Fried Chicken Bucket Processes

Mary McGlohon
Machine Learning Department
Carnegie Mellon University
mcglohon@cmu.edu

Keywords: Stochastic processes, graphical models, hierarchical models

Abstract

Chinese restaurant processes are useful hierarchical models; however, they make certain assumptions on finiteness that may not be appropriate for modeling some phenomena. Therefore, we introduce fried chicken bucket processes (FCBP) that involve different sampling methods. We also introduce spork notation as a simple way of representing this model.

1 Introduction

Chinese restaurant processes and Indian buffet processes are useful in a number of domains for statistical modeling. This work introduces a new model, the Fried chicken bucket process, and presents spork notation, a useful representation for FCBP's and other graphical models.

To the author's knowledge this is the first restaurant-related model that samples from continuous distributions in addition to discrete ones.

2 Related work

It is useful to describe work that has inspired this paper.

2.1 Chinese restaurant processes

The Chinese restaurant process (CRP) is a stochastic process that produces a distribution on partitions of integers [1]. To visualize, one imagines a Chinese restaurant with an infinite number of tables. Customers arrive one at a time. As each arrives, he decides which table to sit at based on the following distribution similar to a Dirichlet distribution:

$$p(Table_i|n) = \frac{n(i)}{\gamma + n - 1}$$

$$p(NewTable|n) = \frac{\gamma}{\gamma + n - 1}$$

where n is the number of previous customers and $n(i)$ is the number seated at table i.

This may be extended into hierarchies such as the customers also choosing from an infinite number of Chinese restaurants [2]. This process also inspired Griffiths and Ghahramani to describe the Indian buffet process for infinite latent feature models, as shown in [5] and applied again by Thibaux and Jordan in [6].

2.2 Plate notation

In high dimensional problems, representation comes in the form of very large graphical models with many nodes. Formerly researchers simply had their graduate students draw all the nodes. Then, in 1994, Buntine introduced plate notation [3], which drastically reduced the work required to draw a graphical model, and has made it possible for today's machine learning graduate students to focus their efforts on maintaining statistics-related entries on Wikipedia. The plate notation simply groups together nodes that are duplicated– that is, have the same interior-exterior links. An example, flips of a thumb tack, is shown in Figure 1.

3 Fried Chicken Bucket Processes

3.1 Description of model

On the top level, one imagines a fried chicken restaurant with a chicken generating function (cgf): that is, a distribution of chicken parts from which the

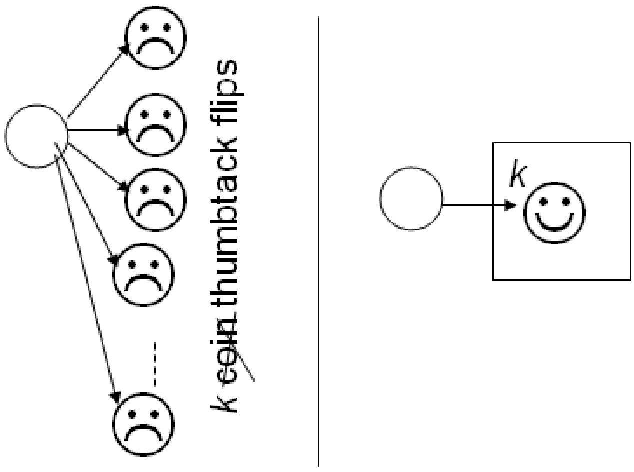

Figure 1: *A graphical model without plate notation (left) and with plate notation (right).*

buckets are made. The restaurant also serves homogeneous okra, coleslaw, or other side dishes which may be treated as continuous.

A family orders a n-piece bucket of fried chicken, which begins the next level. From the cgf, n pieces of fried chicken are drawn, making a much coarser distribution of chicken parts. The family also takes sides. Once the family drives home and spreads dinner on the table, each of k family members chooses chicken pieces from the bucket. Draws are random to avoid squabbles, and the distribution is obviously without replacement[1]. After chicken is drawn, each family member chooses a continuous amount of side dishes. It is well known that the fried chicken runs out while there are often leftover side dishes; therefore for this model we assume that coleslaw and okra are infinite as well as continuous. However, the amount of these dishes may be conditional on the discrete pieces of chicken that were drawn from the bucket, as paper plates have finite capacity.

