Joint and conditional distributions

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Summary

The joint distribution of extreme hazards, such as rain, wind, and surge, tells us the probability that they are all large as well as the distribution of one given the others. This session defines joint and conditional distributions in two and then N dimensions, and then asks how to estimate one from data, using kernel density estimates, Bayesian networks, and copulas as examples.

For helpful background, explore:

- J. K. Blitzstein and J. Hwang [1] §7.1, pp. 304-323, on joint, marginal, and conditional distributions, and §5.3, pp. 224-230, on the probability integral transform.
- J. Friedman, T. Hastie, and R. Tibshirani [2] §6.6.1, pp. 208-210, on kernel density estimation.
- A. Sebastian, E. J. C. Dupuits, and O. Morales-Nápoles [3] §2, pp. 43-44, for a short introduction to Bayesian networks.
- C. Genest and A.-C. Favre [4], pp. 347-353, on copulas.

Bibliography

[1] J. K. Blitzstein and J. Hwang, *Introduction to Probability, Second Edition*, 2nd Edition. Boca Raton: Chapman and Hall/CRC, 2019. [Online]. Available: http://probabilitybook.net/

[2] J. Friedman, T. Hastie, and R. Tibshirani, *The Elements of Statistical Learning*, vol. 1. Springer series in statistics Springer, Berlin, 2009.

[3] A. Sebastian, E. J. C. Dupuits, and O. Morales-Nápoles, "Applying a Bayesian Network Based on Gaussian Copulas to Model the Hydraulic Boundary Conditions for Hurricane Flood Risk Analysis in a Coastal Watershed," *Coastal Engineering*, vol. 125, pp. 42–50, Jul. 2017, doi: 10.1016/j.coastaleng.2017.03.008.

[4] C. Genest and A.-C. Favre, "Everything You Always Wanted to Know about Copula Modeling but Were Afraid to Ask," *Journal of Hydrologic Engineering*, vol. 12, no. 4, pp. 347–368, 2007, doi: 10.1061/(ASCE)1084-0699(2007)12:4(347).