See presentations in the notes on

- Redundancy Numbers
- Inner Orientation GUI with L1-norm blunder detection

L1-norm

for single unknown $\Longleftrightarrow$ sample **median**

L2-norm

sample **mean**

3 obs. of 1 unknown

$$l_1 + v_1 = x$$
$$l_2 + v_2 = x$$
$$l_3 + v_3 = x$$

$n = 3$
$n_0 = 1$
$r = 2$ Ind/Obs.
$u = 1$
$c = 3, n$

$$\left.\begin{aligned} l_1 + v_1 - x &= 0 \\ l_2 + v_2 - x &= 0 \\ l_3 + v_3 - x &= 0 \end{aligned}\right]$$

for framework of LP (linear programming) all variables must be non-negative

$\Rightarrow$ introduce "slack variables"

$$V_1 = u_1 - w_1 \qquad X = \alpha_1 - \alpha_2$$

$$V_2 = u_2 - w_2$$

$$V_3 = u_3 - w_3$$

$$\Phi_1 = \text{objective function}$$

$$= |V_1| + |V_2| + |V_3|$$

$$= \underline{u_1 + w_1 + u_2 + w_2 + u_3 + w_3}$$

V_i $+$ $\quad u_i = V_i, \quad w_i = 0$

V_i $-$ $\quad u_i = 0, \quad w_i = |V_i|$

$$l_1 + u_1 - w_1 - \alpha_1 + \alpha_2 = 0$$

$$l_2 + u_2 - w_2 - \alpha_1 + \alpha_2 = 0$$

$$l_3 + u_3 - w_3 - \alpha_1 + \alpha_2 = 0$$

$$-\alpha_1 + \alpha_2 + u_1 - w_1 = -l_1$$

$$-\alpha_1 + \alpha_2 + u_2 - w_2 = -l_2$$

$$-\alpha_1 + \alpha_2 + u_3 - w_3 = -l_3$$

minimize

$$Z = \begin{bmatrix} 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix} \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ u_1 \\ w_1 \\ u_2 \\ w_2 \\ u_3 \\ w_3 \end{bmatrix}$$

subject to

$$\begin{bmatrix} -1 & 1 & 1 & -1 & 0 & 0 & 0 & 0 \\ -1 & 1 & 0 & 0 & 1 & -1 & 0 & 0 \\ -1 & 1 & 0 & 0 & 0 & 0 & 1 & -1 \end{bmatrix} \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ u_1 \\ w_1 \\ u_2 \\ w_2 \\ u_3 \\ w_3 \end{bmatrix} = \begin{bmatrix} l_1 \\ -l_2 \\ -l_3 \end{bmatrix}$$

$$\boxed{\begin{array}{ll} \min & c^T x = z \\ \text{subj to} & Ax = b \end{array}}$$

$Ax=b$ is underdetermined

$\Rightarrow$ infinite number of solutions,

only allow non-neg $\Rightarrow$ feasible set

$A_{m,n}$ $m<n$ then "corner" of feasible set corresponds to "basic solution"

m of unknowns are nonzero
rest are zero

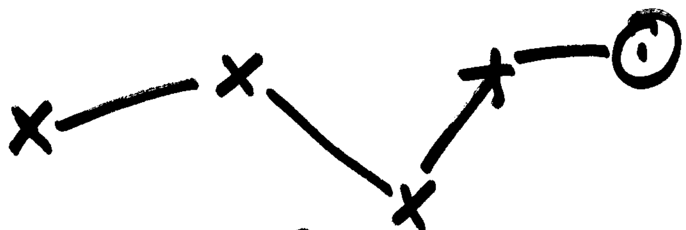
Only finite number of basic solutions

Theorem: obj. funct. minimized @ corner basic solution

So in principle could look @ all solutions + select one with smallest obj. function

