# **Single Curve Construction SKU Build Out**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| C Tanggaard | 1997 | X | X | X | X | X |
| K Adams | 2001 | X | X | X | X | X |
| P Hagan and G West | 2006 | X | X | X | X | X |
| L Andersen | 2007 | X | X | X | X | X |
| P Hagan and G West | 2008 | X | X | X | X | X |
| F Ametrano and M Bianchetti | 2009 | X | X | X | X | X |
| J Kinlay and X Bai | 2009 | X | X | X | X | X |
| F Le Floc’h | 2013 | X | X | X | X | X |
| Y Iwashita | 2013 | X | X | X | X | X |
| Forums | Wilmott | X | X | X | X | X |

### Apex

|  |  |  |
| --- | --- | --- |
| **#** | **AUTHOR** | **INSTITUTION** |
| 1 | Ken Adams | Kamakura Corporation |
| 2 | Fernando Ametrano | Banca IMI |
| 3 | Leif Andersen | Banc of America |
| 4 | Xu Bai | DTCC |
| 5 | Marco Bianchetti | Banca Intesa San Paolo |
| 6 | Patrick Hagan | Deutsche Bank |
| 7 | Yukinori Iwashita | Open Gamma |
| 8 | Jonathan Kinlay | CEO, Systematic Strategies |
| 9 | Fabian Le Floc’h | Calypso |
| 10 | Huston McCulloch | Emeritus Professor of Finance, Ohio State University |
| 11 | Carsten Tanggaard | Professor of Finance, Aarhus University |
| 12 | Greame West | -- deceased -- |

# **Spline Library SKU Build Out**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| S Preuss | 1987 | X | X |  |  |  |
| P H C Eilers and B D Marx | 1996 | X | X |  |  |  |
| C de Boor | 2001 | X | X | X |  |  |
| T N T Goodman | 2003 | X | X | X |  |  |
| D House | 2011 | X | X | X | X | X |
| C Shalizi | 2011 | X | X | X | X | X |
| D Trojand | 2011 | X | X | X | X | X |
| Y R Yue, D Simpson, F Lindgren, and H Rue | 2012 | X | X |  |  |  |
| Wiki (Smoothing Spline) | 2013 | X | X | X | X | X |
| Wiki (Spline) | 2013 | X | X | X | X | X |

### Apex

|  |  |
| --- | --- |
| **AUTHOR** | **INSTITUTION** |
| de Boor | University of Wisconsin |
| Eilers | Leiden University Medical Center |
| Goodman | University of Dundee |
| House | Clemson University |
| Lindgren | Norwegian University of Science and Technology |
| Marx | Louisiana State University |
| Preuss | Colorado School of Mines |
| Rue | Norwegian University of Science and Technology |
| Shalizi | Carnegie Mellon University |
| Simpson | Norwegian University of Science and Technology |
| Trojand | Teacher in Windsor, Canada |
| Yue | City University of New York |

**Multi-Curve Construction SKU Build Out**

### Seminal

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| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| M Fujii, Y Shimada, and A Takahashi | 2010 | X | X | X | X | X |
| C Lentz, M Chang, and S L Dorji | 2010 | X | X | X | X | X |
| M Bianchetti | 2011 | X | X | X | X | X |
| M Bianchetti | 2012 | X | X | X | X | X |
| Bloomberg | 2012 | X | X | X | X | X |
| R White | 2012a | X | X | X | X | X |
| R White | 2012b | X | X | X | X | X |
| F Ametrano and M Bianchetti | 2013 | X | X | X | X | X |
| Open Gamma | 2013 | X | X | X | X | X |
| Forums | Wilmott | X | X | X | X | X |

### Apex

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| --- | --- |
| **AUTHOR** | **INSTITUTION** |
| Ferdinando Ametrano | Banca IMI |
| Marco Bianchetti | Banco Intesa San Paolo |
| Michael Chang | Credit Suisse |
| Sonam Leki Dorji | Credit Suisse |
| Masaaki Fujii | University of Tokyo |
| Carl Lentz | Credit Suisse |
| Yasufumi Shimada | Shinsei Bank |
| Akihiko Takahashi | University of Tokyo  Financial Services Agency |
| Richard White | Open Gamma |

**Single Curve Option SKU Build Out**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| C Kahl and P Jackel | 2009 | X | X | X | X | X |
| N Gisiger | 2010 | X | X | X | X | X |
| L Wang (Option) | 2010a | X | X | X | X | X |
| L Wang (LIBOR Volatility) | 2010b | X | X | X | X | X |
| L Wang (HJM) | 2010c | X | X | X | X | X |
| L Wang (Hull White) | 2010d | X | X | X | X | X |
| L Wang (SABR) | 2010e | X | X | X | X | X |
| F Rouah | 2010a | X | X | X | X | X |
| F Rouah | 2010b | X | X | X | X | X |
| Forums | VBA JSON Integration | | | | | |

### Apex

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| **AUTHOR** | **INSTITUTION** |
| Nicolas Gisiger | Zurich Investment Banking (Credit Suisse?) |
| Peter Jackel | VTB Capital |
| Christian Kahl | CommerzBank |
| Fabrice Rouah | Sapient Global Markers |
| Letian Wang | Deutsche Bank |

