**Krishnendra SHEKHAWAT, PhD**

***Assistant Professor***

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**EDUCATION**

**Ph.D. Mathematics**

* Title: Rectangle Tilings, Connectivity and Associated Covariants
* Supervisor: Prof. Daniel Coray, Department of Mathematics, University of Geneva, Geneva
* Organization: University of Geneva, Geneva
* Duration: 12.2008 – 06.2013
* Grade: Très bien (Highest grade at the University)

**M.Sc. Mathematics**

* Organization: Indian Institute of Technology, Delhi
* Duration: 2006 – 2008
* CGPA: 7.143 /10

**B.Sc.** (Physics, Chemistry, Mathematics)

* Organization: University of Kota, Kota
* Duration: 2002 – 2005
* Percentage: 77.38

**EMPLOYEMENT HISTORY**

**Present Position**

* **Position Held:** Assistant Professor, Department of Mathematics
* **Organization:** BITS Pilani, Pilani Campus
* **Duration:** 01.04.2016 **-** In continuation

**Past Positions**

* **Position Held:** Postdoctoral Fellow, Design & Computation Group, Faculty of Architecture
* **Supervisor:** Prof. José Manuel Pinto Duarte
* **Organization:** University of Lisbon, Portugal
* **Duration:** 01.04.2015 **–** 31.03.2016
* **Position Held:** Postdoctoral Fellow at G-Mod Group, Department of Computer Science
* **Supervisor:** Prof. Marc Daniel,LSIS Laboratory
* **Organization:** Aix-Marseille University, France
* **Duration:** 01.02.2015 **–** 20.03.2015
* **Position Held:** Assistant Professor , Department of Mathematics
* **Organization:** Central University of Rajasthan, India
* **Duration:** 05.08.2013 **–** 23.01.2015

**PUBLICATIONS**

**Book**

* Shekhawat, K. (2014). Tiling Rectangles, Connectivity and Associated Covariants (Application of Mathematics to Architecture). *Scholars’ Press Germany* ISBN 978-3-639-66206-1.

**Journal Articles Published**

1. Shekhawat K. (2017)  A computer-generated plus-shaped arrangement and its architectural applications. [*Journal of Computational Design and Engineering*](http://www.sciencedirect.com/science/journal/22884300), Elsevier, In Press, <https://doi.org/10.1016/j.jcde.2017.05.003>.
2. Shekhawat K., Duarte J.P. (2017) Rectilinear Floor Plans. In: Çagdas G., Özkar M., Gül L., Gürer E. (eds) Computer-Aided Architectural Design. Future Trajectories. CAADFutures 2017. Communications in Computer and Information Science, vol 724. Springer, Singapore
3. Shekhawat, K., Duarte J.P. (2017). Automated best connected rectangular floorplans. In: Gero J. (eds) Design Computing and Cognition ’16, Chapter 27, Springer International Publishing.
4. Shekhawat, K., Duarte J.P. (2017). A compositional schema for the automated generation of best connected rectangular floor plans. In Press: Formal Methods in Architecture and Urbanism, Chapter 20, Cambridge Scholars Publishing.
5. Shekhawat, K. (2016). Best connected rectangular arrangements. *Alexandria Engineering Journal*, Elsevier, 55: 445-449.
6. Shekhawat, K. (2015). Mathematical propositions associated with the connectivity of architectural designs. *Ain Shams Engineering Journal,*Elsevier, In Press, DOI: 10.1016/j.asej.2015.09.009.
7. Shekhawat, K. (2015). Computer-aided architectural designs and associated covariants. *Journal of Building Engineering*, Elsevier, 3: 127-134.
8. Shekhawat, K. (2015). Why golden rectangle is used so often by architects: A mathematical approach. *Alexandria Engineering Journal*, Elsevier, 54: 213-222.
9. Shekhawat, K. (2015). Automated space allocation using mathematical techniques. *Ain Shams Engineering Journal*, Elsevier, 6: 795–802.
10. Shekhawat, K. (2014). Algorithm for Constructing an Optimally Connected Rectangular Floor Plan. Frontiers of Architectural Research, Elsevier, 3: 324-330.
11. Shekhawat, K. (2013). Space Allocation in Rectangular Floor Plan. *ELSA – International Review*vol. 3. iii – iv 138 – 151 Geneva.

**Conference Proceedings**

* Shekhawat, K. (2016). A plus-shape arrangement of rectangles. International Conference on Current Trendsin Graph Theory and Computation CTGTC 2016, South Asian University New delhi, Acceppted.

**RESEARCH INTERESTS**

* Geometric graph theory (rectangular dualization, packing, tiling, space allocation)
* Computational design (architectural designs)

**FELLOWSHIPS**

* 01.12.2008 **–** 31.03.2012: SNF (Swiss National Foundation) Fellow, Geneva, Switzerland
* 01.04.2015 **–** 31.03.2016: FCT Postdoctoral Fellow, Lisbon, Portugal (Funded by Portuguese Foundation for Science and Technology)

**PROJECTS DONE**

**PhD Project**

* **Title:** Formalisation et sens du projet architectural (Formalization and meaning of the architectural project)
* **Duration:** December 2008 to March 2012
* **University:** University of Geneva, Geneva
* **Funding Agency:** Swiss National Science Foundation (subsidy no. K-12K1-120593)
* **Supervisors:** Professors P. Pellegrino (Department of Geography, University of Geneva), D. Coray (Department of Mathematics, University of Geneva) and G. Falquet (Department of Computer Science, University of Geneva)
* **Outline:** In this interdisciplinary Project, the objective was to develop a formalization of the architectural conception and to offer a computer-aided system of inference appropriate to the architectural process of composition. This research relates to the articulation between the sciences of architecture, semiotics of space, mathematics, and computing.

