CHANCELLOR’S AWARD FOR EXCELLENCE IN TEACHING

Nomination for: Sanjiv Bhatia
Associate Professor of Computer Science
Department of Mathematics and Computer Science
College of Arts and Sciences
317 ESH

Nominated by: Prabhakar Rao
Professor
Department of Mathematics and Computer Science
College of Arts and Sciences
348 ESH

Nomination Letter ................................................................................................................... 2
Curriculum Vitae .................................................................................................................... 4
List of Courses Taught ......................................................................................................... 18
Nominee’s Statement of Teaching Philosophy ..................................................................... 20
Evidence Supporting Nomination ......................................................................................... 23

Selected Syllabi

CMP SCI 4760 Operating Systems ..................................................................................... 30
CMP SCI 6420 Topics in Image Processing and Multimedia ......................................... 33

Summary of Course Evaluations .......................................................................................... 34
Course Evaluation Data ........................................................................................................ 34
Student Comments from Course Evaluations ................................................................. 35
Sample Course Evaluation Form ....................................................................................... 41

Letters of Support

Class Observation Letter from Colleague ........................................................................... 43
Letters from Students ........................................................................................................... 44
March 25, 2015

Faculty Senate and University Assembly
Faculty Teaching and Service Awards Committee
University of Missouri-St. Louis

Dear Colleagues:

I am pleased to nominate Dr. Sanjiv Bhatia for the Chancellor’s Award for Excellence in Teaching.

Professor Bhatia has been a member of the computer science faculty in the Department of Mathematics and Computer Science since 1991 and he has been a key person in the development of the computer science curriculum ever since. He has been responsible for overhaul of the undergraduate curriculum on three occasions (1994, 1998, 2013), trying to upgrade the curriculum to follow the latest ACM standards for undergraduate degrees in CS (which changes every ten years or so). He was involved in establishing the MS in computer science in 1998 along with its curriculum, the integrated BS/MS program in 2013, and in establishing the curriculum and qualifying exam for the Computer Science option in our PhD program. Along with that, Sanjiv is one our finest teachers.

Since course numbers changed in Fall 2003, he has taught nine distinct courses at the undergraduate and graduate level. Courses taught (with the number of times taught): CS 2250, 2750(3), 4760 (19), 5130(6), 5420(5), 5740(3), 5780(2), 6420(3) and 6740. CS 4760 (Operating Systems) is the course which Dr. Bhatia has taught most frequently. Several of the graduate courses are new courses that he developed during his tenure here, based on his research and academic interests. These courses include Digital Image Processing, Computer Vision, Multimedia Information Systems, High Performance Computing. Several of these graduate courses also resulted in additional individual research projects or master’s theses with his graduate students, over twenty in the last ten years alone. This mentoring has resulted in a number of papers by or with his students.

Notable among the graduate courses are CS 5420 (Digital Image Processing) and CS 6420 (Topics in Image Processing and Multimedia), which are courses close to Dr. Bhatia’s research work and taught exclusively by him. In addition, he has taught courses like CS 5740 and CS 6740 on Parallel Processing and High Performance Computation. In the latter, he worked with the Department of Energy to obtain privileges for his students to distribute their work among three distinct Open Science Grid sites at institutions around the country and assemble the results for final analysis.
Sanjiv’s teaching is marked by its rigor and thoroughness. The best way to understand his teaching is to focus on CS 4760, Operating Systems, which he has taught at least 19 times in the last 12 years and which may be thought of as his signature course. This course is taken by a mix of undergraduate and graduate students who learn how, in a modern computer explicit resources like the processor and implicit resources like access to the network can be carefully managed, allocated and maintained. CS 4760 teaches these concepts through a mixture of theory and practice.

It is a difficult course to teach, given the amount of knowledge and understanding the instructor has to bring together, and difficult to grade, given the number of projects. Unlike courses in most disciplines, where a holder of a terminal degree can teach any standard undergraduate/graduate course, this course like many other CS courses undergoes constant revision as the technology changes, making it challenging to teach for the same instructor and almost impossible for a casual instructor.

Among UMSL computer science students and alumni, Sanjiv’s Operating Systems course has a legendary reputation. By now, every student who enrolls in this course must be aware that this is no ordinary course, but one where he/she will have to work hard and explore the limits of their ability. Students report that along with the enormous challenge of the course, Sanjiv’s engaging personality keeps it interesting and his approachability and desire to see students succeed give them many opportunities to do well. Alumni tell us that it is this course that has had the longest impact on their thinking and their work. Looking back, they see a professor who has the courage to make his course work harder so that the students know that they earned their degree. One alumnus commented that if all CS courses were taught like this one, UMSL would have a world class program.

Sanjiv Bhatia’s impact on his students is the true measure of his excellence as a teacher. He has made an indelible impression upon most of them as perhaps the best teacher they have come across. As a teacher, he is perhaps the most valuable asset in the department. The campus should recognize him as such.

Sincerely,

Prabhakar Rao
Professor
Sanjiv K. Bhatia
Department of Mathematics & Computer Science
University of Missouri – St. Louis
St. Louis, MO 63121-4499

Work: (314) 516-6520
Home: (636) 519-9272
e-mail: sanjiv@acm.org
URL: http://member.acm.org/~sanjiv

EDUCATION

• Ph.D., Computer Science, University of Nebraska-Lincoln, NE, 1991.
• M.S., Computer Science, University of Arkansas, Fayetteville, AR, 1987.
• B.E., Computer Science & Engineering, Motilal Nehru Regional Engineering College, Allahabad, India, 1983.

EXPERIENCE

1998-present. **Associate Professor.** Department of Mathematics & Computer Science, University of Missouri – St. Louis, St. Louis, MO. Graduate Program Director (Computer Science) 2013-present.

2002–2003. **Associate Professor.** Department of Computer Science, Southern Illinois University Edwardsville, Edwardsville, IL. (on leave from UM–St. Louis)

1991-98. **Assistant Professor.** Department of Mathematics & Computer Science, University of Missouri – St. Louis, St. Louis, MO.

1988-91. **Graduate Assistant.** Department of Computer Science & Engineering, University of Nebraska-Lincoln.

1987-88. **Graduate Assistant.** Department of Computer Science, University of Southwestern Louisiana, Lafayette, LA.

1986-87. **Graduate Assistant.** Department of Computer Science, University of Arkansas, Fayetteville, AR.

1983-86. **Real-time Applications Engineer.** Systems Engineering & Computer Services Division, Engineers India Limited, New Delhi, India.

Summer 1982. **Engineer Trainee.** Speech and Digital Systems Group, Tata Institute of Fundamental Research, Bombay, India.

Research Interests.

Courses Taught.


Most of the above courses, including lecture notes and assignments, can be accessed over the web at http://www.cs.umsl.edu/~sanjiv/index/teaching.html

MS thesis students: S. Climer, D. Goswami

Served on Ph.D. committee for S. Climer in Department of Computer Science, Washington University, St. Louis, MO.

Served on Ph.D. committees for J. Aleshunas and M. Hauschild.

Grants/Projects.


14. **Digital Terrain modeling.** FlightSafety International. 2001. Designed algorithms to map generic texture patterns on digital maps for flight simulators; created algorithms to generate generic texture patterns automatically from aerial photography. These two projects are on Silicon Graphics in C++, and later ported to Solaris and Linux, with hooks into ImageMagick library.

15. **Travel Grant.** Office of Research, University of Missouri – St. Louis, St. Louis, MO. October 1999.


