Bibliography on stable distributions, processes and related topics

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The following sections are a start on organizing references on stable distributions by topic. It is far from complete. Starting on page 20 there is an extensive list of papers on stable distributions, many of which are not included in the first section. Some of the papers there do not directly refer to stable distributions. Someday I may have the time to edit those out, but for now please ignore those references. This list includes a bibliography file provided by Gena Samorodnitsky from Cornell University.

I would like to keep this list correct and up-to-date. If you have corrections or additions, please e-mail them to me at the above address, and suggest where to place your references in one of the sections below. A sentence or two summarizing the content would be useful. Please provide all references in BibTeX form, especially if you have more than one or two additions. (See `http://en.wikipedia.org/wiki/BibTeX` for basic information on BibTeX.) Please send a copy of your papers along.

Contents

1 Univariate stable distributions

1.1 General references

The first chapter of Nolan (2018b) is available online as "An introduction to stable distributions" at: `academic2.american.edu/~jpnolan/stable/stable.html`. Chapter 9 of Breiman (1992) gives a clear exposition of univariate stable laws. More detail can be found in Ibragimov and Linnik (1971), Zolotarev (1986b), Uchaikin and Zolotarev (1999), Samorodnitsky and Taqqu (1994b), Nikias and Shao (1995).

1.2 Computations of stable densities, cdf, simulation, etc.

Worsdale (1975), Panton (1992), Nolan (1997), Nolan (1999a), Robinson (2003a), Robinson (2003b), Robinson (2003c), Matsui and Takemura (2004), Matsui (2005), Chekhmenok (2003), Cheng and Liu (1997), Wang and Zhang (2008), Liang and Chen (2013), Julián-Moreno et al. (2017), Boyarchenko and Levendorskiĭ (2018).

Special cases (generally α a rational number): Fox (1961), Mitra (1981), Mitra (1982), Schneider (1986), Hoffmann-Jørgensen (1994), Zolotarev (1995), Chekhmenok (2003), Penson and Górska (2010), Górska and Penson (2011).

The standard method for simulating univariate stable terms is Chambers et al. (1976); the formula is stated in the introductory chapter mentioned in Section 1.1. The original paper does not give a proof of the method, but focuses on the computational steps, and uses the 0-parameterization (the M parametrization of Zolotarev).

Fractional and truncated moments: Hardin (1984), Paolella (2007), Pinelis (2011), Matsui and Pawlas (2013), Nolan (2018c).

1.3 Generalized Central Limit Theorem and Domains of Attraction

de Haan and Peng (1999), Geluk and de Haan (2000), Geluk and Peng (2000), de Haan et al. (2002)

Central pre-limit theorem: Klebanov et al. (1999), Klebanov et al. (2000), Klebanov et al. (2006).

Fuchs et al. (2001) state a different criteria for being in the domain of attraction of a positive stable distribution ($\alpha < 1$, $\beta = 1$)

Rates of convergence to a stable law: Cramér (1962), Cramér (1963), Hall (1981b), Christoph and Wolf (1992), de Haan and Peng (1999), Kuske and Keller (2001), Rachev (1991), Bobkov et al. (2011), and Bobkov. et al. (2012).

Generalized central limit theorem with dependent terms. For infinite variance summands with normal limit: Bradley (1988), Jakubowski and Kobus (1989), Peligrad (1990), Bradley (1992), Berkes and Philipp (1998), Shao (1993).

For infinite variance summands with non-normal stable limit: Davis (1983), Denker and Jakubowski (1989), Jakubowski (1991), Jakubowski (1993), Dabrowski and Jakubowski (1994), Louhichi and Soulier (2002), Bartkiewicz et al. (2011), Basrak et al. (2012).

1.4 Statistical estimation, diagnostics, assessing fit, hypothesis testing

Estimation of parameters: Nolan (2001a), McCulloch (1986), Nikias and Shao (1995), Tsihrintzis and Nikias (1996), Nolan (1998b), Nolan (1999b), Ojeda (2001), Beaulieu et al. (2005), Dufour and Kurz-Kim (2005), Garcia et al. (2011), Fan (2006a), Brcich et al. (2005), Ferguson (1978), Copas (1975), Haas et al. (1970), Meintanis (2007), Höpfner (1998), Höpfner and Rüschendorf (1999), SenGupta and Roy (2001), Nolan (2019a), Matsui and Takemura (2008a), Kharrat and Boshnakov (2015), Yanushkevichiene and Saenko (2013), Saenko (2016), Barker (2014), Basu and Pakrashi (2018), Meraghni and Soltane (2019), Fahs and Abou-Faycal (2018)

Calculation of Fisher information matrix for MLE of stable parameters: DuMouchel (1973a), Nolan (2001a), Matsui and Takemura (2004), Barker (2015).

Empirical characteristic function methods: Koutrouvelis (1980), Koutrouvelis (1981), Csorgo (1981), Feuerverger and Mureika (1977), Feuerverger and McDunnough (1981b), Feuerverger and McDunnough (1981a), Kogon and Williams (1998), Yu (2004), Besbeas and Morgan (2008), Bibalan et al. (2017), Kateregga et al. (2017), Zhang (2018)

Approximate maximum likelihood estimation Bee and Trapin (2018).

Minimum distance estimator of α: Hu et al. (2014)

L-estimators: Zhang (2010).

