Chair of Aerodynamics and Fluid Mechanics
Department of Mechanical Engineering
Technical University of Munich

Probabilistic Programming for Scientific Discovery

Lecture 2

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Lviv Data Science Summer School

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Practical Introduction to a Probabilistic Programming Framework

Extending the ideas to a more complex examples

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Stan [1]

Overview

- General overview of the purpose behind Stan

[1] Carpenter, B., Gelman, A., Hoffman, M.D., Lee, D., Goodrich, B., Betancourt, M., Brubaker, M., Guo, J., Li, P. and Riddell, A., 2017. Stan: A probabilistic programming language. Journal of statistical software, 76(1).

Stan

Syntax

- Example code to get a grasp for the syntax

Stan

Application Performance

- Example applications

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Venture [2]

Overview

- General overview of the purpose behind venture

[2] Mansinghka, V., Selsam, D. and Perov, Y., 2014. Venture: a higher-order probabilistic programming platform with programmable inference. arXiv preprint arXiv:1404.0099.

Venture

Syntax

- Example code to get a gauge for the syntax

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Venture

Application Performance

- Application performance

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Anglican [3]

Overview

- General overview of the purpose behind Anglican

[3] Tolpin, D., van de Meent, J.W., Yang, H. and Wood, F., 2016, August. Design and implementation of probabilistic programming language anglican. In Proceedings of the 28th Symposium on the Implementation and Application of Functional programming Languages (pp. 1-12).

Anglican

Syntax

- Example code

Anglican

Application Performance

- Application performance

PyMC3 [4]

Overview

- General overview of the purpose behind PcMC3

[4] Salvatier, J., Wiecki, T.V. and Fonnesbeck, C., 2016. Probabilistic programming in Python using PyMC3. PeerJ Computer Science, 2, p.e55.

PyMC3

Syntax

- Example code

PyMC3

Application Performance

- Application performance

TensorFlow Probability [5]

Overview

- General overview of the purpose behind Tensorflow Probability

[5] Dillon, J.V., Langmore, I., Tran, D., Brevdo, E., Vasudevan, S., Moore, D., Patton, B., Alemi, A., Hoffman, M. and Saurous, R.A., 2017. Tensorflow distributions. arXiv preprint arXiv:1711.10604.

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TensorFlow Probability

Syntax

- Example code

TensorFlow Probability

Application Performance

- Application performance

Pyro [6] & NumPyro [7]

Overview

- General overview of the purpose behind Pyro & NumPyro

[6] Bingham, E., Chen, J.P., Jankowiak, M., Obermeyer, F., Pradhan, N., Karaletsos, T., Singh, R., Szerlip, P., Horsfall, P. and Goodman, N.D., 2019. Pyro: Deep universal probabilistic programming. The Journal of Machine Learning Research, 20(1), pp.973-978.

[7] Phan, D., Pradhan, N. and Jankowiak, M., 2019. Composable effects for flexible and accelerated probabilistic programming in NumPyro. arXiv preprint arXiv:1912.11554.

Pyro & NumPyro

Syntax

- Example code of Pyro & NumPyro

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Pyro & NumPyro

Application Performance

- Application performance

Edward2 [8]

Overview

- General overview of the purpose behind Edward2

[8] Tran, D., Hoffman, M.W., Moore, D., Suter, C., Vasudevan, S. and Radul, A., 2018. Simple, distributed, and accelerated probabilistic programming. In Advances in Neural Information Processing Systems (pp. 7598-7609).

Edward2

Syntax

- Example code of Edward2

Edward2

Application Performance

- Application performance

Gen [9]

Overview

- General overview of the purpose behind Gen

[9] Cusumano-Towner, M.F., Saad, F.A., Lew, A.K. and Mansinghka, V.K., 2019, June. Gen: a general-purpose probabilistic programming system with programmable inference. In Proceedings of the 40th ACM SIGPLAN Conference on Programming Language Design and Implementation (pp. 221-236).

Gen

Syntax

- Example code of Gen

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Gen

Application Performance

- Application performance

PyProb [10]

Overview

- General overview of the purpose behind PyProb

[10] Baydin, A.G., Shao, L., Bhimji, W., Heinrich, L., Naderiparizi, S., Munk, A., Liu, J., Gram-Hansen, B., Louppe, G., Meadows, L. and Torr, P., 2019. Efficient probabilistic inference in the quest for physics beyond the standard model. In Advances in neural information processing systems (pp. 5459-5472).

PyProb

Syntax

- Example code of PyProb

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PyProb

Application Performance

- Application performance

Turing [11]

Overview

- General overview of the purpose behind Turing

[11] Ge, H., Xu, K. and Ghahramani, Z., 2018, March. Turing: A Language for Flexible Probabilistic Inference. In International Conference on Artificial Intelligence and Statistics (pp. 1682-1690).

Turing

Syntax

- Example code of Turing

Application performance

- Application performance

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Probabilistic Programming Frameworks

Summary

- Summary of all probabilistic programming frameworks in a single table

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