**Multi Curve Option SKU Build Out**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| A Brace, D Gatarek, and M Musiela | 1997 | X | X | X | X | X |
| F Mercurio | 2009 | X | X |  |  |  |
| F Mercurio | 2010 | X | X |  |  |  |
| D Schatz | 2011 | X | X | X |  |  |
| M Kramin, S Mercuri, M Comporiano and Y Tang | 2017 | X | X | X |  | X |
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|  |  |  |  |  |  |  |
| Forums | Java Sockets Service Bridge | | | | | |

### Apex

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| **AUTHOR** | **INSTITUTION** |
| Alan Brace | National Australia Bank |
| Maximilliano Comporiano | Wells Fargo |
| Dariusz Gatarek | Unicredit |
| Marat Kramin | Wells Fargo |
| Simone Mercuri | Wells Fargo |
| Fabio Mercurio | Bloomberg |
| Marek Musiela | University of Oxford |
| Dennis Schatz | University of Ulm |
| Yi Tang | Wells Fargo |

**Collateral + XVA Metric SKU**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| V Piterbarg | 2010 | X | X | X | X | X |
| V Piterbarg | 2012 | X | X | X | X | X |
| J Hull and A White | 2012 | X | X | X | X | X |
| C Burgard and M Kjaer | 2012a | X | X | X | X | X |
| C Burgard and M Kjaer | 2012b | X | X | X | X | X |
| C Burgard and M Kjaer | 2013 | X | X | X | X | X |
| M Henrard | 2013 | X | X |  |  |  |
| A Pallavicini and D Brigo | 2013 | X | X |  |  |  |
| P Xu, H Li, G Wu, and Y Tang | 2016 | X | X | X |  | X |
| Forums | 2017 | X | X | X | X | X |

### Apex

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| --- | --- |
| **AUTHOR** | **INSTITUTION** |
| Damiano Brigo | Imperial College |
| Christoph Burgard | Barclays |
| Marc Henrard | Open Gamma |
| John Hull | University of Toronto |
| Mats Kjaer | Barclays |
| Heng Li | Wells Fargo |
| Andrea Pallavicini | Imperial College  Banca IMI Milan |
| Vladimir Piterbarg | Barclays |
| Yi Tang | Wells Fargo |
| Alan White | University of Toronto |
| Guowei Wu | Wells Fargo |
| Peng Xu | Wells Fargo |

**Accounting Metric Generation SKU**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| C Albanese and L Andersen | 2014 | X | X | X | X | X |
| C Albanese, L Andersen, and S Iabicino | 2015 | X | X | X | X | X |
| C Burgard and M Kjaer | 2015 | X | X | X | X | X |
| C Albanese and M Syrkin | 2016 | X | X | X | X | X |
| Y Tang | 2017 | X | X |  |  |  |
| G Wu and H Li | 2017 | X | X | X | X | X |
| P Xu and R Zhou | 2017 | X | X | X | X | X |
| P Xu | 2017 | X | X | X | X | X |
| L Andersen, D Duffie, and Y Song | 2017 | X | X |  |  |  |
| Forums | 2018 | X | X | X | X | X |

### Apex

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| --- | --- |
| **AUTHOR** | **INSTITUTION** |
| Claudio Albanese | Global Valuation |
| Leif Andersen | Bank of America Merrill Lynch |
| Christoph Burgard | Barclays |
| Darrell Duffie | Stanford University |
| Stefano Iabicino | Global Valuation |
| Heng Li | Wells Fargo |
| Mats Kjaer | Barclays |
| Yang Song | Stanford University |
| Mark Syrkin | New York Fed |
| Yi Tang | Wells Fargo |
| Guowei Wu | Wells Fargo |
| Peng Xu | Wells Fargo |
| R Zhou | Wells Fargo |

**Inflation Products**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| M Pond, K Sooben, C Mirani, H Skeoch, and K Chow | 2014 | X | X |  |  |  |
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| Forums |  |  |  |  |  |  |

### Apex

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| --- | --- |
| **AUTHOR** | **INSTITUTION** |
| Koon Chow | Barclays |
| Chirag Mirani | Barclays |
| Michael Pond | Barclays |
| Henry Skeoch | Barclays |
| Khrishnamoorthy Sooben | Barclays |

**Treasury/Bond Futures**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| E Stanton | 1999 | X | X | X | X | X |
| M Choudhry | 2004 | X | X | X | X | X |
| J Carpenter | 2010 | X | X | X | X | X |
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|  |  |  |  |  |  |  |
| Forums | Java Sockets Service Integration | | | | | |

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| **AUTHOR** | **INSTITUTION** |
| Jennifer Carpenter | Professor, NYU |
| Moorad Choudhry | Habib Bank AG Zurich |
| Elizabeth Stanton | Bloomberg |

**Asset Backed Analytics**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| R Iyengar | 2015 | X | X | X |  |  |
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| Forums | VBA Sockets Service Bridge | | | | | |

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| **AUTHOR** | **INSTITUTION** |
| Raj Iyengar | PeerIQ |

**Portfolio Construction**

### Seminal

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| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| T Idzorek and J Androgue | 2003 | X | X | X | X | X |
| Z Da and R Jagannathan | 2005 | X | X | X | X | X |
| J Kim | 2005 | X | X | X | X | X |
| S Soontornkit | 2010 | X | X | X | X | X |
| R O’Toole | 2013 | X | X | X | X | X |
| J Walters | 2014 | X | X | X | X | X |
| W Deng | 2015 | X | X | X | X | X |
| R Yamabe | 2016 | X | X | X | X | X |
| Wiki | 2016 | X | X | X | X | X |
| Forums | Java JSON Bridge | | | | | |