Bayesian MCMC approach Buckle (1993), Buckle (1995), Godsill (1999), Godsill and Kuruoğlu (1999), Godsill (1999), Godsill (2000), Kuruoğlu (2001), Lombardi and Godsill (2006a), Lombardi (2007a), Peters et al. (2012), Howlader and Weiss (1988), Tsionas (1999), Tsionas (2000), Tsionas (2013), Bernardi and Casarin (2008), Güner et al. (2010), Riabiz et al. (2015), Lemke and Godsill (2012), Lemke and Godsill (2014), Lemke (2014), Lemke and Godsill (2015), Lemke et al. (2015), Achcar et al. (2013), Vankov et al. (2019)

General information on assessing fit D'Agostino and Stephens (1986), Frain (2007b), Frain (2009), Matsui and Takemura (2008a), Kallenberg et al. (1985), McCulloch and Percy (2013), Paolella (2015), Santana et al. (2015), de Sousa and Michailidis (2004), Gel et al. (2007), Nolan (2016b). Heyde and Kou (2004) emphasizes the problems in determining tail decay rate, and shows that in general it will take very large data sets to distinguish exponential decay from power law decay. Histogram bin width selection Scott (1979)

Goodness-of-fit tests: Saniga and Hayya (1977), Borak et al. (2005), González-Estrada and nor Alva (2010), Yang (2012), Beaulieu et al. (2014), Teimouri et al. (2015), Santana et al. (2015), Rizzo and Székely (2016), Meintanis (2016), Zhang (2018)

Empirical process model with estimated parameters: Section 4.2 of del Barrio et al. (2007)

Tail estimation: Hill (1975), McCulloch (1997), Paulauskas (2003), Paulauskas and Vaiciulis (2011), Resnick and Stărică (1995), Resnick and Stărică (1997), Marohn (1999).

Empirical likelihood: Kunitomo and Owada (2006).

Wavelet based: Antoniadis et al. (2006).

Estimation of concentration data Benson et al. (2001), Rishmawi (2005), Chakraborty et al. (2009).

Comparison of estimators: Akgiray and Lamoureux (1989), Höpfner and Rüschendorf (1999), Ojeda (2001), Nolan (2018b).

1.5 Miscellaneous univariate stable

Characterization problems: Yanushkevichius and Yanushkevichiene (2007)

Law of iterated logarithm for stable summands: Chover (1966), Breiman (1968a), Mijnheer (1972), Pakshirajan and Vasudeva (1977), Qi and Cheng (1996).

Analytic properties of stable laws: Zolotarev (1986b), Gawronski (1984) (mistake in proof, see following), Simon (2011a).

Unimodality: Ibragimov and Chernin (1959) (mistake, see following), Kanter (1976a), Yamazato (1978), Wolfe (1978a), Wolfe (1978b), Wolfe (1981), Hall (1984), Gawronski (1984) (mistake in proof, see Simon (2015)), Gawronski (1988), Gawronski and Wiessner (1992), Simon (2011a), Simon (2011b), Simon (2012), Simon (2014),Simon (2015), Dharmadhikari and Joag-Dev (1988).

Functions of stable random variables: Otiniano et al. (2013), Rathie et al. (2016), Davis et al. (2018).

Cauchy combination test: Liu and Xie (2018)

2 Application areas

2.1 Engineering

The standard models of signal processing are based on Gaussian noise. While this works well in many problems, this assumption is not accurate in some situations where there is impulsive, heavy-tailed noise. In such situations, linear Gaussian filters perform poorly. Using methods based on stable models gives robust non-linear signal processing methods.

General books: Nikias and Shao (1995), Arce (2005), Sheng et al. (2012)

General: Kuruoglu (1998), Der (2003), Lowen and Teich (1990), Ma and Nikias (1995), Pierce (1997), Tsakalides and Nikias (1995), Keshner (1982), Tsihrintzis and Nikias (1996), Ma and Nikias (1995), Kuruoglu and Fitzgerald (1998), Kuruoglu et al. (1998), Astola and Neuvo (1992), Kuruoglu et al. (1997), Kuruoglu et al. (1998), Kosko (2006), Gonzalez et al. (2006), Kalluri and Arce (1998) Ilow et al. (1998), Ilow (1995), Ilow (1998), Ilow (1999), Ilow and Hatzinakos (1997), Ilow and Hatzinakos (1998), Núñez et al. (2008), Nolan (2008), Gonzalez et al. (1997), Gonzalez and Nolan (2007), Wang et al. (2009b), Liu et al. (2008), Zha and Qiu (2007), Tsihrintzis and Nikias (1995), Zimmermann and Dostert (2002), Rupi et al. (2004), Rupi et al. (2000), Legg et al. (2007), Legg (2010), Mahmood and Chitre (2015), Talebi et al. (2018), Shongwe et al. (2015)

Stuck (2000) gives an overview of early work on stable laws in signal processing. See also: Mertz (1965), Stuck (1976a), Stuck (1976b), Stuck (1978), and Newman and Stuck (1979).

The following papers apply stable distributions to biomedical signals: Pander (2003), Pander (2004), Pander (2006), Pander (2010), Pander and Przybyła (2012), Pander et al. (2012).

See also Ghannudi et al. (2007), Azzaoui and Clavier (2007), Azzaoui et al. (2003), Win et al. (2009), Ghannudi et al. (2010), Azzaoui and Clavier (2010).

Bhaskar et al. (2008), Bhaskar et al. (2010), Mihaylova et al. (2005), Nolan et al. (2010).

Chen et al. (2017), Chen et al. (2016), Kuruoglu and Wang (2016), Karakuş et al. (2018), Wang et al. (2018).

