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Praktikum 4, Monte Carlo
Math modeling of the atmosphere

Importance sampling

Apply importance sampling to the autoconversion integral that you have studied previously. The function to integrate, $f(\chi, N_c)$, is a function of χ, which is related to cloud water mixing ratio, and N_c, which is the cloud droplet number. The PDF, $P(\chi, N_c)$, is a normal-lognormal; it is given by Eqns. (31) and (32) in Larson and Griffin (2013), *except* that you should include N_{cn} in the denominator of the prefactor.

1. Exponential tilting. As the importance function q, choose a normal-lognormal PDF, like $P(\chi, N_c)$, but with more favorable values of the means $\overline{\chi}$ and $\overline{N_c}$. Experiment with pairs of mean values until you find a pair that produces reduced noise.

2. Compute the effective sample size, n_e, and compare it to the number of sample points, N. Is $n_e << N$?

3. Combine exponential tilting with the control variate that you tried previously. Does the combination reduce the noise?

4. Defensive importance sampling. As the importance function q_α, choose the exponential tilting importance function, q, plus P itself: $q_\alpha = \alpha_1 P + \alpha_2 q$. Experiment with different values of α_1, and different values of the parameters in q. Can you find values that improve upon standard importance sampling?

5. Compute the effective sample size for defensive sampling, n_e, and compare it to the number of sample points, N. How does n_e compare to that from regular importance sampling.

6. Combine defensive sampling with the control variate that you tried previously. Does the combination reduce the noise?