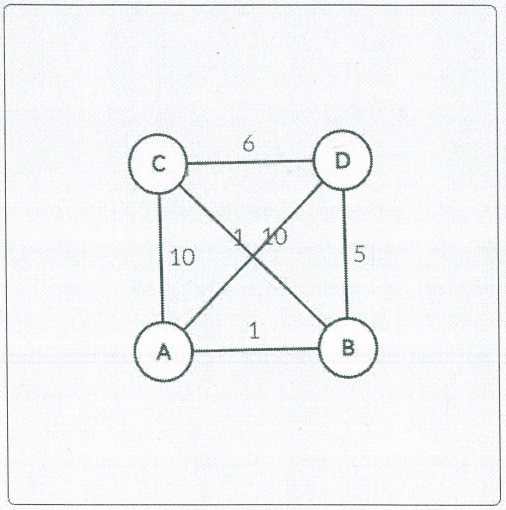
Grafo 3

Node Count:
4
Graph Data:

```
1  A B 1
2  A C 10
3  A D 1
4  B C 10
5  B D 5
6  C D 6
```



- Hiperparametros
  - $k = 2$
  - $t = 4$
  - $\alpha = 1$
  - $\beta = 1$
  - $P = 0.5$
  - $Q = 5$

Variables:

$$d = \begin{array}{c} \\ A \\ B \\ C \\ D \end{array} \begin{array}{c} \begin{array}{cccc} A & B & C & D \end{array} \\ \begin{bmatrix} \infty & 1 & 10 & 1 \\ 1 & \infty & 10 & 5 \\ 10 & 10 & \infty & 6 \\ 1 & 5 & 6 & \infty \end{bmatrix} \end{array}$$

$$\eta = d^{-1} \begin{bmatrix} 0 & 1 & 0.1 & 1 \\ 1 & 0 & 0.1 & 0.2 \\ 0.1 & 0.1 & 0 & 0.17 \\ 1 & 0.2 & 0.17 & 0 \end{bmatrix}$$

$$\tau = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}$$

Formulas

$$w_{xy} = \tau_{xy}^{\alpha} \cdot \eta_{xy}^{\beta}$$

$$P_{xy} = \frac{w_{xy}}{\sum w_{xy}}$$

Hormiga 1

Paso 1

$$w_{AB} = 1^1 \cdot 1^1 = 1 \cdot 1 = 1$$
$$w_{AD} = 1^1 \cdot 1^1 = 1 \cdot 1 = 1$$
$$w_{AC} = 1^1 \cdot 0.1^1 = 1 \cdot 0.1 = 0.1$$
$$\sum_{y}^{w} w_{xy} = 2.1$$

$$\rightarrow P_{AB} = 0.48 = 48\%$$
$$P_{AD} = 0.48 = 48\%$$
$$P_{AC} = 0.048 = 4.8\%$$

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Selecciono B - Paso 2

$W_{BC} = 1^1 \cdot 0.1 = 1 \cdot 0.1 = 0.1 \quad P_{BC} = \frac{0.1}{0.3} = 0.33\%$

$W_{BD} = 1^1 \cdot 0.2 = 1 \cdot 0.2 = 0.2 \rightarrow P_{BD} = \frac{0.2}{0.3} = 0.67\%$

$\sum W_{Ai} = 0.3$

Selecciono D

Unica opcion C → A

Ruta = A B D C A = 22

Hormiga 2

Paso 1

$W_{AB} = 1^1 \cdot 1^1 = 1 \cdot 1 = 1 \quad P_{AB} = \frac{1}{2.1} = 0.48 = 48\%$

$W_{AD} = 1^1 \cdot 1^1 = 1 \cdot 1 = 1 \rightarrow P_{AD} = \frac{1}{2.1} = 0.48 = 48\%$

$W_{AC} = 1^1 \cdot 0.1^1 = 1 \cdot 0.1 = 0.1 \quad P_{AC} = \frac{0.1}{2.1} = 0.048 = 0.048\%$

$\sum W_{xy} = 2.1$

Selecciono D - Paso 2

$W_{DC} = 1^1 \cdot 0.17^1 = 0.17 \quad P_{DC} = 0.17/0.37 = 46\%$

$W_{DB} = 1^1 \cdot 0.2^1 = 0.2 \rightarrow P_{DB} = 0.2/0.37 = 54\%$

$\sum W_{xy} = 0.37$

ADBCA = 26

Calcular Deltas

$\Delta T^1_{xy} = Q/L_1 = 5/22 = 0.23$

$\Delta T^2_{xy} = Q/L_2 = 5/26 = 0.19$

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Actualizar feromonas

$$\begin{bmatrix} 0.5 & 0.5 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0.5 \end{bmatrix} \quad J^2 = (1-\rho)J^1 + \Delta J = (1-0.5)J^1 + \Delta J = 0.5J^1 + \Delta J$$

