COMP108
Data Structures and Algorithms

Graphs (Part III More on BFS/DFS)

for students who haven't taken COMP111

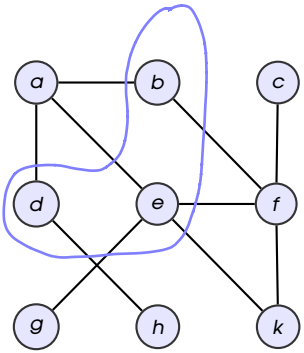
Professor Prudence Wong

pwong@liverpool.ac.uk

2022-23

BFS...

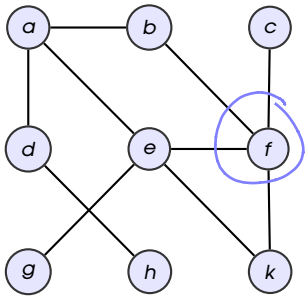
Breadth First Search (BFS)



- Order of exploration:

  a

Breadth First Search (BFS)

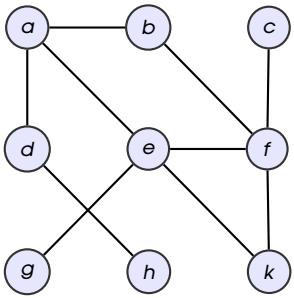


- Order of exploration:

  a

  a, ***b***, ***d***, ***e***

Breadth First Search (BFS)



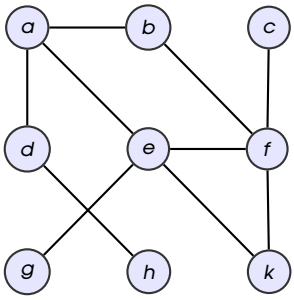
- Order of exploration:

  a

  a, ***b, d, e***

  a, *b*, *d*, *e*, ***f***

Breadth First Search (BFS)



- Order of exploration:

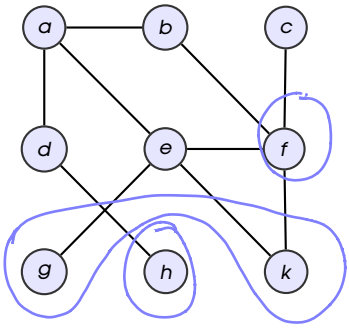
  a

  a, ***b***, ***d***, ***e***

  a, *b*, *d*, *e*, ***f***

  a, *b*, *d*, *e*, *f*, ***h***

Breadth First Search (BFS)



- Order of exploration:

  a

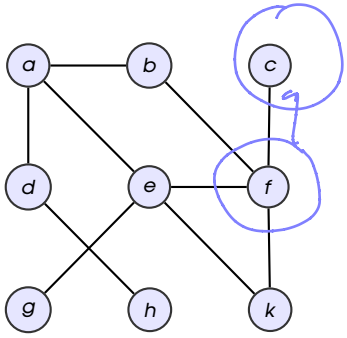
  a, ***b, d, e***

  a, *b*, *d*, *e*, ***f***

  a, *b*, *d*, *e*, *f*, ***h***

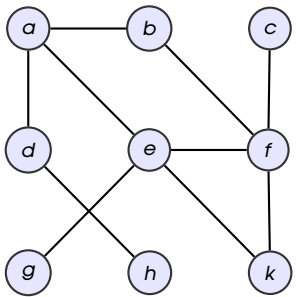
  a, *b*, *d*, *e*, *f*, *h*, ***g, k***

Breadth First Search (BFS)



- Order of exploration:
  - ***a***
  - *a*, ***b, d, e***
  - *a*, *b*, *d*, *e*, ***f***
  - *a*, *b*, *d*, *e*, *f*, ***h***
  - *a*, *b*, *d*, *e*, *f*, *h*, ***g, k***
  - *a*, *b*, *d*, *e*, *f*, *h*, *g*, *k*, ***c***

Breadth First Search (BFS)



- Order of exploration:

  a

  a, ***b, d, e***

  a, *b*, *d*, *e*, ***f***

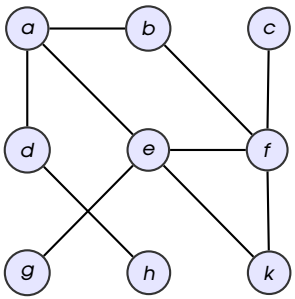
  a, *b*, *d*, *e*, *f*, ***h***

  a, *b*, *d*, *e*, *f*, *h*, ***g, k***

  a, *b*, *d*, *e*, *f*, *h*, *g*, *k*, ***c***

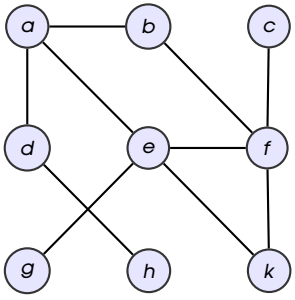
  a, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*