Generalizations of the Kalman filter: Stuck (1978), Balakrishna and Hareesh (2009), Le Breton and Musiela (1993), Sornette and Ide (2001), Gordon et al. (2003), Tzagkarakis and Tsakalides (2009), Idan and Speyer (2010), Idan and Speyer (2012) , Idan and Speyer (2013)

Particle filters: Gençağa et al. (2008), Li et al. (2017), Cortés-Aburto et al. (2018)

Compressive sampling: Ramirez et al. (2010), Arce et al. (2010), Otero and Arce (2011a), Li et al. (2007), Tzagkarakis and Tsakalides (2009), Tzagkarakis et al. (2017), Tzagkarakis et al. (2019), Tzagkarakis et al. (2018), Lopes (2016), Zhou and Yu (2017), Carrillo et al. (2016), Liu et al. (2019)

2.1.1 Radar processing

Banerjee et al. (1999), Kapoor et al. (1999), Achim et al. (2002), Achim et al. (2003), Amiri and Amindavar (2005), Belkacemi and Marcosa (2007), Messali and Soltani (2007), Tsakalides and Nikias (1999), Tsakalides et al. (1999), Tsakalides et al. (2000), Pierce (1996), Lee (1999), Kuruoglu and Zerubia (2004), Farina et al. (1997)

2.1.2 Image processing

Carassso (2002), Carassso (2006), Kuruoglu and Zerubia (2003), Arce (2005), Nava-Tudela (2017), Boccignone and Ferraro (2013), Karine (2014)

2.1.3 Telecommunications

Land lines: Stuck and Kleiner (1974), Mertz (1965). Cell phones: Yang and Petropulu (2001b), Gonzalez (1997), Aysal (2007), Georgiadis (2000), Georgiadis (2001), Georgiadis (2005), Rabbachin et al. (2011), Jaoua et al. (2014), Li et al. (2019), Barazideh et al. (2019)

Vehicle-to-vehicle communication Bazzi et al. (2019)

2.1.4 Acoustics (including sonar and ultrasound)

Kidmose (2001), Kidmose (2002), Chitre et al. (2006), Chitre et al. (2004), Chitre et al. (2005), Chitre et al. (2007), Zha and Qiu (2006a), Zha and Qiu (2006b), Kyriakakis et al. (1999), Petropulu et al. (1996), Peterson et al. (2003), Georgiou et al. (1999), Achim et al. (2001), Taroudakis et al. (2006), Petropulu et al. (1996). Fialkowski et al. (2004), Fialkowski and Gauss (2010), Pelekanakis et al. (2018), Zhidkov (2018b)

Frequency dependent lossy media: Szabo (1994), Kelly and McGough (2007), Kelly et al. (2008), Kelly (2008), Chen and Holm (2003), Zhao and McGough (2016), Pereyra and Batatia (2012). For multivariate isotropic stable laws, see Nolan (2013).

2.1.5 Network modeling

Erramilli et al. (1996), Leland et al. (1994), Parulekar and Makowski (1996), Paxson and Floyd (1994), Willinger et al. (1997), Souryal et al. (2003), Wolpert and Taqqu (2005), Mikosch et al. (2002), Beran et al. (1995), Petropulu et al. (2000), Yang and Petropulu (2001a), Yang and Petropulu (2003), Yu et al. (2005), Cappé et al. (2002), Muñoz-Rodriguez et al. (2006), Simmross-Wattenberg et al. (2008).

Clauset et al. (2009), Virkar and Clauset (2014), Broido and Clauset (2018).

2.1.6 Queueing theory

Heath et al. (1997), Heath et al. (1998), Heath et al. (1999), Volume 33 of Queueing Systems (1999). Boxma and Dumas (1996), Resnick and Samorodnitsky (1997b), Resnick and Samorodnitsky (2001), Resnick and Samorodnitsky (1997a), Szczotka and Woyczyński (2004), Szczotka and Woyczyński (2003)

2.1.7 ICA/blind source separation and PCA

Kidmose (2001), Kidmose (2002), Sahmoudi et al. (2004), Wang et al. (2009b), Alparslan et al. (2016), Magron et al. (2017)

Kriegel et al. (2008), Candés et al. (2010), Chenouri et al. (2014), Haug et al. (2013), Pad and Unser (2015), Leglaive et al. (2017).

2.1.8 Miscellaneous engineering applications

Kosko and Mitaim (2001) and Kosko (2006) show that stochastic resonance also occurs with heavy tailed stable noise. See also Yilmaz and Savaci (2015).

Jeske and Chakravartty (2006) examine clock synchronization in the presence of heavy tailed noise.

Ayenu-Prah and Attoh-Okine (2009) find heavy tailed fluctuations in the study of road surfaces.

Li and Yu (2010) and Yu et al. (2013) use stable laws to model vibration data in industrial roller bearings. Further work on this topic in Wodecki et al. (2016), Zak et al. (2016), Xu and Liu (2019)

2.2 Finance, Economics, Value at Risk, Real Estate, Insurance

The main motivation for considering stable laws in finance is that empirical returns have heavier tails than the normal/Gaussian model predicts. And stable laws allow one to model cumulative returns using the stability of sums: if $X_1, X_2, \ldots, X_n$ are returns over one period with an α-stable distribution, then the cumulative return over n time periods $X_1 + X_2 + \cdots + X_n$ also has an α-stable distribution. This is true if the terms are independent or dependent stable, but is not true for other models of returns.