18. **Small Grants Fund.** University of Missouri – St. Louis, St. Louis, MO. January 1996.


20. **Summer Research Fellowship.** University of Missouri – St. Louis, St. Louis, MO. May – July 1993.


22. **Summer Research Fellowship.** University of Missouri – St. Louis, St. Louis, MO. May – July 1992.

23. **Fuzzy Logic Based Knowledge Acquisition.** Improved Research Quality Grant. University of Missouri – St. Louis, St. Louis, MO. June 1992.


**Statement of Research Interests**

While working on my Ph.D., I primarily did my work in the application of Artificial Intelligence techniques to enhance Information Retrieval (Journal Articles 11, 13). After graduation, I established my own research program and started work in digital image processing applications. I achieved this by gradually moving into algorithms for image retrieval, where I developed heuristics to enhance the efficiency of retrieval process based on spatial relationship of objects in images (Journal Articles 12, 15, 16). Then, I went deeper into the subject and developed techniques to create indices for image databases using available image properties such as DCT coefficients in JPEG-compressed images (Journal Article 10; Conference Paper 10). We have developed a web interface to our database and connected it to a commercial relational database (Oracle) on the back end (Conference Papers 3, 4). We are investigating the use of this set up in the retrieval of satellite images for urban planning applications (1, 2, 7). I have graduate students working on the analysis of satellite imagery for land classification and cloud cover analysis and expect to submit the research for publication in late 2014.

I have also worked on the clustering techniques (Journal Articles 11, 13; Conference Paper 17), developing an adaptive clustering algorithm that was used to improve the performance of an IR sensor as well as to find the most perceptually distributed colors in a flight simulator application (Conference Paper 5), image databases (Conference Paper 4), and knowledge acquisition (Conference Papers 13, 16).
I am also interested in Computer Vision and have published a few articles in face recognition (Journal Articles 4, 14; Conference Paper 12, Book Article 4), line detection (Journal Article 9), image stitching (Journal Article 6), image segmentation (Conference Paper 1), and a survey on the use of image processing in ballistic specimens (Journal Article 3).

After having developed sufficient expertise in image processing, I was invited to develop a system for Forward-Looking Infra-Red video stream for a simulator for V-22 Osprey aircraft that should work in real-time (Conference Paper 8). Later, I developed techniques for Digital Terrain Modeling (Conference Paper 6, 7) and gave a tutorial on the subject in a conference. I have worked on image database indexing, cluster analysis algorithms (Conference Paper 5), and developed techniques for object tracking in noisy video streams (infra-red and low light TV) for flight simulators used to train pilots in the armed forces. I have also developed techniques to analyze on-line videos for business applications.

After we started our graduate program in Computer Science around 2000, I have tried to mentor our graduate students in research and worked with them in publishing the same. I have been fairly successful in doing this and have already published a number of articles with them as coauthors (Journal Articles 1, 3, 9, 10; Conference Articles 1, 3).

Publications.

Articles Published in Scholarly Journals


**Articles Published in Conference Proceedings, Books, etc.**


Book


Reviewed Abstracts.


Guest Editorial.


Conference Tutorial


Magazine Articles


Current Work.


Creative Software Development

- RISE: A Robust Image Search Engine. An image database system to organize, index, and retrieve images over the internet.
- Code to perform wavelet analysis on an image, using Daubechies wavelet.
- A web based application to generate isotropic toroidal tile from an arbitrary image.
- A web based image processing application.
- A package to mathematically determine contrast sensitivity in an image.
• A package for image database indexing using JPEG transform. This package has been improved by rewriting in Java and adding a relational database back end, resulting in RISE.
• A package for knowledge acquisition and analysis based on personal construct psychology
• Image processing package for image degradation for a project
• A utility to create documentation for projects (like man pages in Unix) using WWW interface
• A bulletin board system in world-wide web for students

Program Development

• Proposed an Integrated MS Program for Computer Science, 2013.
• Proposed a program for undergraduate degree in Software Engineering at UM–St. Louis, 1998. (In collaboration with Cezary Janikow)
• New degree program for Masters’ in Computer Science at UM–St. Louis, 1998 (includes graduate curriculum). (In collaboration with Cezary Janikow)
• New curriculum for undergraduate Computer Science degree at UM–St. Louis, 1998. (In collaboration with Cezary Janikow)
  – Completely revamped the curriculum in 2009.
• Graduate Certificate in Telecommunications Science, a collaborative program between the Department of Mathematics & Computer Science and the School of Business at the UM–St. Louis (In collaboration with Ashok Subramanian). 1998.

Membership in Professional Societies.

• Member, Association for Computing Machinery. 1986 – present. Awarded Senior Member ranking in January 2012.
• Member, ACM SIGGRAPH – Special Interest Group in Computer Graphics. 2002 – present.
• Member, American Association for Artificial Intelligence. 1987 – present.

Professional Activities.


• Technical Editor, AI Magazine (1989-92).


• Mentor for a High School student at Marquette High School through St. Louis Junior Science Academy to prepare him for science competition (July 2002 – March 2003).

• Mentor for an Engelmann scholar in the NSF Young Scholars program, 1998.

• Moderator for the Computer Science portion of the panel discussion in the NSF Workshop Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering and Technology, St. Louis, MO. April 1997.

• Invited talks
  – “Project Management with RCS.” St. Louis Unix Users Group – Linux SIG. July 1997. 60 minutes.


• Member, Organizing Committee. CCNC’2012: Smart Spaces and Personal Area Networks. 2012.

• Member, Program Committee, Pacific Rim Symposium on Image and Video Technology, Tokyo, Japan, January 2009.

• Member, Program Committee, Pacific Rim Symposium on Image and Video Technology, Santiago, Chile, December 2007.

• Session chair in the following conferences:
- **ISVC 07**: International Symposium on Visual Computing
- **SAC’94**: Symposium on Applied Computing.
- **SAC’93**: Symposium on Applied Computing.

- Reviewer for the Computer Science Program, Gulf University of Science & Technology, Kuwait. November 2010.
- Reviewer for the BS in Information Communication Technology, Modern College of Business and Science, Sultanate of Oman. November 2004.
- Member of the team to review Computer Science Program at the Arkansas State University, Jonesboro, AR. April 2002.

- Reviewer for the following funding agencies:
  - University of Missouri Research Board (1992-present)
  - Oak Ridge Associated Universities (2012).

- Reviewer for the following books:

- Referee for the following journals:
  - AI Magazine
  - Applied Computational Intelligence and Soft Computing.
  - The Computer Journal
  - IEEE Computer (Special Issue on Content-Based Picture Retrieval Systems)
  - Data and Knowledge Engineering
  - IEEE Transactions on Knowledge and Data Engineering
  - IEEE Transactions on Pattern Analysis and Machine Intelligence
  - IEEE Transactions on Systems, Man, and Cybernetics
  - Image and Vision Computing
– Information Sciences
– International Journal of Human-Computer Interaction
– International Journal of Intelligent Information Systems
– International Journal of Physical Sciences
– Journal of Discrete Algorithms
– Journal of Electronic Imaging.
– Journal of Machine Learning Research
– Journal of Visual Communication and Image Representation
– Machine Vision and Applications Journal
– Mathematical and Computer Modelling
– Pattern Analysis and Applications
– Pattern Recognition Letters

• Referee for the following conferences:
  – AAAI-05.
  – IFIP 2.6 VDB-3 Conference, 1995.
  – CIKM-93: Conference on Information and Knowledge Management.
  – 30th ACM Southeast Conference.
  – 24th Hawaii International Conference on System Sciences.

