

## ANA RADOVANOVIC

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### RESEARCH INTERESTS

Fundamental principles of operation, design and control of systems where uncertainty is an inherent property and is important assumption in analysis and design. Special attention: distributed content delivery systems, modeling statistical variability in data, efficient and risk-aware experiment design, design and average case analysis of low complexity, near-optimal approximation algorithms, asymptotic analysis.

### APPLICATIONS

Web caching, revenue management in systems with reusable resources (communication networks, workforce management, Display advertising), online advertising, traffic modeling, job scheduling in large machine clusters.

### EDUCATION

- 9/01 – 12/04     **COLUMBIA UNIVERSITY, Doctor of Philosophy in Electrical Engineering**     New York, NY  
Thesis title: 'Nearly optimal cache replacement policies for efficient Web access', with Prof. Predrag Jelenkovic  
*Eliahu Jury Award for Outstanding Doctoral Work in Communications, Signal Processing and Systems (awarded annually to the best graduating Ph.D. student in EE, Columbia U.)*
- Developed *new online algorithms* for efficient cache replacements with the objective to reduce the time of document retrieval from the Internet. New algorithms have desirable features such as: adaptive to fluctuations in user access patterns, easy to implement, scalable and excellent performance with respect to long term optimal schemes. Near optimality of the novel policies proved explicitly using new probabilistic techniques under quite general assumptions on statistical dependency in user access patterns. Implementation of the new algorithms demonstrated their excellent performance.
- 9/99-9/01     **COLUMBIA UNIVERSITY, Master of Science in Electrical Engineering**     New York, NY  
GPA: 4.15 (out of 4.3)
- 9/93-12/98     **UNIVERSITY OF BELGRADE, Bachelor of Science in Electrical Engineering**     Belgrade, Serbia  
Major: Telecommunications, GPA: 9.59 (out of 10.0)  
*The best student award (awarded annually to top 3% of graduating students)*

### WORK EXPERIENCE

- 03/8-present     **GOOGLE, INC., (Senior) Research Scientist**     New York, NY  
Statistics and Market Algorithms Group
- **Scheduling in large machine clusters**  
Design, analysis and implementation of online job scheduling algorithms that lead to improved throughput and resource (cpu, ram, disk) utilization. One of the key goals is creating energy efficient clusters: turn off unnecessary machines!
  - **Traffic characterization**  
Modeling resource demand (job arrival patterns) to a large machine cluster. Create a simple and easy-to-implement model that captures statistical properties of an incoming traffic. Used for resource provisioning and schedulability analysis in large clusters.
  - **Display (Internet) advertising**  
Design risk-aware pricing experiments with the objective to increase publisher's revenue. Proposed the most efficient and least complex experimental methodology within the current Display business environment. The main goal is having a procedure that leads to revenue Improvements through inventory price adjustments while taking into consideration various risk factors such as economic trends, changing managerial decisions, variability in the sales agents' sales practices, etc.
  - **Audience targeting**  
Developed a large scale learning method for identifying generic properties of click-y Web

visitors. Worked with large online publishers.

- **Research work:**

- *Job scheduling in large computer clusters* where jobs have highly variable resource (cpu, ram, disk) requirements.
- *Dynamic inventory allocation policies in the context of Display advertising.* The main goal is to design a simple and intuitive impression allocation rule that meets advertisers' campaign requirements and, at the same time, maximizes publisher's effective revenue.
- *Characterization of the overflow traffic in large capacitated systems:* explicitly characterize the overflow traffic in systems where resources are substitutable, i.e., if there are not enough available requested resources, the demand is met by some other, substitute resources.
- *Optimal stochastic online bin packing algorithms.*

12/04-3/08

**IBM THOMAS J. RESEARCH CENTER, Research Staff Member**

Stochastic Analysis group, Mathematical Sciences Department

Yorktown  
Heights , NY

- **Risk-Based Workforce Management and Planning Tool**

Applied stochastic loss network theory in *modeling, analysis and design of workforce management process* within a large organization. Designed a mechanism for controlling available human resources with specific skills that are required by incoming potential clients/engagements. Developed analytic methods that are further implemented to automatically optimize staffing of incoming engagements, select profitable clients and appropriately size skill pools, subject to service level guarantees (bounds on risks of losing engagements). This product, used by IBM Global Services organization, helped increase organization profitability by 10%.

