instructor typed on screen and type it ourselves, and do it, without error to get the same results. If each example, with inputs and necessary, editing, were written out, it would be easier to think about what we were doing., Also, when we broke into working groups, there were two groups and both ended up, working on a problem in disease control. Most of the attendees were interested first, and foremost in disease control, but my problems are in ecology and I am not involved in, any work involving diseases. So I will have to apply the stuff in the tutorial on my own.

Time suggestions (4)

The allotted time

Each lab session seemed too long, and time was not best used.

More time in small groups! Perhaps this could include breaking up into even smaller groups -- four or five people in size -- after the initial, "expert"-guided sessions.

Length of talks given by specialists - break them into two talks with either discussion or a break in between

More materials in advance (3)

I would have liked to have Paul's papers in advance. While the use of one example to illustrate the different methods was educative, it also made the practicum of Paul's part more tedious. The use of different examples from his research would have made it more interesting.

Linear, integer, nonlinear, stochastic and chance-constrained programming methods. I followed it but it was difficult since the programs were not very user friendly. Having a handout prior to the session might have helped on the numbers to input and so on.

Provide the participants ahead of time with all the slides (ppt) and documents of the presentations and talks. It makes it easier to read in advance about the topic and write extra notes on the printed ppt or document presentations., In addition, It would help to have group presentations at the end of the tutorial where groups composed by the participants would work on some of the covered projects in the tutorial, such as the project in the labs.

The tutorial format would have been more effective if: (n=1)

More examples from the biological/real world are included

Please indicate any suggestion you have for facilitating communication among participants during the tutorial: (n=7)

Breaking into smaller groups (5)

Break up in smaller work groups of participants, reconvening with the larger group at regular intervals during the afternoon.

Perhaps the attendees should break into groups to introduce and discuss their own problems sooner, than evening of the second day (we weren't fresh then). Attendees could start thinking about a, problem before they have all the tools to handle it.

more time or chance in break-up group discussion or putting the people on the same topic in small group

Break into smaller groups according to interested problems by participants themselves.

Small groups working on small representative projects, such as those covered in the lab, where a short group presentation is required at the end of the tutorial.

Miscellaneous (2)

After I registered for the tutorial I received about 10 e-mails about the Wiggio and other aspects of the tutorial. Being new to Wiggio and this type of tutorial set-up, it was difficult to wade through all the various e-mails.

Maintain Wiggio and use it as a communication tool.

Other social networking tools used: (n=6)

Linked In and Wiggio

face to face, phone, email etc

Talking.

Email

email

Wiggio, Labmeeting

If you maintain a blog about your research and would like a link posted on the NIMBioS website, please provide a the URL here along with a brief description; (n=0)

Please use this space for additional comments: (n=6)

This Tutorial has been a great exposure to different kinds of control and to meet several people working in our related fields. I have gained a lot for my future research. Lectures by Dr. Lenhart, Dr. Fister and others were very encouraging and their scientific pursuit is very inspiring.

Thanks very much for giving me a chance to learn the valuable materials in this compact Tutorial. It is very helpful to my research. By the way, I appreciate the help from the assistants in the lab study.

You have a great facility to foster research. The food was exceptional and the opportunities for discussion were valuable.

I thank you for all NIMBioS staffs, especially to Dr. Lou Gross and Dr. Su Lenhart for their wonderful job for the Tutorial.

the helps from the assistants are very appreciated

Thank you. It was a great Tutorial. I will recommend NIMBioS Tutorial to my Colleagues. The hall was comfortable, but it was very cold. That was the only issue about Comfort. Thanks to Susan, Pam, Jennifer, Chris, Lou and all who made this a success. I learned a lot. I just need to try and see how and where to apply the knowledge.

NSF Grant (n=3)

Optimal control related to Cholera Studies

NSF Graduate Research Fellowship Program

CAREER: Integrated Research and Education in Nonlinear Dynamics in Biological Systems

What topics would you have liked to have covered in this tutorial given more time? (n=18)

Differential equations (9)

differential equations

optimization related to partial differential equations

Different numerical techniques for solving differential equations on Matlab.

More details on the optimal control of ordinary differential equations and difference equations.

stochastic differential equations

Optimal control on complicated ODE and some PDE models. More examples of different kinds of control applications and construction of related objective functions.

because of my research area, I would have like a more detailed presentation of optimal control for ODEs

Optimal Control Applied to PDES.

optimal control of pdes

Applications in specific fields (4)

more applications in life sciences research.

I would suggest a special topic: Optimal control for epidemiological (infectious disease) models in human and animal population based on both ODEs and Markov Chain Models.

Optimal control of ordinary differential equations and difference equations with applications in epidemiology.

Natural Resource Management and Fisheries Modeling

Miscellaneous (3)

If we had one or two more days, I like to see a (small) group project based on the, first two days material. Then a group presentation on each group's (<= 5 people), presentation. Alternatively, it would

be great if we had more topics in optimal control, in PDEs or Stochastic equations rather than integer programming and linear optimization. Over all, it was very insightful and productive Tutorial.

I would have liked to see how the presenters chose their objective function while going through examples, so that we can start developing more of an intuition for how to do this with our own problems. Also, I think it would have been helpful to go over the control codes a little. Finally, I think I could have used more of an introduction to the linear programming section since I am not familiar with this subject.

optimal method used in data analysis and modeling

More time on linear programming (2)

Optimal control applied to problems over a region in space (u is a vector of length n); rules for and practice in setting up programming problems (linear, stochastic, etc.) on our own.

I would have liked to go through linear programming more slowly, especially the simulations. Also, the group discussions were extremely useful and I would have like to spend a portion of each afternoon in working groups.