Programming, Problem Solving, and Algorithms

CPSC 203, 2024 W2
(January – April 2025)
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Lecture 09A

Planning (first algorithm)

Given: Image filename and center density *d*

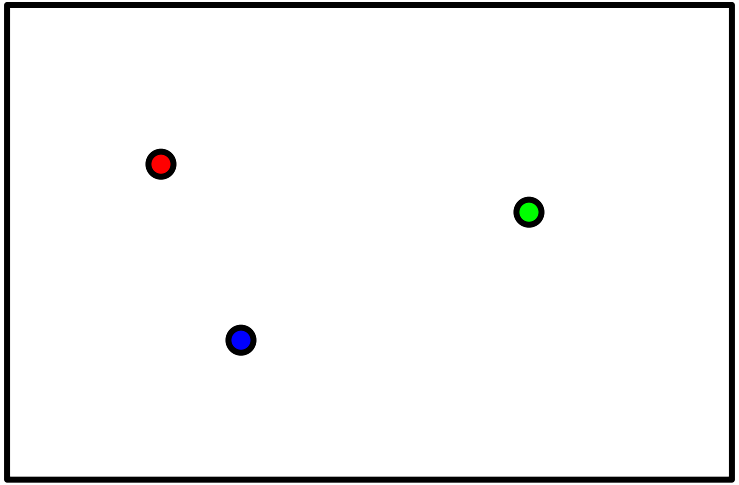
Algorithm:

1. Load original image (with *n* pixels) & create blank output image
2. Choose $c = dn$ centers by randomly selecting pixels from the image
3. For each pixel:
   - For each center:
     - Compute distance from pixel to center
   - Set colour of pixel to colour of closest center
4. Save output image

Demo and Analysis

How much work is done? Let n denote the size of the image, n = width * height

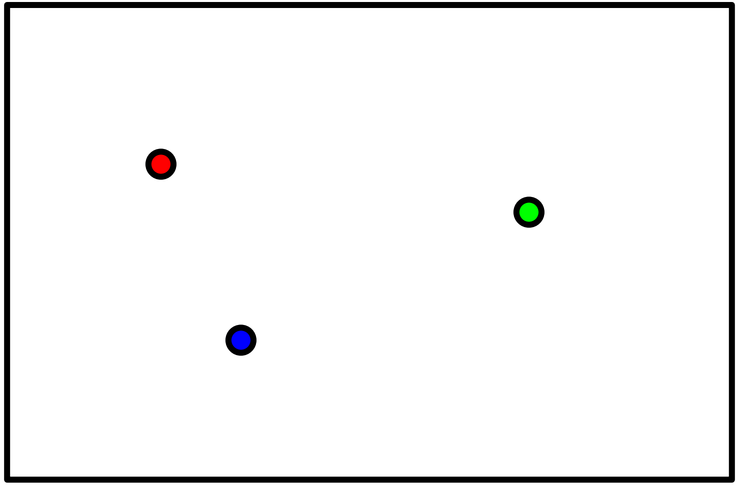
1) Read image:
2) Choose centers:
3) Build new image:
4) Write out new image:



Can we do better?