2.2.1 Modeling asset returns

Rachev and Mittnik (2000), Nolan (2003), Mandelbrot (1960), Mandelbrot (1961), Mandelbrot (1963b), Fama (1963), Fama (1965), Fama and Roll (1968), Rachev (2003), McCulloch (1996a), McCulloch (1997), Bidarkota and McCulloch (1998), Peters (1994), Walter (1999), Belkacem et al. (2000), Haas et al. (2005), Lombardi and Calzolari (2005), Ortobelli and Rachev (2005), Borak et al. (2005), Martin et al. (2006), Frain (2007a), Frain (2009), Stuck (1976c), Leitch and Paulson (1975), Kozubowski et al. (2003), Dominicy et al. (2010), Hardy (2003), Carr et al. (2002), Kaplan (2010) and Kaplan (2012). Wright (2007) quotes Leslie Rahl, founder of Capital Market Risk Advisors, "We seem to have a once-in-a-lifetime crisis every three of four years."

Bidarkota (1999), Bidarkota (2000), Bidarkota (2001), Bidarkota (2003), Bidarkota and McCulloch (2003), Bidarkota and McCulloch (2004), Kiani and Bidarkota (2004), Bidarkota (2004), Bidarkota and Dupoyet (2007b), Bidarkota and Dupoyet (2007a), Bidarkota et al. (2009), Wang and Bidarkota (2010), Wang and Bidarkota (2012).

Salhi et al. (2015), Champagnat et al. (2013), Cont (2001), Fries (2018), Gouriéroux and Zakoïan (2017)

VaR for Mexican equities: Serrano and Mata (2019)

Morningstar Encorr Analyzer now includes the ability to model returns with a stable distribution.

Extension of CAPM to include stable laws, portfolio selection: Fama (1971), Fama and Miller (1972), Press (1982), Rachev et al. (2005), section 17.4 of Uchaikin and Zolotarev (1999), Bawa et al. (1979), Rachev and Han (2000), Ortobelli et al. (2002a), Ortobelli et al. (2004), Stoyanov et al. (2006).

Jama (2009) looks at returns on the South African exchange. The works by Cont and Tankov (2004), Tankov (2007), Kallsen and Tankov (2006) use Lévy processes to model returns, arguing that jumps are an important part of the behavior of actual returns that cannot be captured by a Gaussian model. A probability book with an emphasis on computational issues and finance, which includes a chapter on stable distributions, is Paolella (2007).

stable GARCH Bonato (2011), Broda et al. (2013)

CDOs Scherer and Prange (2009)

Energy markets: Pantalone et al. (2016)

Predicting crashes: Bielinskyi et al. (2019)

2.2.2 Option pricing

McCulloch (1996a), Carr and Wu (2003), Cartea and Howison (2003), Cartea and Howison (2007), Vollert (2001), Hurst et al. (1999), Hauksson and Rachev (2001).

2.2.3 Value at risk

Khindanova et al. (2001), Lamantia et al. (2006), Sy (2006), Marinelli et al. (2006), Frain (2008), Frain (2009).

2.2.4 Foreign exchange/parallel market rates

Basterfield et al. (2003), Basterfield et al. (2005a), Basterfield et al. (2005b), Fofack and Nolan (2001), Lan and Tan (2007), Zhao and Wu (2009).

2.2.5 Real estate

King and Young (1994), Young and Graff (1995), Graff et al. (1997), Brown (2000), Brown (2004), Brown (2005),Young et al. (2006), Young (2008). The first paper above argues that because of the non-normality of real estate prices, diversification is not a good idea (unless you have a huge portfolio); careful management of property is more important.

2.2.6 Insurance

Asmussen et al. (1997), Embrechts et al. (1997)

2.2.7 Commodity price modeling

Commodity pricing Weron (2005), Jin (2005), Weron (2006)

2.2.8 Miscellaneous econ/finance

De Vany and Walls (1999), De Vany and Walls (2004a) De Vany (2003), and Walls (2005) argue that the extreme volatility in Hollywood movie revenues can be modeled with stable laws. De Vany (2006) uses truncated stable laws to model home runs in baseball. Also De Vany and Walls (2004b), De Vany and Walls (1996)

Lau and Lau (1993), Lau and Lau (1997), Fielitz and Rozelle (1983)

Ibragimov (2005) discusses consequences of heavy tails for economic models.

Farmer and Geanakoplos (2005) and Gabaix (2009) review the occurrence of power laws in economics and finance.

Li and Ma (2013) discuss a stable Cox-Ingersoll-Ross model for interest rates.

Copulas: Prange and Scherer (2006), Kallsen and Tankov (2006), Mikosch (2006).

Computational issues: Rachev (2004)

Discussion of the work of Nobel prize winners Thomas Sargent and Christopher Sims Boumans and Sent (2013).

2.3 Extreme value theory

Fougéres et al. (2009) build models for multivariate dependent extreme value distributions using multiplicative mixtures with stable models. More information in Fougères et al. (2013).

2.4 Computer science

Long computation times: Harchol-Balter et al. (1998), Harchol-Balter (1999), Gomes and Selman (1999), Harchol-Balter (2013)

Streams and sketches, etc.: Indyk (2000), Cormode et al. (2002), Gilbert et al. (2002), Cormode (2003), Cormode and Muthukrishnan (2003), Cormode and Indyk (2006), Nelson (2011).

Machine learning and α-stable graphical models: Misra and Kuruoglu (2014), Misra and Kuruoglu (2016).

Anomaly detection: Simmross-Wattenberg et al. (2011), S. Mercan (2011), Simmross-Wattenberg et al. (2015), Bollmann et al. (2018).

