Turbulent Flows
Stephen B. Pope
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Solution to Exercise 3.36

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According to the central-limit theorem, the distribution of the sample mean value tends to a Gaussian distribution for a large number of independent samples N. The confidence interval can then be computed as follows:

$$\left[\langle U\rangle_N - z_{(1-\alpha/2)}\frac{\sigma_U}{\sqrt{N}}, \langle U\rangle_N + z_{(1-\alpha/2)}\frac{\sigma_U}{\sqrt{N}}\right], \tag{1}$$

where $z_{(1-\alpha/2)}$ is the $(1-\alpha/2)$ quantile of standard normal distribution. In terms of the 95% confidence interval ($\alpha = 0.05$) the corresponding quantile yields

$$z_{0.975} = 1.96, \tag{2}$$

giving a confidence interval of

$$\begin{aligned} &\left[11.24\tfrac{m}{s} - 1.96\tfrac{2.5m/s}{\sqrt{1000}}, 11.24\tfrac{m}{s} + 1.96\tfrac{2.5m/s}{\sqrt{1000}}\right] \\ = &\left[11.085\tfrac{m}{s}, 11.395\tfrac{m}{s}\right]. \end{aligned} \tag{3}$$

With confidence of 95% the true mean $\langle U\rangle$ lies in the interval between $11.085m/s$ and $11.395m/s$.