The running time of the original algorithm: ____________________

What would be better? ____________________

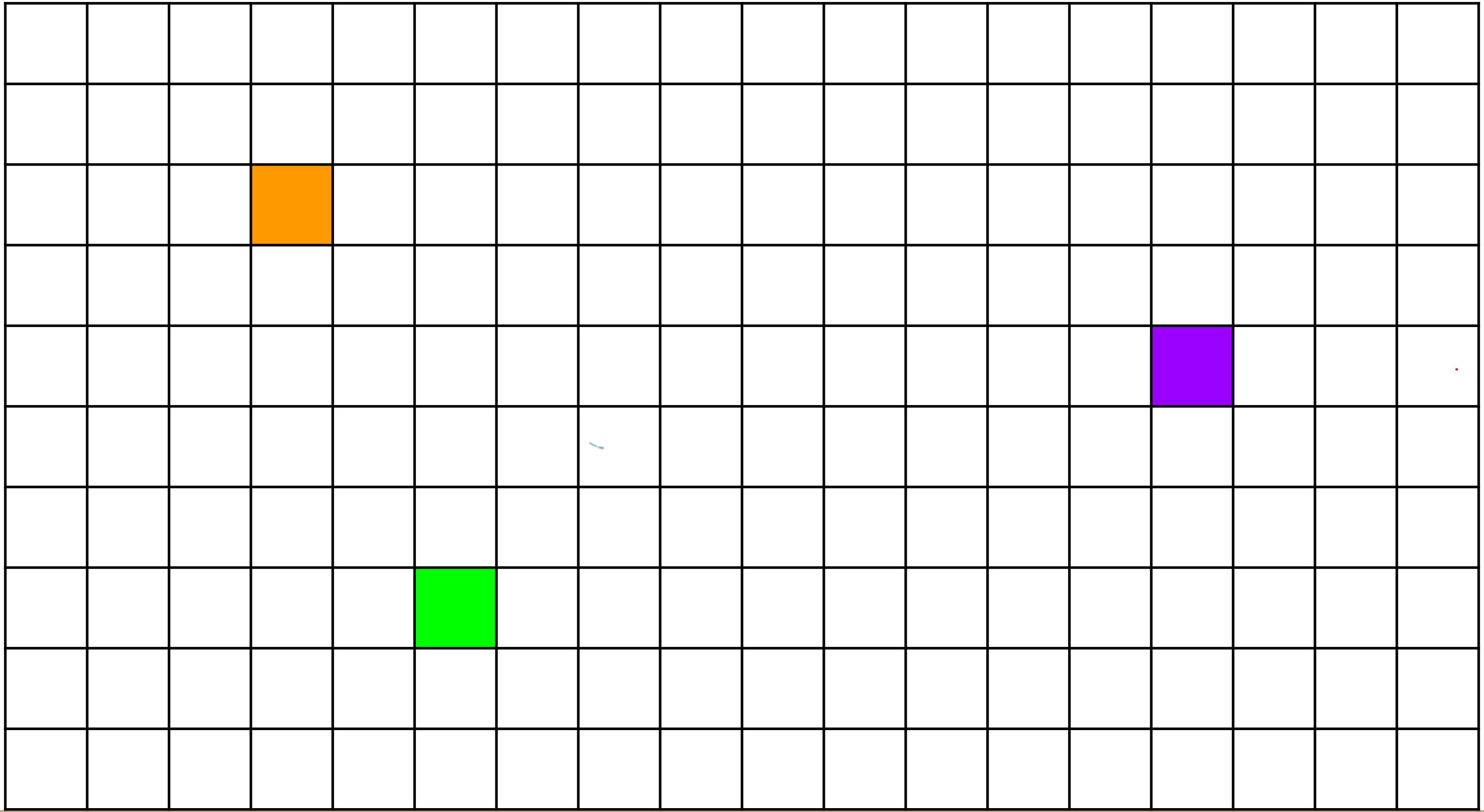


Orchestrate a fill from each center, growing out at the same rate.

Each pixel is processed exactly once, not once per center as before.

This means we can have lots of centers!

Design an Algorithm



Planning (new algorithm)

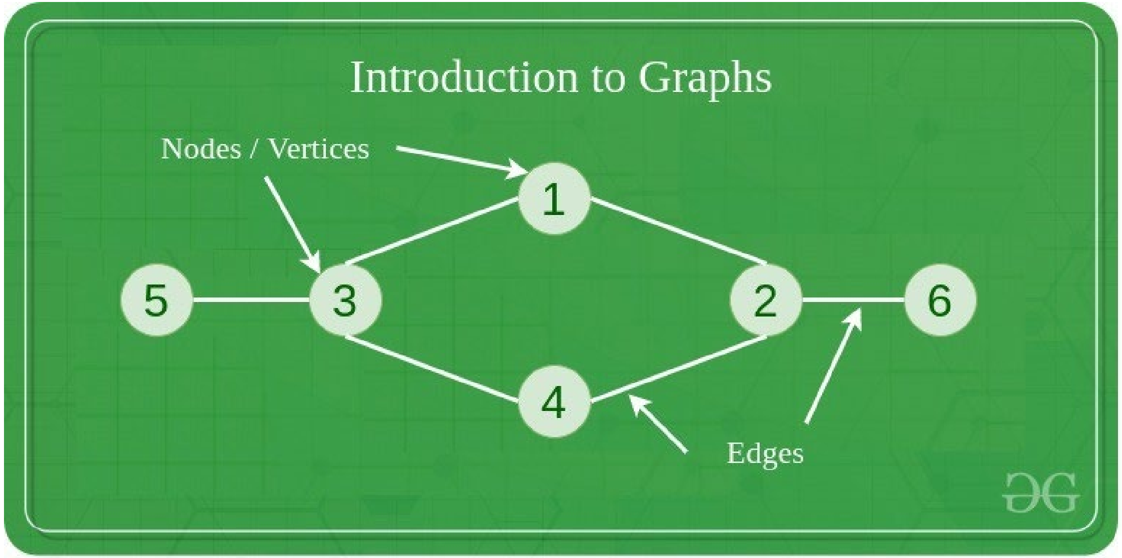
Given: Image filename and center density *d*

