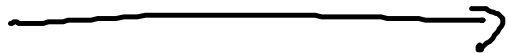


ANWENDUNGINFORMATIK

?



GRAPH



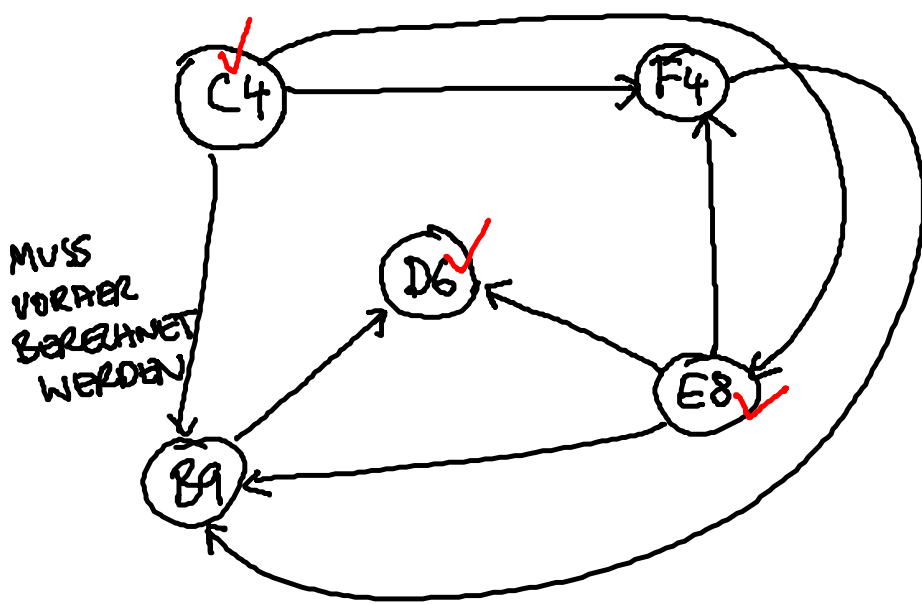
GRAPHALGORITHMEN

?

!



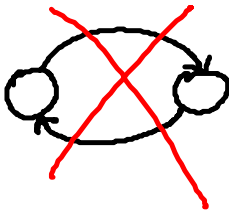
LÖSUNG



REIHENFOLGE

C4 E8 F4 B9 D6





- 1) WATCH 2) SHIRT 3) TIE
 4) SOCKS 5) PANTS 6) SHOES 7) BELT 8) JACKET
 4b) UNDERSHORTS

AUFWAND (boxed) branches into:
 - **NORST** (boxed)
 - **BEST** GRÖSSE EINGABE : n
 - **AVERAGE**
 - **PLATE**
 - **ZEIT** (circled in red)
 $n \rightarrow \infty$ ZEITAUFWAND ?

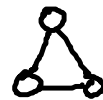
$$G = (V, E)$$

"n" : $|V|, |E|$

KNOTEN # KANTEN PRO KNOTEN

$$\frac{|V| \cdot (|V| - 1)}{2}$$

FÜR VOLLSTÄNDIGE GRAPHEN
 "WORST CASE"



K_3



K_2



K_4



K_1

AUFWAND VON TOPOLOGICAL SORT (DFS)

$\in O(n!)?$

$\sim (|V| + |E|) \in O(|V|^2)$ $\in O(|V| + |E|)$ OFFIZIELL
 \uparrow "PROPORTIONAL"
 $n \rightarrow \infty?$

$$|E| \leq |V|^2$$

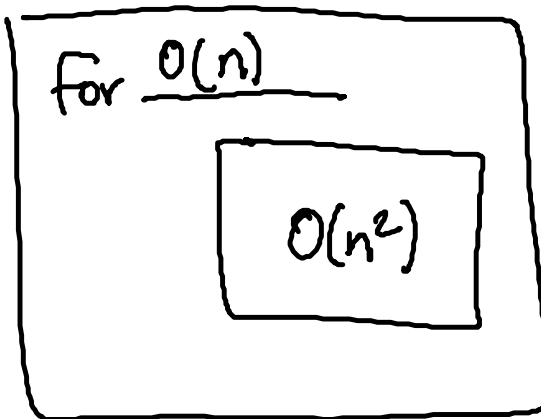
$$T_{BS} \approx \underline{|V|} + |V|^2$$

