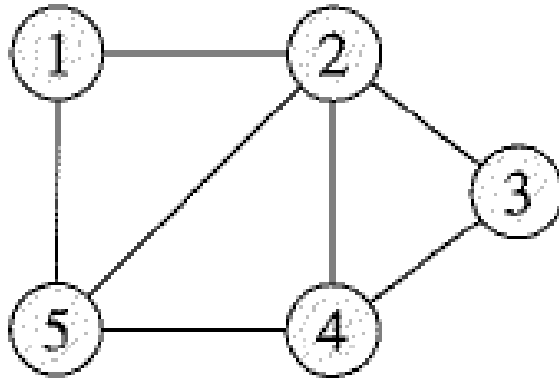


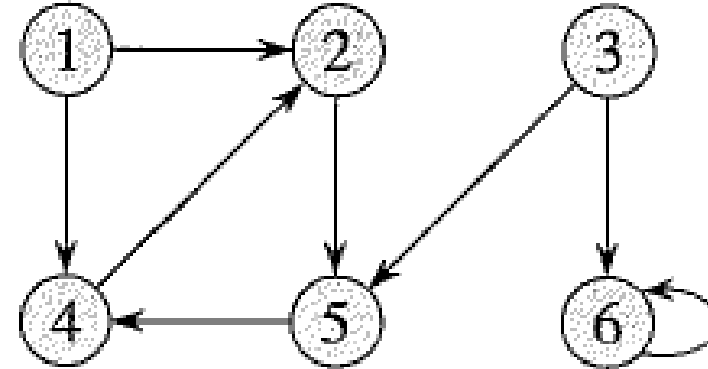
Algoritmer og Datastrukturer

Graf repræsentationer, bredde først søgning (BFS)
[CLRS, kapitel 22.1-22.2]

Grafer



Uorienterede grafer



Orienterede grafer

$G = (V, E)$ graf med knuder V og kanter E

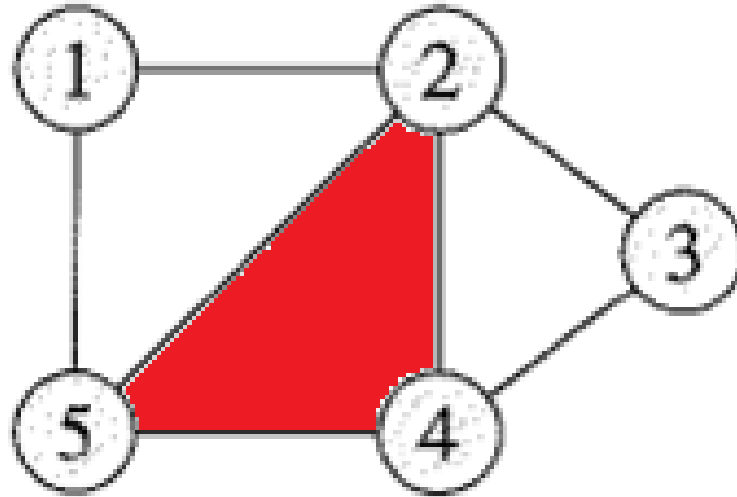
$E: \{u, v\}$ kant mellem u og v i en uorienteret graf og

(u, v) en orienteret kant fra u til v .

$n = |V|$ = antal knuder

$m = |E|$ = antal kanter (forbindelser mellem knuder)

Planar Grafer - Eulers formel



$$\begin{aligned} |V| &= 5 \\ |E| &= 7 \\ \# \text{ flader} &= 4 \end{aligned}$$

For en sammenhengende planar graf gjelder:

Eulers formel: $|V| - |E| + \# \text{ flader} = 2$

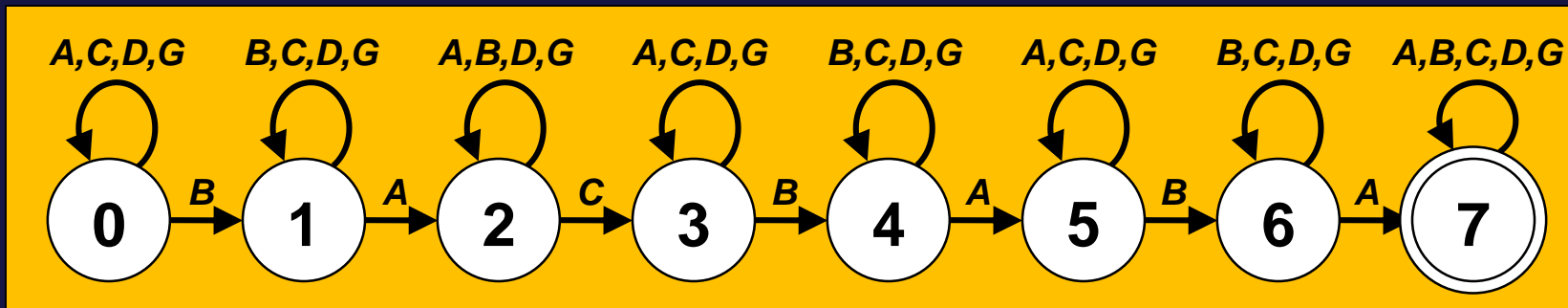
Korollar:

$$|E| \leq 3|V| - 6$$

(for $|V| \geq 3$, ingen selvløkker,
ingen parallelle kanter)

Hvilken løsning finder den grådige algoritme?