(dumb search)

intelligent search



simplex algorithm

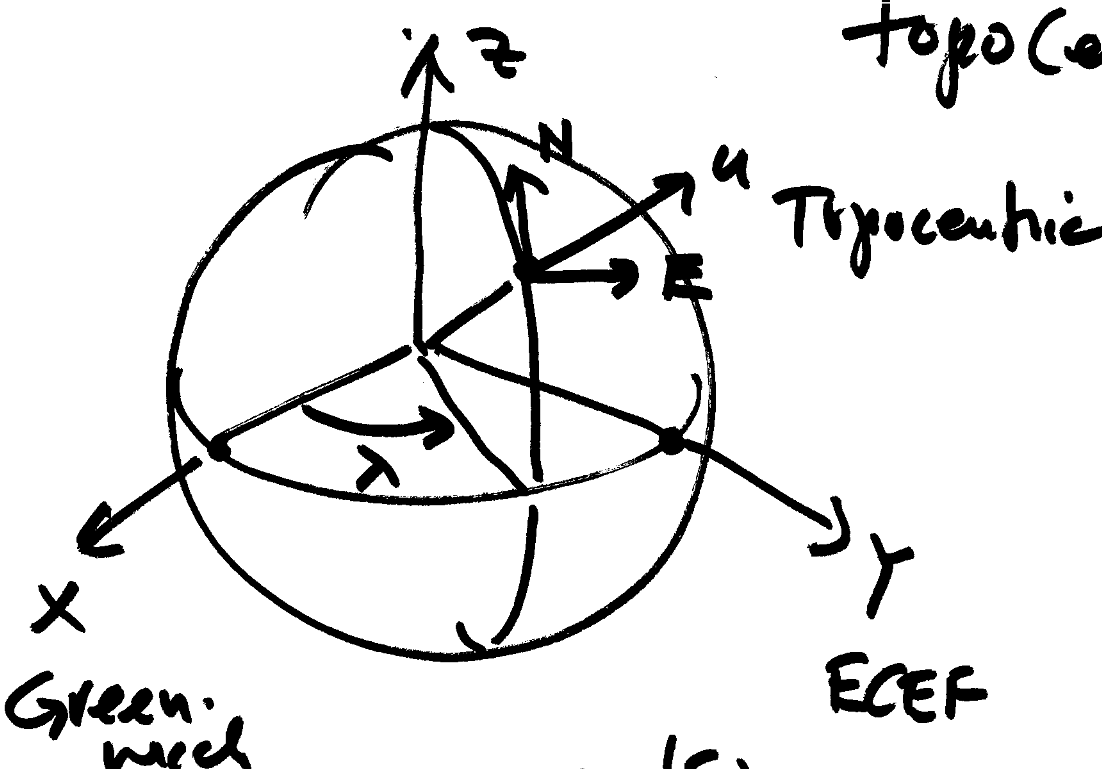
interior point algorithm

GPS pseudorange solution

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} \text{ ECEF}$$

would like local reference frame

topocentric (local)



$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} \rightarrow \begin{pmatrix} E \\ N \\ u \end{pmatrix}$$

parallel to $\begin{pmatrix} E \\ N \\ u \end{pmatrix} = M_x(90^\circ - \phi)\, M_z(\lambda + 90^\circ) \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$

$$\begin{pmatrix} E \\ N \\ u \end{pmatrix} = M_x(90^\circ - \phi)\, M_z(\lambda + 90^\circ) \left[\begin{pmatrix} X \\ Y \\ Z \end{pmatrix}_{ECF} - \begin{pmatrix} X_c \\ Y_c \\ Z_c \end{pmatrix}_{ECF} \right]$$

project center

$$\Sigma_{\begin{pmatrix} E \\ N \\ u \end{pmatrix}} = J \Sigma_{\begin{pmatrix} x \\ y \\ z \end{pmatrix}} J^T$$

$$J = \begin{bmatrix} \frac{\partial E}{\partial x} & \frac{\partial E}{\partial y} & \frac{\partial E}{\partial z} \\ \frac{\partial N}{\partial x} & \cdots & \\ \cdots & & \end{bmatrix}$$

$J = M_x(90^\circ - \phi)\, M_z(\lambda + 90^\circ)$

$$HDOP = \sqrt{q_E + q_N}$$

diagonal elements of $Q_{\Delta\Delta}$

$$VDOP = \sqrt{q_u}$$

do adjustment with $W = I$

compute $\hat{\sigma}_0^2 = \dfrac{v^T W v}{r}$

~~re-adjust with $W_i = \dfrac{1}{\sigma^2}$~~ NO, just do as above