### Apex

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| **AUTHOR** | **INSTITUTION** |
| Jill Androgue | Zephyr Associates |
| Zhi Da | University of Notre Dame |
| Weiwei Deng | Axioma |
| Thomas Idzorek | Zephyr Associates |
| Ravi Jagannathan | Northwestern University |
| Jane Kim | Wall Street Journal |
| Randy O’Toole | Federated Investors |
| Supakorn Soontornkit | MFC Asset Management |
| Jay Walters | Boston University |
| Ryoichi Yamabe | Simplex |

**Asset Allocation**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| G He and R Litterman | 1999 | X | X | X | X | X |
| T Idzorek | 2005 | X | X | X | X | X |
| P Xu, A Chen, and P Tsui | 2008 | X | X | X | X | X |
| T Yotsuzuka | 2016 | X | X | X | X | X |
| D Cvengros | 2016 | X |  |  |  |  |
| J Lewis | 2016 | X | X | X | X | X |
| J Kollross, A Mittal, and V Agrawala | 2017 | X | X | X | X | X |
| E Shen and D Srinivasan | 2017 | X | X | X | X | X |
| P Corbin | 2017 | X | X | X | X | X |
| Forums | VBA JSON Bridge | | | | | |

### Apex

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| **AUTHOR** | **INSTITUTION** |
| Vivek Agrawala | UBS Asset Management |
| Allen Chen | University of California, Berkeley CA |
| Paige Corbin | Wisdom Tree Capital Management |
| David Cvengros | SSGA |
| Thomas Idzorek | MorningStar Incorporated |
| Guangliang He | Goldman Sachs Asset Management |
| Johannes Kollross | AIM Software |
| James Lewis | SSGA |
| Robert Litterman | Goldman Sachs Asset Management |
| Ashish Mittal | UBS Asset Management |
| Ethan Shen | AIM Software |
| Deepak Srinivasan | AIM Software |
| Pui Wah Tsui | University of California, Berkeley CA |
| Patrick Xu | University of California, Berkeley CA |
| Toshi Yotsuzuka | Waseda University |

**Asset Liability Management**

### Seminal

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| K L Judd, K Kubler, and L Schmedders | 2011 | X | X |  |  |  |
| D Cvengros | 2019a | X | X | X | X | X |
| D Cvengros | 2019b | X | X | X | X | X |
| Wikipedia | 2019a | X | X | X | X | X |
| Wikipedia | 2019b | X | X | X | X | X |
| Wikipedia | 2019c | X | X | X | X | X |
| Wikipedia | 2019d | X | X | X | X | X |
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| **AUTHOR** | **INSTITUTION** |
| David Cvengros | SSGA |
| Kenneth Judd | Hoover Institution |
| Felix Kubler | University of Zurich |
| Karl Schmedders | University of Zurich |

**Transaction Cost – Optimal Execution**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| Almgren R and N Chriss | 1999 | X | X | X | X | X |
| Almgren R and N Chriss | 2000 | X | X | X | X | X |
| Almgren R | 2003a | X | X | X | X | X |
| Almgren R and N Chriss | 2003b | X | X | X | X | X |
| Almgren R, C Thum, E Hauptmann, and H Li | 2005a | X | X | X | X | X |
| Almgren R, C Thum, E Hauptmann, and H Li | 2005b | X | X | X | X | X |
| Almgren R, and J Lorenz | 2006 | X | X | X | X | X |
| Almgren R | 2008 | X | X | X | X | X |
| Almgren R | 2009 | X | X | X | X | X |
| Forums | VBA JSON Bridge | | | | | |

### Apex

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| --- | --- |
| **AUTHOR** | **INSTITUTION** |
| Robert Almgren | University of Toronto |
| Neil Chriss | Institute of Advanced Studies  Hutchin Hill Capital  SAC Capital Advisors  Institute of Advanced Studies  Harvard University  New York University  Fermilab |
| Emmanuel Hauptmann | RAM Active Investments |
| Hong Li | Citigroup |
| Julian Lorenz | IMC Asset Management |
| Chee Thum | Citigroup |

**Transaction Cost – Cross Asset**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| Almgren R, and J Lorenz | 2006 | X | X | X | X | X |
| Almgren R | 2012 | X | X | X | X | X |
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| Forums | Wilmott | | | | | |

### Apex

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| **AUTHOR** | **INSTITUTION** |
| Robert Almgren | University of Toronto |
| Julian Lorenz | IMC Asset Management |

**Statistical Learning**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| P Bartlett, S. R. Kulkarni, and S E. Posner | 1997 | X | X | X | X | X |
| R Williamson, A Smola, and B. Scholkopf | 2001 | X | X | X | X | X |
| O Bousquet, S Boucheron, and G Lugosi | 2003 | X | X | X |  | X |
| S Boucheron, O Bousquet, and G Lugosi | 2005 | X | X |  |  |  |
| U von Luxburg and B Scholkopf | 2009 | X | X | X | X | X |
| G Lugosi | 2009 | X | X | X | X | X |
| A Rakhlin and K Sridharan | 2014 | X | X |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Forums | VBA Sockets Service Integration | | | | | |