Algorithm:

1. Load original image (with *n* pixels) & create blank output image
2. Choose *c* = *dn* centers by randomly selecting pixels from the image
3.
4. Save output image

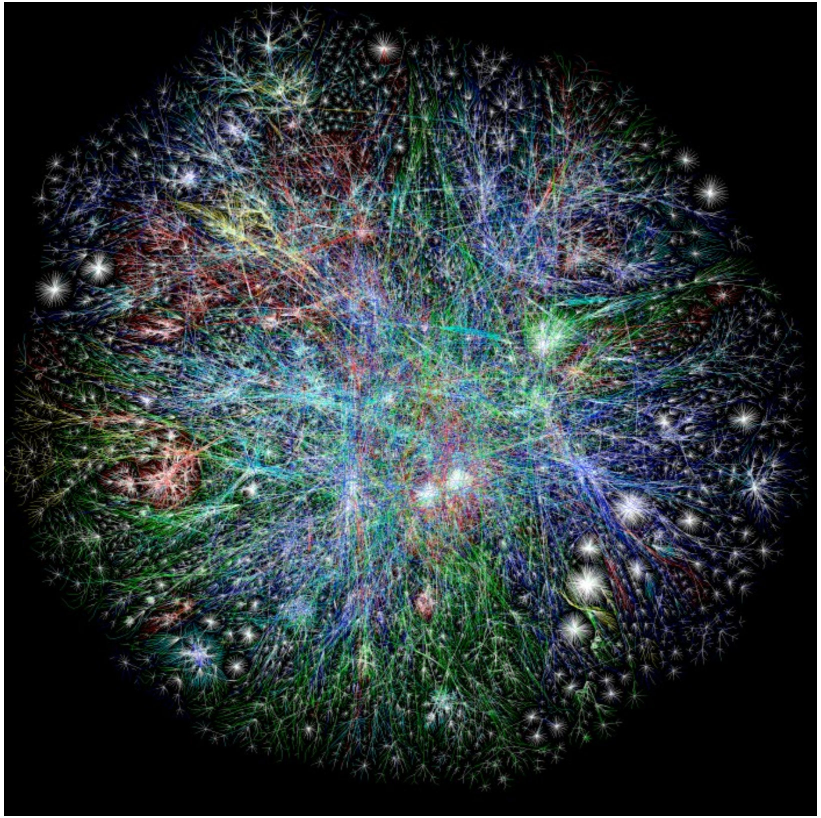
New Data Structure: Graphs

- Representation of the “neighbour” (or other) relationship(s) between entities
    - “Nodes” / “Vertices” denote entities, “edges” denote relationships