• Reviewer for Engelmann Institute Scholar Research papers. 1996-98.

• Other service
  – Elected to Faculty Senate, UM St. Louis. 2008 – present.
  – Faculty Advisor, UMSL Game Design Club. (2004-05).
  – Faculty Advisor, ACM Student Chapter. (1993-96, 1997-99)
  – Chair, Senate Committee on Committees. UM St. Louis. 2011-12.
  – Member, Committee of Rules and Bylaws. UMSL. 2012-14.
– Member, Senate/Assembly IT Committee. UM St. Louis. 1998-2000, 2006-10, 2012-present. (chair of subcommittee on IT Research) [Chair of the Committee, 2013-14].


– Member, Committee on Committees. College of Arts and Sciences, UM–St. Louis, St. Louis, MO. 2005-06.

– Member, Senate Curriculum and Instruction Committee. UM–St. Louis, St. Louis, MO. 1998-99.

– Member, Joint committee to improve coordination between the CS and MIS programs, UM St. Louis, St. Louis, MO. 1997.

– Member, Campus Computing Workgroup, UM St. Louis, St. Louis, MO. (1996-97).

– Chair, Academic Computing Committee, Dept. of Math & Computer Science, UM – St. Louis, St. Louis, MO. (1997-2000)

– Chair, Recruitment Committee, Dept. of Math & Computer Science, UM – St. Louis, St. Louis, MO. (1998-99)

– Member, Advisory Committee, Dept. of Math & Computer Science, UM – St. Louis, St. Louis, MO. (1999-2000).

– Curriculum Committee, Dept. of Math & Computer Science, UM – St. Louis, St. Louis, MO. (Member 1999-2000, 2006-07; Chair 2003-06, 2007-12)

– Chair, Computing Committee, Department of Mathematics & Computer Science, University of Missouri – St. Louis, St. Louis, MO. (1995-96; 1999-2000)

– Member, Committee for a Special Graduate Program for McDonnell Douglas Employees, Department of Mathematics & Computer Science, University of Missouri – St. Louis, St. Louis, MO. (1995-97)

– Member, Colloquium Committee, Department of Mathematics & Computer Science, University of Missouri – St. Louis, St. Louis, MO. (1995-96, 2004-2013). Twice organized the Spencer Lecture.

– Academic Computing Committee, Department of Mathematics & Computer Science, University of Missouri – St. Louis, St. Louis, MO. (Member 1994-95; Chair 2003-04)

– Member, Library Committee, Department of Mathematics & Computer Science, University of Missouri – St. Louis, St. Louis, MO. (1991-93)

• Course coordinator
– Introduction to Computer Science (2003–09)
– Data Structures and Problem Solving
– Advanced Programming Techniques
– Advanced Programming with Unix (2003–06)
– Algorithm Analysis

Advisor for a number of undergraduate and graduate students.

Participant in the Speakers for Science program, Academy of Science – St. Louis.
LIST OF COURSES TAUGHT (FALL 2004 TO FALL 2014)

FALL 2014
CMP SCI 4760 Operating Systems
CMP SCI 5420 Digital Image Processing

SPRING 2014
CMP SCI 4760 Operating Systems (2 sections)

FALL 2013
CMP SCI 4760 Operating Systems
CMP SCI 5130 Advanced Data Structures and Algorithms

SPRING 2013
CMP SCI 4760 Operating Systems
CMP SCI 6420 Topics in Image Processing and Multimedia

FALL 2012
CMP SCI 4760 Operating Systems
CMP SCI 5420 Digital Image Processing

SPRING 2012
CMP SCI 2750 System Programming and Tools
CMP SCI 4760 Operating Systems

FALL 2011
CMP SCI 4760 Operating Systems
CMP SCI 5740 High Performance Computing

SPRING 2011
CMP SCI 4760 Operating Systems
CMP SCI 6420 Topics in Image Processing and Multimedia

FALL 2010
CMP SCI 4760 Operating Systems
CMP SCI 5420 Digital Image Processing

SPRING 2010
CMP SCI 4760 Operating Systems
CMP SCI 5740 Parallel and Distributed Computing
FALL 2009
CMP SCI 4760 Operating Systems
CMP SCI 5130 Advanced Data Structures and Algorithms

SPRING 2009
CMP SCI 4760 Operating Systems
CMP SCI 5130 Advanced Data Structures and Algorithms

FALL 2008
CMP SCI 4760 Operating Systems
CMP SCI 6740 High Performance Computing

SPRING 2008
CMP SCI 4760 Operating Systems
CMP SCI 5740 Parallel and Distributed Computing

FALL 2007
CMP SCI 2750 System Programming and Tools
CMP SCI 4760 Operating Systems

SPRING 2007
CMP SCI 2250 Programming and Data Structures
CMP SCI 5130 Advanced Data Structures and Algorithms

FALL 2006
CMP SCI 5130 Advanced Data Structures and Algorithms
CMP SCI 6420 Topics in Image Processing and Multimedia

SPRING 2006
CMP SCI 4760 Operating Systems
CMP SCI 5420 Digital Image Processing

FALL 2005
CMP SCI 4760 Operating Systems (2 sections)

SUMMER 2005
CMP SCI 5130 Advanced Data Structures and Algorithms

SPRING 2005
CMP SCI 2750 System Programming and Tools
CMP SCI 5420 Digital Image Processing

FALL 2004
CMP SCI 4760 Operating Systems
CMP SCI 5780 Systems Administration
TEACHING PHILOSOPHY

TEACHING GOALS
Teaching is defined as imparting the knowledge or skill in a subject to another person. In the University environment, teaching typically involves lecturing to students and answering their questions. But is that all that should be used to define the phenomenon we call teaching? I prefer to distinguish “teaching” from “effective teaching,” measured by how much has been absorbed by the students, rather than how much has been presented to them in a lecture. In Computer Science, we have to teach not only the techniques and best practices to the students but also prepare them for a successful career in the field. With such a goal in mind, the teacher needs to prepare the student not only for the current technology but also for the future technologies, plus a critical mind that can help a student distinguish good technology from not-so-good technology.

In recent times, there has been a lot of emphasis on training the students about specific tools that are in vogue at the moment. I’ll rather teach the students about fundamentals of the subject, using the tools as examples. If a student is well versed in the concepts, he can adapt the technology to solve the problem at hand due to his knowledge of the concepts. This fact was realized by an early computer scientist, Peter Landin, who coined the term syntactic sugar to indicate the fact that most of the programming languages are sugar-coated to make the powerful constructs in the languages easier to understand and use for humans. If we can bring the students to realize and understand the underlying concepts, the transition from C++ to Java is just a matter of following the syntactic sugar. This is an extremely important issue for teaching in Computer Science because nobody can predict the new tools that appear in this field at regular intervals.

TEACHING STRATEGIES
I foster a friendly relationship with students in all my classes. I believe in teaching by example and encourage self-learning among students. Towards that end, I have always stayed on top of the subjects I teach -- a time-consuming task, especially since the classes I teach may not be related to my research, and are typically taught at advanced levels. With the rapid changes in
the field, the job becomes even tougher, as I learn the material to be presented from a variety of sources, including professional journals, mailing lists, and Internet.