Feature modeling: Fiche et al. (2013).

Chapter 14 of Yang (2018) uses Lévy flights in random search algorithms.

Using stable laws as mutation operators in evolutionary algorithms: Obuchowicz and Pretki (2005), Obuchowicz and Smolka (2016), Obuchowicz and Prkobuchetki (2004), Obuchowicz (2019).

2.5 Random walks

Borovkov and Borovkov (2008) gives an exhaustive treatment of random walks when the distribution of step sizes is heavy tailed.

There have been several papers using Lévy flights to describe foraging behavior for different animals, see Viswanathan et al. (1996) and Viswanathan et al. (1999), Reynolds and Frye (2007). However, more recent work points out some errors in the data used in these papers and questions the relevancy of heavy tailed models for foraging, see Edwards et al. (2007) and Travis (2007). Marine foraging Humphries et al. (2010) and Viswanathan (2010).g See also Ali Ahmed et al. (2018) and Mutwiri et al. (2019). Scaling laws in human travel Brockmann et al. (2006), Raichlen et al. (2013). Statistical issues in Kawai and Petrovskii (2012).

2.6 Random walks in random environments

In random environments: Kesten et al. (1975), Mayer-Wolf et al. (2004), Hughes et al. (1981), Hughes (1995), Hughes (1996).

2.7 Branching processes

Jagers (1975), Dawson et al. (1989), Dawson and Perkins (1991), Vakolbinger and Vatutin (1998), Haynatzki et al. (2000), Fleischmann and Mytnik (2003), Birkner et al. (2005), Bojdecki et al. (2007), Chen and Shiozawa (2007), Berestycki et al. (2007), Croydon and Kumagai (2008), Basdevant and Singh (2008), Bojdecki et al. (2008), Pakes (2010)

2.8 Fractional/anomalous diffusions

Stable densities give the Greens functions for certain fractional differential equations. Solomon et al. (1994), Gorenflo and Mainardi (1998a), Mainardi et al. (2001), Gorenflo et al. (2007), Gorenflo et al. (2002a), Paradisi et al. (2001), Gorenflo and Mainardi (2001), Gorenflo et al. (2002b), Mainardi et al. (2006), Mainardi and Tomirotti (1997), Gorenflo et al. (1999), Gorenflo and Mainardi (1998b), Meerschaert et al. (2002), Ditlevsen (2004), Cushman and Moroni (2001), Moroni and Cushman (2001), Cushman et al. (2005), Roop (2006), Mainardi et al. (2007), Meerschaert and Sikorskii (2012), Uchaikin (2013a),Uchaikin (2013b),Uchaikin and Sibatov (2013), Gottwald and Melbourne (2016), Berman and Cederbaum (2018), Odzijewicz et al. (2013)

2.9 Dynamical systems, ergodic theory, stochastic recurrence equations

Gouëzel (2004), Gouëzel (2007), Guivarc'h and Le Page (2008), Zweimüller (2003)

Stochastic recurrence equations: Kesten (1973), Mikosch et al. (2012).

2.10 Physics, astronomy and chemistry

Montroll and Shlesinger (1982), Metzler and Klafter (2000), Liu and Chen (1994), Strobl (1997), Boldyrev and Gwinn (2003), Bendler (1984), Freeman and Chisham (2005), Metzler and Klafter (2002), Metzler et al. (2007), Csörgő et al. (2004a), Csörgő et al. (2004b),Csörgő et al. (2005), Novák (2006a),Csorgo et al. (2006), Novák et al. (2007), Novák (2006b), Csörgő et al. (2008),Novak (2008), Novák et al. (2009), Peach (1981), Hetman et al. (2003), Lan (2001), Shlesinger (2001), Lan (2002), Metzler et al. (2014), Tommaasi et al. (2016), Bulyak and Shul'ga (2019)

Fluctuation flux for plasma in a controlled fusion experiment are modeled by a stable law in Yanushkevichiene and Saenko (2013).

The Kohlraush-Williams-Watts function - relaxed exponentials: Kohlrausch (1847), Williams and Watts (1970), Montroll and Bendler (1984), Shlesinger and Montroll (1984), Anderssen et al. (2004), Elton (2018). For multivariate isotropic stable laws, see Nolan (2013).

Anomalous diffusion: Ott et al. (1990), ben Avraham and Havlin (2000), Vlahos et al. (2008), Bouchaud and Georges (1990).

Laser cooling of atoms: Bardou et al. (2002)

Random lasers: Lin et al. (2018), Uppu and Mujumdar (2014)

Lévy glass Barthelemy et al. (2008), Janzen et al. (2010) and Janzen et al. (2010).

The Landau distribution is used in physics to describe the fluctuations in the energy loss of a charged particle passing through a thin layer of matter. This distribution is a special case of the stable distribution with parameters $\alpha = 1$, and $\beta = 1$. It was originally discussed in Landau (1944), more information is in Leo (1994).

Polymer kinetics: Herrchen (2001).

Out-of-equilibrium systems: Campi and Bianconi (2019)

Turbulence: Kida (1991).

Superconductivity: Augello et al. (2010) and Valenti et al. (2014) give a computational analysis of the phase dynamics of short and long Josephson junctions in the presence of non-Gaussian (Lévy) noise sources (Resonant Activation, Noise Enhanced Stability and Soliton dynamics). Guarcello et al. (2016) analyze phase dynamics, i.e., focus on solitons, in long Josephson junctions, as a Lévy noise source is taken into account. Guarcello et al. (2017) study the effects of the Lévy noise on the switching currents of graphene-based Josephson junctions. See also Gattenlöhner et al. (2016) and Briskot et al. (2014)

Dattoli et al. (2014) use stable laws to describe photoluminescence decay of silicon nanocrystals.