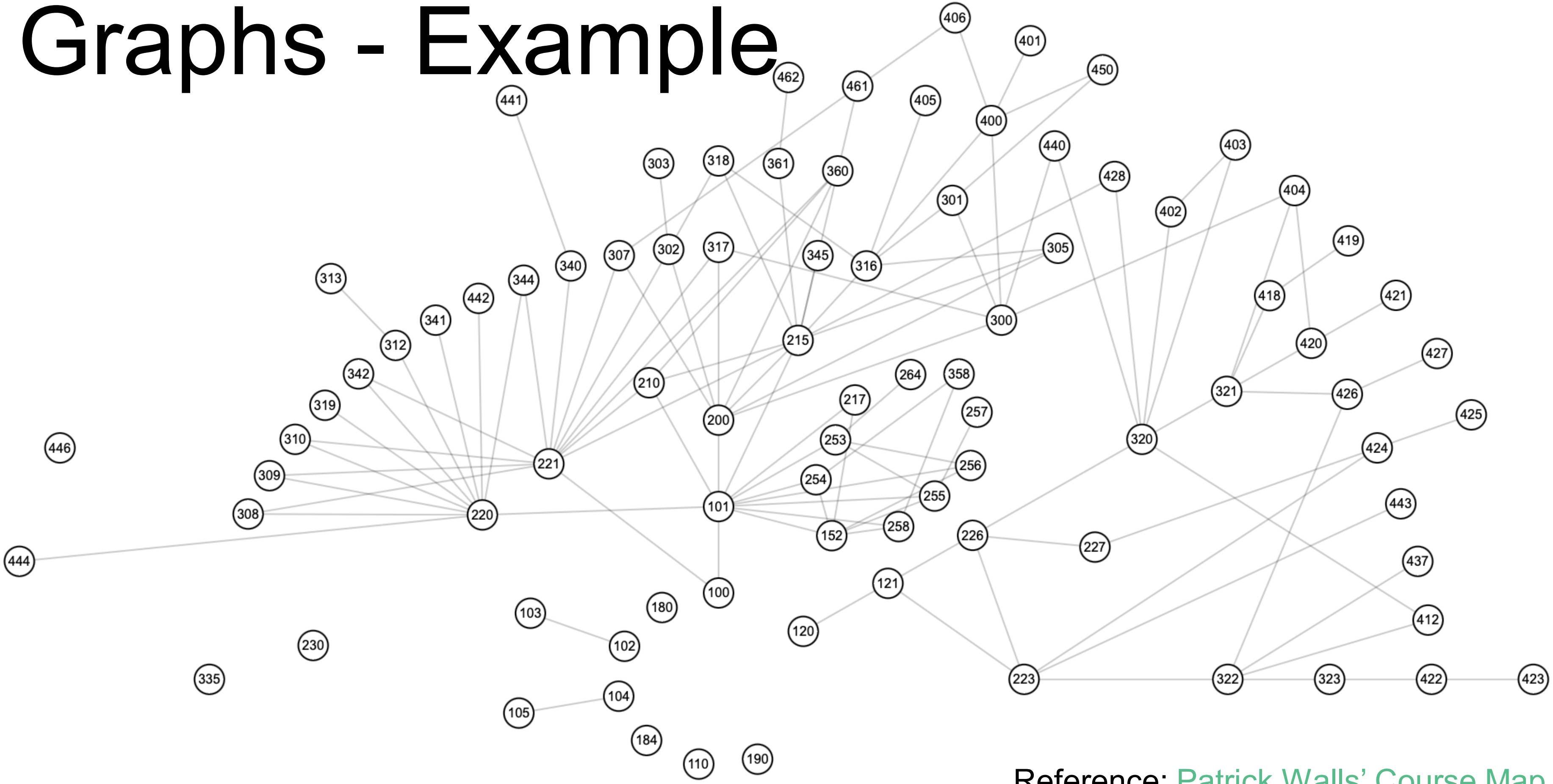


Reference:
Geeks for Geeks

Introduction to Graphs:



Graphs - Example



Reference: [Patrick Walls' Course Map]

Graphs: A new model for representing images

00	10	20	30	40	50	60	70	80	90
01	11	21	31	41	51	61	71	81	91
02	12	22	32	42	52	62	72	82	92
03	13	23	33	43	53	63	73	83	93
04	14	24	34	44	54	64	74	84	94
05	15	25	35	45	55	65	75	85	95