I believe in organizing the class well. I have used the technology provided by the Internet to manage the class in a fashion that encourages interactive learning. In the process, I have discovered that I always have some students who go out of their way to research a new topic and present their results to the class via email. I must admit that I learn new things myself while reading their emails. In addition, I see students help their classmates with the problems, or even in better understanding the problems. I like to challenge the students in their projects and most of the times, I see them rise to the challenge. The students help each other via email discussions so that even the students who may not be well prepared from their previous classes, learn the material and come up-to-speed.

I make use of the technology to the maximum possible extent to deliver the instruction as well as to communicate with the students. This results in an improved quality of instruction and communication. I prepare my lecture notes electronically and make those available to the classes prior to lectures. I encourage the students to print the notes and bring the same to lecture so that they can concentrate on learning the new material, and possibly annotate the fine points being discussed on the notes. In addition, I provide any old tests and project materials to my classes via web. This helps the students prepare better for the tests, as well as project assignments.

Email is the lifeline of my communication with the class. I have extensively used mailing lists for class communication and it helps in boosting the productivity and knowledge attained in the class. Typical uses of the mailing list include sending announcements to students, telling them of possible pitfalls in the assignments, and sending them current news stories about the subject. This provides for extra material that may not be available in textbooks and that is current enough to get reasonable amount of information from authoritative sources. Another advantage of email communication is my availability to students. I receive a lot of queries over the weekends and late evenings when the students are working on the projects. The use of mailing lists saves time when a possible error, or advantages of using one method over another, can be pointed to all students rather than being told to just one.
I have been successful in challenging the students to be creative and they have risen to the challenge. The best testimonial to my teaching was when a former student called to tell me of a problem that puzzled a number of his colleagues at his work and he had already done it as a part of an Operating Systems assignment.

I have adapted the technology into teaching as it evolved. The availability of computers in the classroom opened a new multimedia method to teach the course. Now, instead of telling the students to experiment and discover the subtleties of Unix by themselves, I am able to demonstrate the topics in class. I have been helped in this by a large amount of open source software that I have installed on my workstation. This also makes the students relate to the concepts in a better manner.

**BRINGING RESEARCH AND SCHOLARSHIP INTO TEACHING**

My experience in the industry, even though it is limited to research and development, has allowed me to observe some issues that may come up when the students enter the workforce. I attempt to incorporate things I learned in the industry into lectures to show better programming techniques to students. Thus, I have tried to make students familiar with concepts such as versioning (RCS), project management (the make utility), and code optimization (gprof) in my courses on Operating Systems and Algorithms. I also teach the students some esoteric features of the C/C++ languages, which the students may not learn in their earlier classes on the subject. The students turn into better programmers due to this knowledge and can perform well in the industry.

I have been active in social networking sites such as stackoverflow and OpenCV forum where I answer questions on Computer Science and Computer Vision topics. I have established a good reputation on those sites, under my handle unxnut. Additionally, I have learned a lot about newer technologies and trends from those sites. I am also an ardent advocate for Open Source and was invited as a panelist in the ACM SIGCSE 2009 conference in the panel on the use of Open Source in education.
unxnut's profile - overview

Interested in target tracking in particular, and image processing in general.

14 Questions

Problem compiling cvBlobsLib with OpenCV 2.4.2

Problem with meanStdDev

cvBlobsLib problem; wrong dimensions for blob 0

Number of keypoints for an object

Videocapture problem on Linux

Reading an online video

Euclidean distance between two cv::Mat images
I teach and perform research in image processing, computer vision, and high performance computing.
0 Active bounties

You have no active bounties

160 Votes Cast

<table>
<thead>
<tr>
<th>all time</th>
<th>by type</th>
<th>month</th>
</tr>
</thead>
<tbody>
<tr>
<td>154 up</td>
<td>37 question</td>
<td>1</td>
</tr>
<tr>
<td>6 down</td>
<td>123 answer</td>
<td></td>
</tr>
</tbody>
</table>

view more
I teach and perform research in image processing, computer vision, and high performance computing.
<table>
<thead>
<tr>
<th>Active bounties</th>
<th>active</th>
<th>offered</th>
<th>earned</th>
</tr>
</thead>
<tbody>
<tr>
<td>You have no active bounties</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 170 Votes Cast

<table>
<thead>
<tr>
<th>all time</th>
<th>by type</th>
<th>month</th>
</tr>
</thead>
<tbody>
<tr>
<td>168 up</td>
<td>32 question</td>
<td>2</td>
</tr>
<tr>
<td>2 down</td>
<td>138 answer</td>
<td></td>
</tr>
</tbody>
</table>

view more
Cmp Sc 4760 Operating Systems Spring 2015

Instructor       Sanjiv K. Bhatia
Office           317 ESH (Phone 314.516.6520)
e-mail           sanjiv@umsl.edu
url              http://www.cs.umsl.edu/~sanjiv/classes/cs4760
Office Hrs       M W 4:00pm – 5:30pm
Any other time by appointment
Prerequisites    Cmp Sc 2700, Cmp Sc 2750, and Cmp Sc 3130

/objectives
We’ll discuss the structure of a generic operating system, with an emphasis on the algorithms and data structures needed to perform various tasks to manage processes, resources, memory, files, and IO devices. There will be extensive programming in C under Linux environment. The sequence of topics will be as follows (in that order):

- Concurrent Programming, Process Interaction and Synchronization.
- Process Management and Scheduling.
- Deadlock Problem.
- Memory Management.
- File System and I/O management.

/policy I’ll expect you to be present in most of the classes. I will not be taking attendance but if you start missing too many classes, please take responsibility for your absence, specially when it concerns tests and homeworks. When you come to class, you must change your cell phones to silent mode. If your cell phone rings during a test, I’ll deduct 10% points from that test score for you.

If you are more than ten minutes late, please try to not disrupt the class. I’ll penalize you by one letter grade for habitually coming late to class (more than five times I notice you coming late or leaving early).

The grade will be based on programming assignments and three tests. Each assignment must be meticulously documented and clearly identify its purpose, author, and date. I will like to read your submitted code; I should not have to figure it out. It will do you good if you peruse the Gnu Coding Standards at http://www.gnu.org/prep/standards/. When you come to me for help with the code, or when you submit the code, make sure that you follow good indentation practices.

All tests will be open book and open notes but no electronic devices will be permitted. Tests are non-comprehensive but may have a small overlap of material from one test to next. If you miss any test or assignment without making prior arrangements, you will have a zero. When making such arrangements, please stop by my office instead of sending me an email. I will not give any make up tests. The distribution of grades will be as follows:

Programming Assignments and Projects 40%
Three non-comprehensive tests 20% each

/exam_dates

<table>
<thead>
<tr>
<th>Test</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>February 18, 2015</td>
</tr>
<tr>
<td>2</td>
<td>April 01, 2015</td>
</tr>
<tr>
<td>3</td>
<td>May 06, 2015</td>
</tr>
</tbody>
</table>
There is no final exam. In case of class cancellation due to weather-related or other campus emergency on the day of a test, the test will be held in the following class period. For the third test, if the campus is closed on May 06, the alternative date will be May 07, 2015; possibly in the conference room of the department.

/other.important.dates

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 28, 2015</td>
<td>Last day to enroll in the course</td>
</tr>
<tr>
<td>February 16, 2015</td>
<td>Last day to drop without receiving a grade</td>
</tr>
<tr>
<td>April 20, 2015</td>
<td>Last day to drop the course with instructor approval</td>
</tr>
</tbody>
</table>

Anyone desiring an EXC grade after March 31, 2015 must be passing the course at that point to get EXC.