During this Project, I worked on the different space allocation problems with different constraints. Also, I worked for the optimization and classification of architectural designs.

Precisely, I developed a prototype that generates best connected floor plans for various shapes, and computes the corresponding graph and a number of associated covariants, for a given set of data.

**M.Sc. Project**

* **Title:** Survivability Of Wireless Networks
* **Duration:** August 2007 – May 2008
* **University:** Department of Mathematics, Indian Institute of Technology, Delhi.
* **Supervisor:** Professor S. Dharmaraja, Department of Mathematics, IIT Delhi.
* **Outline:** The objective of the project is to study the general survivability quantification framework which is applicable to a wide range of system architectures, applications, failure/recovery behaviours, and desired metrics. And to show how this framework can be used to derive survivability measures based on different definitions and extend it to other measures not covered by current definitions which can provide helpful information for better understanding of system steady state and transient behaviours under failures/attacks. An illustrative example of a telecommunications switching system and Markov models are developed and solved to depict various aspects of system survivability.

**TEACHING EXPERIENCE**

**Courses Taught at Central University of Rajasthan as an Assistant Professor**

* Linear Algebra (M.Sc. Mathematics Second Semester, 2013)
* Linear Algebra and Analysis (M.Sc. Statistics First Semester, 2013 & 2014)
* Discrete Mathematical Structures (M.Sc. Mathematics First Semester, 2014)
* Vector Analysis and Matrices (B.Sc. Computer Science Second Semester, 2014)
* Mathematics for Biologists (M.Sc. Life Sciences First Semester, 2013 & 2014)

**Courses Taught at undergraduate level at University of Geneva as a Teaching assistant**

* Programming laboratory as a T.A. of Dr. [Pierre-Alain CHERIX](http://www.unige.ch/math/people/cherix.html)
* Probability and statistics as a T.A. of Dr. [Sylvain SARDY](http://www.unige.ch/math/people/sardy.html)
* Numerical analysis as a T.A. of Prof. [Martin](http://www.unige.ch/math/people/sardy.html) GANDER

**M.Sc. THESIS SUPERVISED**

* **Student:** Sunita Kumari
* **Title:** Why Golden Rectangle is Used So Often by Architects
* **Duration:** January 2014 – May 2015
* **University:** Department of Mathematics, Central University of Rajasthan
* **Student:** Upasana Gautam
* **Title:** Best Connected Rectangular Arrangements
* **Duration:** January 2014 – May 2015
* **University:** Department of Mathematics, Central University of Rajasthan

**PhD THESIS ABSTRACT**

In this work, we focus on Tiling by rectangles, Connectivity of the corresponding tilings and Covariants associated with the corresponding tilings.

Tiling by rectangles is the geometric problem of arranging a given family of rectangles in a larger specific frame. A primitive version is rectangle tiling, i.e., tiling rectangles inside a rectangular frame. Then the notion of rectangle tiling is extended to tiling rectangles inside some other shapes. This generalization is achieved through another object of a mathematical nature, namely the allocation matrix. This problem also involves the study of another mathematical concept the extra spaces which are introduced in the geometric distribution process. For this we shall use different algebraic and topological covariants.

When tiling by rectangles, we measure the degree of connectivity of the final tiling; an effort has been made to obtain a tiling which is best from the point of view of connectivity. Connectivity is defined in terms of adjacency for both the given rectangles and the extra spaces.

In addition, some methods have been defined to reduce the area of the obtained tilings in such a way that connectivity remains preserved. We have studied and developed several covariants related to tilings and their graph which are used to refine the number of solutions originating from the algorithm.

As far as the applications are concerned, the concept of tiling by rectangles has been applied to different fields, with special emphasis on architectural designing, where the aim is to obtain floor plans of some assigned shapes. Our mathematical theory leads to some interesting solutions, which have been tested in the framework of an interdisciplinary research project supported by the Swiss National Science Foundation (see motivation and related footnote for details about the project). The software TOR (tiling of rectangles), which we have produced on this occasion, generates the tiling by rectangles for various shapes, and computes the corresponding graph and a number of associated covariants, for a given set of data.

The presented research work opens a new field for applied mathematicians, in that it combines various aspects of geometry, topology and optimization theory, towards the solution of a problem which is well known to architects, but which has rarely been attacked by mathematical methods. The covariants associated with graphs provide an innovative approach to understand and analyze the problem.

**REFERENCES**

* Late Prof. Daniel Coray, Department of Mathematics, University of Geneva, [lcoray@sunrise.ch](mailto:lcoray@sunrise.ch)
* Prof. Pierre Pellegrino, Department of Geography, University of Geneva, [pellegri@bluewin.ch](mailto:pellegri@bluewin.ch)
* Dr. Amit Chakraborty, Department of Mathematics, Central University of Rajasthan, [amitc.maths@curaj.ac.in](mailto:amitc.maths@curaj.ac.in)
* Prof. José P. Duarte, Department of Architecture, University of Lisbon, [jduarte@fa.ulisboa.pt](mailto:jduarte@fa.ulisboa.pt)
* Prof. A.P. Singh, Department of Mathematics, Central University of Rajasthan, [apsingh@curaj.ac.in](mailto:apsingh@curaj.ac.in)
* José Nuno Beirão, Department of Architecture, University of Lisbon,  [jnb@fa.ulisboa.pt](mailto:jnb@fa.ulisboa.pt)

**PERSONAL DETAILS**

* **Permanent Address:** C-91, Aditya Nagar, Morak, Kota, Rajasthan, India
* **E-mail:** [krishnendra.iitd@gmail.com](mailto:krishnendra.iitd@gmail.com)
* **Date of Birth:** 15th October, 1984
* **Nationality:** Indian