- a) ABABGACBABAD
- 😊 b) ABABGACBABAD
- c) ABABGACBABAD
- d) Ved ikke



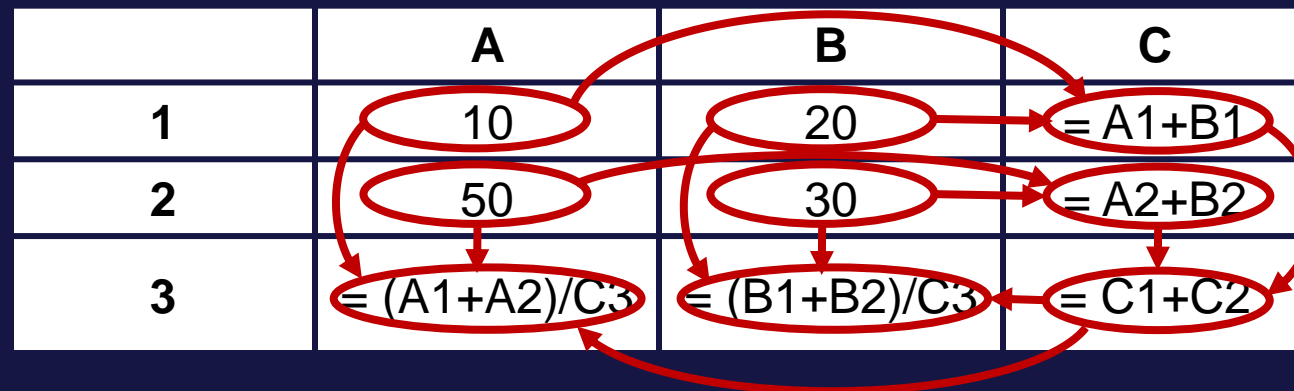
Microsoft Excel - Copy of SheepFlock								
File Edit View Insert Format Tools Data Window Help Adobe PDF								
Type a question for help								
H18 =B18*G18								
	A	B	C	D	E	F	G	H
3	I. Description of animals in flock during the year.							
4	Ewes in flock:	700			[Green cells are those you can change.]			
5	Lambing rate:	4	times per	3	years =	1.33	times/year.	
6	Lambs weaned/lambing:	1.5	Days of lactation/lambing:			60		
7	Adult death loss per year:	3%	Days in lactation/year:			80		
8	Postweaning lamb loss:	2%	Lambs weaned per ewe per year:			2.0		
9	Ewe culling rate:	15%	Ram culling rate:			50%		
10	Rams/100 ewes:	1	(Only 1/3 of ewes bred per season under STAR system.)					Inventory
11			Weaning	Market	Final	Price	Value	or sale
12		Number	wt, lb	wt, lb	wt, lb	\$/lb	per head	value
13	Ewes	700			150	\$1.00	\$150	\$105,000
14	Rams	8			200	\$2.00	\$400	\$3,200
15	Ewe lamb rplcmnts	126	30		100	\$1.25	\$125	\$15,750
16	Ram lamb rplcmnts	5	40		130	\$2.00	\$260	\$1,300
17	Ewe lambs sold	560	30	70		\$1.10	\$77	\$43,120
18	Ram lambs sold	681	40	70		\$1.10	\$77	\$52,437
19	Cull ewes sold	105		150		\$0.30	\$45	\$4,725
20	Cull rams sold	5		200		\$0.30	\$60	\$300
21	Fleece weight per adult	708			6	\$0.30	\$1.80	\$1,274
22							Inventory:	\$125,250
23							Sales:	\$101,856

Sheep flock /

Ready

Hvilken beregningsrækkefølge ?

	A	B	C
1	10	20	$= A1+B1$
2	50	30	$= A2+B2$
3	$= (A1+A2)/C3$	$= (B1+B2)/C3$	$= C1+C2$



a) C1 C2 A3 B3 C3

b) A3 B3 C2 C1 C3



c) C2 C1 C3 B3 A3

d) Ved ikke

Microsoft Excel - Book1

File Edit View Insert Format Tools Data Window Help Adobe PDF

Type a question for help

B3 =A1+1

	A	B	C	D	E
1	3	2	1		
2					
3		0			
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					