$$f(n) = n + n^2$$

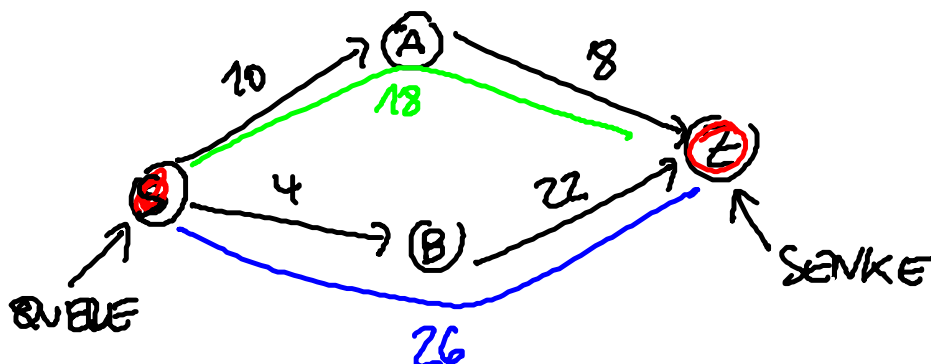
$$g(n) = n^2$$

$$f(n) \in O(g(n))$$

$$n_0? \quad c? \\ = 100 \checkmark \quad 2 \checkmark$$



$$O(n) \cdot O(n^2) = O(n^3)$$



9. JUNI 2016

ALGO DAT

a) SINGLE-SOURCE SHORTEST PATH

b) FLOW IN GRAPHS

SINGLE-SOURCE SHORTEST PATH

DIJKSTRA

BELMAN-FORD

VOLL VERKNÜPFTER GRAF $O(V^2 + \dots)$

$$O(|E| + |V| \log |V|) \rightarrow O(|V| + |V| \log |V|)$$

$$O(|V| \cdot |E|) \rightarrow O(|V| \cdot |V|) = O(|V|^2)$$

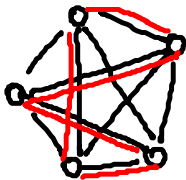
$$\boxed{|V| = |E|}$$

$$\rightarrow O(|V|^2 \cdot |V|) = O(|V|^3)$$

WIE GUT SIND DIE EIGENTLICH?

K_n = VOLL VERKNÜPFTER GRAF MIT n KNOTEN

K_5



$$\# \text{PFADE} = \sum_{k=1}^n \underbrace{\# \text{PFADE DURCH } k \text{ KNOTEN}}_{P_k}$$

$$\sum \begin{cases} P_1 = n \\ P_2 = n(n-1) \\ P_3 = n(n-1)(n-2) \\ \vdots \\ P_n = n! \end{cases}$$

ZIEMLICH GUT!

FLOYD-WARSHALL

$$O(|V|^3)$$

$k=0$

| | 1 | 2 | 3 | 4 | ... |
|-----|----------|----------|----------|----------|-----|
| 1 | 0 | ∞ | ∞ | | |
| 2 | | | \dots | $w(2,4)$ | |
| 3 | $w(3,1)$ | | \dots | ∞ | |
| 4 | | ∞ | | 0 | |
| ... | | | | | |

← FÜR $Z_0 \triangleq$ KEINEN ZWISCHENKNOTEN

START
ZIEL
 $SP(i, j, k)$

MENGE Z DER KNOTEN DIE WIR ALS
"ZWISCHENKNOTEN" ZULASSEN

$$Z_k = \{v_1, \dots, v_k\}$$

$$SP(1, j, 0) = w(i, j)$$

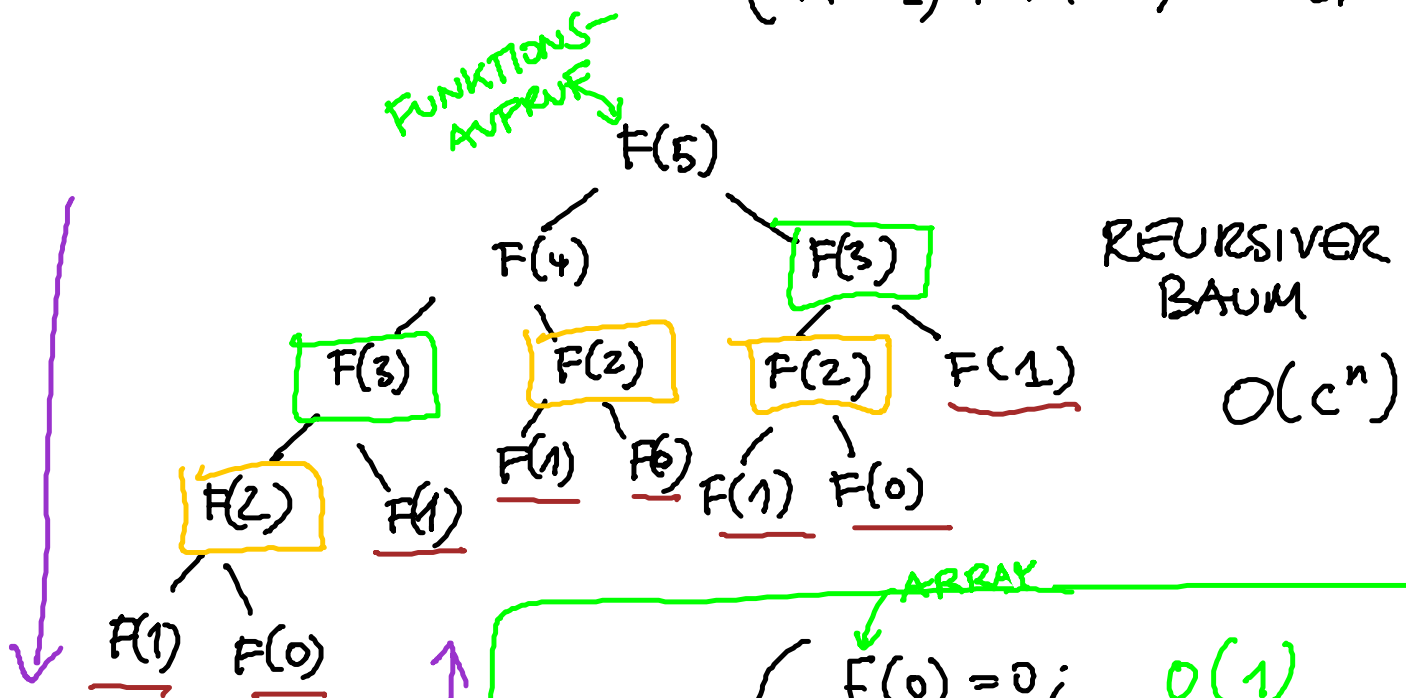
$$SP(i, j, k+1) = \min \begin{cases} SP(i, j, k) \\ SP(1, k+1, k) + SP(k+1, j, k) \end{cases}$$

