SLIM ML4Seismic

Controlled injection rates

k=3

Compute *controlled* injection rates

- for $N = 128$ samples of $\mathbf{K} \sim p(\mathbf{K})$ and $\mathbf{x}_3 \sim p(\mathbf{x}_3 \,|\, \bar{\mathbf{y}}_3^{\mathrm{o}})$

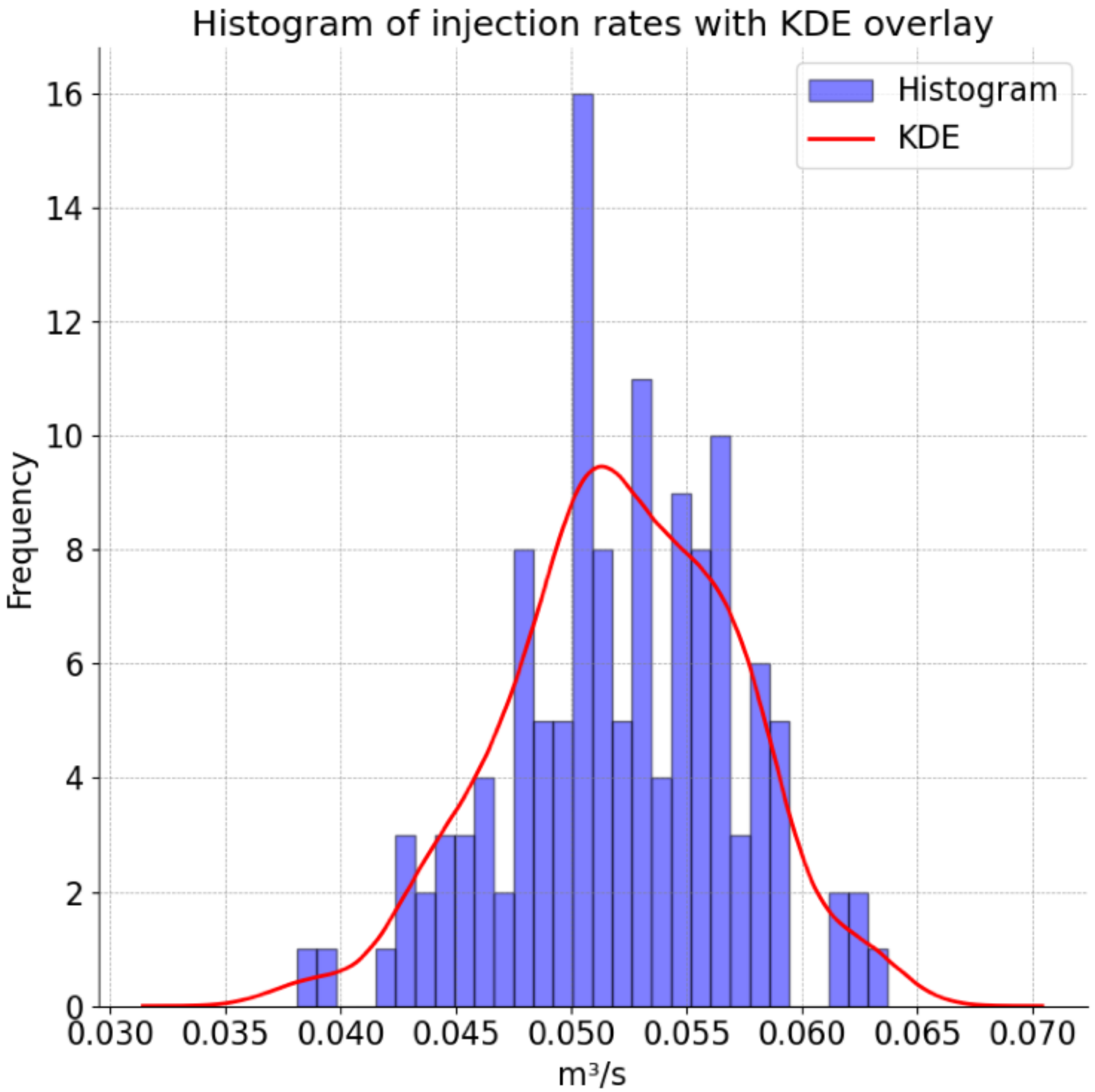
- *by* finding injectivities, q_3, that *maximize* the total CO_2 injected volume while ***not*** *exceeding* the *fracture* pressure via

$$\max_{q_3} q_3 \Delta t \quad \text{subject to} \quad \mathbf{x}_4['p'] < \mathbf{p}_{\max}$$

$$\mathbf{x}_4 = \mathscr{M}_3(\mathbf{x}_3, \mathbf{K}; q_3)$$

- use Gaussian kernel density estimation

- approximate the probability density function of the *controlled* injection rates