Circular Reference

\$B\$3

Microsoft Excel Help

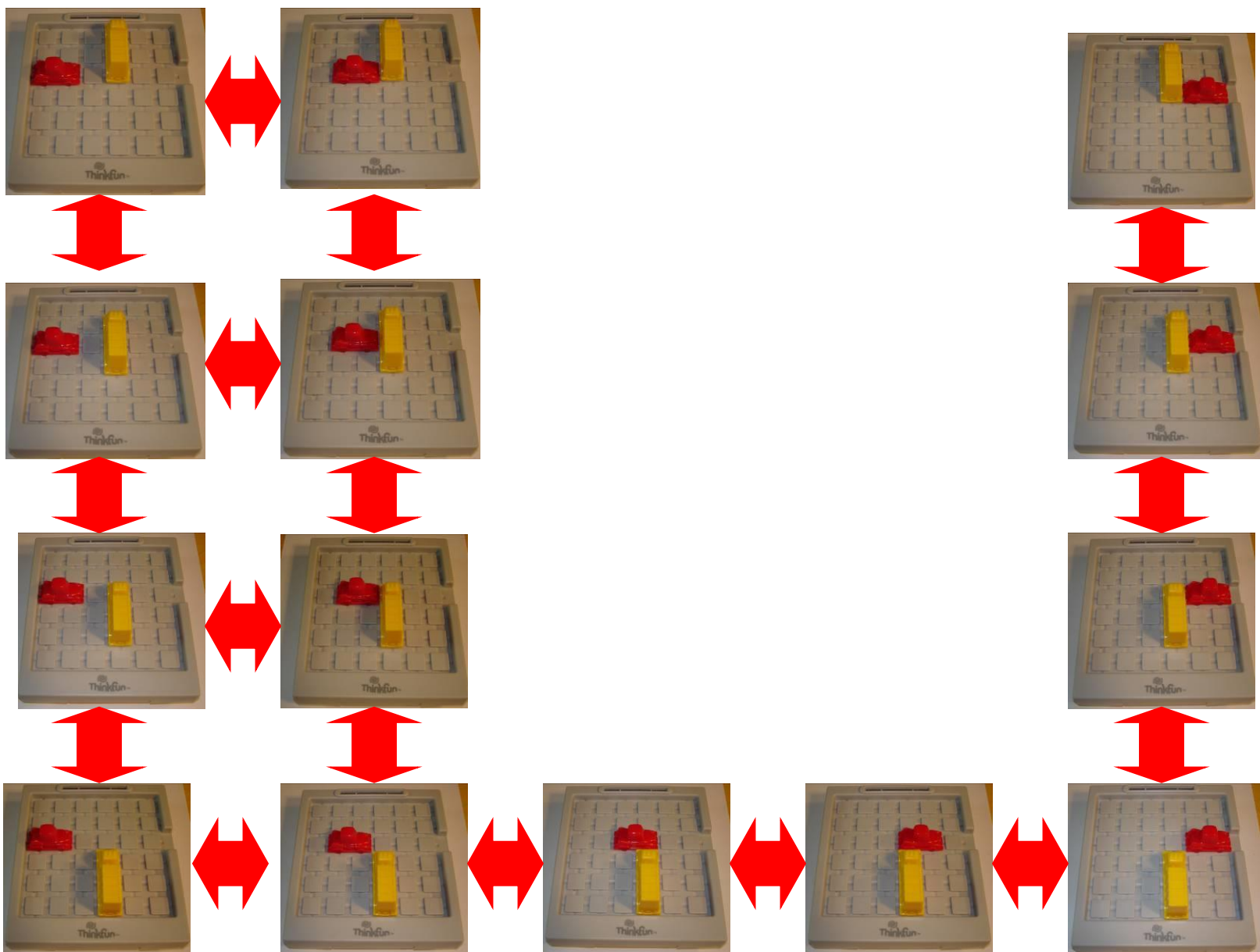
← →

Show All

Allow or correct a circular reference

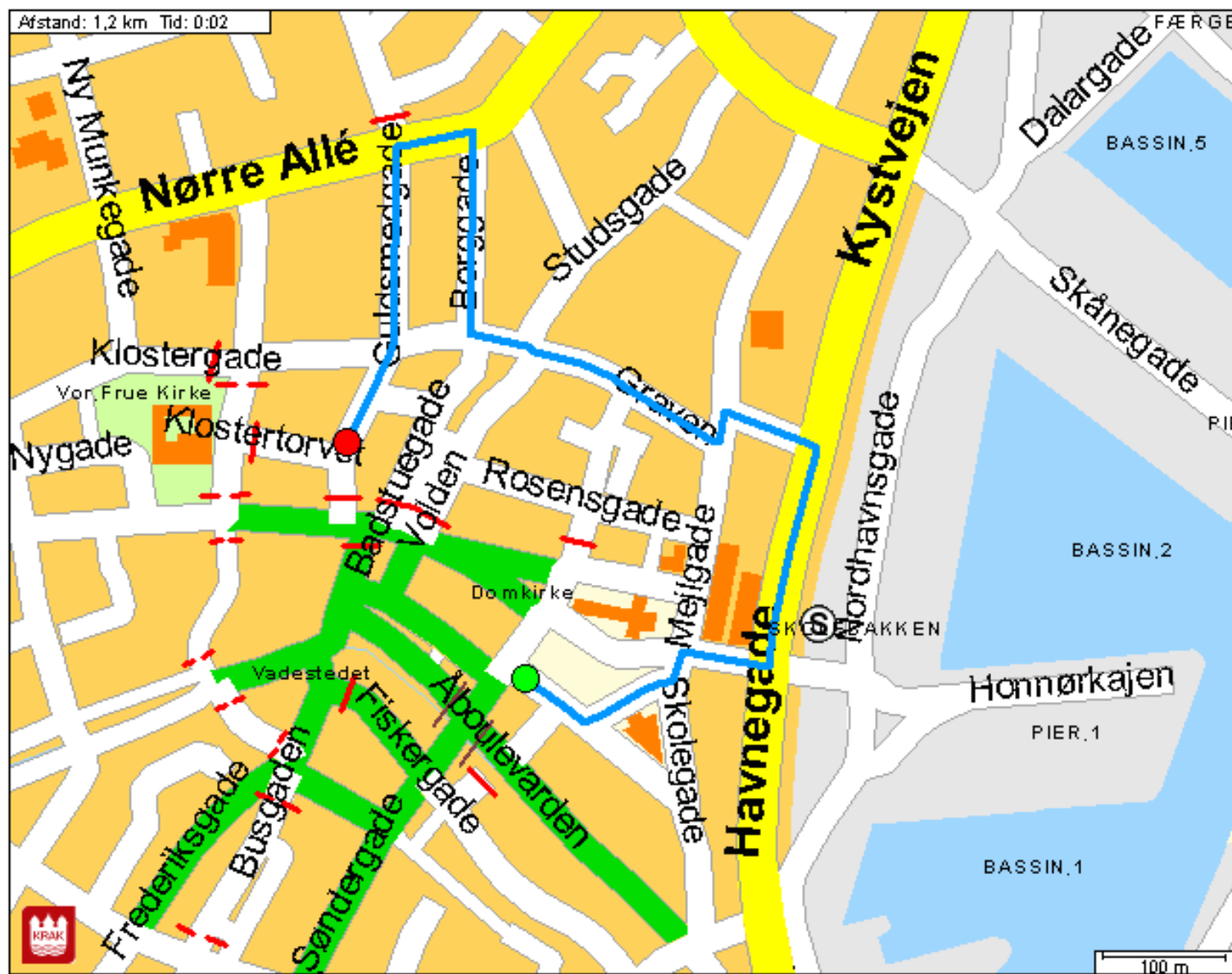
When a **formula** refers back to its own cell, either directly or indirectly, it is called a circular reference. Microsoft Excel cannot automatically calculate all open workbooks when one of them contains a circular reference. You can remove a circular reference, or you can have Excel calculate each cell involved in the circular reference once by using the results of the previous **iteration**. Unless you change the default settings for iteration, Excel stops calculating after 100 iterations or after all values in the circular reference change by less than 0.001 between iterations, whichever comes first.

