# Tutorial : Linear Optimization

## GIAN Short Course on Optimization: Applications, Algorithms, and Computation

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# The Busy College Student Problem

Formulate the student problem in AMPL (see Lecture 10)

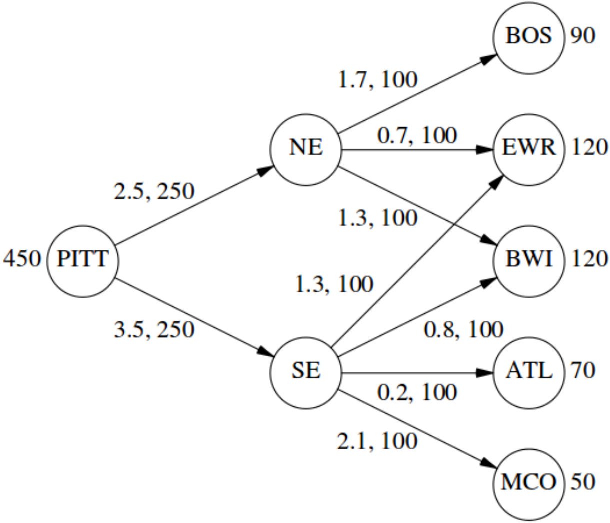
- $h(t) \geq 0$ as hours spent on task $t \in \mathcal{T}$
- maximize value $\underset{h}{\text{maximize}} \quad \sum_{t \in \mathcal{T}} \text{Value}(t) \cdot h(t)$
- College Rule 1: $h(\text{study}) + h(\text{tutorial}) \leq h(\text{lecture})$
- College Rule 2: $h(\text{study}) + h(\text{tutorial}) + h(\text{lecture}) \geq 8$
- College Rule 3: $h(\text{study}) + \frac{3}{2} h(\text{tutorial}) + 2h(\text{lecture}) \geq 10$
- Parents Rule 1: $h(\text{eat}) + h(\text{sleep}) \geq 10$
- Parents Rule 2: $h(\text{sleep}) \geq 8h(\text{eat})$
- Only 24 hours: $\sum_{t \in \mathcal{T}} h(t) \leq 24$

... you can add your own preferences!

# Tutorial : A transshipment model

- A plant PITT makes 450 packs of a product. Cities NE and SE are northeast and southeast distribution centers (DC).
- The DCs receive packs from PITT and ship them to warehouses at cities BOS, EWR, BWI, ATL and MCO.
- For each intercity 'link' there is shipping cost per pack and an upper limit on the packs that can be shipped (shown in figure).
- Find the lowest-cost shipping plan of packs over available links, respecting the specified capacities and meeting the demands at warehouses. Use network.dat for input data.

# Tutorial : The network



# Tutorial : Mathematical model

**Notation**

- Set of all cities: $\mathcal{C}$
- Set of all links between cities: $\mathcal{L}$
- Supply from city $k$: $s_k$
- Demand at city $k$: $d_k$
- Cost of transshipment from city $i$ to $j$: $c_{ij}$
- Capacity of link $(i,j)$: $U_{ij}$
- Amount of packs to be transfered from city $i$ to $j$: $x_{ij}$

$$
\begin{aligned}
\underset{x}{\text{minimize}} \quad & \sum_{i,j\in\mathcal{C}:(i,j)\in\mathcal{L}} c_{ij}x_{ij} && \text{(objective)} \\
.\text{subject to:} \quad & s_k + \sum_{(i,k)\in\mathcal{L}} x_{ik} \geq d_k + \sum_{(k,j)\in\mathcal{L}} x_{kj}, \ \forall k \in \mathcal{C} && \text{(balance cons.)} \\
& 0 \leq x_{ij} \leq U_{ij}, \quad \forall i,j \in \mathcal{C} : (i,j) \in \mathcal{L} && \text{(bound cons.)}
\end{aligned}
$$