Fitting – Global χ^2 Fitter (GX2F)

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Contents

Global χ^2 Fitter (GX2F)

General

- Least Square Fit like KF, GSF, CKF
- Global method $\rightarrow$ can overcome instabilities
- ATLAS offline reconstruction (Cornelissen et al., 2008)

Advantages

- Only needs estimate of track parameters, not errors
- Solves left/right ambiguities
- Scattering angles $\rightarrow$ alignment

Global χ^2 Fitter (GX2F) – Mathematics

Residuals r

$$r = m - H\vec{x}_0$$

m . . . measurments
$\vec{x}_0$ . . . starting track parameters
H . . . transport matrix

Chi2 χ^2

$$\chi^2 = r^T V_\alpha^{-1} r$$

V_α . . . covariance matrix of the track parameters

Update $\vec{x}_0 \to \vec{x}_1$ (and iterate)

$$\vec{x}_1 = \vec{x}_0 - \left(\frac{\partial^2 \chi^2}{\partial x^2}\right)^{-1} \frac{\partial \chi^2}{\partial x}$$

$$\frac{\partial \chi^2}{\partial x} = -2H^T V_\alpha^{-1} r$$

$$\frac{\partial^2 \chi^2}{\partial x^2} = 2H^T V_\alpha^{-1} H$$

Practice – Implementation

Update $\vec{x}_0 \rightarrow \vec{x}_1$ (and iterate)

$$\vec{x}_1 = \vec{x}_0 - \left(\frac{\partial^2 \chi^2}{\partial x^2}\right)^{-1} \frac{\partial \chi^2}{\partial x}$$

$$\frac{\partial \chi^2}{\partial x} = -2 H^T V_\alpha^{-1} r$$

$$\frac{\partial^2 \chi^2}{\partial x^2} = 2 H^T V_\alpha^{-1} H$$

```
const auto& deriv1 = -2 * Hi.transpose() * covInv * residuals;
const auto& deriv2 = 2 * Hi.transpose() * covInv * Hi;

BoundVector delta_start_parameters =
 c2r.collectorDeriv2Sum.colPivHouseholderQr().solve(
 c2r.collectorDeriv1Sum);
```

Practice – Structure

- Close to KF implementation, but
  - no smoothed state
  - no filtered sate
  - only predicted state
- Currently separated from other fitters (folder)

Future Steps of the Global χ^2 Fitter (GX2F)

- Finish implementation
- Add: multiple scattering
- Add: energy loss
- Testing, testing, testing, ...