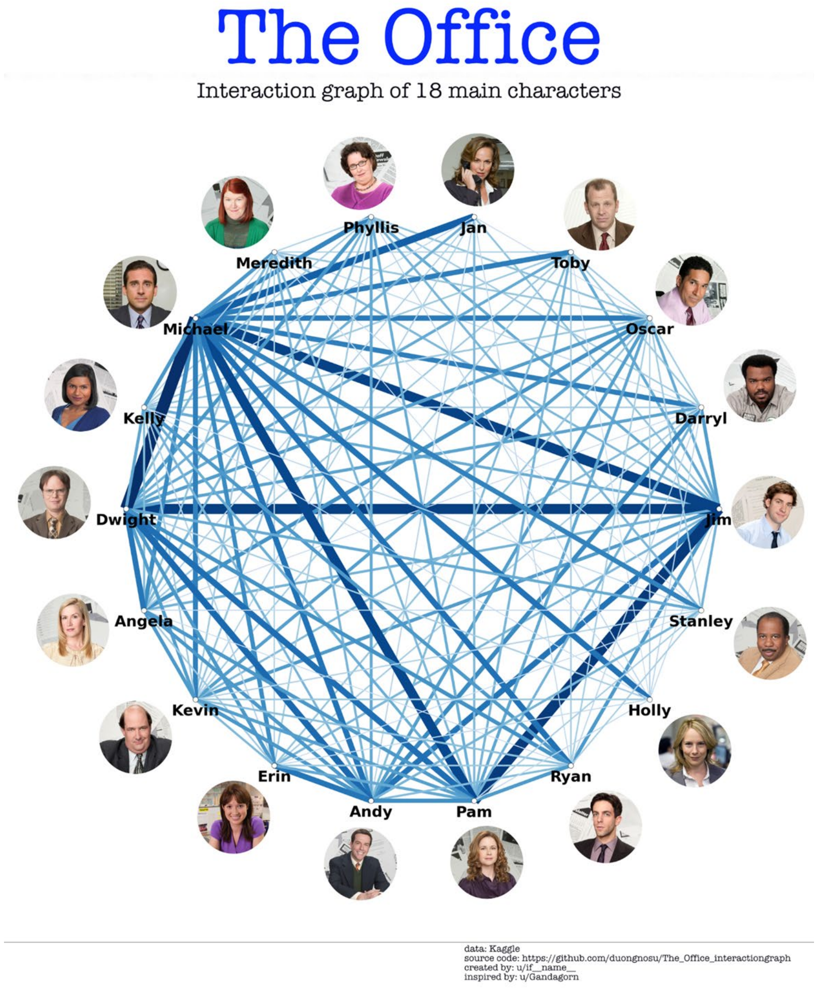
A *Graph* is a collection of *vertices*, and *edges* between them. They're used as a general model for many problems.

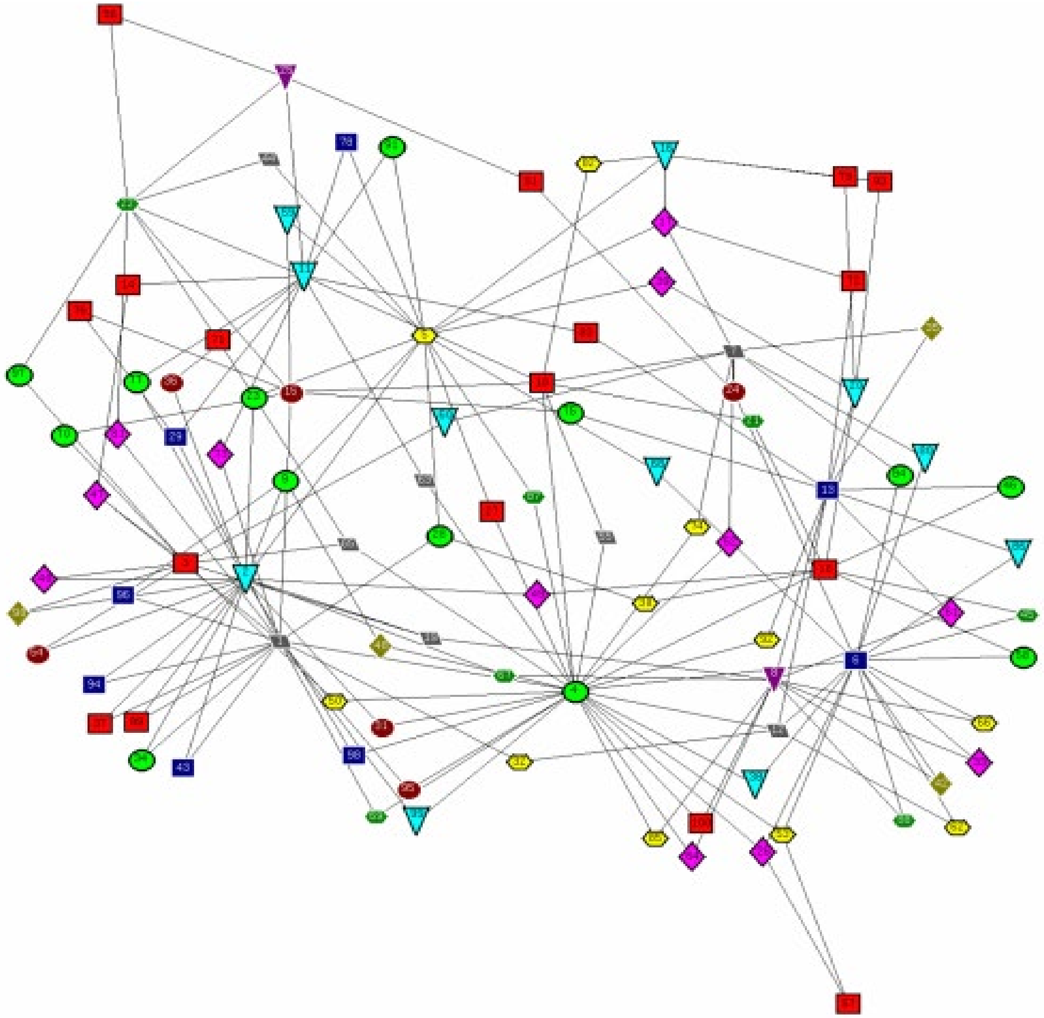
In our images every **pixel** is a vertex, and every **neighbour** is an edge. How many edges are there in the graph representing the image on the left?