/etc Failure to hand in any assignment will result in an automatic zero for that assignment. If some student is unable to hand in an assignment by the deadline, he/she must discuss it with me before the deadline. I’ll encourage you to talk to other students regarding homework but you should not collaborate to the extent that two submissions are copies of each other. If you are found copying an assignment (from another student or internet), or if your submission has unreasonable similarity to another submission, you get a zero for that assignment automatically. A second offense will be reported to the University officials and students involved will face serious consequences. I may ask you to come to my office and explain your code to me; in case you do not come for this or you are not able to explain the code to my satisfaction, I’ll assign you a zero in that project.

The projects in this class will take up a lot of your time. So, you should start working on those as soon as they are assigned. In the past, the students who have asked a lot of questions have scored better grades. Do not hesitate to ask a question in class, in my office, or over email, especially if you do not have an idea on how to start working on the project.

If you have any disability that requires an accommodation (as per UMSL policy), you must notify me in advance. If you cannot attend the class due to a religious holiday or a university-sanctioned event, please let me know in advance as well. In case you are down with the flu, please stay absent from the class till you recover, and contact me via phone or email. I’ll try my best to make accommodation for you in that case.

You will have an account on the Linux machine hoare.cs.umsl.edu in the CS department and you should use it for all assignments. All programs must be done in C. The class notes and old tests are available on the class web page in PDF format. Please use the class email list on MyGateway for communications.

Any unsigned email and email not in plain text will go unanswered by me. Please do not send me any attachments without talking to me first.

Tentative Calendar

| Week 1      | Overview of operating systems and concepts |
| Week 2      | Overview of operating systems and concepts; Interprocess Communications |
| Week 3      | Interprocess Communications               |
| Week 4      | Interprocess Communications               |
| Week 5      | Interprocess Communications; Test 1       |
| Week 6      | Process Management                        |
| Week 7      | Process Management                        |
| Week 8      | Process Management                        |
| Week 9      | Resource Management                       |
| Week 10     | Spring Break                              |
| Week 11     | Resource Management; Test 2               |
| Week 12     | Memory Management                         |
| Week 13     | Memory Management                         |
| Week 14     | File Systems                              |
| Week 15     | File Systems                              |
| Week 16     | I/O Management; Test 3                    |
Detailed course outline:

1. Introduction
   - Basic elements of a computer system: processor, memory, I/O modules
   - Evolution of a microprocessor
   - Instruction execution
   - Interrupts
   - Processor registers
   - Memory hierarchy
   - Multiprocessor and multicore organization
   - Classification of operating systems
   - Process execution modes in Unix/Linux
   - Overview of operating systems structuring methods like monolithic, layered, and object-oriented
   - I/O communication
   - Multiprogramming and multitasking

2. Process Coordination and Synchronization
   - Process concept
   - Overview of multitasking and role of interrupts
   - Concurrent execution and precedence graphs (process flow diagrams)
   - Race conditions, Sharing access
   - Critical Section Problem
     - Models for two processes, including Dekker’s Algorithm
     - Models for multiple processes, including Bakery Algorithm
     - Semaphores, mutex locks, and monitors

3. Process Scheduling and Dispatch
   - Preemptive and non-preemptive scheduling strategies
   - Short term, medium-term, and long-term scheduling

4. Deadlocks – Causes, conditions, avoidance, prevention, and resolution

5. Physical and Virtual Memory Organization
   - Offset registers, partitions, pages, segments, swapping, overlays
   - Caching and associative buffers
   - Fetch, placement, and replacement policies
   - Thrashing and working sets

6. Device and File Management
   - File systems
   - File types
   - File access and directory management
   - Distributed file systems
   - Equivalence of files and devices
   - Organization of I/O subsystems, free space management, and file layout
   - Disk scheduling algorithms
Objectives
This course is a continuation of Cmp Sci 5420 from Fall 2014. We will study the algorithms for wavelets and multiresolution processing, image compression, morphological image processing, and segmentation. In addition, we’ll look at the current research in image processing and computer graphics. Every student will select a project of his/her own choice and get it approved by me. Then, the student will study and implement the project and make a presentation to the class.

Policy
I’ll expect you to be present in most of the classes. I will not be taking attendance but if you start missing too many classes, please take responsibility for your absence, specially when it concerns tests and homeworks. When you come to class, you must change your cell phones to silent mode. If your cell phone rings during a test, I’ll deduct 10% points from that test score for you.

If you are more than ten minutes late, please try not to disrupt the class. I’ll penalize you by one letter grade for habitually coming late to class (more than five times I notice you coming late or leaving early). Attendance in presentations by other students will be graded.

The grade will be based on programming projects, a test, and a presentation of current research in the field. I’ll expect each of you to select a topic in computer graphics, image processing, computer vision, or multimedia, and present current research on the topic. You should search journals, or recent proceedings from Siggraph, Eurographics, or CVPR conferences and select at least one paper from within the past five years and present the paper in class. I’ll also like to see an implementation of the ideas in the paper as well as a written report. If needed, I may allow two persons to combine their implementation of a topic. The distribution of grades will be as follows:

- Test 15%
- Paper presentation 10%
- Written report 10%
- Paper idea implementation 40%
- Class projects 20%
- Class attendance 5%

The test will be held on April 8. The deadline for approval of topic for research is February 20, 2015. You can also look at http://scholar.google.com for papers.

Etc./Note: Use hoare for your projects. Your account from last semester should still be active. You can communicate with all the students in the class using MyGateway. I’ll make the lecture notes and your project reports available on the class web site.

Any unsigned email and email not in plain text will go unanswered by me. Please do not send me any attachments without talking to me first.
SUMMARY OF COURSE EVALUATIONS
(Qualitative and Quantitative Data)

Dr. Bhatia has taught a variety of undergraduate and graduate computer science courses at UMSL. Courses taught include CMP SCI 2250 (Programming and Data Structure), CMP SCI 2750 (System Programming and Tools), CMP SCI 3130 (Analysis of Algorithms), CMP SCI 4760 (Operating Systems), CMP SCI 5130 (Advanced Data Structures and Algorithms, CMP SCI 5420 (Digital Image Processing), CMP SCI 5740 (Parallel and Distributed Computing renamed in Fall 2011 to High Performance Computing), CMP SCI 5780 (Systems Administration), CMP SCI 6420 (Topics in Image Processing and Multimedia), and CMP SCI 6740 (High Performance Computing).

Several of the graduate courses developed by Dr. Bhatia led to additional projects being done by graduate students. A number of them resulted in publication of papers with these students. Below are some of the papers with the students names highlighted.


COURSE EVALUATION DATA
Every semester, students in each course offered by the department fill out questionnaires evaluating the instruction in that course. This is done through the use of a standardized course evaluation form.

The standardized scale used in the questionnaire is from 1 to 5, with 5 indicating the best performance. In the questionnaire, the two most important items are the communication skills of the instructor and the overall quality of instruction. In all the classes that Dr. Bhatia has taught at
UMSL in the last ten years, his average communication score is 4.49, while his average quality of instruction score is 4.30.

His averages at different course levels are summarized in the following table:

<table>
<thead>
<tr>
<th>Class level</th>
<th>Communication</th>
<th>Instruction Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>4.09</td>
<td>4.03</td>
</tr>
<tr>
<td>4000</td>
<td>4.50</td>
<td>4.29</td>
</tr>
<tr>
<td>5000</td>
<td>4.55</td>
<td>4.34</td>
</tr>
<tr>
<td>6000</td>
<td>4.57</td>
<td>4.49</td>
</tr>
</tbody>
</table>

The corresponding overall averages for in-rank faculty in the department over the past ten years are 4.18 for communications and 4.13 for instructional quality. As evident from above, Dr. Bhatia has consistently performed very well in terms of both measures at all levels.