Metrology: Douglas (2007), Hunt et al. (1995), Verdi (2014)

2.11 Survival analysis, frailty, reliability

A clear introduction to the concept of fraility is Wienke (2003). The use of stable distributions in this way started with Hougaard (1986). More references and applications in Hougaard (2000), Singpurwalla (1995), Wassell et al. (1999), Qiou et al. (1999), Ravishanker and Dey (2000), Gjessing et al. (2003), Mallick and Ravishankaer (2004), Gaver et al. (2004), Hanagal (2011).

2.12 Embedding of Banach spaces

Johnson and Schechtman (1982), Ledoux and Talagrand (1991), Friedland and Guédon (2011).

2.13 Geology and Geophysics

Tukey (1965) wrote "In general, as I am sure almost every geophysicist knows, distributions of actual errors and fluctuations have much more straggling extreme values than would correspond to the magic bell-shaped distribution of

Gauss and Laplace." Painter et al. (1995), Gaynor et al. (2000), Painter (2001), Gunning (2002), Velis (2003), Molz et al. (2004), Sahimi and Tajer (2005). Marcus (1970), Li and Mustard (2000), Li and Mustard (2005), Rishmawi (2005), Zaliapin et al. (2005), Meerschaert et al. (2004), Hill and Tiedeman (2007)

Earthquake modeling: Lavallée and Archuleta (2003)

Magnetotelluric data: Chave (2014), Chave (2017).

2.14 Medicine, biology, genetics

West (1999), Salas-Gonzalez et al. (2009d), Crato et al. (2011).

Modeling cancer dynamics Durrett et al. (2011), Durrett (2013).

Sorace (2012) describes a long-tailed distribution of disease combinations in the U.S. Medicare system. In this setting, the idea it more of sparsity: rather than prominent clusters of combinations of diseases, there are many, many combinations of different illnesses that occur. This argues that the costs of medical care cannot be significantly lessened by focusing on a few common clusters of diseases.

Sassi (2009) uses stable laws to study heart beat rates. See also Lan and Toda (2013).

Lan and Chandran (2011) model fluctuations in animal population sizes. Segura et al. (2013) model fluctuations in microbial populations with log-stable distributions. They find heavy tails in the logarithms of ratios of successive population sizes. Harmful algae blooms can result when large fluctuations occur. Batt et al. (2017) discuss heavy tails and extreme events in ecosystem time series.

Saenko and Saenko (2015) propose using stable laws to model gene expression data.

Van den Heuvel et al. (2018) and Van den Heuvel et al. (2015) use stable laws to model proton beams in cancer treatment.

Di Gioacchino et al. (2019) uses stable laws to describe myelin protein dynamics.

Forest fires Malamud et al. (1998)

Nanopore modeling: Kotulska (2007).

2.15 Random trees

Duquesne and Le Gall (2002) relate random trees with nodes having offspring distribution that is heavy tailed. Beta-coalescents and continuous stable random trees Berestycki et al. (2007), Berestycki (2009).

2.16 Rainfall, hydrology, climatology

Modeling rainfall: Lovejoy (1982), Lovejoy and Mandelbrot (1985), Lovejoy and Schertzer (1986b), Gupta and Waymire (1990), Menabde and Sivapalan (2000), Millán et al. (2011), Gomi and Kuzuha (2013)

Hydrology: Guadagnini et al. (2013), Guadagnini et al. (2014), Guadagnini et al. (2015), Nan (2014), Nan et al. (2016), Zhang et al. (2018)

Climatology: Lavallée and Beltrami (2004)

2.17 Miscellaneous: reliability, etc.

Reliability testing: Gaver et al. (2004).

Wrapped stable: SenGupta (1996), Jammalamadaka and SenGupta (2001), SenGupta and Pal (2001), Gatto and Jammalamadaka (2003), Pewsey (2008)

Tuerlinckx (2004) uses a positive stable law to model a multivariate counting model for response times in psychology.

Heinrich (1987) considers sums of ψ-mixing random variables and a connection with continued fractions. See also Hensley (2000), Finch (2007) and Heinrich et al. (2004), where a connection to rounding errors is made.

Farsad et al. (2016), Farsad et al. (2015), Farsad et al. (2018) use stable laws to model time synchronization in molecular timing channels.

2.18 Long tails in business, political science, etc.

These references are about extreme events, generally not situations where there is a numeric value that is being measured. There is not a direct probability distribution involved, but the idea of unusual/atypical occurrences can be important.

Anderson (2006) discusses the "Long Tail" occurring in sales, where many low volume items can account for significant revenue. The best known example of this is Amazon.com, where the lack of brick-and-mortar stores make it feasible to sell low volume goods on a large scale. Brynjolfsson et al. (2006) also discuss this.

King and Zeng (2001) discuss measuring rare events in international relations. The first author has a webpage on rare events at `http://gking.harvard.edu/category/research-interests/methods/rare-events`.

Bremmer and Keat (2009) write about the fat tail in political and economic events. They do not measure a quantitative variable, rather they write about typical events that cluster around some center and occasionally there is an extreme event, like the 1998 financial crisis in Russia or the September 11, 2001 terrorists attacks on the U.S. These are bulges/bumps far from the normal events that happen. They argue that one should be thinking about these possible risky events.