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| --- | --- |
| **AUTHOR** | **INSTITUTION** |
| Peter Bartlett | University of California, Berkeley |
| Stephane Boucheron | University of Paris, Diderot |
| Olivier Bousquet | Google, Zurich |
| Sanjeev Kulkarni | Princeton University, Princeton |
| Gabor Lugosi | Pamper Fabra University |
| S E Posner | University of Toronto, Toronto |
| Alexander Rakhlin | University of Chicago, Chicago |
| Bernhard Scholkopf | Max Planck Institute |
| Alex Smola | Australian National University |
| Karthik Sridharan | Cornell University, Ithaca |
| Ulrike von Luxburg | University of Hamburg |
| Robert C Williamson | Australian National University |

**Convex Optimization and Numerical Methods**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| K Hauser | 2012 | X | X | X | X | X |
| J Heyl | 2014 | X | X | X | X | X |
| Wiki (Interior Point Method) | 2016 | X | X | X | X | X |
| Wiki (Simplex Algorithm) | 2016 | X | X | X | X | X |
| Wiki (Lagrange Multiplier) | 2016 | X | X | X | X | X |
| Wiki (Constrained Optimization) | 2016 | X | X | X | X | X |
| Wiki (Karush-Kuhn-Tucker Conditions) | 2016 | X | X | X | X | X |
| Newton’s Method in Optimization (Wiki) | 2016 | X | X | X | X | X |
| Wolfe’s Conditions (Wiki) | 2016 | X | X | X | X | X |
| Forums | Java JSON Incorporation | | | | | |

### Apex

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| **AUTHOR** | **INSTITUTION** |
| Kris Hauser | Indiana University |
| Jeff Heyl | Pearson Education |

**Special Functions, Derivatives, and Properties**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I** | **Pass II** | **Pass III** | **Implement** | **Review** |
| Wiki (Error Function) | 2019 | X | X | X | X | X |
| Wiki (Gamma Function) | 2019 | X | X | X | X | X |
| Wiki (Stirling’s Approximation) | 2019 | X | X | X | X | X |
| Wiki (Lanczos Approximation) | 2019 | X | X | X | X | X |
| Wiki (Incomplete Gamma Function) | 2019 | X | X | X | X | X |
| Wiki (Digamma Function) | 2019 | X | X | X | X | X |
| Wiki (Beta Function) | 2019 | X | X | X | X | X |
| Wiki (Hyper-geometric Function) | 2019 | X | X | X | X | X |
| Wiki (Bessel Function) | 2019 | X | X | X | X | X |
| Wiki (Stretched Exponential Function) | 2019 | X | X | X | X | X |

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| **AUTHOR** | **INSTITUTION** |
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**Numerical Integrand Quadrature Evaluation**

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| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| Wiki (Numerical Integration) | 2019 | X | X | X | X | X | X |
| Wiki (Gaussian Quadrature) | 2019 | X | X | X | X | X | X |
| Wiki (Gauss-Kronrod Quadrature Formula) | 2019 | X | X | X | X | X | X |
| Wiki (Sylvester’s Formula) | 2019 | X | X | X | X | X | X |
| Wiki (Determinant) | 2019 | X | X | X | X |  |  |
| Wiki (Matrix Exponential) | 2019 |  |  |  |  |  |  |
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| **AUTHOR** | **INSTITUTION** |
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**Statistical Distribution PDF, CDF, Properties**

### Seminal

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| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| Wiki ( Distribution) | 2018 | X | X | X | X | X | X |
| Wiki (Student’s t-Distribution) | 2019 |  |  |  |  |  |  |
| Wiki (Gamma Distribution) | 2019 | X | X | X | X | X | X |
| Wiki (Non-central Chi-Square Distribution) | 2019 | X | X | X | X | X | X |
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### Apex

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| **AUTHOR** | **INSTITUTION** |
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**Margin Modeling**

### Seminal

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| M Pykhtin | 2009 | X | X | X | X | X | X |
| L Andersen, M Pykhtin, A Sokol | 2017a | X | X | X | X | X | X |
| L Andersen, M Pykhtin, A Sokol | 2017b | X | X | X |  |  |  |
| F Anfuso, D Aziz, K Loukopoulos, and P Giltinan | 2017a | X | X | X | X | X | X |
| F Anfuso, D Aziz, K Loukopoulos, and P Giltinan | 2017b | X | X | X |  |  |  |
| A Woodward | 2018 | X | X | X | X | X | X |
| T Phillips | 2018 | X | X | X | X | X | X |
| S Cheong, T Phillips, and A Woodward | 2018 | X | X | X | X | X | X |
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### Apex

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| --- | --- |
| **AUTHOR** | **INSTITUTION** |
| Leif Andersen | Bank of America |
| Fabrizio Anfuso | Credit Suisse |
| Daniel Aziz | Credit Suisse |
| Samuel Cheong | Nomura |
| Paul Giltinan | Quaternion |
| Klearchos Loukopoulos | Credit Suisse |
| Tobias Phillips | Nomura |
| Michael Pykhtin | New York Fed |
| Alexander Sokol | CompatibL |
| Alastair Woodward | Nomura |