STUDENT COMMENTS FROM COURSE EVALUATIONS

A section on the questionnaire asks the question, “What do you particularly like (if anything) about this course?” Below are some comments that students in Dr. Bhatia’s sections of CMP SCI 2250, 2750, 4760, 5130, 5420, 5740, 6420, and 6740 have made over the last ten years from Fall 2004 to Fall 2014.

**CMP SCI 2250, Programming and Data Structures**  
*SP2007*

- It was extremely challenging, but Sanjiv was always available to help when we got stuck.
- Teacher was friendly and challenging.
- The assignments are difficult, but the instructor works with the class to help us complete them.
- We really learned the materials well.

**CMP SCI 2750, System Programming and Tools**  
*SP2012, FS2012, SP2005*

- The teacher answer quickly to our emails when we have problems.
- Sanjiv is very smart and very good teacher.
- Prof. Bhatia’s humor keep class interesting and enjoyable for what could easily be a dull class. Prof. knows material very well and could explain things well. Enjoyable class, although difficult to me.
- Instructor is very dedicated to help student.

**CMP SCI 2750, System Programming and Tools  
continued**

- Instructor is great. Very interesting subject matter.
- The format and the teachers overall knowledge of the material.
- Prof. Bhatia’s humor keep class interesting and enjoyable for what could easily be a dull class. Prof. knows material very well and could explain things well. Enjoyable class, although difficult to me.
- The teacher answer quickly to our emails when we have problems.
- Instructor is very dedicated to help student.
- The format and the teachers overall knowledge of the material.
- Sanjiv tends to make dry topics interesting.

**CMP SCI 4760, Operating Systems**

- Class was challenging and encouraged independent learning.
- I like how the course is taught. The number of projects has been helpful in my learning to program, the projects are interesting and force the student to think a lot. I like the challenge presented in the course.
- The homework is challenging and interesting.
- I like the information in the course. It is useful and I liked making project that utilized that information.
- I really liked this class for a lot of reasons. This was the first CS class where it felt like the professor (Bhatia) had high expectations for us, and was not going to be easily swayed into making accommodations for people who were behind. The course material was incredibly wide and diverse and explained well the various aspects of operating systems in depth. The projects were difficult and gave a good taste of what simple operating systems programming entails. I would say the thing I liked the most is just the fact that the professor was very open to talking with his students outside of class, unlike many of the other researching professors at UMSL.
- Sanjiv definitely knows this subject well. When I asked him a question, I received a thorough and correct response.
Dr. Bhatia is very excited about the subjects he teaches and if another student shows a general desire to further their own knowledge, he is just as excited to show them. The material for the course is challenging, yet not overly difficult.

Dr. Bhatia knows what he is doing -- I definitely wish I could've had him for more courses during my time at UMSL.

Enthusiastic, engaging professor. Interesting, challenging projects.

While the program assignments were difficult to work through, I did like the material covered in class lectures. I felt this material was well covered and explained and that the tests were an accurate reflection of the material we had covered.

This is the best course which gives us lot of exposure to comp. science. I liked the assignments, tests and the way instructor handles the class.

Professor explanation with real world examples.

I like the material we covered in the course. I also liked how the instructor linked to advancing/present technology and methodology in class.

Instructor’s interest and his knowledge about course and he was very passionate about it in class. It was a great experience with Sanjiv and also gained a lot of knowledge.

Very challenging, interesting projects. If all CS courses were taught like this one we would have a world-class program.

Operating systems was my favorite class that I have taken at UMSL. I feel much better prepared to do well in a job now that I have taken it.

Whatever we learn in the class, we are made to implement that in our assignments. This gives lot of confidence.

Very interesting material, very in depth, challenges the student to work. I have new insights into Operating Systems and programming now.

Good lectures, presentations, communication.

Very challenging and time consuming but I learned a lot and the instructor was very well organized.

This is my second course with Sanjiv and I believe that though the course is challenging, he is very fair and teaches a lot of important concepts. He is also very willing to help whenever needed.

Instructor extremely knowledgeable. Instructor was very helpful and did not look down on students for dumb questions. Programming assignments were very relevant to class material. Instructor gets A+.
**CMP SCI 4760, Operating Systems continued**

- Very challenging. I really liked the semaphore project and the fact it used shared memory. These were both new and powerful concepts to me. The instructor seemed very impressive regarding depth of knowledge.

- Instructor is very friendly and willing to answer questions about projects or lecture material. Basically any question is fair game except “show me how to do it” (if referring to a project) – he will help you work on the problem, but not give you the answer.

---


- Teacher has a good personality, amicable and approachable. Topics appear to be in line with what should be covered in an advanced algorithms course.

- I did like learning the theory and math behind the algorithms. The nondeterministic stuff was especially interesting.

- Lectures were informative and I did learn a lot about the material presented. My homeworks were graded in a timely manner which helped me gauge where I stood in the class.

- Good treatment of difficult theoretical content.

- Knowledge. Sanjiv Bhatia is full of knowledge and would love to take more courses with him.

- I really like the amount of effort Prof. Bhatia puts into the course. He seems to really care about the success of the students.

- The assignments are interesting and the teacher is entertaining. He responds quickly to email, which is helpful.

- You will like this class after the class is done because you are forced to learn, you have learned many when you looked back. The class is challenging, but reachable.

- Personal stories – how the topics relate to the real world.
I like the content of most of the programming assignments. They helped to visualize and understand the material.

Huge practical experience with projects. This is my favorite course so far. Very clear application of mathematics.

The material/subject is very interesting. Sanjiv really knows the subject matter.

The assignments were a big help in understanding. Providing class notes online was also nice.

This course is extremely interesting and has lot of practical application.

I thought that the topics of this course were extremely interesting. Also, I felt the instructor did a wonderful job.

Very interesting material, and also very challenging. There are a lot of applications for the material presented. Good presentation – instructor provided extra help whenever requested.

Very informative and stayed near the cutting edge of technology.

This is the need of the hour now. With sequential speed limits reaching their limits, parallel execution is the next big thing. It gives one the opportunity to view the algorithms he/she already know from different (parallel) point of view. This is a very well designed, well planned and well taught subject. I really found it useful studying under Dr. Bhatia.

Challenging assignments, great sense of humor of instructor.

I really enjoyed the material covered.

The independent projects were very interesting. All the students ended up acquire great topics. I felt that it was one of the best ways to prepare us for writing papers, as we had to do a whole project and then make a paper out of it.

The presentations. I liked the extra material on wavelets presented.
The material is very interesting and the approaches made to achieve the end results varied.

I really enjoyed learning about different algorithms and the projects. I enjoyed writing the programs in C++. I enjoyed being exposed to recent developments in image processing.

I liked the presentation and research. I liked the freedom to implement the project in any fashion.

Challenge level scene appropriate for a 6000 class. I didn’t expect it to be easy, and it wasn’t. I appreciated the chance to learning something unique.

Very interesting material. Sanjiv is very interested and makes an effort to show us things to get us interested.

Instructor is very knowledgeable in the topics presented.

I think the topic is very interesting and relevant to what is hot in CS right now. The hands on work with open science grid was very exciting and I should be able to use this knowledge in my research.

Very interesting topic. I think this course can be expanded and there is room to do much more.
Course: __________  Instructor: _________________________  Semester: _______

Evaluation of teaching is a critical component of our Department’s overall assessment of our faculty. One important factor in this assessment is the student evaluation of courses. This on-line evaluation is an attempt to obtain an objective assessment of this course.