q_3

https://en.wikipedia.org/wiki/Bernoulli_distribution

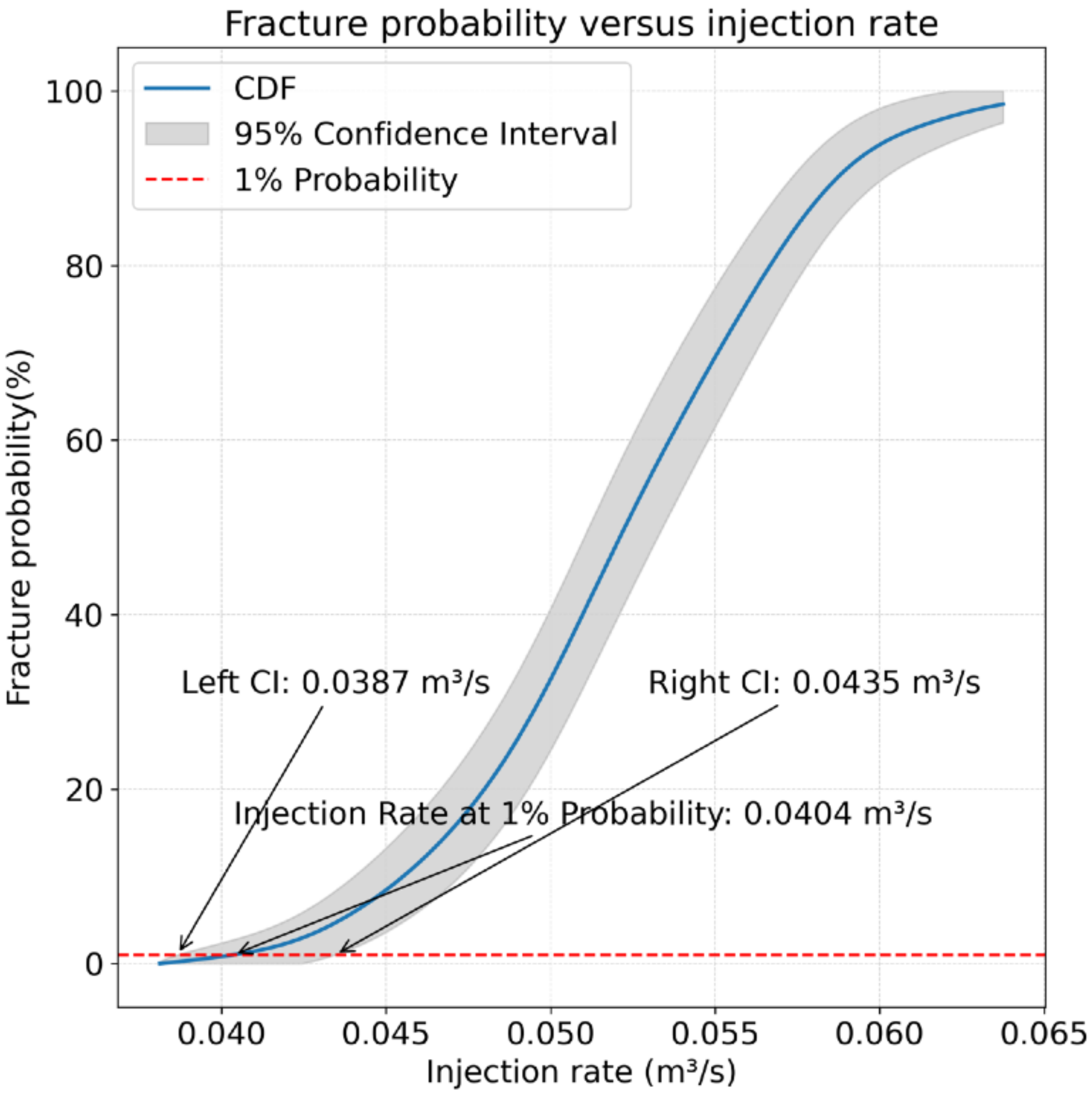
Injection rate
under uncertainty

Integrate the KDE to obtain cumulative distribution function

Assumption: non-fracture/fracture follows *Bernoulli* distribution (“toss a coin”)

For injection rate q_3:

- MLE of fracture probability $\hat{p}(q_3) = \mathrm{CDF}(q_3)$
- confidence interval $= \hat{p} \pm Z_{\frac{\alpha}{2}}\sqrt{\dfrac{\hat{p}(1-\hat{p})}{N}}$
- for 95% ($\alpha = 0.05$) confidence interval, $Z_{\frac{\alpha}{2}} = 1.96$



q_3