Optimal parameter estimation problem for the vehicle dynamics. The optimization tries to find a set of model parameters, that best explain/reproduce the experiment data.

$$
\begin{aligned}
\underset{\boldsymbol{x}_k^j, \boldsymbol{p}}{\text{minimize}} \quad & \sum_{j=1}^{n_{experiments}} \sum_{k=1}^{n_{timesteps}} E(\boldsymbol{x}_k^j - \hat{\boldsymbol{x}}_k^j) \\
\text{subject to} \quad & \boldsymbol{x}_{k+1}^j = \boldsymbol{x}_k^j + \Delta t \cdot f(\boldsymbol{x}_k^j, \hat{\boldsymbol{u}}_k^j, \boldsymbol{p}) \\
& k = 1..(n_{timesteps} - 1) \\
& j = 1..n_{experiments}
\end{aligned}
$$

$\hat{\boldsymbol{x}}_k^j$	Measured States
$\hat{\boldsymbol{u}}_k^j$	Measured Inputs
f	Vehicle dynamics model
$\boldsymbol{p}$	Model parameters
Δt	Constant timestep $0.02s$
E	Error penalty function

Error penalty E: Weighted quadratic error with model specific extensions. The yaw error function has a period of 2π, so that a full rotation does not count as an error. This is done using $\sin(\Delta\psi/2)$.