3 Multivariate stable distributions

3.1 General references

Samorodnitsky and Taqqu (1994b), overview Nolan (1998a)

Existence of spectral measures: Feldheim (1937), Lévy (1954), Courrège (1964)

3.2 Multivariate stable densities, cdf, simulation, etc.

Nolan and Rajput (1995), Abdul-Hamid (1996), Abdul-Hamid and Nolan (1998), Nolan (2005), Matsui and Takemura (2008b), Nolan (2013), Nolan (2018a), Nolan (2018d).

For exact simulation, see Modarres and Nolan (1994) for discrete spectral measures. Can also simulate radially symmetric and elliptically contoured using sub-Gaussianity, this is used in Nolan (2005). Sub-stable vectors can be simulated in the same way. And sums of any of the above are stable.

Approximating by sums: Davydov and Nagaev (2002a), Davydov and Nagaev (2002b). Approximating by a sum of Poisson and Brownian terms: Asmussen and Rosiński (2001), Cohen and Rosiński (2007), Cohen et al. (2010).

Tail behavior of multivariate stable densities: Hiraba (2003), Arkhipov (2003), Nagaev (2007), Watanabe (2007)

Support of stable and semi-stable laws: Port and Vitale (1988), Ashbaugh et al. (1992), Rajput (1993), Rajput (1994), Rajput et al. (1994), Rajput (1977b).

3.3 Multivariate estimation

Rachev and Xin (1993), Cheng and Rachev (1995), Nolan et al. (2001), Nolan and Panorska (1997), Pivato and Seco (2003), Nolan (2005), Davydov and Paulauskas (1999b), Liu (2009), Ogata (2010), Nolan (2013), Mohammadi et al. (2014), Sathe and Upadhye (2019).

3.4 Conditional distributions and moments

Hardin (1982a), Cambanis and Wu (1992), Cioczek-Georges and Taqqu (1994a), Cioczek-Georges and Taqqu (1995a), Hardin et al. (1991a), Hardin et al. (1991b), Samorodnitsky and Taqqu (1994b), Gouriéroux and Zakoïan (2017), Fries (2018).

3.5 Dependence measures

Press (1972c), Paulauskas (1976), Cambanis and Miller (1981), Chapter 4 of Samorodnitsky and Taqqu (1994b), summary and proposed measures in Nolan (2001b), Boland et al. (2000), Levy. and Taqqu (2005), Samorodnitsky and Taqqu (1993), Mohammadpour et al. (2006), d'Estampes et al. (2002), Garel et al. (2004), Garel and Kodia (2009), Garel and Massé (2009), Garel and Kodia (2010), Alparslan and Nolan (2016)

General tests for independence using the empirical distribution function: Hoeffding (1948), Blum et al. (1961). Tests using the characteristic function: Csörgő (1985), Székely et al. (2007), Székely and Rizzo (2009).

3.6 Approximation and metrics

Byczkowski et al. (1993), Rachev (1991), Davydov and Paulauskas (1999b), Davydov and Nagaev (2002b), Nolan (2010)

3.7 Miscellaneous multivariate stable

Substable: Misiewicz and Takenaka (2002)

Sums of dependent heavy tailed random variables: Basrak et al. (2011), Bartkiewicz et al. (2011), Tyran-Kamińska (2010a,b,c).

Concentration of measure: Ledoux (2001), Houdré and Marchal (2004), Marchal (2005), Houdré et al. (2008), Houdré and Marchal (2008)

4 Regression, time series, etc.

4.1 Regression

Barmi and Nelson (1997), McCulloch (1998a), Ojeda (2001), Nolan and Ojeda-Revah (2013), LePage et al. (1998), LePage and Podgórski (1996), Kurz-Kim et al. (2005), Paulauskas and Rachev (2003), Blattberg and Sargent (1971), Walls (2005), Preve (2015), Liu and Preve (2016), Riabiz et al. (2017a), Riabiz et al. (2017b), Jensen (2018).

Walls and McKenzie (2019) uses stable regression to analyze movie revenues using covariates and Rodriguez-Aguilar et al. (2019) predict Mexican electricity prices using regression.

Vector autoregression: Hannsgen (2008) discusses whether there are heavy tailed distributions involved in structural VAR used for policy analysis. The presence of infinite variance makes the use of structural VAR questionable. A revision of this paper is available in Hannsgen (2012).

4.2 Time series

Cline and Brockwell (1985), Davis and Resnick (1986b), Durbin and Cordero (1993), Mikosch et al. (1995), Part II of Adler et al. (1998), Calder (1998), Qiou and Ravishanker (1998), Nolan and Ravishanker (2009), Resnick et al. (1999), Resnick et al. (2000a), Section 13.3 of Brockwell and Davis (1991), Andrews et al. (2009), Sousa et al. (2014), Kruczek et al. (2017), Riabiz and Godsill (2017), Riabiz et al. (2018), Lombardi and Godsill (2006b), Lemke and Godsill (2012), Lemke and Godsill (2014), Lemke et al. (2015), Godsill and Kuruoğlu (1999), Godsill (1999).

5 Stable processes

5.1 General references

Samorodnitsky and Taqqu (1994b), Janicki and Weron (1994)

5.2 Stochastic integrals, series, minimal representations

LePage et al. (1981), Hardin (1982b), Samorodnitsky and Taqqu (1990c), Rosiński (1990b), Kwapień and Woyczyński (1992), Rosiński (1992), Samorodnitsky and

Taqqu (1994b), Rosiński (1995), Rosiński (1995), Al-Khach (1997), Roy (2010)

Riabiz and Godsill (2017), Riabiz et al. (2017), Riabiz et al. (2018), Riabiz et al. (2017b), Riabiz et al. (2017a), Lemke and Godsill (2011), Lemke (2014), Lemke et al. (2015).

