Ikjyot Singh Kohli, Ph.D.

144 Spadina Road
Richmond Hill, Ontario
Phone: (905) 508-7213 Fax: (905) 508-6396
E-Mail: ikjyotsingh.kohli@gmail.com
Web: ca.linkedin.com/pub/ikjyot-singh-kohli/aa/881/21

July 5, 2015

Citi
New York, New York

Re: Data Scientist, Global Analytics and Insights Position

The purpose of this letter is to express great interest in applying for the aforementioned position within Citi.

I hold a Doctorate and Master of Science degree in Mathematical and Theoretical Physics from York University in Toronto as well as an Honours Bachelor of Science degree in Physics and Mathematics from The University of Toronto.

As you will see from my curriculum vitae, I have extensive knowledge and experience in pioneering new techniques in the fields of applied mathematics of which I have contributed to the fields of Einstein's theory of General Relativity, data analytics, and quantitative finance. I have very strong research-oriented skills, which is evidenced by my publications in top-level academic research journals. In addition, I have great strengths in data analytics and machine learning with deep knowledge of multivariate statistics, time-series analysis, signal processing, cluster analysis, logistic regression, decision trees, SVMs, and the concept of Shannon entropy. I had to use these tools to a great extent both as part of the projects I worked on in the Applied Mathematics Group at York University and in my own Ph.D. research.

Complementary to the above, I have a very strong skillset in computer programming, being able to implement the aforementioned algorithms in Python (NumPy, SciPy, Pandas), MATLAB, R, Mathematica, SQL, and Excel. With respect to big data, I have experience in writing Map/Reduce applications in Python using the Hadoop streaming architecture to gain insights on cosmological data used in my research. In addition, I have experience in writing programs in higher-level languages such as Spark, Pig and Hive/HiveQL to further leverage valuable insights from very large datasets.

I have spent a significant amount of time conducting high-level research in most areas of applied mathematics including quantitative finance and risk management. In fact, for the past three months I worked as a Senior Analytics Analyst at RBC in the Operational Risk Methodologies group. In this role, I assisted and provided strong quantitative support in maintenance and development of Op-Risk methodologies, designed new aspects and implementations of the bank's AMA model per Basel regulations. I developed a new theory based on combining quantile distance estimation and kernel density estimation with respect to enabling the bank to accurately tackle the problem of severity distribution fitting and more general loss distribution approach techniques. I also provided expertise in developing new approaches to scenario analysis based on Bayesian probabilities. After coming up with these theories, I spent a significant amount of time implementing these ideas in MATLAB, R, Python, and MS Excel.

With respect to computational skills, I have significant experience and knowledge of MATLAB, Python, R, Visual Basic. I also have database experience as well in MS Access and SQL. I have frequently had to find efficient ways to extract data from relational databases for further use and analysis in statistical software packages. This was of particular importance throughout my graduate studies and my role at RBC. I also am involved in running the relativitydigest.com blog, which receives up towards 10 – 50,000 hits per month. The purpose of this blog is to showcase some broader areas of mathematics which I am involved in and has recently focused on statistical modeling with respect to predicting the outcomes of political elections and

using data science and machine learning techniques to provide deep insights into the way sports teams play to help them win games.

I have led several research groups being the principal investigator for three cosmology-related projects which all resulted in top-level publications in refereed journals. I also have extensive experience in teaching hard physics-related concepts to those from a non-technical background in my work as a head teaching assistant in the Faculty of Science at York University, earning very strong reviews from students who took these courses. This is direct evidence of my ability of being a strong leader, and being able to explain very technical concepts with ease to those from a non-technical background, which I imagine is very important for a position such as this.

I therefore hope you will find my background suitable for this position, and look forward to hearing from you soon.

Sincerely,

Ikjyot Singh Kohli, Ph.D.