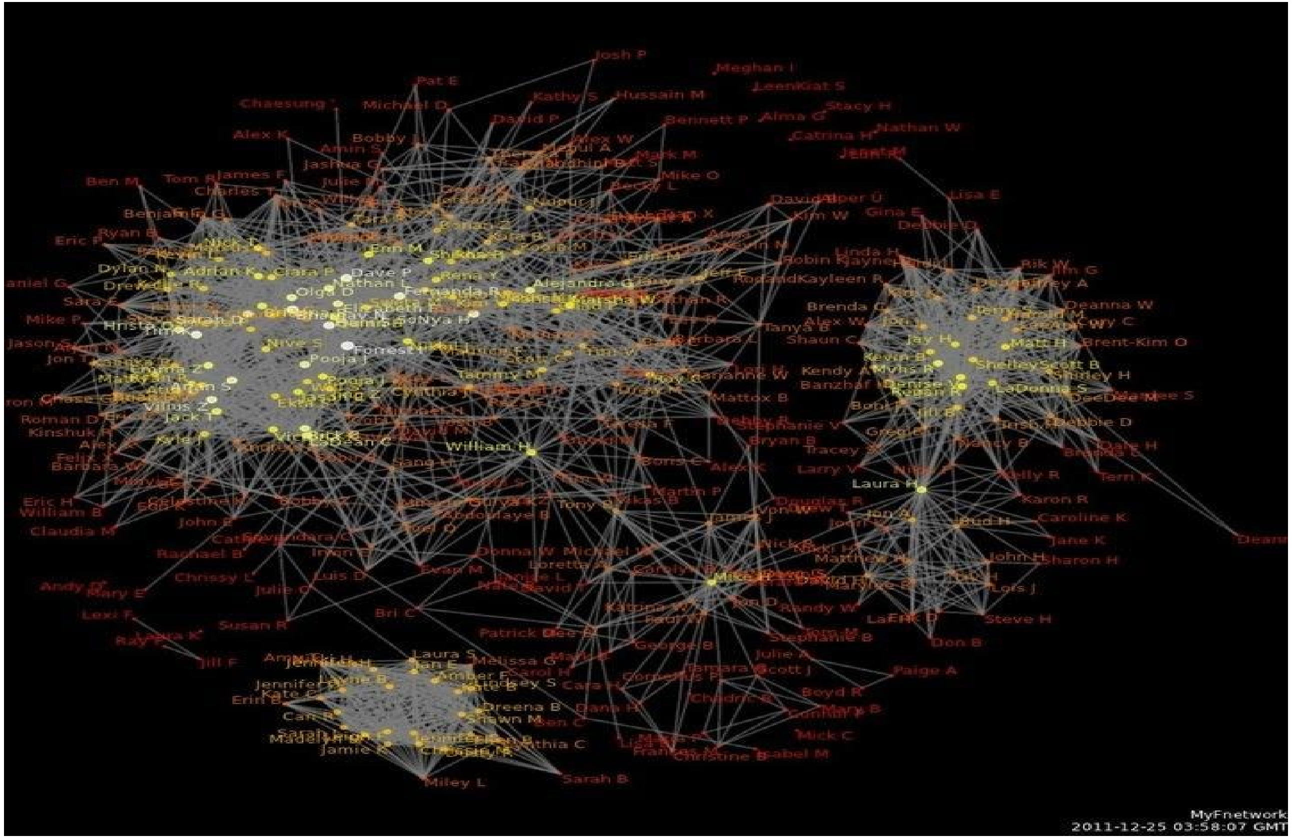
Our fast algorithm for Voronoi Art mirrors a classic algorithm on graphs called Breadth First Search.