| k | 1 | 2 | 3 | 4 | ... | $k+1$ | 1 | 2 | 3 | 4 | ... |
|-----|---|---|---|---------------|-----|-------|---|---|---|---|-----|
| 1 | | | | | | 1 | | ⊙ | | | |
| 2 | | | | $SP(2, 4, k)$ | | 2 | | | | | |
| 3 | | | | | | 3 | | | | | |
| 4 | | | | | | ... | | | | | |
| ... | | | | | | ... | | | | | |

Diagram illustrating the recursive step for $SP(2, 4, k)$ using the table for $k+1$. An orange circle is at $(1, 2)$ in the $k+1$ table. Two orange arrows originate from this circle: one points to the cell $(2, 4)$ in the k table, labeled $SP(2, 4, k)$, and the other points to the cell $(1, 4)$ in the $k+1$ table. A black arrow points from the k table towards the $k+1$ table.

AUSFLUG

$$F(n) = \begin{cases} 0 & n=0 \\ 1 & n=1 \\ F(n-1) + F(n-2) & \text{SONST} \end{cases}$$



ARRAY

$O(n)$

```
F(0) = 0;    O(1)
F(1) = 1;    O(1)
for (i = 2; i ≤ n; i++)
    F(i) = F(i-1) + F(i-2);
return F(n);
```

$O(n)$

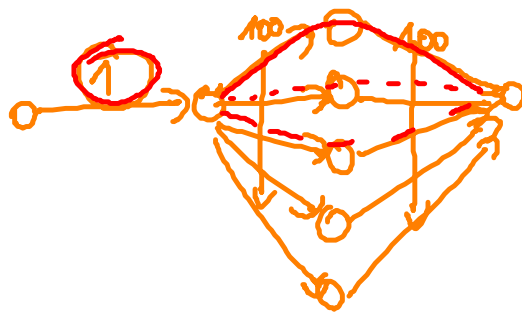
DYNAMISCHE PROGRAMMIERUNG

- ✓ WIEDERKEHRENDE UNTERPROBLEME
- ✓ LÖSUNG DES UNTERPROBLEMS MUSS TEIL DER LÖSUNG DES GESAMT PROBLEMS

A diagram showing a path starting at node i , going down to node k , then up to node j . A red line forms a loop from node i to node k , crossing itself. A blue 'X' is drawn on the red loop.

A hand-drawn network diagram illustrating a flow from a source ('QUELLE') to a sink ('SENKE'). The source is represented by a cylinder. The sink is represented by a circle. The flow is divided into two main paths, each ending at a node circled in red and labeled 'LEITER'. The top path goes from 'QUELLE' to a node labeled 'S-Bahn', then to another 'S-Bahn' node, and finally to the top 'LEITER' node. The bottom path goes from 'QUELLE' to a node labeled 'Auto', then to a node labeled 'Autobahn', and finally to the bottom 'LEITER' node. The flow from the top 'LEITER' node goes to a node labeled 'Hotel Wertvoll', and the flow from the bottom 'LEITER' node goes to the 'SENKE' node. The edges are labeled with transportation modes: 'S-Bahn', 'S-Bahn', 'Auto', 'Autobahn', 'Bundesstrasse', 'Leiter', and 'Hotel Wertvoll'.

FRAGE: SIND PFADE EINDEUTIG?



$|F| = 1$

- DFS

- BFS

$$O(|E| f)$$

$$O(|V| |E|^2)$$

HAUSAUFGABE