Hormiga 1

$$\begin{bmatrix} 0.5 & 0.73 & 0.73 & 0.5 \\ 0.73 & 0.5 & 0.5 & 0.73 \\ 0.73 & 0.5 & 0.5 & 0.73 \\ 0.5 & 0.73 & 0.73 & 0.5 \end{bmatrix} \rightarrow t^2 = \begin{bmatrix} 0.5 & 0.73 & 0.92 & 0.69 \\ 0.73 & 0.5 & 0.69 & 0.92 \\ 0.92 & 0.69 & 0.5 & 0.73 \\ 0.69 & 0.92 & 0.73 & 0.5 \end{bmatrix}$$

Ciclo 2

Hormiga 1-paso 1

$W_{AB} = 0.73^1 \cdot 1^1 = 0.73 \rightarrow P_{AB} = 0.73/1.512 = 0.48 = 48\%$
$W_{AD} = 0.69^1 \cdot 1^1 = 0.69 \quad P_{AD} = 0.69/1.512 = 0.46 = 46\%$
$W_{AC} = 0.92 \cdot 0.1^1 = 0.092 \quad P_{AC} = 0.092/1.512 = 0.060 = 6\%$
$\sum_x W_{xy} = 1.512$

Selecciona B paso 2

$W_{BC} = 0.69^1 \cdot 0.1^1 = 0.069 \quad P_{BC} = 0.069/0.253 = 0.272$
$W_{BD} = 0.92^1 \cdot 0.2^1 = 0.184 \rightarrow P_{BD} = 0.184/0.253 = 0.727$
$\sum_x W_{xy} = 0.253$

Selecciona D → C → A
Ruta = A B D C A = 22

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Hormiga 2 - Paso 1

$W_{AB} = 0.73^1 \cdot 1^1 = 0.73$ $\quad P_{AB} = \frac{0.73}{1.512} = 0.48 = 48\%$

$W_{AD} = 0.69^1 \cdot 1^1 = 0.69 \rightarrow P_{AD} = \frac{0.69}{1.512} = 0.46 = 46\%$

$W_{AC} = 0.92 \cdot 0.1 = 0.092$ $\quad P_{AC} = 0.092/1.512 = 0.060 = 6\%$

$\sum_y W_{xy} = 1.512$

Selecciono D paso 2

$W_{DB} = 0.92^1 \cdot 0.2^1 = 0.184$ $\quad P_{DB} = 0.184/0.3081 = 60\%$

$W_{DC} = 0.73^1 \cdot 0.17^1 = 0.1241$ $\quad P_{DC} = 0.1241/0.3081 = 40\%$

$\sum_y W_{xy} = 0.3081$

Selecciona B → C → A

Ruta = A D B C A = 26

Calcular Deltas

$\Delta J_{xy}^1 = Q/L_1 = 5/22 = 0.23$

$\Delta J_{xy}^2 = Q/L_2 = 5/26 = 0.19$

Actualizar feromonas

0.5	0.73	0.92	0.69
0.73	0.5	0.69	0.92
0.92	0.69	0.5	0.73
0.69	0.92	0.73	0.5

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0.25	0.365	0.46	0.345
0.365	0.25	0.345	0.46
0.46	0.345	0.25	0.365
0.345	0.46	0.365	0.25

→

0.25	0.545	0.88	0.535
0.545	0.25	0.535	0.88
0.88	0.535	0.25	0.545
0.535	0.88	0.545	0.25

Ciclo 3

Hormiga 1 - paso 1

$W_{AB} = 0.545 \cdot 1^1 = 0.545 \rightarrow P_{AB} = 0.545/1.218 = 49\%$
$W_{AD} = 0.535 \cdot 1^1 = 0.535 \quad P_{AD} = 0.535/1.218 = 44\%$
$W_{AC} = 0.88 \cdot 0.1^1 = 0.088 \quad P_{AC} = 0.088/1.218 = 7\%$
$\sum W_{xy} = 1.218$

Selecciona B paso 2

$W_{BD} = 0.88^1 \cdot 0.2^1 = 0.176 \rightarrow P_{BD} = 0.77\%$
$W_{BC} = 0.535^1 \cdot 0.1^1 = 0.0535 \quad P_{BC} = 0.23\%$
$\sum W_{xy} = 0.2295$

Selecciona D → C → A
ABDCA = 22

Hormiga 2 - paso 1

$W_{AB} = 0.545 \cdot 1^1 = 0.545 \rightarrow P_{AB} = 0.545/1.218 = 49\%$
$W_{AB} = 0.535 \cdot 1^1 = 0.535 \quad P_{AD} = 0.535/1.218 = 44\%$
$W_{AC} = 0.88 \cdot 0.1 = 0.088 \quad P_{AC} = 0.088/1.218 = 7\%$
$\sum W_{xy} = 1.218$