Breadth First Search

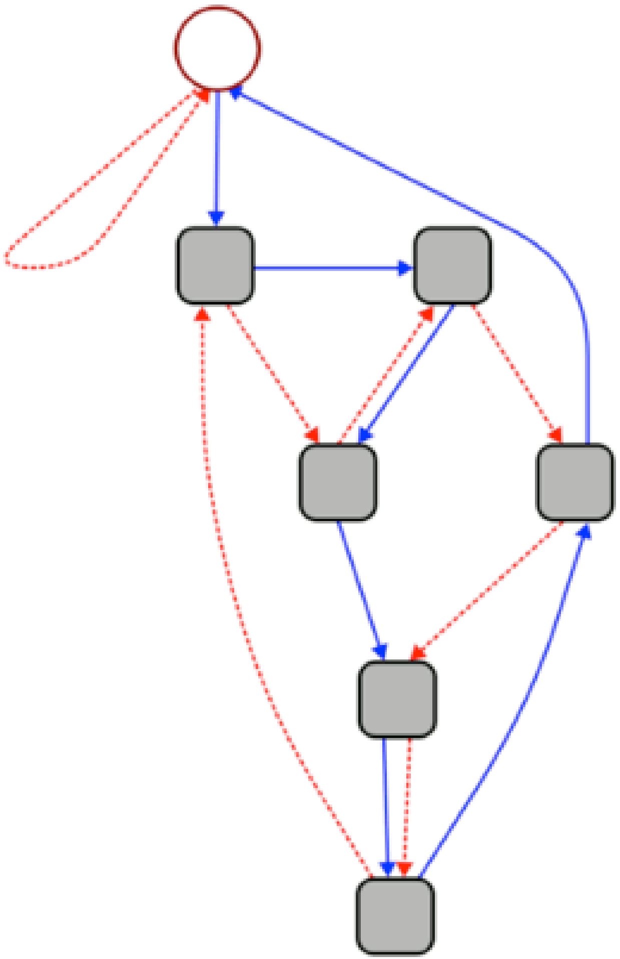
Breadth-first search (**BFS**) is an algorithm for traversing or searching tree or graph data structures. It starts at the tree root (or some arbitrary node of a graph, …), and explores all of the neighbor nodes at the present depth prior to moving on to the nodes at the next depth level. (--Wikipedia)


The Office
Interaction graph of 18 main characters
Phyllis
Jan
Meredith
Toby
Michael
Oscar
Kelly
Darryl
Dwight
Jim
Angela
Stanley
Kevin
Holly
Erin
Ryan
Andy
Pam
data: Kaggle
source code: https://github.com/duongnosu/The_Office_interactiongraph
created by: u/if__name__
inspired by: u/Gandagorn





Josh P
Meghan I
LeenKiat S
Stacy H
Nathan W
Pat E
Chaesung
Michael D
Kathy S
Hussain M
David P
Bennett P
Alma G
Catrina H
Alex K
Bobby J
Mark M
Mike O
Ben M
Tom R
James F
Lisa E
Gina E
Kim W
Linda H
Rik W
Deanna W
Brent-Kim O
Shirley H
Dylan N
Adrian K
Ciara P
Dave P
Nathan L
Fernanda R
Alejandro G
Olga D
Forrest H
Pooja J
Vilius Z
Jack T
William H
Laura H
Tanya B
Shaun C
Kendy A
Mattox B
Bryan B
Stephanie V
Larry V
Tracey S
Douglas R
Karon R
Caroline K
Jane K
Sharon H
Lois J
Steve H
Don B
Paige A
Boyd R
Mick C
Isabel M
Christine B
Eric H
William B
Claudia M
John B
Rachael B
Chrissy L
Andy D
Mary E
Lexi F
Susan R
Julie C
Luis D
Bri C
Jill F
Laura S
Jan E
Melissa G
Amber F
Lindsey S
Dreena B
Shawn M
Cynthia C
Sarah B
Miley L
Jamie K
Jennifer
Erin B
Patrick B
George B
Scott J
Tamara
Julie A
Stephanie B
Randy W
Jon D
Matthew H
John H
Bud H
Kelly R
Debbie D
Terri K
Dale H
Debbie O
Jeff E
Kayleen R
Brenda G
Alex W
Jay H
Matt H
Shelley
Scott B
LaDonna S
Banzhaf
Denise V
Regan R
Bobk
Jill B
Greg
Nancy B
Mike P
Sara E
Jon T
Eric R
Ryan B
Roman D
Kinshuk R
Felix X
Barbara W
Evan M
Donna W
Michael W
Loretta A
Abdoulaye B
Tony
Martin P
Boris C
Alex K
Tammy M
Cynthia R
Nive S
Sarah D
MyFnetwork
2011-12-25 03:58:07 GMT



This graph can be used to quickly calculate whether a given number is divisible by 7.

