L173 Pre-reading response for session 6

D.J. Wischik

Read *Conditional neural processes*, Garnelo et al. 2018. Write a short response, about half a page pdf, answering these questions. LLM usage is permitted.

1. Consider a Bayesian linear regression $Y_i \sim \alpha + \beta x_i + N(0, \sigma_0^2)$ with a Gaussian prior on (α, β) and where σ_0 is known. We have data $\mathcal{O} = [(x_1, y_1), \ldots, (x_n, y_n)]$ and we want to generate values Y_a, Y_b at two new coordinates x_a, x_b. Here are two ways to do this: (i) generate (Y_a, Y_b) jointly given $\mathcal{O}$, or (ii) generate Y_a given $\mathcal{O}$, then generate Y_b given $\mathcal{O}$ with (x_a, Y_a) appended. These two methods give the same distribution for (Y_a, Y_b); we say that the model generates *consistently*.

   Does the CNP of §2.2 generate consistently? Does the model in §4.2.3? If we replaced equations (1)–(3) by $\phi_* = g_\theta(x_*, \mathcal{O})$, where g_θ is a network that operates on sequences, would it?

2. The training objective (4) requires that we choose the conditioning set and the target coordinates. What does the paper say about how these are chosen, for the experiment in figure 2? Write out a version of the objective with every choice made explicit.

   Does your objective train the network to be good at interpolation or at extrapolation? If you wanted to improve its performance at extrapolation, what would you change and how would you evaluate whether you had succeeded? What is the Bayesian way to evaluate interpolation performance versus extrapolation performance, for the linear regression from question 1?

The questions are mostly about judgement, and ask you to read between the lines or think about the paper's unstated premise, or explain an argument that is implied rather than directly stated. You get the marks for interpretation and engaging critically with the paper, not for simply repeating what it says.

Be concrete. For example, point to a specific passage, equation, or figure, say why it matters and what it does. Answer from the paper and the course; facts brought in from elsewhere earn no marks, however true. Engaging critically means setting the paper against the course, not against the later literature.