Selecciona B paso 2

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$W_{BD} = 0.88^1 \cdot 0.2^1 = 0.176 \rightarrow P_{BD} = 0.77\%$
$W_{BC} = 0.535^1 \cdot 0.1^1 = 0.0535 \quad P_{BC} = 0.23\%$
$\sum W_{xx} = 0.2295$

Selecciona $D_2 \rightarrow C \rightarrow A$
ABDCA = 22

Obtener Deltas

$\Delta \tau^1_{xy} = Q/L_1 = 5/22 = 0.23$
$\Delta \tau^1_{xy} = Q/L_1 = 5/22 = 0.23$

0.96

Actualizar feromonas

0.125	0.298	0.44	0.268
0.298	0.125	0.268	0.44
0.44	0.268	0.125	0.298
0.268	0.44	0.298	0.125

→

0.125	0.758	0.9	0.268
0.758	0.125	0.268	0.9
0.9	0.268	0.125	0.758
0.268	0.9	0.758	0.125

Ciclo 4

Hormiga 1 paso 1

$W_{AB} = 0.758 \cdot 1^1 = 0.758 \rightarrow P_{AB} = 0.758/1.116 = 68\%$
$W_{AD} = 0.268 \cdot 1^1 = 0.268 \quad P_{AD} = 0.268/1.116 = 24\%$
$W_{AC} = 0.9 \cdot 0.1^1 = 0.09 \quad P_{AD} = 0.09/1.116 = 8\%$
$\sum W_{xy} = 1.116$

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Selecciono B — paso 2

$W_{BD} = 0.9^1 \cdot 0.2^1 = 0.18 \rightarrow P_{BD} = 0.18/0.2068 = 87\%$
$W_{BC} = 0.268^1 \cdot 0.1^1 = 0.0268 \quad P_{BC} = 0.0268/0.2068 = 13\%$
$\sum_x w_{xx} = 0.2068$

Selecciono D → C → A
ABDCA = 22

Hormiga 2 - paso 1

$W_{AB} = 0.758 \cdot 1^1 = 0.758 \rightarrow P_{AB} = 0.758/1.116 = 68\%$
$W_{AD} = 0.268 \cdot 1^1 = 0.268 \quad P_{AD} = 0.268/1.116 = 24\%$
$W_{AC} = 0.9 \cdot 0.1^1 = 0.09 \quad P_{AC} = 0.09/1.116 = 8\%$
$\sum_y w_{xy} = 1.116$

Hormiga 2 - paso 2

$W_{BD} = 0.9^1 \cdot 0.2^1 = 0.18 \rightarrow P_{BD} = 0.18/0.2068 = 87\%$
$W_{BC} = 0.268 \cdot 0.1^1 = 0.0268 \quad P_{BC} = 0.0268/0.2068 = 13\%$
$\sum_y w_{xy} = 0.2068$

Selecciono D → C → A
ABDCA = 22

Obtener Deltas

0.0625	0.379	0.45	0.134
0.379	0.0625	0.134	0.45
0.45	0.134	0.0625	0.379
0.134	0.45	0.379	0.0625

$\Delta J^1_{xx} = Q/L_1 = 5/22 = 0.23$
$\Delta J^2_{xy} = Q/L_2 = 5/22 = 0.23$

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Actualizar feromonas

0.0625	0.839	0,91	0,134
0.839	0.0625	0.134	0.91
0.91	0.134	0.0625	0.839
0.134	0.91	0.839	0.0625

Hormiga greedy - Ruta final

$W_{AB} = 0.839^1 \cdot 1^1 = 0.839 \rightarrow P_{AB} = 0.839/1.064 = 79\%$
$W_{AD} = 0.134^1 \cdot 1^1 = 0.134 \quad P_{AD} = 0.134/1.064 = 13\%$
$W_{AC} = 0.91^1 \cdot 0.1^1 = 0.091 \quad P_{AC} = 0.091/1.064 = 9\%$
$\sum_{x,y}^{w} = 1.064$

Selecciona B al tener la probabilidad mas alta

$W_{BD} = 0.91^1 \cdot 0.2^1 = 0.182 \rightarrow P_{BD} = 0.182/0.1954 = 93\%$
$W_{DC} = 0.134^1 \cdot 0.1^1 = 0.0134 \quad P_{BC} = 0.0134/0.1954 = 7\%$
$\sum W_{xy} = 0.1954$

Selecciona D → C → A
Ruta final = A → B → D → C → A = 22