**Initial Margin Modeling**

### Seminal

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| ISDA SIMM | 2011 | X | X | X | X | X | X |
| M Baxter | 2015 | X | X | X | X | X | X |
| ISDA SIMM | 2016 | X | X | X | X | X | X |
| C Albanese, S Caenazzo, and O Frenkel | 2016 | X |  |  |  |  |  |
| M Sato | 2017 | X | X | X | X | X | X |
| LCH ClearNet | 2017 | X | X | X |  |  |  |
| C Albanese, S Caenazzo, and M Syrkin | 2017 | X |  |  |  |  |  |
| ISDA SIMM | 2018 | X | X | X | X | X | X |
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### Apex

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| **AUTHOR** | **INSTITUTION** |
| Martin Baxter | Nomura |
| Simone Caenazzo | IMEX |
| Mitsuhiro Sato | Nomura |
| Mark Syrkin | Federal Reserve Bank of New York |

**Basel**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| BCBS | 2013 | X | X | X | X | X | X |
| G Pepe | 2013 | X | X |  |  |  |  |
| Wiki (Basel II) | 2018 | X | X | X | X | X | X |
| Wiki (Basel III) | 2018 | X | X | X | X | X | X |
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### Apex

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| **AUTHOR** | **INSTITUTION** |
| Giovanni Pepe | Banca d’Italia |

**Model Review, Validation, and Governance**

### Seminal

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| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| Federal Reserve | 2011 | X | X | X | X | X | X |
| F Anfuso, D Karyampas, and A Nawroth | 2017 | X | X | X | X | X | X |
| Wiki ( Test) | 2018 | X | X |  |  |  |  |
| Wiki (t-statistic) | 2018 | X | X | X | X | X | X |
| Wiki (Probability Integral Transform) | 2018 | X | X | X | X | X | X |
| Wiki (Q-Q plot) | 2018 | X | X | X | X | X | X |
| Wiki (Coefficient of Determination) | 2019 | X | X |  |  |  |  |
| Wiki (p-value) | 2019 | X | X | X | X | X | X |
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### Apex

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| **AUTHOR** | **INSTITUTION** |
| Fabrizio Anfuso | Credit Suisse |
| Dimitrios Karyampas | UBS |
| Andreas Nawroth | Credit Suisse |

**VaR and Stress Capital Estimate**

### Seminal

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| Wu B | 2010 | X | X | X | X | X | X |
| K Bennett | 2017 |  |  |  |  |  |  |
| Tao C and J Kim | 2017 | X | X | X | X | X | X |
| Monet C and W Zhu | 2018 | X | X | X | X | X | X |
| Citigroup | 2018b | X | X | X | X | X | X |
| Citigroup | 2018c | X | X | X |  |  |  |
| Citigroup | 2019a | X | X | X |  |  |  |
| Citigroup | 2019b | X | X | X |  |  |  |
| Tao C | 2019 | X | X | X | X | X | X |
| Wang H | 2019 | X | X | X | X | X | X |

### Apex

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| **AUTHOR** | **INSTITUTION** |
| Kenneth Bennett | Citigroup |
| Jun Kim | Citigroup |
| Charles Monet | Citigroup |
| Charles Tao | Citigroup |
| Hong Wang | Citigroup |
| Wei Zhu | Citigroup |

**Default and Risk Capital Simulation**

### Seminal

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| Vasicek O | 2002 | X | X | X | X | X | X |
| Tao C and J Kim | 2016 | X | X | X |  |  |  |
| He C | 2019 | X | X | X | X | X | X |
| Citigroup | 2019d | X | X | X | X | X | X |
| Alvarado C | 2019 | X | X | X | X | X | X |
| Citigroup | 2019e |  |  |  |  |  |  |
| Li X, Zhu W, and Zeng C | 2019 | X | X | X | X | X | X |
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### Apex

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| **AUTHOR** | **INSTITUTION** |
| Carlos Alvarado | Citigroup |
| Claudia He | Citigroup |
| Jun Kim | Citigroup |
| Xu Li | Citigroup |
| Charles Tao | Citigroup |
| Oldrich Vasicek | Moody’s KMV |
| Wei Zhu | Citigroup |
| Chen Zeng | Citigroup |

**VaR-Stress Risk Capital Allocation**

### Seminal

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| Citigroup | 2017 | X | X | X | X | X | X |
| Xiong, L | 2017 | X | X | X | X |  |  |
| Wang, H | 2018 | X | X | X | X | X | X |
| Citigroup | 2018a | X | X | X | X | X | X |
| Citigroup | 2018c | X | X | X | X | X | X |
| Citigroup | 2020 | X | X | X | X | X | X |
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### Apex

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| **AUTHOR** | **INSTITUTION** |
| Hong Wang | Citigroup |
| Lian Xiong | Citigroup |