*A First Patent Application Invention Achievement Award For: Method and Structure for Risk-Based Workforce Management and Planning* (Filed four patents in this area.)

- **Technical consultant for Business Optimization group, IBM Haifa Research Lab**

Proposed novel analytic techniques to estimate desirable staffing levels subject to service level agreements for jobs with different priorities. Used queueing model approach to optimize shift work with business objectives and agent satisfaction constraints. The new analytics match accurately real system's performance and are to be implemented as part of the tool for the strategic agent capacity planning.

- **Research work:**

- *Revenue management and pricing:* proposed provably near optimal algorithms for selecting incoming customers with the objective to maximize expected collected revenue. Designed schemes perform near optimal in a stochastic framework where there is uncertainty in customer arrival processes, project durations, revenues they are willing to pay. Developed techniques for optimal pricing of offered services.
- *Stochastic loss networks:* generalized existing probabilistic frameworks and provided novel analytic techniques to incorporate general assumptions on customer arrivals, random resource demands, processing times and possibility of advance reservations.
- Designed adaptive, easy to implement and *scalable caching algorithms* with provably near optimal performance in the presence of statistical dependency in access patterns.

1/07-5/07

**COLUMBIA BUSINESS SCHOOL, Adjunct Faculty**

Decision, Risk and Operations Department

Taught a Finance Ph.D. course: Mathematical Models II (basic probability, basic sampling theory, estimation, hypothesis testing, linear regression, least squares).

New York, NY

9/01-12/04

**DEPARTMENT OF ELEC. ENG., COLUMBIA UNIVERSITY, Research Assistant**

Conducted research in the area of *design and probabilistic analysis* of cache replacement algorithms.

New York, NY

3/03-8/03

**IBM THOMAS J. WATSON RESEARCH CENTER, Student Intern**

Stochastic Analysis group, Mathematical Sciences Department

Explored *statistical properties* of the Web access patterns at large commercial Web sites

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Heights, NY

(such as IBM server farms for the retail industry). Investigated how temporal correlation in access patterns influences the performance, server's response time, of a Web site. (with Bonnie Ray and Mark Squillante)

*IBM Graduate Student Fellowship Award (Honors truly exceptional Ph.D. students throughout the world with technical focus in areas fundamental to innovation; annually given to four Ph.D. students)*

9/99-9/01	<b>DEPARTMENT OF ELEC. ENG., COLUMBIA UNIVERSITY, Teaching Assistant</b> Teaching assistant/manager/grader (held recitations, office hours, graded homeworks and exams).	New York, NY
2/93-3/93	<b>PETNICA RESEARCH CENTER, Research Intern</b> Elementary particle physics – worked on a methodology for neutrino detection in cosmic radiation.	Petnica, Serbia

### **PATENTS**

- Methods and Structure for Risk-Based Workforce Management and Planning (2006)
- Method and Apparatus for End-to-End Workforce Management (2006)
- A Method and Apparatus for Strategic Planning (2006)
- A Generic Architecture for Integrated End-to-End Workforce Management (2006)
- A Method and Apparatus for Information Boosting in related but disconnected databases (filed in 2007)
- Predicting the Value of Publishers' Inventory (2010)
- CTR Based User Targeting (filed in 2011)

### **SKILLS AND INTERESTS**

Programming	C++, python, sawzall, Matlab (CVX), Mathematica, LaTeX, R, modeling in AMPL with extensive use of different optimizers (especially IPOPT); working on LINUX/UNIX/MAC/WINDOWS platforms
Interests	Reading non-fiction, music (jazz), running (long distance), SCUBA diving (Dive Master, CMAS org.), Iyengar Yoga
Activities	Member of the Radio-Television Choir of Belgrade (1986-92), SCUBA Dive Master, alto in the Google 'Scaleability' Choir (2011-present)

### **PROFESSIONAL ACTIVITIES**

- Member IEEE, ACM, INFORMS; Reviewer for the top journals in the areas of operations research and applied probability.
- Organizer of the Applied Probability seminar within IBM Research and a member of the Herman Goldstine Fellowship Award Committee (2005, 2006)

Publication list and downloadable papers can be found at <http://www.anaradovanovic.com>.