- ▶ [Locate and remove a circular reference](#)
- ▶ [Make a circular reference work by changing the number of times Microsoft Excel iterates formulas](#)





Rute på kort
Fra Kannikegade 1 , 8000 Århus C
Til Guldsmedgade 1 , 8000 Århus C
Via



Hvor mange knuder skal man bruge for at repræsentere et vejkryds?

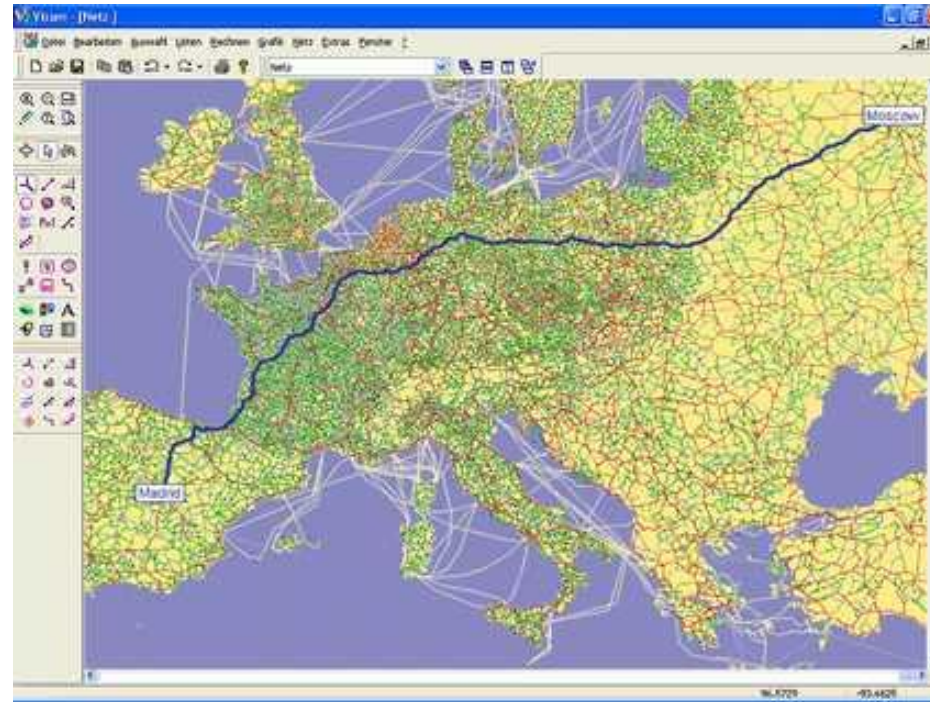


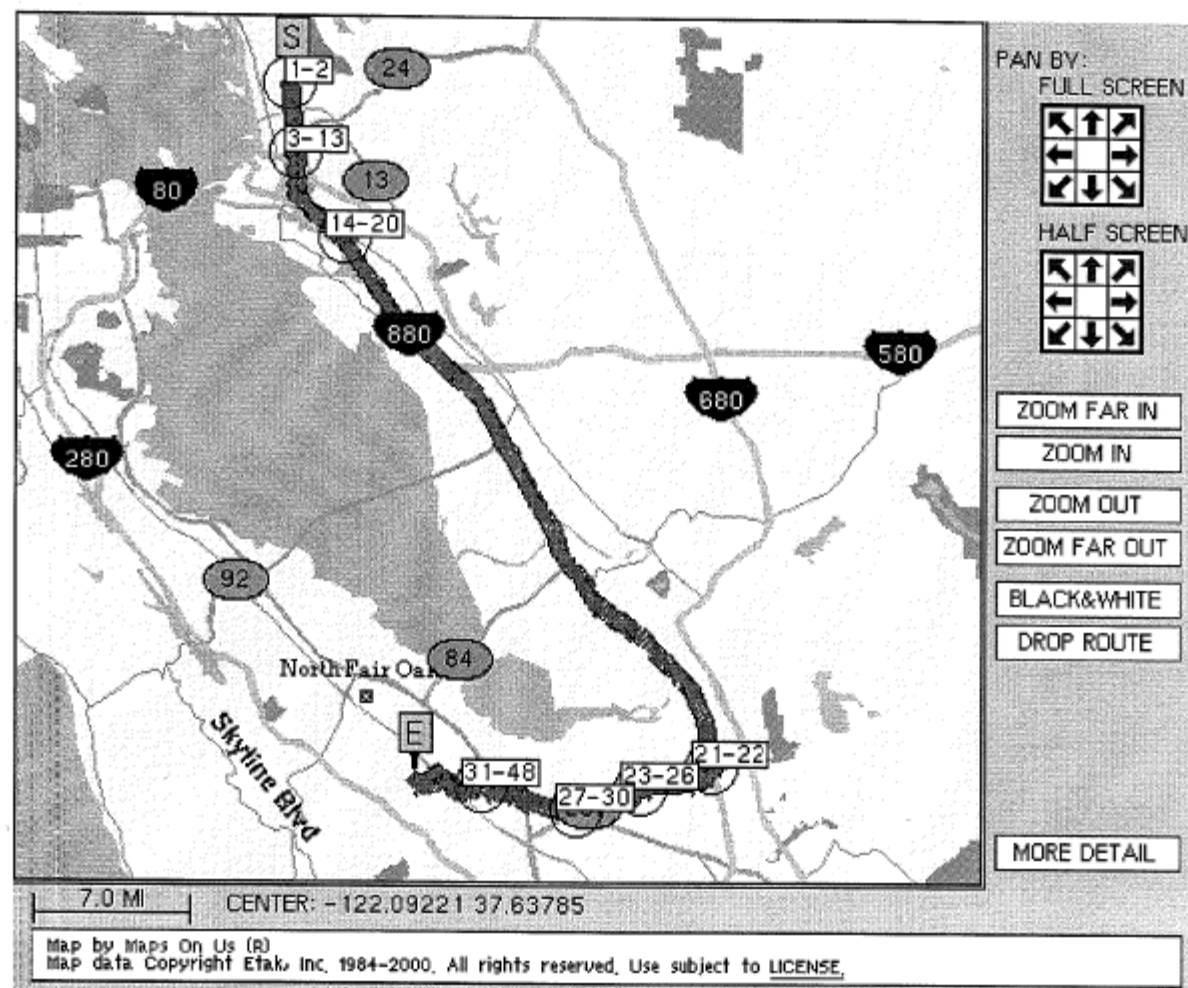
- a) 1
- b) 2
- c) 4
- d) 5
- e) 8
- f) 9
- g) 12
- h) Ved ikke