**Mixed Integer Non-Linear Programming**

### Seminal

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| Tadonki, C. and P. Vial | 2004 | X | X | X | X | X | X |
| Bonami, P., Biegler, L. T., Conn, A. R., Cornuejols, G., Grossmann, I. E., Laird, C. D., Lee, J., Lodi, A., Margot, F., Swaya, N., and Wachter, A. | 2006 | X | X |  |  |  |  |
| Berthold, T. | 2014a | X | X | X | X | X | X |
| Berthold, T. | 2014b | X |  |  |  |  |  |
| Saxena, S. | 2017 | X |  |  |  |  |  |
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| **AUTHOR** | **INSTITUTION** |
| Timo Berthold | Technical University Berlin |
| Lorenz Biegler | IBM |
| Pierre Bonami | Carnegie Mellon University |
| Andrew Conn | Carnegie Mellon University |
| Gerard Cornuejols | Carnegie Mellon University |
| Ignacio Grossmann | Carnegie Mellon University |
| Carl Laird | IBM |
| Jon Lee | Carnegie Mellon University |
| Andrea Lodi | Carnegie Mellon University |
| Francois Margot | Carnegie Mellon University |
| Sanjeev Saxena | IIT Kanpur |
| Nicolas Swaya | IBM |
| C Tadonki | University of Geneva |
| J Vial | University of Geneva |
| Andreas Wachter | IBM |

**Graph Algorithms**

### Seminal

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| Kruskal, J. | 1956 | X | X | X | X | X | X |
| Prim, R. | 1957 | X | X | X | X | X | X |
| Bellman, R., and L. Ford | 1958 | X | X | X | X | X | X |
| Dijkstra, E. | 1959 | X | X | X | X | X | X |
| Wikipedia | 2019a | X | X | X | X | X | X |
| Wikipedia | 2019b | X | X | X | X | X | X |
| Wikipedia | 2020a | X | X | X | X | X | X |
| Wikipedia | 2020b | X | X | X | X | X | X |
| Wikipedia | 2020c | X | X | X | X | X | X |
| Wikipedia | 2020d | X | X | X | X | X | X |

### Apex

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| --- | --- |
| **AUTHOR** | **INSTITUTION** |
| Richard Bellman | University of Southern California |
| Edsger Dijkstra | University of Texas |
| Lester Ford | RAND Corporation |
| Joseph Kruskal | Bell Labs |
| Robert Prim | Bell Labs |

**Graph Algorithms**

### Seminal

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| Karger, D. R., P. N. Klein, and R. E. Tarjan | 1995 | X | X | X | X | X | X |
| Chazelle, B. | 2000a | X | X | X | X | X | X |
| Chazelle, B. | 2000b | X | X | X | X | X | X |
| Pettie, S., and V. Ramachandran | 2002 |  |  |  |  |  |  |
| Wikipedia | 2008 | X | X | X | X | X | X |
| Haim, K. and U. Zwick | 2017 | X | X | X | X | X | X |
| Wikipedia – Binomial Heap | 2019c | X | X | X | X | X | X |
| Wikipedia – Johnson’s Algorithm | 2019d | X | X | X | X | X | X |
| Wikipedia – Priority Queue | 2020a | X | X | X | X | X | X |
| Wikipedia – Binary Heap | 2020b | X | X | X | X | X | X |
| Wikipedia – Shortest Path Problem | 2020c | X | X | X | X | X | X |
| Wikipedia – A\* Algorithm | 2020d | X | X | X | X | X | X |
| Wikipedia – Floyd-Warshall Algorithm | 2020e | X | X | X | X | X | X |

### Apex

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| --- | --- |
| **AUTHOR** | **INSTITUTION** |
| David Karger | Stanford University |
| Philip Klein | Brown University |
| Robert Tarjan | Princeton University |
| Joseph Kruskal | Bell Labs |
| Robert Prim | Bell Labs |

**Selection Algorithms**

### Seminal

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| Wikipedia (Floyd-Rivest Algorithm) | 2019 | X | X | X | X | X | X |
| Wikipedia (Introselect) | 2019 | X | X | X | X | X | X |
| Wikipedia (Order-Statistic Algorithm) | 2019 | X | X | X | X | X | X |
| Wikipedia (Quickselect) | 2019 | X | X | X | X | X | X |
| Wikipedia (Selection Algorithm) | 2019 | X | X | X | X | X | X |
| Wikipedia (Median-of-Medians) | 2020 | X | X | X | X | X | X |

**Array Algorithms**

### Seminal

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| Wikipedia (Maximum Sub-array Problem) | 2020 | X | X | X | X | X | X |
| Wikipedia (Subset Sum Problem) | 2020 | X | X | X | X | X | X |
| Wikipedia (3SUM) | 2020 | X | X | X | X | X | X |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
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**Computation Support**