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144 Spadina Road • Richmond Hill, Ontario L4B 2V2 • Phone: 905-508-7213 • E-Mail: ikjyotsingh@icloud.com • Web: http://goo.gl/Tt4ZgJ

Education

Ph.D. - Mathematical Physics – York University 2014

Dissertation Title – "Topological Dynamical Systems Methods in Early-Universe Cosmologies" – Supervised by: Michael C. Haslam

M.Sc. – Mathematical Physics – York University 2012

Thesis Title – "A Bianchi Type IV Viscous Fluid Model of The Early Universe" – Supervised by: Michael C. Haslam

B.Sc. – Physics Specialist Program, Mathematics Minor – University of Toronto 2010

Senior Undergraduate Thesis: "Chaos in General Relativity" – Supervised by: Charles C. Dyer – Graduated with Honours

Experience

York University – Researcher, Department of Mathematics & Statistics February, 2015 - Present

- Using new methodologies to research solutions to Einstein's field equations of General Relativity
- Research in applied mathematics, dynamical systems, general relativity, data analytics, and statistical learning.
- Applied big data algorithms using Spark, Scala, Hive, Pig, and Sqoop.
- For smaller data sets, used R, Python, and MATLAB to leverage useful information.

RBC – Senior Analyst, Operational Risk Methodologies February, 2015 – April, 2015

- Assisted and provided strong quantitative support in maintenance and development of Operational Risk (Op Risk) Methodologies
- Designed new aspects and implementation of the bank's AMA model per Basel regulations.
- Designed and implemented a brand new methodology concerning loss distribution approach and severity distribution fitting.
- Provided expertise in designing a new approach to the scenario analysis methodology with respect to the AMA model.
- Developed key insights from several historical data sources, and used this data to perform several tasks related to statistical learning including K-means clustering, SVMs, and mixture distribution fitting via a Kernel density method.
- Responsible for conducting, implementing, maintaining, and improving all of the bank's backtesting with respect to the AMA model.
- Implemented these ideas in MATLAB, SQL, and R.

Relativitydigest.com 2014 - Present

- A blog dedicated to Relativity, Cosmology, and Physics. Since its inception, averages more than 80,000 views per month educating people from around the world interested in these topics.
- I use advanced analytics from Wordpress and writing programs in Python using the Twitter extension via the Python-Twitter API in combination with Pandas, NumPy, and SciPy to gain insights on how to extend the reach of the website using advanced statistical and machine learning methods.

York University – Mathematical Physics Research 2011-2014

- Worked on detailed problems in General Relativity, Dynamical Systems, Fluid Mechanics.
- Numerically solving PDEs, ODEs in MATLAB, Python (NumPy and SciPy) , discovered three new solutions to Einstein's field equations of General Relativity.

- Took on several problems in dynamical systems theory as well ranging from mathematical epidemiology to mathematical and computational neuroscience. These were developed using the built-in R-K ODE solvers in MATLAB.
- Analyzed and worked on several problems in quantitative finance. These included developing methodologies to price derivatives/options, interest rate models (Vasicek, CIR, Black-Derman-Toy, HJM), and portfolio and risk management techniques. Implemented solutions to several of these problems numerically using Monte Carlo and finite differences methods. These applications were developed in MATLAB and Python.
- Performed advanced-level analysis of large sets of scientific (cosmological, astrophysical) data to obtain insights and patterns for further analysis. Used the following techniques from machine/statistical learning such as Data Analytics/Machine Learning: Linear regressions (including multiple linear regressions), classification techniques, resampling methods, nonlinear regressions (splines, GAMs), tree-based methods (decision trees, regression trees, classification trees, bagging, random forests, boosting), SVMs (maximal margin classifiers, support vector classifiers), Unsupervised learning techniques (PCA, K-means clustering, Hierarchical clustering). Implemented these techniques using Hadoop Streaming, MATLAB, Python, R, Mathematica, and MS Excel.

