On Bin Centering

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Where to stick your data points, Lafferty and Wyatt

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NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH
Section A

Where to stick your data points: The treatment of measurements within wide bins

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Definitions

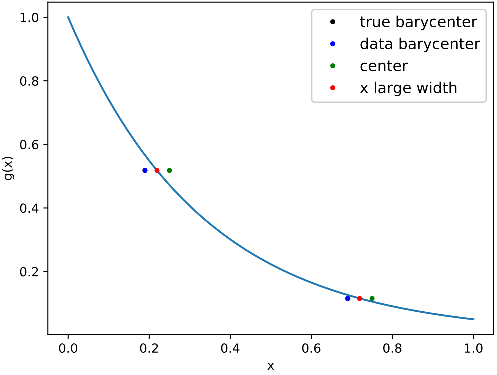
$$g_{\text{meas}} = n_{\text{meas}}/\Delta x$$

$$\langle g_{\text{meas}} \rangle = \frac{1}{\Delta x} \int_{x_1}^{x_2} g(x) dx$$

- x_1 = left bin-edge
- x_2 = right bin-edge
- $\Delta x = x_2 - x_1$
- $g(x)$ = true generating function

Not the middle of the bin!

$$x_c = x_1 + \Delta x/2$$

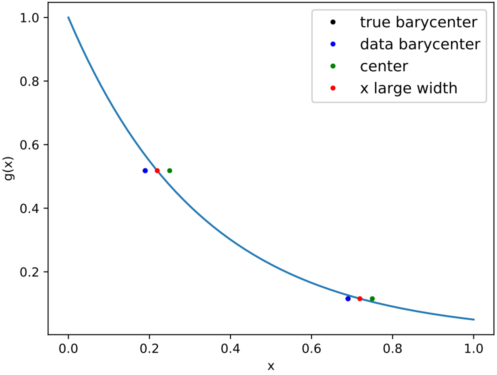


Not the barycenter!

$$\bar{x}_{\text{true}} = \frac{\int_{x_1}^{x_2} x g(x) dx}{\int_{x_1}^{x_2} g(x) dx}$$

$$\bar{x}_{\text{data}} = \frac{1}{N} \sum_{i=1}^{N} x_i$$

$$\lim_{N \to \infty} \bar{x}_{\text{data}} = \bar{x}_{\text{true}}$$



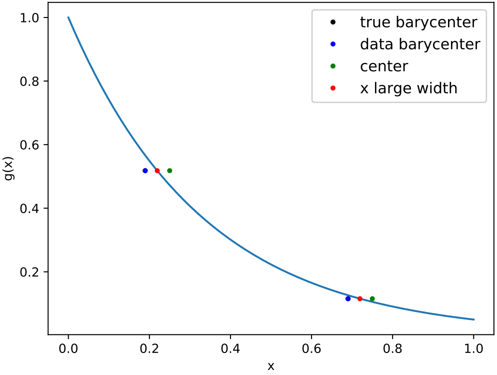
The answer:

$$g(x_{lw}) = \frac{1}{\Delta x}\int_{x_1}^{x_2} g(x)dx$$

$$x_{lw} = g^{-1}\left(\frac{1}{\Delta x}\int_{x_1}^{x_2} g(x)dx\right)$$

x_{lw} = *large width* (or *lafferty wyatt*) ordinate

- $g(x)$ must be known
- need $g^{-1}(x)$, analytically or numerically



Notes

- Opinion: No bin-centering correction to abscissa!
- Comparing data to model, should use *that model* to calculate x_{lw}
- If $g(x)$ is linear, then $x_{lw} = x_c = \bar{x}$

What about corrections?

- For bin-by-bin corrections in x, should we use x_{lw} or $\bar{x}$?
- Radiative Corrections:
  - Use x_{lw}, since it uses a model anyway
- Positron Subtraction:
  - Probably use x_{lw}? Need to pick a $g(x)$...
- Endcap Subtraction:
  - Probably use x_{lw}? Need to pick a $g(x)$...
- Hopefully has a very small effect on corrections

What about ratio measurement?

- What about our ratio results?
- Keep ratio as pure as possible!
- We measure $r(x)$ in an x-bin, not at an x-value
- Calculate $r_{\mathrm{meas}}(x)$ first, then decide on x
- For us, $g(x)$ and $h(x)$ should be pretty similar

$$r(x) = \frac{g(x)}{h(x)}$$

$$\langle r_{\mathrm{meas}} \rangle = r(x_{lw}) = \frac{\int_{x_1}^{x_2} g(x)dx}{\int_{x_1}^{x_2} h(x)dx}$$

Ratio toyMC example