### Seminal

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Author | **Year** | **Pass I**  **Read Scan** | **Pass II Write Scan** | **Pass III Absorb** | **Pass IV Script** | **Pass V Transcribe** | **Pass VI Implement** |
| Kubernetes | 2020 | X | X | X | X | X | X |
| Kafka | 2020 | X | X | X | X | X | X |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
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| --- | --- | --- | --- |
| **2018 Build Count** | | | |
| 1 | ~~Burgard, C., and M. Kjaer~~ | ~~2017~~ | ~~Derivatives Funding, Netting, and Accounting~~ |
| 2 | ~~Albanese, C., L. Andersen, and S. Iabichino~~ | ~~2014~~ | ~~The FVA Puzzle: Accounting, Risk Management, and Collateral Trading~~ |
| 3 | ~~Albanese, C., and M. Syrkin~~ | ~~2016~~ | ~~Prudent Adjustments~~ |
| 4 | ~~Andersen, L., M. Pykhtin, and A. Sokol~~ | ~~2017a~~ | ~~Re-thinking Margin Period of Risk~~ |
| 5 | ~~Pykhtin, M.~~ | ~~2009~~ | ~~Modeling Counterparty Credit Exposure in the Presence of Margin Agreements~~ |
| 6 | Andersen, L., M. Pykhtin, and A. Sokol | 2017b | Credit Exposure in the Presence of Initial Margin |
| 7 | ~~Anfuso, F., D. Aziz, K. Loukopoulos, and P. Giltinan~~ | ~~2017a~~ | ~~A Sound Modeling and Back-testing Framework for Forecasting Initial Margin Requirements~~ |
| 8 | Anfuso, F., D. Aziz, K. Loukopoulos, and P. Giltinan | 2017b | A Sound Modeling and Back-testing Framework for Forecasting Initial Margin Requirements |
| 9 | ~~Anfuso, F., D. Karyampas, and A. Nawroth~~ | ~~2017~~ | ~~A Sound Basel III Compliant Framework for Back-testing Credit Exposure Models~~ |
| 10 | ~~A Woodward~~ | ~~2018~~ | ~~Intraday Credit Monitoring FSD 1.6~~ |
| 11 | ~~T Phillips~~ | ~~2018~~ | ~~Intraday Credit Monitoring FSD 1.7~~ |
| 12 | ~~S Cheong, T Phillips, and A. Woodward~~ | ~~2018~~ | ~~Intraday Credit Monitoring FSD 1.8~~ |
| 13 | ~~ISDA~~ | ~~2018~~ | ~~ISDA SIMM Methodology 2.0~~ |
| 14 | Andersen, L., M. Pykhtin, and A. Sokol | 2017b | Re-thinking Margin Period of Risk |
| 15 | ~~Martin Baxter~~ | ~~2015~~ | ~~Initial Margin Model~~ |
| 16 | ~~Mitsuhiro Sato~~ | ~~2017~~ | ~~Initial Margin Model Implementations~~ |
| 17 | ~~Bellman, R., and L. Ford~~ | ~~1958~~ | ~~Bellman-Ford Algorithm~~ |
| 18 | ~~Dijkstra, E.~~ | ~~1959~~ | ~~Dijkstra Algorithm~~ |
| 19 | LCH ClearNet | 2017 | Liquidity Margin |
| 20 | ~~ISDA~~ | ~~2016~~ | ~~ISDA SIMM Methodology Principles~~ |
| 21 | ~~ISDA~~ | ~~2018~~ | ~~ISDA SIMM Methodology 2.1~~ |
| 22 | ~~Wikipedia~~ | ~~2018~~ | ~~Power Iteration~~ |
| 23 | ~~Wikipedia~~ | ~~2018~~ | ~~Rayleigh Quotient Iteration~~ |
| 24 | Albanese, C., S. Caenazzo, and O. Frenkel | 2016 | Regression Sensitivities for Initial Margin |
| 25 | Albanese, C., S. Caenazzo, and M. Syrkin | 2017 | VaR Optimization and Regression Sensitivities |

|  |  |  |  |
| --- | --- | --- | --- |
| **2019 Build Count** | | | |
| 1 | ~~Wikipedia~~ | ~~2018~~ | ~~Basel II~~ |
| 2 | ~~Wikipedia~~ | ~~2018~~ | ~~Basel III~~ |
| 3 | ~~BCBS~~ | ~~2013~~ | ~~Basel III Phase-in Arrangements~~ |
| 4 | Pepe, G. | 2013 | Basel 2.5: Potential Benefits and Unintended Consequences |
| 5 | ~~Wikipedia~~ | ~~2018~~ | ~~t-statistic~~ |
| 6 | ~~Wikipedia~~ | ~~2018~~ | ~~Probability Integral Transform~~ |
| 7 | Wikipedia | 2019 | Coefficient of Determination |
| 8 | ~~Wikipedia~~ | ~~2019~~ | ~~p-value~~ |
| 9 | ~~Wikipedia~~ | ~~2018~~ | ~~Chi-squared Distribution~~ |
| 10 | ~~Wikipedia~~ | ~~2018~~ | ~~Chi-squared Test~~ |
| 11 | ~~Federal Reserve~~ | ~~2011~~ | ~~Supervisory Guidance on Model Risk Management~~ |
| 12 | ~~Wikipedia~~ | ~~2018~~ | ~~Q-Q Plot~~ |
| 13 | ~~Wikipedia~~ | ~~2019~~ | ~~Gamma Function~~ |
| 14 | ~~Wikipedia~~ | ~~2019~~ | ~~Stirling’s Approximation~~ |
| 15 | ~~Wikipedia~~ | ~~2019~~ | ~~Lanczos Approximation~~ |
| 16 | Wikipedia | 2019 | Student’s t-Distribution |
| 17 | ~~Wikipedia~~ | ~~2019~~ | ~~Error Function~~ |
| 18 | ~~Wikipedia~~ | ~~2019~~ | ~~Numerical Integration~~ |
| 19 | ~~Wikipedia~~ | ~~2019~~ | ~~Gaussian Quadrature~~ |
| 20 | ~~Wikipedia~~ | ~~2019~~ | ~~Gauss-Kronrod Quadrature Formula~~ |
| 21 | ~~Wikipedia~~ | ~~2019~~ | ~~Incomplete Gamma Function~~ |
| 22 | ~~Wikipedia~~ | ~~2019~~ | ~~Digamma Function~~ |
| 23 | ~~Wikipedia~~ | ~~2019~~ | ~~Hyper-geometric Function~~ |
| 24 | ~~Wikipedia~~ | ~~2019~~ | ~~Bessel Function~~ |
| 25 | ~~Wikipedia~~ | ~~2019~~ | ~~Stretched Exponential Function~~ |

