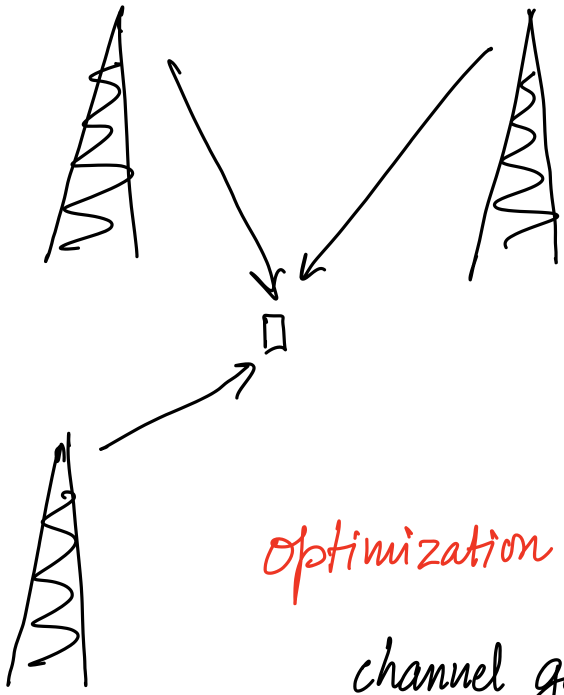
Communication Example



user can combine signals received from multiple B.S.

$N = \#$ B.S.

$M = \#$ users

B.S. $j = 1 \ldots N$

tx power p_i^j

optimization variable

user $i = 1 \ldots M$

channel gain : g_i^j → measured

rx power at i-th user $= \sum_{j=1}^{N} p_i^j g_i^j$

(coherent combining)

P_1 : minimize tx power
but ensure rx power is not too low

(LP)

$$\min_{\{p_i^j\}} \sum_{i=1}^{M} \sum_{j=1}^{N} p_i^j$$

s.t.

$$\sum_{j=1}^{N} p_i^j g_i^j \geq \gamma_i$$

threshold (to decode the signal)

$$p_i^j \geq 0 \quad \forall i, j$$

(P_2) fair allocation

- maximize received power at the worst user

$$\max_{\{p_i^j\}} \left(\underbrace{\min_{1 \le i \le M} \sum_{j=1}^{N} p_i^j g_i^j}_{\text{rx power}} \right)$$

pointwise min. of affine (concave)

$$\text{s.t.} \quad \sum p_i^j \le P^j_{max}$$

power budget at j

$$p_i^j \ge 0$$

LP?

note: $F = \max f(x) = -\min -f(x)$

$G = \min g(x) = -\max -g(x)$

so

$$-\min_{\{p_i^j\}} -\left(\min_i \sum_{j=1}^{N} p_i^j g_i^j \right)$$

$$= -\min_{\{p_i^j\}} \underbrace{\left(\max_i -\sum_{j=1}^{N} p_i^j g_i^j \right)}_{\text{convex}}$$

LP?

epigraph trick

$$\min f(x)$$
$$\Updownarrow$$
$$\min t$$
$$\text{s.t. } f(x) \le t$$

$$-\min_{\{p_i^j, t\}} t$$
$$\left(\max_{1 \le i \le M} \underbrace{-\sum_{j=1}^{N} p_i^j g_i^j}_{} \right) \le t$$

$$\Leftrightarrow \quad -\min_{\{p_i^j, t\}} t \qquad \text{(LP)}$$
$$-\sum_{j=1}^{N} p_i^j g_i^j \le t$$
$$\sum p_i^j \ge 0$$

usually LP are simpler to solve than convex