5.3 Path properties

Blumenthal and Getoor (1960), Rosiński (1986), Rosiński (1989), Nolan (1988), Nolan (1989a), Nolan (1989b), Cambanis et al. (1990), Nolan (1991), Rosiński et al. (1991), Rosiński and Samorodnitsky (1993), Samorodnitsky (1988), Samorodnitsky (1993b), Adler (1990), Port (1990)

Hitting times: Blumenthal et al. (1961)

Laws of the iterated logarithm: Breiman (1968b), Mijnheer (1975), Oodaira (1973), Albin (1992), Dehling and Taqqu (1989b), Kôno (1983b), Monrad and Rootzén (1995), Taqqu (1977), Taqqu and Czado (1985b).

Level crossings. Gaussian case: Marcus (1977), Marcus and Shen (1997), Slud (1991), Slud (1992b), Slud (1992a). Stable case: Adler et al. (1993), Adler and Samorodnitsky (1997), Marcus (1989), Michna and Rychlik (1992a), Michna and Rychlik (1992b), Marcus and Shen (1998).

Maxima/extremes: Heyde (1969), Aleškevičienė (1990), Berman (1992), Molchan (2000), Samorodnitsky (2004b), Samorodnitsky (2004a), Kuznetsov (2011).

5.4 Prediction

Cambanis and Soltani (1984), Cline and Brockwell (1985), Miamee and Pourahmadi (1988), Brockwell and Davis (1991), Kokoszka (1996), Mohammadi and Mohammadpour (2009)

5.5 Miscellaneous stable processes

Self-similarity: there are several disjoint classes of self-similar stable processes. See Chapter 7 of Samorodnitsky and Taqqu (1994b). Beran (1986). A general review is Taqqu (1986a), Doukhan et al. (2003).

Long memory/long-range dependence: Taqqu (1986a), Beran (1992), Doukhan et al. (2003), Samorodnitsky (2006a)

Local nondeterminism and local times: Berman (1973), Berman (1974), Cuzick (1978), Cuzick (1987), Berman (1983), Berman (1987), Monrad and Pitt (1987), Berman (1991), Nolan (1989b), Soltani (1992), Shieh (1991), Shieh (1992), Xu (1995), Khoshnevisan et al. (2006), Xiao (2006a), Ayache and Xiao (2016)

Potential theory: Doob (1953), Blumenthal and Getoor (1968), Doob (1984), Jakubowski (2002)

Ergodicity/mixing: Janicki and Weron (1994), Rosiński and Samorodnitsky (1996), Rosiński and Zak (1997)

Ornstein-Uhlenbeck processes: expressions for joint distribution by Wooster (2009)

Connections between continuous and discrete processes: Lee (2009).

6 Stable measures on vector spaces and groups

Hazod and Siebert (2001), Linde (1984), Linde (1986), Linde et al. (1980), Lewandowski et al. (1992), Lewandowski et al. (1995), Lewandowski and Żak (1987), Zak (1984), Zak (1989), Ryznar (1986).

7 Related distributions and processes, extensions of the notion of stability

Tempered stable distributions: Rosiński (2004), Terdik and Woyczyński (2006), Houdré and Kawai (2006), Houdré and Kawai (2007), Cohen and Rosiński (2007), Jurek (2007), Rosiński (2007), Grabchak (2008), Grabchak and Samorodnitsky (2010), Grabchak (2012), Kawai and Masu (2011), Dassios et al. (2018), Fallahgoul and Loeper (2019)

Geometric stable laws: Rachev and SenGupta (1991), Rachev and SenGupta (1993), Panorska (1996), Kozubowski (1994), Kozubowski (1995), Kozubowski and Rachev (1994),

Laplace distributions: Kotz et al. (2001)

Operator stable laws: if the scaling term a_n in the definition of joint stability is replaced by a matrix A_n, then a larger class of multivariate distributions results. One simple case is if the matrix is diagonal, say A_n =diag($n^{-1/\alpha_1}, n^{-1/\alpha_2}, \ldots, n^{-1/\alpha_d}$) with the joint distribution having independent components with the j-th coordinate being an α_j-stable r.v. These are called *marginally stable* laws. The general case is more complicated, see Jurek and Mason (1993), Cambanis and Taraporevala (1995), Meerschaert and Scheffler (2001a). Two dimensional case: Michaliček (1972b), Michaliček (1972a).

Weakly stable vectors Mazurkiewicz (2007).

α-symmetric multivariate distributions of Cambanis et al. (1983), see Fang et al. (1990).

Tsilevich and Vershik (1999) consider $\alpha = 0$.

Davydov et al. (2007) and Davydov et al. (2008) have defined a general notion of stability on a cone K with some operation $+$, that generalizes sum stability and includes max-stability, min-stability, and more.

α-symmetric distributions: Cambanis et al. (1983), Chapter 7 of Fang et al. (1990).

Discrete stable laws: caused by digitization and truncation in signal processing, see Lee et al. (2005). Discrete distributions with some sort of stability property: Steutel and Van Harn (2004), Klebanov and Slámová (2012), Slámová and Klebanova (2012). Multivariate discrete stable distributions: Rao and Shanbhag (1994), pg. 160.

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