Kort over Vest-Europa

- 18.029.721 knuder
- 42.199.587 orienterede kanter





“However, because of the size of the routing data, we have to use heuristics when planning routes. As a result, sometimes a Favor Highways route will be slightly faster than the Fastest route.”

— MapsOnUs

Dine valg

Fra: Skagen st
Til: Rødby Færge
Udrejse: 27.04.07
Kl.: 10:00 (Afgang)

Vælg anden Fra/Til

Oversigt

[Tidligere forbindelser](#)

	Station/Stop	Dato	Kl.	Varighed	Skift	Transportmidler
<input type="checkbox"/>	Skagen st Rødby Færge	27.04.07 27.04.07	Afg. 08:56 Ank. 17:35	8:39	2	
<input type="checkbox"/>	Skagen st Rødby Færge	27.04.07 27.04.07	Afg. 09:56 Ank. 17:35	7:39	3	
<input type="checkbox"/>	Skagen st Rødby Færge	27.04.07 27.04.07	Afg. 09:56 Ank. 18:30	8:34	2	
<input type="checkbox"/>	Skagen st Rødby Færge	27.04.07 27.04.07	Afg. 11:54 Ank. 19:35	7:41	3	
<input checked="" type="checkbox"/>	Skagen st Rødby Færge	27.04.07 27.04.07	Afg. 13:54 Ank. 22:31	8:37	3	

[Senere forbindelser](#)

Vis valgte Vis alle

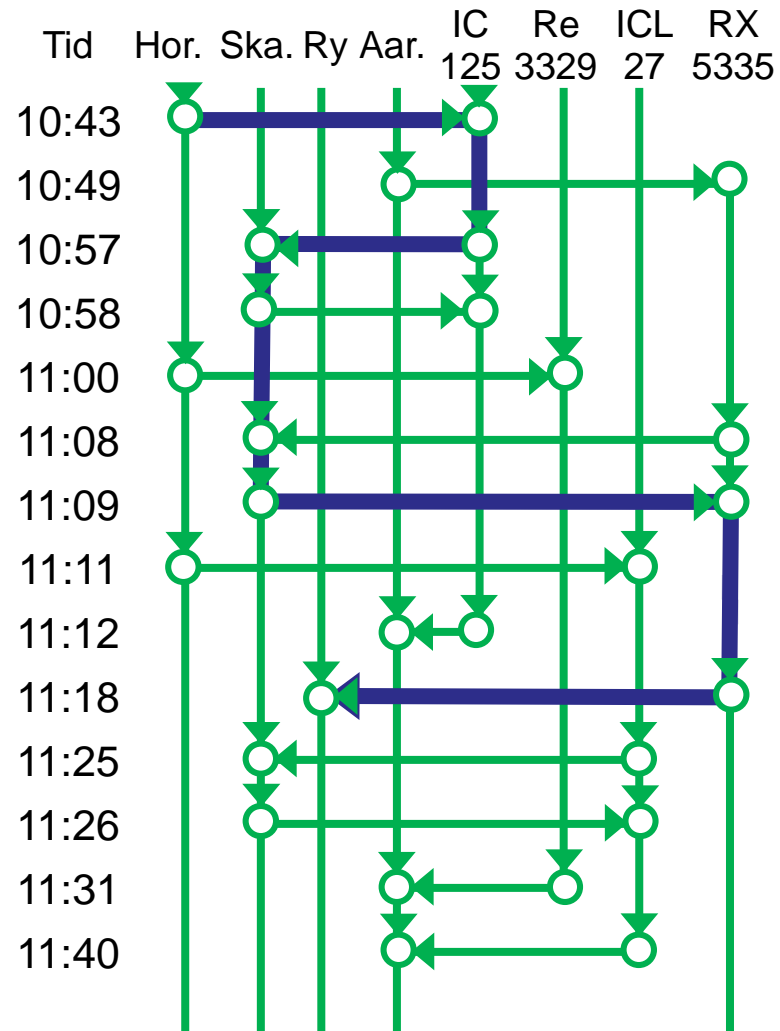
Din rejseplan

Station/Stop	Dato	Kl.	Spor	Transportmidler	Bemærkninger
Skagen st Frederikshavn st	27.04.07 27.04.07	Afg. 13:54 Ank. 14:31			Privatbane Retning: Frederikshavn st
Frederikshavn st Frederikshavn Busterminal	27.04.07 27.04.07				0 min.
Frederikshavn Busterminal Aalborg Busterminal	27.04.07 27.04.07	Afg. 14:35 Ank. 15:48			X-BUS Retning: Aalborg Busterminal
Aalborg Busterminal Aalborg st	27.04.07 27.04.07				5 min.
Aalborg st Høje Taastrup st	27.04.07 27.04.07	Afg. 15:59 Ank. 20:14	3 2		IC Lyntog Retning: København H Spørnummeret er kun vejledende.
Høje Taastrup st Rødby Færge	27.04.07 27.04.07	Afg. 20:23 Ank. 22:31			Regionaltog Retning: Rødby Færge

Varighed: 8:37; kører 27. apr, 11. maj

Bemærkning: En station/stop er passeret flere gange, hvilket kan have betydning for prisudregningen af billetten.