[1]Sampling with replacement would be unsanitary.

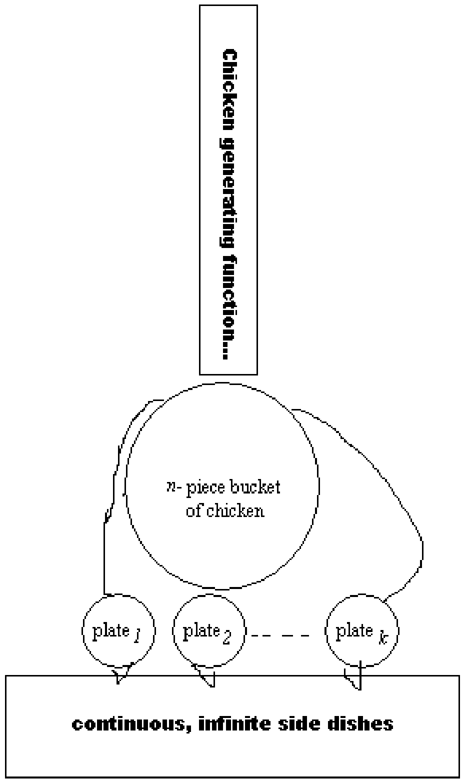

Figure 2: *A FCBP in spork notation.*

3.2 Illustration of model

We can best illustrate the FCBP using a piece of hardware related to the fried chicken bucket: the spork. The cfg (suggested through the handle of the spork) generates the bucket in the reservoir of the spoonlike part. From the bucket, the plates result (prongs), which then "pick" items from the continuous and infinite side dishes. This is shown in Figure 2.

We propose that spork notation be used for any process where a discrete sampling influences a subsequent continuous sampling.

3.3 Instances of model

For theatrical purposes one may choose to specify the cgf. The most obvious choice is a multinomial distribution, with one p_i for each chicken part that may go into the bucket, where $\sum_i p_i = 1$. For example, we might choose $(p_{leg} = .3, p_{breast} = .39, p_{wing} = .3, p_{beak} = .01)$.

4 Applications of FCBP

Many phenomena may be modeled as an interaction between a discrete sampling that influences the way in which a continuous sampling behaves. One may think of mixture models in this fashion; the prongs of the spork may be considered k classes from which different continuous distributions of variables may result. This is significant because mixture models and the methods are sometimes difficult to grasp, and machine learning concepts are easier to understand when they are presented using culinary examples [4].

5 Future Work

It would be desired to extend FCBP's to yet another hierarchy. For instance, one might imagine a strip mall, college campus, or region of a country with an infinite number of fast food stands and allow mixing proportions on a family's dinner table. This, and other further applications of FCBP are left as an exercise to the reader.

6 Conclusion

Machine learning researchers need to stop having meetings when they're hungry.

References

[1] D. J. Aldous. Exchangeability and related topics. *École 'e' té de probabilités de Saint-Flour XIII-1983. Lecture Notes in Mathematics*, 1117.

[2] D. Blei, T. Gri, M. Jordan, and J. Tenenbaum. Hierarchical topic models and the nested chinese restaurant process, 2004.

[3] W. L. Buntine. Operations for learning with graphical models. *Journal of Artificial Intelligence Research*, 2:159–225, 1994.

[4] K. El-Arini. Pizza delivery processes. In *Machine learning office conversations*, 2006.

[5] T. Griffiths and Z. Ghahramani. Infinite latent feature models and the indian buffet process, 2005.

[6] R. Thibaux and M. I. Jordan. Hierarchical beta processes and the indian buffet process. Technical report, University of California, Berkeley.