1. Start at the circle node at the top.
2. For each digit d in the given number, follow d blue (solid) edges in succession. As you move from one digit to the next, follow 1 red (dashed) edge.
3. If you end up back at the circle node, your number is divisible by 7.

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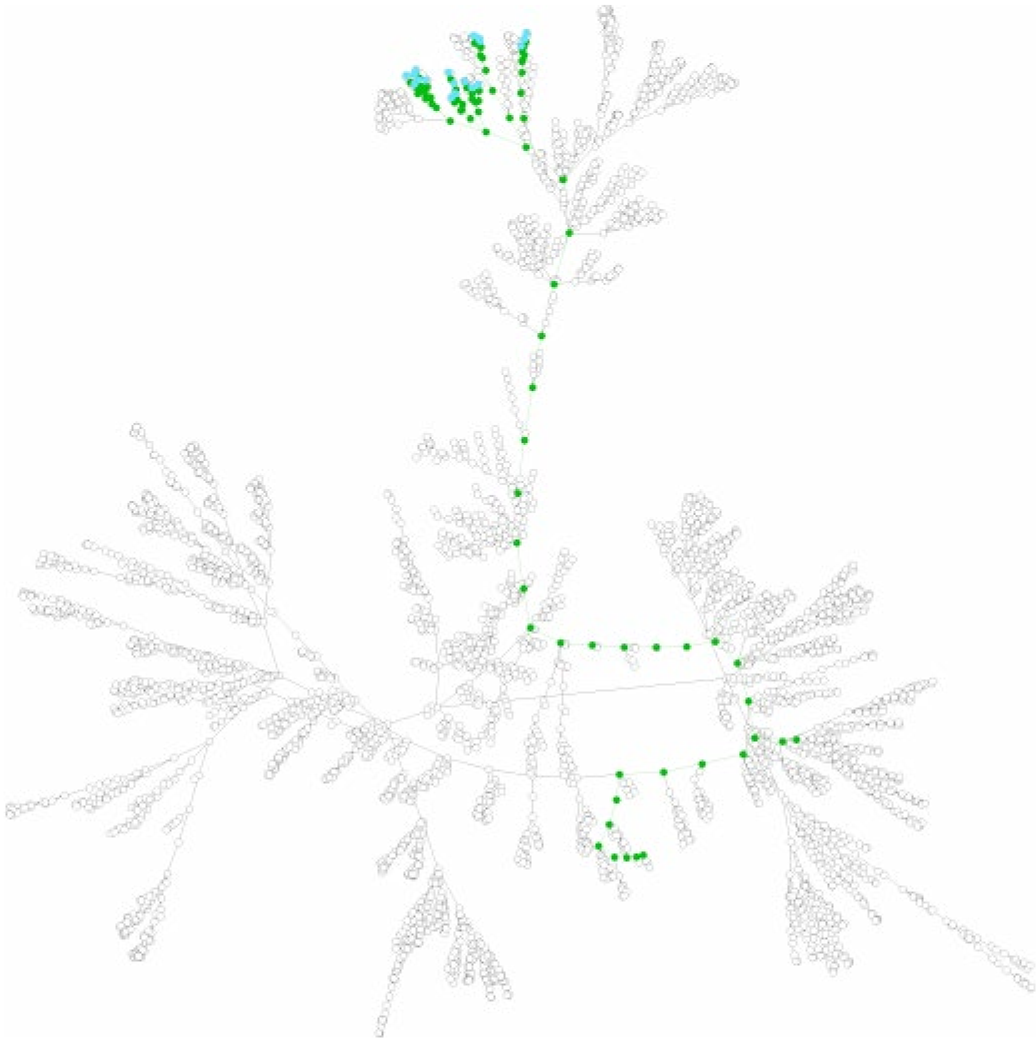


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