Coins $X := \{x_1, \cdots, x_n\}$

Total value needed: $v$.

We want: Can we make change of $v$ using the coins given?
Subproblem?

- $C(w); 1 \leq w \leq v$
- $C(w) = 1$ if we CAN make change for $w$. 0 otherwise.
- We want to compute: $C(v)$
- Base case: $C(0) = 1$
- Recursion: Idea: choices of first coin used

$$C(w) = \max_{x_i \in \text{coin set}} C(w - x_i)$$
Running Time

- No. of subproblems: $O(v)$
- Transition Time: $O(n)$ time
- So, total running time $O(vn)$
Garage sales $G := \{g_1, \cdots, g_n\}$
Cost of traveling from garage $g_i$ to $g_j$ is $d_{ij}$
Profit earned at garage $g_i$ is $p_i$.

We want: Most profitable route from home ($g_0$) and back.
Subproblem?

- $C(S, j); \ S \subseteq G, g_j \in S$
- $C(S, j)$ is the max profit earned starting at home, ending at $g_j$ and only being allowed to use the garages in $S$.
- **We want to compute:** $\max_{g_i \in G} C(G, j) + d_{j0}$
- **Base case:** $C(\{g_j\}, j) = p_j - d_{0j}$
- **Recursion:** Idea: choices of garage visited just before $g_j$

$$C(S, j) = \max_{g_i \in S: i \neq j} \{C(S - \{g_j\}, i) + p_j - d_{ij}\}$$
Running Time

- No. of subproblems: $O(n) \cdot O(2^n)$
- Transition Time: $O(n)$ time
- So, total running time $O(n^22^n)$.
4.1 - Bellman Ford example 1.

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![Graph representation of the Bellman Ford example](image-url)
4.1 - Bellman Ford example 1.

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![Graph Diagram]

- **Graph Diagram:**
  
  - Node A connected to B with a weight of 1
  - Node B connected to C and D with weights 2 and 1 respectively
  - Node C connected to G with a weight of 2
  - Node D connected to E and H with weights 4 and 1 respectively
  - Node E connected to F with a weight of 5
  - Node F connected to G with a weight of 1
  - Node G connected to H with a weight of 1

- **Bellman Ford Algorithm:**
  
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![Bellman Ford example 1 diagram](image-url)
### 4.1 - Bellman Ford example 1.

#### Graph

![Graph](image)

#### Bellman Ford Algorithm Table

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4.1 - Bellman Ford example 1.

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#### Graph

![Graph Diagram](image-url)
4.1 - Bellman Ford example 1.

Shortest path tree:
4.2 - BF e.g. 2

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### 4.2 - BF e.g. 2

#### Iteration

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4.2 - BF e.g. 2

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### 4.2 - BF e.g. 2

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### Graph

![Graph Diagram](image-url)
4.2 - BF e.g. 2

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### 4.2 - BF e.g. 2

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4.2 - BF e.g. 2

Shortest path tree:
5.1 - Kruskal example 1

Kruskal order:

- AE: yes [cut: A, V - A]
- EF: yes [cut: F, V - F]
- BE: yes [cut: B, V - B]
- BF: no
- FG: yes [cut: G, V - GH]
- GH: yes [cut: H, V - H]
- CG: yes [cut: C, V - C]
- DG: yes [cut: D, V - D]

n - 1 = 7 edges done!
5.1 - Kruskal example 1

Kruskal order:

- AE - yes [cut: $A, V - A$]
5.1 - Kruskal example 1

Kruskal order:

- **AE** - yes [cut: $A, V - A$]
- **EF** - yes [cut: $F, V - F$]
5.1 - Kruskal example 1

Kruskal order:

- AE - yes [cut: A, V − A]
- EF - yes [cut: F, V − F]
- BE - yes [cut: B, V − B]

n − 1 = 7 edges done!
5.1 - Kruskal example 1

Kruskal order:

- AE - yes [cut: A, V − A]
- EF - yes [cut: F, V − F]
- BE - yes [cut: B, V − B]
- BF - no
- FG - yes [cut: GH, V − GH]
- GH - yes [cut: H, V − H]
- CG - yes [cut: C, V − C]
- DG - yes [cut: D, V − D]

n − 1 = 7 edges done!
5.1 - Kruskal example 1

Kruskal order:

- AE - yes [cut: A, V → A]
- EF - yes [cut: F, V → F]
- BE - yes [cut: B, V → B]
- BF - no
- FG - yes [cut: GH, V → GH]
5.1 - Kruskal example 1

Kruskal order:

- AE - yes [cut: A, V - A]
- EF - yes [cut: F, V - F]
- BE - yes [cut: B, V - B]
- BF - no
- FG - yes [cut: GH, V - GH]
- GH - yes [cut: H, V - H]
5.1 - Kruskal example 1

Kruskal order:

- AE - yes [cut: $A, V - A$]
- EF - yes [cut: $F, V - F$]
- BE - yes [cut: $B, V - B$]
- BF - no
- FG - yes [cut: $GH, V - GH$]
- GH - yes [cut: $H, V - H$]
- CG - yes [cut: $C, V - C$]

$n - 1 = 7$ edges done!
5.1 - Kruskal example 1

Kruskal order:

- AE - yes [cut: A, V − A]
- EF - yes [cut: F, V − F]
- BE - yes [cut: B, V − B]
- BF - no
- FG - yes [cut: GH, V − GH]
- GH - yes [cut: H, V − H]
- CG - yes [cut: C, V − C]
- DG - yes [cut: D, V − D]

$n − 1 = 7$ edges done!
5.2 - Kruskal example 2

```
5.2 - Kruskal example 2

AB - yes [cut:
A, V - A]

FG - yes [cut:
F, V - F]

DG - yes [cut:
D, V - D]

GH - yes [cut:
H, V - H]

BC - yes [cut:
ABE, V - ABE]

CG - yes [cut:
ABC, V - ABC]

CD - no

AE - yes [cut:
E, V - E]

n - 1 = 7 edges done!
```
5.2 - Kruskal example 2

**AB** - yes [cut: $A, V - A$]

![Graph with edge weights:](image)
5.2 - Kruskal example 2

- AB - yes [cut: A, V - A]
- FG - yes [cut: F, V - F]
5.2 - Kruskal example 2

- AB - yes [cut: $A$, $V - A$]
- FG - yes [cut: $F$, $V - F$]
- DG - yes [cut: $D$, $V - D$]
- AE - yes [cut: $E$, $V - E$]

$n - 1 = 7$ edges done!
5.2 - Kruskal example 2

- **AB** - yes [cut: A, V − A]
- **FG** - yes [cut: F, V − F]
- **DG** - yes [cut: D, V − D]
- **GH** - yes [cut: H, V − H]

![Graph diagram](image-url)
5.2 - Kruskal example 2

▶ AB - yes [cut: A, V − A]
▶ FG - yes [cut: F, V − F]
▶ DG - yes [cut: D, V − D]
▶ GH - yes [cut: H, V − H]
▶ BC - yes [cut: ABE, V − ABE]
5.2 - Kruskal example 2

- AB - yes [cut: A, V - A]
- FG - yes [cut: F, V - F]
- DG - yes [cut: D, V - D]
- GH - yes [cut: H, V - H]
- BC - yes [cut: ABE, V - ABE]
- CG - yes [cut: ABC, V - ABC]
5.2 - Kruskal example 2

- AB - yes [cut: A, V − A]
- FG - yes [cut: F, V − F]
- DG - yes [cut: D, V − D]
- GH - yes [cut: H, V − H]
- BC - yes [cut: ABE, V − ABE]
- CG - yes [cut: ABC, V − ABC]
- CD - no
5.2 - Kruskal example 2

- AB - yes [cut: $A, V - A$]
- FG - yes [cut: $F, V - F$]
- DG - yes [cut: $D, V - D$]
- GH - yes [cut: $H, V - H$]
- BC - yes [cut: $ABE, V - ABE$]
- CG - yes [cut: $ABC, V - ABC$]
- CD - no
- AE - yes [cut: $E, V - E$]

$n - 1 = 7$ edges done!