Breadth First Search (BFS)



- Order of exploration:
  - ***a***
  - *a*, ***b***, ***d***, ***e***
  - *a*, *b*, *d*, *e*, ***f***
  - *a*, *b*, *d*, *e*, *f*, ***h***
  - *a*, *b*, *d*, *e*, *f*, *h*, ***g***, ***k***
  - *a*, *b*, *d*, *e*, *f*, *h*, *g*, *k*, ***c***
  - *a*, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*
  - *a*, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*
  - *a*, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*
  - *a*, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*

Breadth First Search (BFS)



- Order of exploration:

  a

  a, ***b, d, e***

  a, *b*, *d*, *e*, ***f***

  a, *b*, *d*, *e*, *f*, ***h***

  a, *b*, *d*, *e*, *f*, *h*, ***g, k***

  a, *b*, *d*, *e*, *f*, *h*, *g*, *k*, ***c***

  a, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*

  a, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*

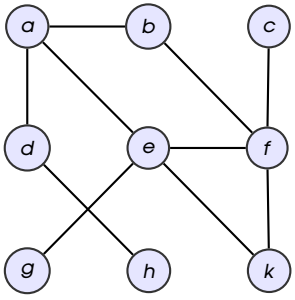
  a, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*

  a, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*

- Summary:

  a, $\underbrace{b, d, e,}_{\text{distance 1}}$ $\underbrace{f, h, g, k,}_{\text{distance 2}}$ *c*

Breadth First Search (BFS)

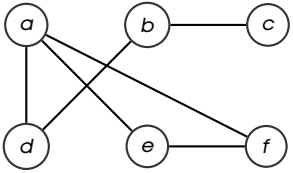


- Order of exploration:
  - ***a***
  - *a*, ***b, d, e***
  - *a*, *b*, *d*, *e*, ***f***
  - *a*, *b*, *d*, *e*, *f*, ***h***
  - *a*, *b*, *d*, *e*, *f*, *h*, ***g, k***
  - *a*, *b*, *d*, *e*, *f*, *h*, *g*, *k*, ***c***
  - *a*, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*
  - *a*, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*
  - *a*, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*
  - *a*, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*
- Summary:

  a, *b*, *d*, *e*, *f*, *h*, *g*, *k*, *c*

  distance 1 | distance 2
- Can we have *g* before *h*?

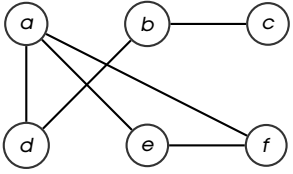
Exercises - BFS starting from vertex a

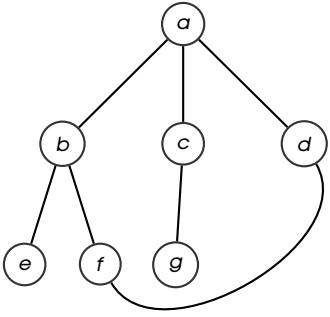


Possible BFS:

a, d, e, f, b, c
a, d, f, e, b, c
a, e, d, f, b, c
a, e, f, d, b, c
a, f, d, e, b, c
a, f, e, d, b, c

Exercises - BFS starting from vertex a





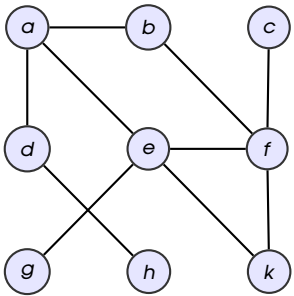
Possible BFS:

```
a, b, c, d, e, f, g
a, b, c, d, f, e, g
a, b, d, c, e, f, g
a, b, d, c, f, e, g
a, c, b, d, g, e, f
a, c, b, d, g, f, e
```

```
a, c, d, b, g, e, f
a, c, d, b, g, f, e
a, d, b, c, f, e, g
a, d, c, b, f, g, e
```

DFS...