Rejseplan (Horsens til Ry)



Algoritme

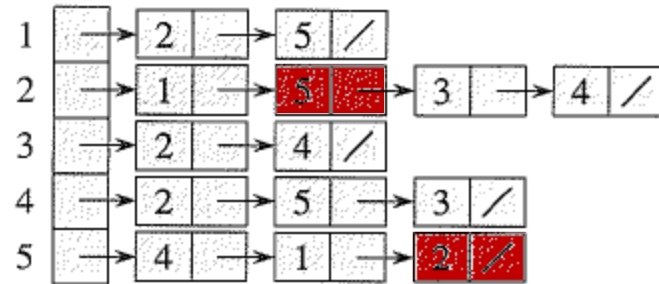
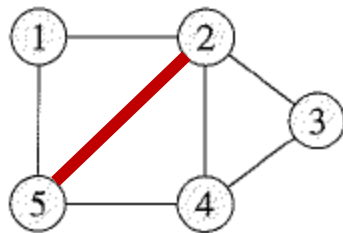
Find tidligste knude for **Ry** der kan nås
fra en given start-knude i **Horsens**

Tog	Ank	Afg	Station
		10:43	Horsens
IC125	10:57	10:58	Skanderborg St
	11:12		Aarhus H
Re3329		11:00	Horsens
	11:31		Aarhus H
		11:11	Horsens
ICL27	11:25	11:26	Skanderborg St
	11:40		Aarhus H
		10:49	Aarhus H
RX5335	11:08	11:09	Skanderborg St
	11:18		Ry St



uddrag af køreplaner

Graf repræsentationer: Incidenslister og incidensmatricer

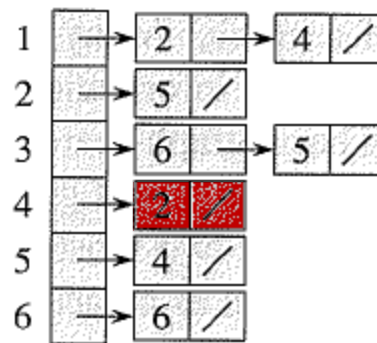
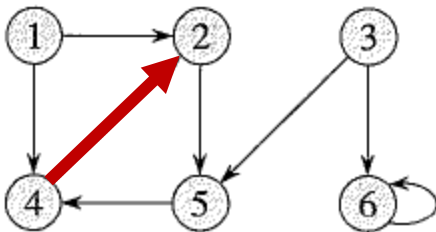


	1	2	3	4	5
1	0	1	0	0	1
2	1	0	1	1	1
3	0	1	0	1	0
4	0	1	1	0	1
5	1	1	0	1	0

Uorienterede grafer

Plads $O(n+m)$

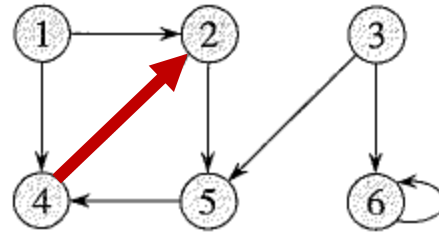
Plads $O(n^2)$



	1	2	3	4	5	6
1	0	1	0	1	0	0
2	0	0	0	0	1	0
3	0	0	0	0	1	1
4	0	1	0	0	0	0
5	0	0	0	1	0	0
6	0	0	0	0	0	1