York University – Faculty of Science – Undergraduate Teaching 2011-2014

- Was the head teaching assistant for several courses including PHYS 2030 (Computational Methods for Scientists and Engineers), MATH 1013 – Applied Calculus, MATH 1025 – Applied Linear Algebra, Math/Stats Lab, PHYS 1510 – Introduction to Physics – Lab demonstrator, NATS1810 – Energy, NATS 1840 – Science, Technology, and the Environment.
- Average teaching reviews – 3.9/4 (reviews available upon request). Earned high praise from students and colleagues on the ability to explain complicated concepts in a simple and clear manner.

University of Toronto – Advanced Physical Labs 2007-2010

- Performed several advanced level experiments trying to understand the physics behind the cloud chamber, 3-D conductivity, Fourier transform of waves, high energy physics, magnetization, and other special projects. All of these experiments involved very sophisticated data analysis, stochastic analysis via Markov chain implementations, and numerically solving differential equations. These tasks were implemented using MATLAB, Python, MS Excel/Apple Numbers, and Visual Basic.
- Due to the accomplishments and novel results developed in my work, my lab notebook is kept on display at the Advanced Physical Labs as an example of how to carry out excellent computational and data science based research for future researchers.

University of Toronto - Department of Physics 2010

- Advanced research projects completed in Geophysics and Atmospheric Physics: Researched several problems in geophysics including tomography problems, earthquake origin point problems, solving the inhomogeneous heat and wave equations across multiple connected boundaries. These tasks were numerically implemented using MATLAB, Python, and relied on existing source code written in FORTRAN. I also was involved in atmospheric physics research which largely involved solving the Navier-Stokes equations in various settings numerically using finite differences approximations.

Publications

- *On Optimal Offensive Strategies in Basketball* – Ikjyot Singh Kohli – arXiv:1506.06687[math.DS] – June, 2015 – Submitted to Journal of Differential Equations
- *On Singularities in Cosmic Inflation* – Ikjyot Singh Kohli – arXiv:1505.07770 [gr-qc] – May, 2015 – Submitted for Publication
- *On a Quantile Distance Algorithm for the RBC AMA Model* – Ikjyot Singh Kohli – RBC Internal Publication – March, 2015

- *Mathematical Issues in Eternal Inflation* – Ikjyot Singh Kohli and Michael C. Haslam - arXiv: 1408.2249 [math-ph] - Published in: Class.Quant.Grav. 32(2015) 7, 075001
- *Exploring Vacuum Energy in a Two-Fluid Bianchi Type I Universe* – Ikjyot Singh Kohli and Michael C. Haslam – arXiv: 1402.1967 [math-ph] – Submitted – 2014
- *Dynamics of a Closed Viscous Universe* – Ikjyot Singh Kohli and Michael C. Haslam – arXiv:1311.0389 [gr-qc] – Published in: Phys.Rev.D89 (2014) 4, 043518
- *Dynamical Systems Approach to a Bianchi Type I Viscous Magnetohydrodynamic Model* – Ikjyot Singh Kohli and Michael C. Haslam – arXiv:1304.8042 [gr-qc] – Published in: Phys.Rev.D.88 (2013) 6, 063518
- *Future Asymptotic Behaviour of a Nontilted Bianchi Type IV Viscous Model* – Ikjyot Singh Kohli and Michael C. Haslam - arXiv:1207.6132 [gr-qc] – Published in: Phys.Rev.D.87 (2013) 6, 063006

References

- Michael C. Haslam – Professor of Mathematics and Statistics – York University – mchaslam@mathstat.yorku.ca
- Randy Lewis – Professor of Physics – York University – randy.lewis@yorku.ca
- Peter C. Gibson – Professor of Mathematics and Statistics – York University – pcgibson@mathstat.yorku.ca
- Joe Repka – Professor of Mathematics – University of Toronto – repka@math.utoronto.ca
- Charles C. Dyer – Professor of Physics – University of Toronto – dyer@astro.utoronto.ca
- Peter Kreiger – Professor of Physics – University of Toronto – krieger@physics.utoronto.ca