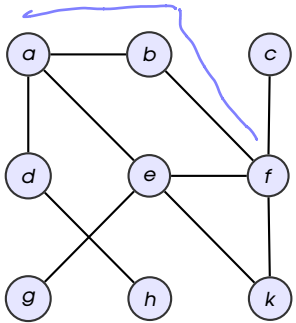
Depth First Search (DFS)



- Order of exploration:

  a

Depth First Search (DFS)

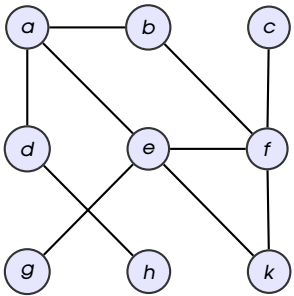


- Order of exploration:

  a

  a, ***b***

Depth First Search (DFS)



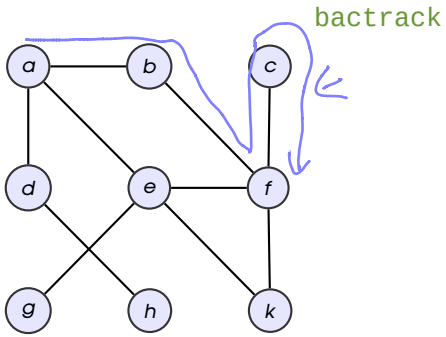
- Order of exploration:

  a

  a, ***b***

  a, *b*, ***f***

Depth First Search (DFS)



- Order of exploration:

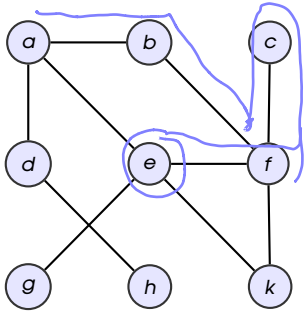
  a

  a, ***b***

  a, *b*, ***f***

  a, *b*, *f*, ***c***

Depth First Search (DFS)



- Order of exploration:

  a

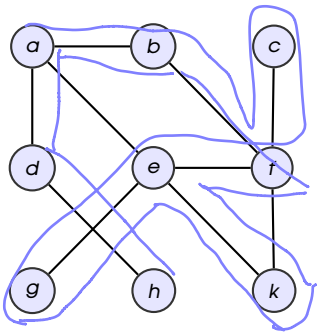
  a, ***b***

  a, *b*, ***f***

  a, *b*, *f*, ***c***

  a, *b*, *f*, *c*, ***e***

Depth First Search (DFS)



- Order of exploration:

  a

  a, ***b***

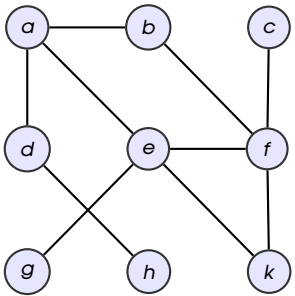
  a, *b*, ***f***

  a, *b*, *f*, ***c***

  a, *b*, *f*, *c*, ***e***

  a, *b*, *f*, *c*, *e*, ***g***

Depth First Search (DFS)



- Order of exploration:

  a

  a, ***b***

  a, *b*, ***f***

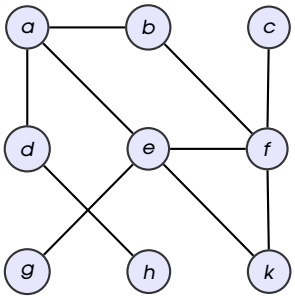
  a, *b*, *f*, ***c***

  a, *b*, *f*, *c*, ***e***

  a, *b*, *f*, *c*, *e*, ***g***

  a, *b*, *f*, *c*, *e*, *g*, ***k***

Depth First Search (DFS)



- Order of exploration:

  a

  a, ***b***

  a, *b*, ***f***

  a, *b*, *f*, ***c***

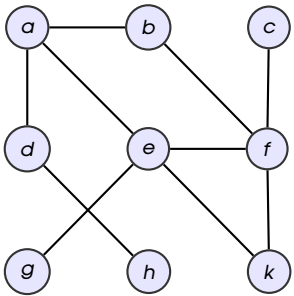
  a, *b*, *f*, *c*, ***e***

  a, *b*, *f*, *c*, *e*, ***g***

  a, *b*, *f*, *c*, *e*, *g*, ***k***

  a, *b*, *f*, *c*, *e*, *g*, *k*

Depth First Search (DFS)