Orienterede grafer

Graf repræsentationer: ... et par flere alternativer

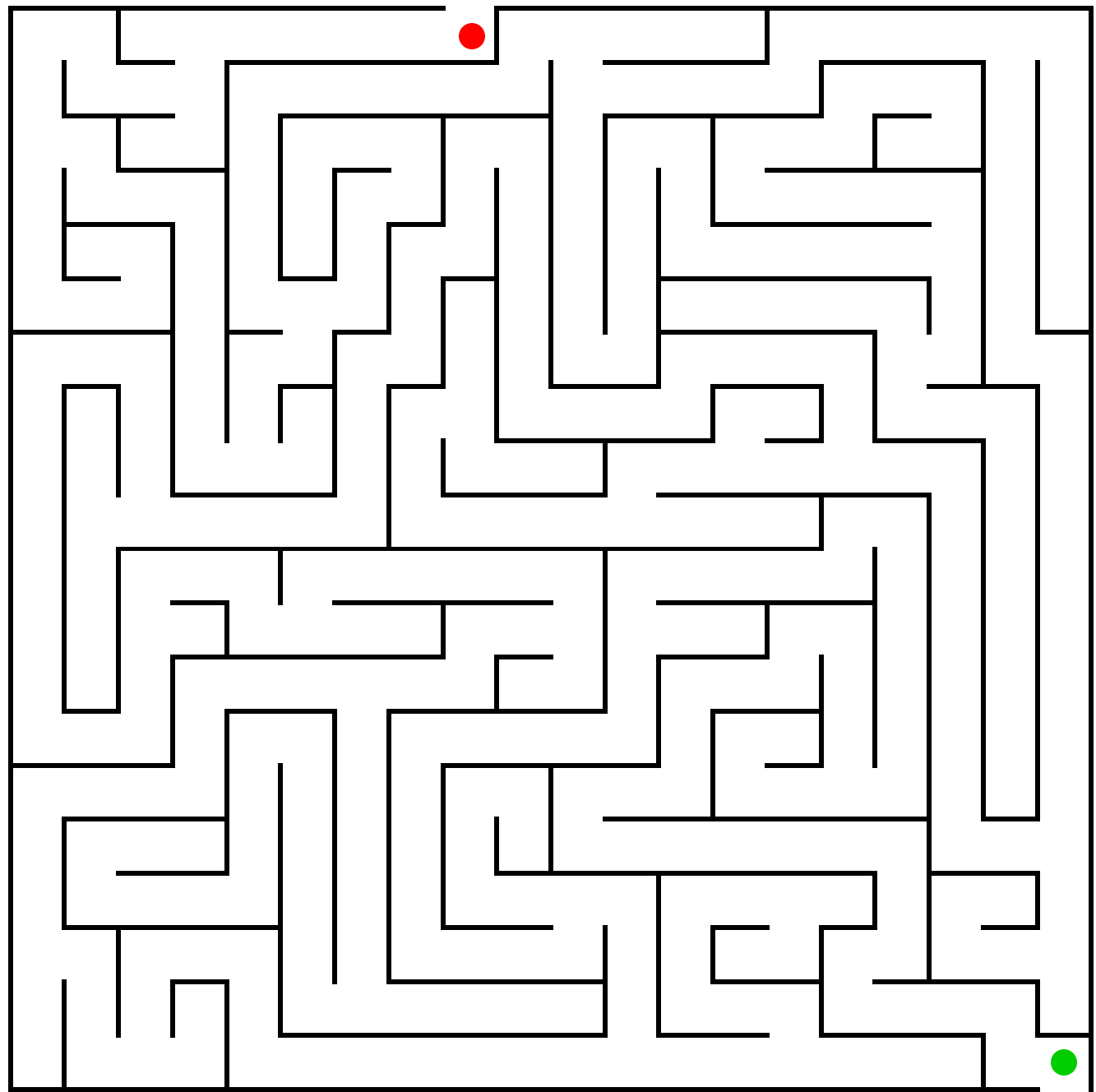


Kantliste
(list/array med par af heltal)

(1, 2)	(1, 4)	(2, 5)	(3, 5)	(3, 6)	(4, 2)	(5, 4)	(6, 6)
--------	--------	--------	--------	--------	--------	--------	--------

Kompakte incidenslister
(to arrays med heltal)

	1	2	3	4	5	6	
<i>V</i>	1	3	4	6	7	8	
<i>E</i>	2	4	5	5	6	2	4



Bredde først søgning (BFS)

BFS(G, s)

```

1  for each vertex  $u \in G.V - \{s\}$ 
2     $u.color = \text{WHITE}$ 
3     $u.d = \infty$ 
4     $u.\pi = \text{NIL}$ 
5   $s.color = \text{GRAY}$ 
6   $s.d = 0$ 
7   $s.\pi = \text{NIL}$ 
8   $Q = \emptyset$ 
9  ENQUEUE( $Q, s$ )
10 while  $Q \neq \emptyset$ 
11    $u = \text{DEQUEUE}(Q)$ 
12   for each  $v \in G.Adj[u]$ 
13     if  $v.color == \text{WHITE}$ 
14        $v.color = \text{GRAY}$ 
15        $v.d = u.d + 1$ 
16        $v.\pi = u$ 
17       ENQUEUE( $Q, v$ )
18    $u.color = \text{BLACK}$ 
    
```

$u.color$:

WHITE = knuderne endnu ikke besøgt

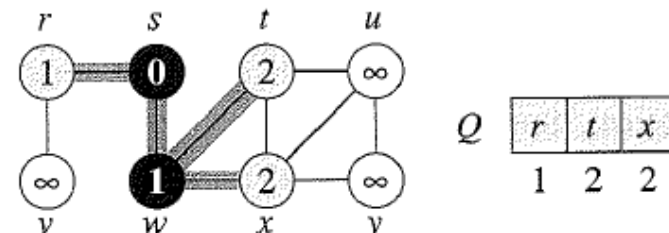
GRAY = knuderne i køen Q

BLACK = knuderne besøgt

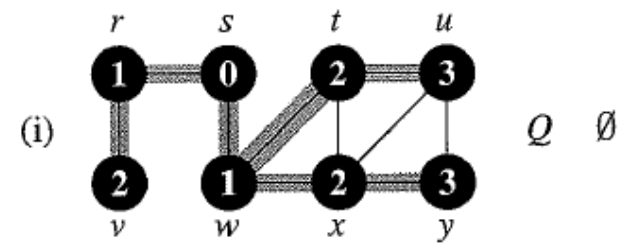
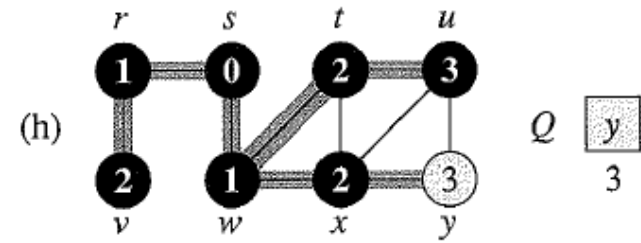
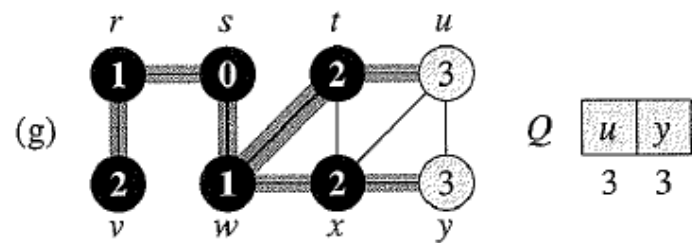
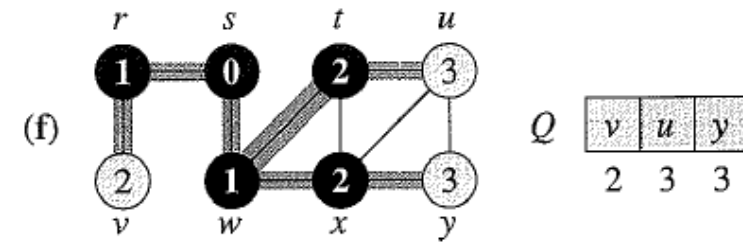
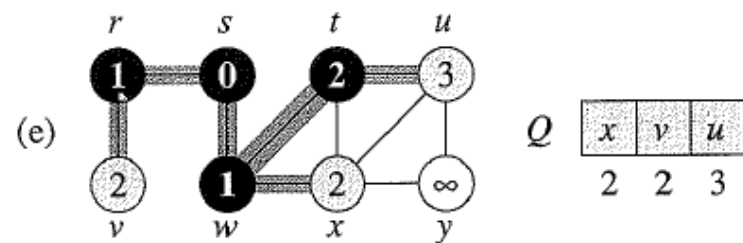
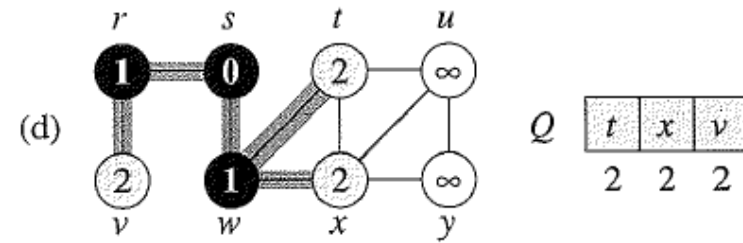
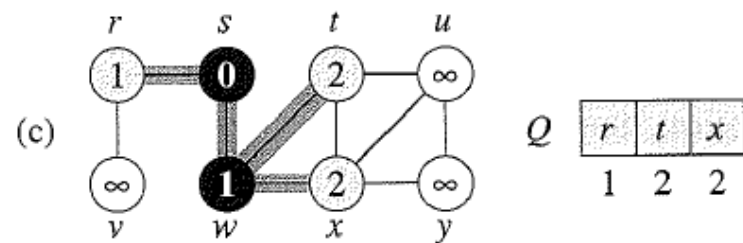
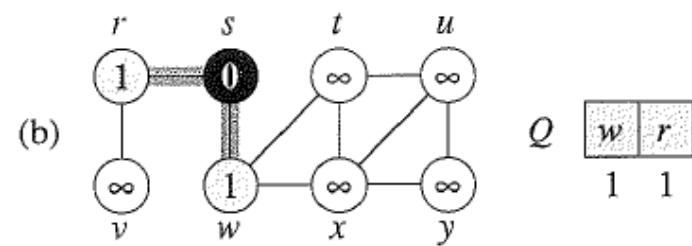
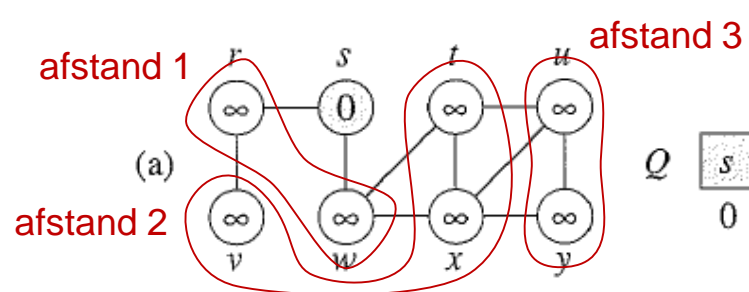
$u.d$ = afstand til s

$u.\pi$ = faderen til u i BFS træet

Q = kø af grå knuder (som er forbundet til sorte knuder)



Tid $O(n+m)$



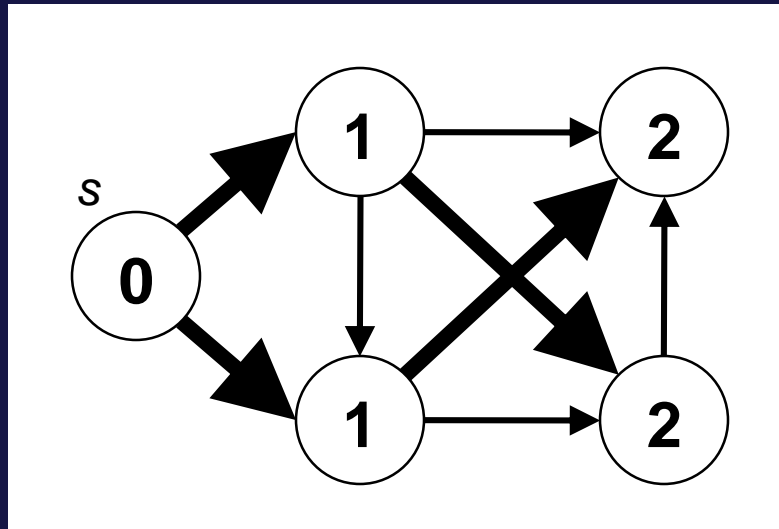
Er nedenstående et BFS træ?

a) Ja



b) Nej

c) Ved ikke



BFS : Udskrivning af sti fra s til v

PRINT-PATH(G, s, v)

```
1  if  $v == s$   
2      print  $s$   
3  elseif  $v.\pi == \text{NIL}$   
4      print “no path from”  $s$  “to”  $v$  “exists”  
5  else PRINT-PATH( $G, s, v.\pi$ )  
6      print  $v$ 
```