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| --- | --- | --- | --- |
| **2020 Build Count** | | | |
| ~~1~~ | ~~Vasicek, O.~~ | ~~2002~~ | ~~Distribution of Loan Portfolio Value~~ |
| 2 | Judd, K. L., F. Kubler, and K. Schmedders | 2010 | Bond Ladders and Optimal Portfolios |
| ~~3~~ | ~~Wu, B.~~ | ~~2010~~ | ~~Integrated VaR and Stress Testing (iVAST) Risk Capital Methodology – Level 2 Validation~~ |
| 4 | Tao, C. and J. Kim | 2016 | Six-factor IRC/CRM Correlation Model for Credit Default and Migration |
| ~~5~~ | ~~Tao, C. and J. Kim~~ | ~~2017~~ | ~~Integrated VaR and Stress Testing (iVAST) Risk Capital Methodology~~ |
| 6 | Citigroup | 2017 | Facility Risk Rating (FRR) Model for Margin Financing |
| 7 | Citigroup | 2018 | Multi-factor CCAR Trading and Counter-party Credit Risk Incremental Default Loss (IDL) |
| ~~8~~ | ~~Citigroup~~ | ~~2018a~~ | ~~ICG Trading Risk Capital Allocation – a Proposal~~ |
| ~~9~~ | ~~Monet, C. and W Zhu~~ | ~~2018~~ | ~~TCE Forecasting and iVAST Issues~~ |
| ~~10~~ | ~~Citigroup~~ | ~~2018b~~ | ~~iVAST Methodology: Integrated VaR and Stress Testing~~ |
| ~~11~~ | ~~Citigroup~~ | ~~2018c~~ | ~~Two-beta Allocation of Trading Capital (iVAST)~~ |
| 12 | Citigroup | 2018 | Economic Risk Capital Model for SFT’s |
| 13 | Citigroup | 2018 | Stress Scenarios for Risk Capital – Applicable to Trading Risk Models |
| 14 | Citigroup | 2019a | Risk Capital Framework - Overview |
| 15 | Citigroup | 2019b | Risk Capital Methodologies - Overview |
| 16 | Citigroup | 2019c | Six-factor IRC/CRM Correlation Model |
| ~~17~~ | ~~Wang, H.~~ | ~~2019~~ | ~~Integrated VaR and Stress Testing (iVAST) Risk Capital Methodology – Annual Model Review~~ |
| ~~18~~ | ~~Tai, C~~ | ~~2019~~ | ~~iVAST Ongoing Monitoring Report~~ |
| ~~19~~ | ~~He C~~ | ~~2019~~ | ~~iVAST GoC Implementation~~ |
| ~~20~~ | ~~Citigroup~~ | ~~2019d~~ | ~~iVAST Data Flow~~ |
| ~~21~~ | ~~Alvarado C~~ | ~~2019~~ | ~~iVAST Business Hierarchy~~ |
| ~~22~~ | Citigroup | 2019e | Market Risk Exposure Specification |
| ~~23~~ | ~~Cvengros D~~ | ~~2019a~~ | ~~Asset Liability Matching Model - 1~~ |
| ~~24~~ | ~~Cvengros D~~ | ~~2019b~~ | ~~Asset Liability Matching Model - 2~~ |
| ~~25~~ | ~~Li X., Zhu, W., and Zeng, C.~~ | ~~2019~~ | ~~Limitations of 1F Vasicek Model~~ |

|  |  |  |  |
| --- | --- | --- | --- |
| **2021 Build Count** | | | |
| ~~1~~ | ~~Kruskal, J.~~ | ~~1956~~ | ~~Kruskal’s Algorithm~~ |
| ~~2~~ | ~~Prim, R.~~ | ~~1957~~ | ~~Prim’s Algorithm~~ |
| ~~3~~ | ~~Tadonki, C. and P. Vial~~ | ~~2004~~ | ~~Portfolio selection with cardinality and bound constraints~~ |
| 4 | Bonami, P., Biegler, L. T., Conn, A. R., Cornuejols, G., Grossmann, I. E., Laird, C. D., Lee, J., Lodi, A., Margot, F., Swaya, N., and Wachter, A. | 2006 | An Algorithmic Framework for Convex Mixed Integer Non-linear Programs |
| ~~5~~ | ~~Berthold~~ | ~~2014a~~ | ~~Heuristic Algorithms in Global MINLP Solvers - Abstract~~ |
| 6 | Berthold | 2014b | Heuristic Algorithms in Global MINLP Solvers - Concepts |
| ~~7~~ | ~~Citigroup~~ | ~~2017~~ | ~~BHC Market Risk Volcker Hierarchy~~ |
| ~~8~~ | ~~Xiong, L.~~ | ~~2017~~ | ~~Incremental Default Risk for CVA Economic Risk Capital~~ |
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