- Order of exploration:

  a

  a, ***b***

  a, *b*, ***f***

  a, *b*, *f*, ***c***

  a, *b*, *f*, *c*, ***e***

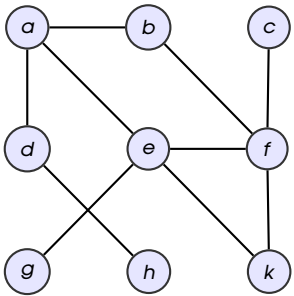
  a, *b*, *f*, *c*, *e*, ***g***

  a, *b*, *f*, *c*, *e*, *g*, ***k***

  a, *b*, *f*, *c*, *e*, *g*, *k*

  a, *b*, *f*, *c*, *e*, *g*, *k*

Depth First Search (DFS)



- Order of exploration:

  a

  a, ***b***

  a, *b*, ***f***

  a, *b*, *f*, ***c***

  a, *b*, *f*, *c*, ***e***

  a, *b*, *f*, *c*, *e*, ***g***

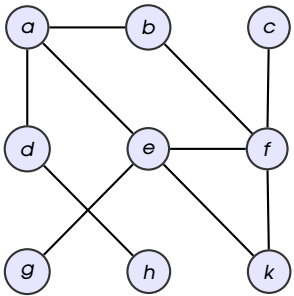
  a, *b*, *f*, *c*, *e*, *g*, ***k***

  a, *b*, *f*, *c*, *e*, *g*, *k*

  a, *b*, *f*, *c*, *e*, *g*, *k*

  a, *b*, *f*, *c*, *e*, *g*, *k*, ***d***

Depth First Search (DFS)



- Order of exploration:

  a

  a, ***b***

  a, *b*, ***f***

  a, *b*, *f*, ***c***

  a, *b*, *f*, *c*, ***e***

  a, *b*, *f*, *c*, *e*, ***g***

  a, *b*, *f*, *c*, *e*, *g*, ***k***

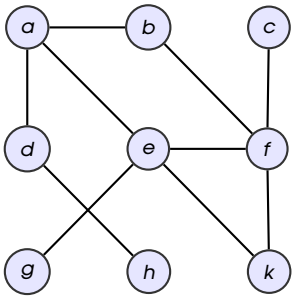
  a, *b*, *f*, *c*, *e*, *g*, *k*

  a, *b*, *f*, *c*, *e*, *g*, *k*

  a, *b*, *f*, *c*, *e*, *g*, *k*, ***d***

  a, *b*, *f*, *c*, *e*, *g*, *k*, *d*, ***h***

Depth First Search (DFS)



- Order of exploration:

  a

  a, ***b***

  a, *b*, ***f***

  a, *b*, *f*, ***c***

  a, *b*, *f*, *c*, ***e***

  a, *b*, *f*, *c*, *e*, ***g***

  a, *b*, *f*, *c*, *e*, *g*, ***k***

  a, *b*, *f*, *c*, *e*, *g*, *k*

  a, *b*, *f*, *c*, *e*, *g*, *k*

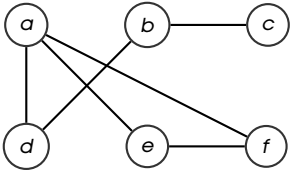
  a, *b*, *f*, *c*, *e*, *g*, *k*, ***d***

  a, *b*, *f*, *c*, *e*, *g*, *k*, *d*, ***h***

- Summary:

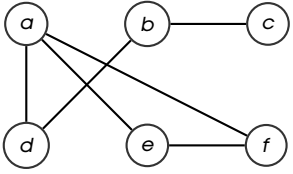
  a, *b*, *f*, *c*, *e*, *g*, *k*, *d*, *h*

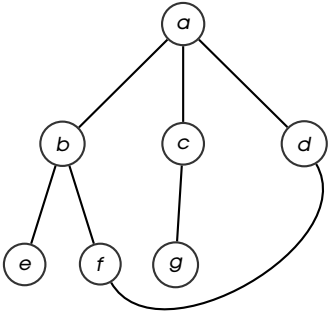
Exercises - DFS starting from vertex *a*




```
Possible DFS:
a, d, b, c, e, f
a, d, b, c, f, e
a, e, f, d, b, c
a, f, e, d, b, c
```

Exercises - DFS starting from vertex *a*





Possible DFS:

```
a, b, e, f, d, c, g
a, b, f, d, e, c, g
a, c, g, b, e, f, d
a, c, g, b, f, d, e
a, d, f, b, e, c, g
```

For note taking