We hope you will take some time to give an honest appraisal in completing this evaluation. Replies are completely anonymous.

1. Class Standing
   (Credit Hours)
   Freshman (0-24)
   Sophomore (24-59)
   Junior (60-89)
   Senior (90 and up)
   Graduate

2. Approximately how many hours per week did you spend outside of class working on the course? ______

3. Did your prerequisite course(s) prepare you for this course? Yes _____  No _____
   Course:    Grade:    School:

4. Does the instructor present the material in a well-organized manner?  
   Low 1 2 3 4  High 5

5. How well does the instructor communicate in English?  
   1 2 3 4 5

6. Did you find the course challenging?  
   1 2 3 4 5

7. How much did you learn in the course?  
   1 2 3 4 5

8. What is your overall rating of the instructor of this course?  
   1 2 3 4 5

9. Grade you expect to receive in this course? _______

10. What do you particularly like (if anything) about this course?

11. What do you particularly dislike (if anything) about this course?

Please turn over and complete other side
EVALUATION OF ALTERNATE TEACHING METHODS

Answer only those parts (if any) that apply to the course

Part 1 – Working in Groups
1. What percentage of class time was spent using this method? 0% 25% 50% 75% 100%
2. Did the method enhance your learning experience? 1 2 3 4 5
3. How would you change the method?
4. Would you want to take another mathematics or computer science course that used this method? Yes _____ No _____
5. How many members do you prefer in your working group? _____

Part 2 – CourseCompass/Excel/iLrn/Maple/Math XL/Matlab/Minitab/MyMathLab/SAS Assignments
1. What percentage of class time was spent using this method? 0% 25% 50% 75% 100%
2. Did the method enhance your learning experience? 1 2 3 4 5
3. How would you change the method?
4. Would you want to take another mathematics or computer science course that used this method? Yes _____ No _____

Part 3 – Use of Technology by Instructor (My Gateway, PowerPoint Presentations, Web, etc.)
1. Briefly, describe the methods.
2. What percentage of class time was spent using this method? 0% 25% 50% 75% 100%
3. Did the method enhance your learning experience? 1 2 3 4 5
4. How would you change the method?
5. Would you want to take another mathematics or computer science course that used this method? Yes _____ No _____

Part 4 – Other Teaching Methods
1. Briefly, describe the methods.
2. What percentage of class time was spent using this method? 0% 25% 50% 75% 100%
3. Did the method enhance your learning experience? 1 2 3 4 5
4. How would you change the method?
5. Would you want to take another mathematics or computer science course that used this method? Yes _____ No _____
6. Do you have any additional comments about these new teaching methods?

Thank you for your cooperation.
CLASS OBSERVATION REPORT

I observed a class CMP SCI 4760 Operating Systems taught by Professor Sanjiv Bhatia on March 11, 2015. The class session started at 6:55pm and ended at 8:10pm. When the students came to the class, they used the laptops (MacBook type) equipped in the classroom to open the notes for this class. The notes were a PDF document. When the instructor came to the class, he displayed the notes on the screen using the overhead projector.

At the beginning of the class, the instructor reminded the students about the homework assignment. It was the third assignment of the class and it was a programming project using regular C and system calls. From the expressions and reactions of the students, it was a tough project. Some students requested helps for the project, and the instructor provided them his available time slots. The instructor was willing to spend extra time other than the standard office hours to help the students.

Then the instructor started to explain the notes. The first concept was Processor Scheduling. This concept was not easy to understand. The instructor spent plenty of time to explain the properties of this concept using a clear language in a patient way. The instructor encouraged the students to ask questions. For the part that was relatively complex, the instructor drew diagrams on the whiteboard. Several students asked questions during the explanation, and the instructor gave the answers that addressed the points directly. The students looked satisfied. The notes contained a long list of concepts. The instructor explained one after another. In order to make the classroom atmosphere easier for the students, the instructor made jokes occasionally. The conversations in the classroom were constructive and healthy.

When the class moved to a new important concept, the instructor spent some time to motivate the students. At certain point, there was a concept called "Deadlock Problem". The instructor used an example in politics about deadlock to explain the general idea. It can be seen that the absurdness of the example in politics was used to inspire the interest of the students for this concept. The response looked positive. The time used in class was very efficient. Many concepts were covered. The time allocated to each concept was not evenly distributed, with harder concepts more time. The transition between two concepts was natural.

The class finished just before 8:10pm. After the class, there were 3 to 4 students waiting in line to ask questions. The instructor still patiently spent time to answer questions. It seemed that the students were very serious about this class, and were willing to spend more time to do well in this class.

Wenjie He
Associate Professor
Award and Nomination Committee,

I am very pleased to provide a letter of support for Dr. Sanjiv Bhatia for the university's Chancellor's Award for Excellence in Teaching. I was working toward my Master's Degree in Computer Science from January of 2010 until I graduated in December of 2011, and had Dr. Bhatia for four classes including an Individual Study. I was also a Graduate Teaching Assistant who graded programming assignments for Dr. Bhatia's CS 4760 course during the 2010-2011 academic year.

Dr. Bhatia's lectures were always well-organized, covering a breadth of topics and going into great detail on the key topics, in both Operating Systems and Image Processing. The lectures also involved much hands-on work, with the students following along on our computers as Dr. Bhatia led the exercises with his computer projected on the screen. Of particular help to me, Dr. Bhatia explained and demonstrated the mathematical principles well, so that we were able to understand them, and then apply and practice them on the homework assignments.

The homework assignments were always in-depth and project-oriented. Many of the assignments were designs for components of operating systems, based on operating system principles, which in turn were based on discrete mathematics and related sequential algorithms. Most of the image processing assignments were programming projects to implement the principles and mathematics learned in class. By the end of CS 5420, we had a significant toolkit of image processing programs that we thoroughly understood and were able to combine as necessary to solve various problems.

Dr. Bhatia also related and communicated well and openly with the students. He shared with us his current research and past experiences, including particular difficulties and how he overcame them. He always answered students' questions thoroughly and we often had a discussion-oriented classroom environment. He also put a lot of trust in me as a Graduate Teaching Assistant, and genuinely complimented me on my thorough work. As a community college instructor, I still emulate Dr. Bhatia's classroom demeanor and instructional techniques, and am very happy to support him for this award.

Sincerely,

Lawrence Appelbaum
Assistant Professor, Computer Information Systems
Dear Nomination Committee,

I am delighted to have this opportunity to provide my opinion of Dr. Sanjiv Bhatia’s teaching abilities. I was enrolled in a number of undergraduate- and graduate-level courses taught by Dr. Bhatia from 1996 to 2001. I also took independent study courses with Dr. Bhatia while we conducted research and authored two journal manuscripts. Additionally, Dr. Bhatia has gone out of his way to stay in touch over the years and has been an invaluable mentor throughout my career.

Dr. Bhatia’s courses are challenging and rewarding. He holds a high standard, and I knew from day one that I would need to invest focused time and effort to meet that standard. Dr. Bhatia was always exceptionally well prepared for class, with perfect slides (I don’t remember ever catching an error on one!) and a well-conceived lecture that flowed in a smooth logical manner. What impressed me the most was that Dr. Bhatia would take difficult concepts and explain them in a clear and transparent way that made them not only comprehensible, but also provided insights of their nature, thereby making it possible to play with their underpinnings. These lessons were memorable and things that I have never used since those classes (such as operating systems scheduling) still remain vivid in my mind more than a decade later.

