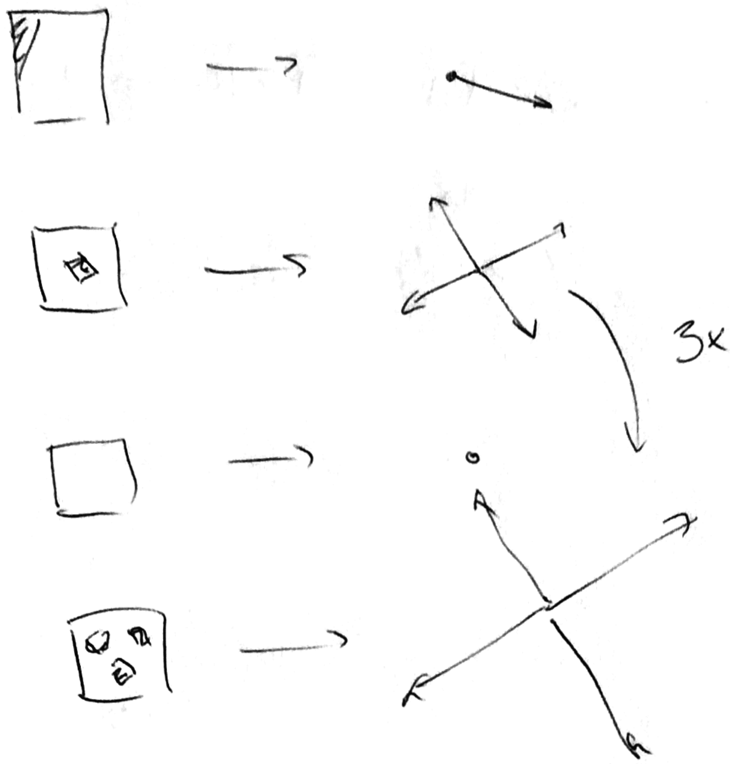
1a)



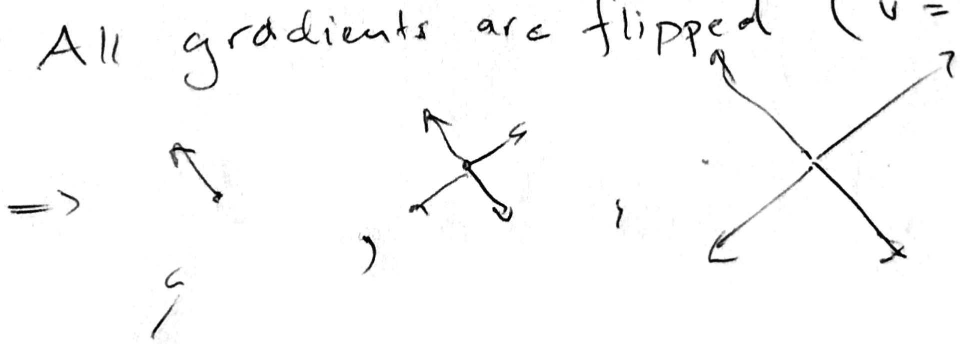
3x longer

A 32-vector that is normalized

b) All gradients get twice as long but after normalization there is no difference.

c) Adding a constant does not affect gradients

d) All gradients are flipped ($v = -v$)



only this one is changed.

2a) Case 1: Sample from S_1 is chosen

$$L_i = -\ln(p_1) \Rightarrow \frac{\partial L_i}{\partial w_1} = -\frac{1}{p_1} \cdot \frac{\partial p_1}{\partial y_1} \cdot \frac{\partial y_1}{\partial w_1}$$

$$\frac{\partial p_1}{\partial y_1} = p_1(1-p_1), \quad \frac{\partial y_1}{\partial w_1} = I, \quad \frac{\partial y_1}{\partial c_1} = 1$$

Update rule:

$$w_1^{(k+1)} = w_1^{(k)} + \mu(1-p_1) I$$

$$c_1^{(k+1)} = c_1^{(k)} + \mu(1-p_1)$$

Case 2: Sample from S_2 is chosen

$$L_i = -\ln(p_2) \Rightarrow \frac{\partial L_i}{\partial w_1} = -\frac{1}{p_2} \frac{\partial p_2}{\partial y_1} \cdot \frac{\partial y_1}{\partial w_1}$$

$$\frac{\partial p_2}{\partial y_1} = -p_1 p_2,$$

Update rule:

$$w_1^{(k+1)} = w_1^{(k)} - \mu p_1 I$$

$$c_1^{(k+1)} = c_1^{(k)} - \mu p_1$$

Case 3: as case 2.

2b) $10 \cdot (5 \cdot 5 \cdot 3 + 1) + 20(3 \cdot 3 \cdot 10 + 1) +$

$20(3 \cdot 3 \cdot 20 + 1) = 6200$

3a) See lab code.

b) The chance of picking five inlier meas is much smaller ⇒ It will take much longer to find a good solution.

4a) $\lambda u = PU \qquad \lambda > 0$

$\hat{\lambda}\hat{u} = \hat{P}U \qquad \hat{\lambda} > 0$

b) . . .

c) Almost certainly wrong

b) 2 views $\Rightarrow$ overdetermined so pretty certain.

c) Very good.

5a) Model 1:

Time per iteration: $1 + 0.01 \cdot 100 = 2$

Rate of outlier-free subsets ~~0.1^3~~ ~~0.1^3~~ ~~0.1^3~~

0.1^3

Model 2:

Time per iteration: $0.01 + 0.01 \cdot 100 = 1.01$

Rate of outlier-free subsets: 0.1^4

Model 2 is $\frac{1.01}{0.1^4} \Big/ \frac{2}{0.1^3} \approx 5$ times slower.

b) Change of variables $\Rightarrow$ edge point at $(0,0)$

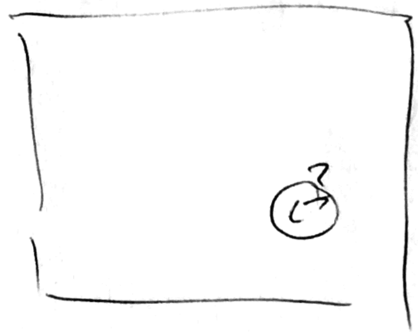
$M(x,y) \approx M(0,0) + (x,y)\nabla M + \frac{1}{2}(x,y)H\begin{pmatrix} x \\ y \end{pmatrix}$

Let $g = \begin{pmatrix} I'_x \\ I'_y \end{pmatrix} = \nabla I$. Set $\begin{pmatrix} x \\ y \end{pmatrix} = s \cdot g$

We get a 1D taylor expansion perp

to the edge. Solve for a local max.

6a)



Prob of a random inlier: $\frac{\pi \cdot 2^2}{1000^2} \approx 10^{-5}$

$97 \approx 100$ candidates $\Rightarrow n \approx 100$, $np \approx 10^{-3} = \lambda$

We get 3 inliers for free and

$e^{-0.001} \approx 1$

$$P(x=5) = \frac{(10^{-3})^5 \, e^{-0.001}}{5!} \approx 10^{-17}$$

b) ~~Another binomial dist. with~~

$P(x>5)$ is negligible compared to $P(x=5)$. $\Rightarrow$ binomial dist with

$n = 1000$ $p = 10^{-17} \Rightarrow \lambda = 10^{-14}$

$$P(x=1) \approx \frac{10^{-14} \, e^{-(10^{-17})}}{1!} \approx 10^{-14}$$

$P(x>1)$ is neglible

Ans: 10^{-14}