



# Multiple View Geometry: Exercise Sheet 9

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## Part I: Theory

### 1. Robust Least Squares

- (a) What situations can you think of where a robust loss function might be needed?  
Missing (i.e. black or white) pixels in the image, dynamic changes of the scene, ...
- (b) Write down the weight function for the Huber loss.

$$w_{\delta}(t) = \begin{cases} 1 & |t| \leq \delta \\ \frac{\delta}{|t|} & \text{else} \end{cases}$$

### 2. Optimization Techniques

Write down the update step  $\Delta\xi$  for each of the following minimization methods:

- (a) Gradient descent, normal least squares,

$$\Delta\xi = -\lambda J^{\top} \mathbf{r}$$

- (b) Gradient descent, weighted least squares,

$$\Delta\xi = -\lambda J^{\top} W \mathbf{r}$$

- (c) Gauss-Newton, normal least squares,

$$\Delta\xi = -(J^{\top} J)^{-1} J^{\top} \mathbf{r}$$

- (d) Gauss-Newton, weighted least squares,

$$\Delta\xi = -(J^{\top} W J)^{-1} J^{\top} W \mathbf{r}$$

- (e) Levenberg-Marquardt, normal least squares,

$$\Delta\xi = -(J^{\top} J + \lambda \text{diag}(J^{\top} J))^{-1} J^{\top} \mathbf{r}$$

- (f) Levenberg-Marquardt, weighted least squares.

$$\Delta\xi = -(J^{\top} W J + \lambda \text{diag}(J^{\top} W J))^{-1} J^{\top} W \mathbf{r}$$