While I was a student in your department, Dr. Bhatia invited me to work on an automated image retrieval system that he was developing. His system cleverly operates on compressed data and eliminates the investment required to process full images. After I made some modifications to his code, he supervised me while I revised and extended his conference paper into a journal manuscript. (Although I am a native English speaker and Dr. Bhatia is not, he corrected my grammatical errors and greatly improved my writing style!) This manuscript was subsequently published in *Pattern Recognition* and formed the basis of my Master’s thesis. My thesis was later selected to represent UM-St. Louis in the Midwestern Association of Graduate Schools (MAGS) 2002 Distinguished Thesis Award Competition.

During this time, I implemented a novel line detector for a project in a class with a different professor and asked him if we should try to publish the work. He declined and suggested that I approach another faculty member. When I explained my idea to Dr. Bhatia, he was highly supportive and enthusiastic. He generously provided his time and thoughtful considerations to this project, culminating with a publication in *Pattern Recognition Letters*. 
Dr. Bhatia encouraged me to apply for scholarships and fellowships. He carefully critiqued my applications and provided reference letters. Under his supervision, I was awarded a National Defense Science and Engineering Graduate (NDSEG) Fellowship (tuition and stipend for three years), an Olin Fellowship (tuition and stipend for four years at Washington University in St. Louis), an UM-St. Louis Summer Graduate Research Fellowship, a Donald Hankinson Scholarship, and an Alumni Scholarship.

Thanks to Dr. Bhatia’s time and expertise, I entered Washington University’s doctoral program with two journal publications and two prestigious fellowships in hand. Over the years since that time, Dr. Bhatia has kept in touch and provided me with priceless advice and strong letters of support. I know that he generously shares his exceptional expertise with many other alumni. Whenever I see him, he has updates on their status and it is obvious that he truly cares about each and every one of them. I can’t imagine how many lives he has positively impacted over his decades of teaching.

In short, Dr. Bhatia is an ideal candidate for the University of Missouri-St. Louis Chancellor’s Award for Excellence in Teaching. He is an exemplary teacher, advisor, and mentor. Dr. Bhatia gives his time and expertise generously and continues to help and support his students long after they graduate and move on. He has impacted my career in profound ways and I am deeply grateful for his expert guidance and sincere enthusiasm.

Please do not hesitate to contact me if you would like any additional information.

Sincerely,

[Signature]
Sharlee Climer, Ph.D.
Research Assistant Professor
Computer Science and Engineering
March 25, 2015

Award and Nomination Committee  
UMSL – Dept. of Mathematics and C.S.  
One University Boulevard  
St. Louis MO, 63121

To whom it may concern,

Mr. Bhatia has been a professor of mine and a mentor through a number of years at UMSL during both my graduate and undergraduate degrees. His expertise, commitment to academics, and effective teaching style should be used as an example of how practical education should be done.

As a student of his through a number of courses I found that Mr. Bhatia had personally pushed me to do more and work harder than any other professor that I have ever had. The bridging of the gap between academic research and its actual real-world implementations never seemed more real to me than in his classes which is very rare to find since these disparate worlds usually do not interact much. Yes, the classes were always hard but the goals were always within reach with a touch more work and to be fair I would have been bored otherwise indicating his keen sense of student studying limits which is critical to maximizing individual gains in knowledge.

Outside of the academia proper, Mr. Bhatia has also helped me understand the balances between choosing to continue my education versus joining the workforce at different academic stages which makes him doubly as a extremely effective student coordinator too. Additionally, I have referenced work or research that was mentioned in his class exponentially more than any other teacher’s and I have thought about attending more of his classes multiple times after graduating but sadly my available time has never coincided with them.

In conclusion, if someone needs to learn how to teach they should be sent to audit Mr. Bhatia’s class first to see how things should be done. In fact, at the risk of sounding off-kilter, I think not recognizing his exceptional work would be a great disservice to academia and I only wish I had more professors like him throughout my schooling.

Sincerely,

Srdjan Grubor  
4923A Lindenwood Ave

Phone: 314-540-8328  
E-Mail: sgmn7@sgmn7.org
To whom it may concern:

This letter is to support Dr. Bhatia in his nomination for the Chancellor’s Award for Excellence in Teaching.

I read through all the strategic plan guidelines for earning this Award, but in the end decided just to talk about my relationship with Dr. Bhatia, and how his approachable and dedicated teaching style inspired me to enroll for and finish my graduate degree in computer science at UMSL.

My first graduate class at UMSL was taught by Dr. Bhatia. I was not originally a degree seeking student—I actually found his image processing class online while browsing UMSL’s website and decided to enroll in the class as a non-degree seeking student. I struggled in his class, and I’m very glad he pushed his students because we learned a great deal. He then convinced me to take his follow-up class, and eventually encouraged me to formally apply and complete my graduate degree in computer science at UMSL. While I became friends with other teachers, I don’t think others would have pulled me aside and told me to consider seeking a degree. I appreciate that he did that for me.

I would like to include a few words about Dr. Bhatia’s teaching style. He is known as a “tough” teacher, deservedly so, and I say this with utmost respect to him. He knows his material backwards and forwards. He is always in a good mood, motivated and prepared for his class sessions. He does not waste time and does not truncate lectures or end class early. He presses to cover the material intended in the class. His tests are difficult and designed to make you think past the homework assignments. He is a practiced and clear communicator, interacts well with his students during class, and keeps his students engaged. During student presentations, he critiques fairly and asks great questions. He enjoys helping students understand class material outside of class.

I’d like to end this letter of support by saying Dr. Bhatia takes great pride in his job and works hard to excel at it. Additionally, he is a great ambassador for UMSL—I am grateful that my first interaction with UMSL was through him, and that he took the time to talk to me outside of class and convince me to keep coming back to UMSL.

Thank you,

Dan Hagrman, former UMSL grad student, now a proud graduate

hagrdan@gmail.com
March 25, 2015

Dear Nomination Committee,

This letter is in support of Dr. Sanjiv Bhatia’s nomination for the University of Missouri - St. Louis Chancellor’s Award for Excellence in Teaching. I am a former Computer Science student at the University of Missouri St. Louis. I completed both my Undergraduate and Masters studies under the guidance of the excellent Math and Computer Science Department. During my studies I had the privilege of studying under excellent professors and working with terrific staff. Dr. Bhatia had the most influence on my studies and eventually my professional career.

Dr. Bhatia is a great teacher, mentor and technical ambassador for our school. Working in the computer science field requires technical knowledge and a sense for how to solve problems yourself, or if you are lucky, no one has encountered before. Dr. Bhatia’s undergraduate classes did an excellent job at preparing me for solving real world problems. His classes were just the right amount of challenging, fun, and exhausting. He fostered an environment of togetherness in his classes where students felt like they were on the same team. If you weren’t ready to join the professional world before his classes, you were after.

During my Graduate studies, Dr. Bhatia took me under his mentorship to work on his passion: Computer Vision. During this time I saw what was required to be an outstanding member of the Computer Science community. I was lucky to take several classes and work on some very interesting research during this time.

Dr. Bhatia would be a terrific choice for the Chancellor’s Award of Excellence in Teaching. He is known in the Computer Science community as a great teacher and example of technical leadership. Many of my colleagues have had classes and been influenced by Dr. Bhatia.

Sincerely,

Chris Leighton
Technical Team Lead of Streaming
Products Swank Motion Pictures