# Human gaze inspired routing algorithm

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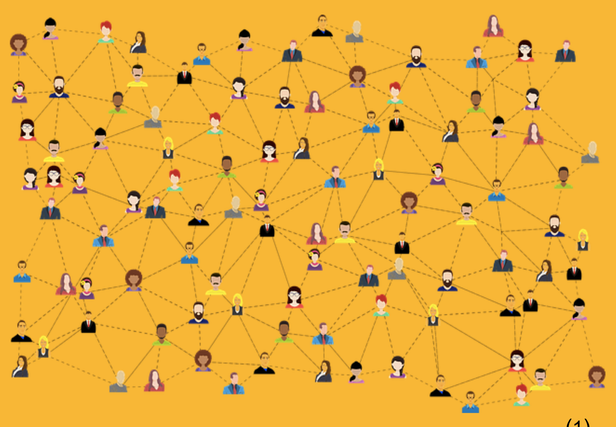
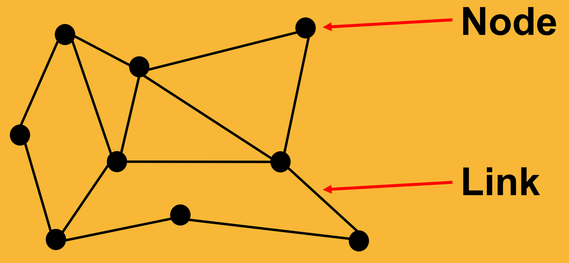
## 1. Context🤔

- **Network maps** are made of nodes and links
- We use them to reveal relationships between entities



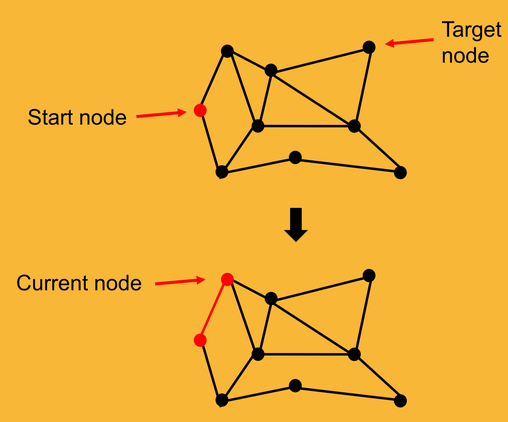
(1)



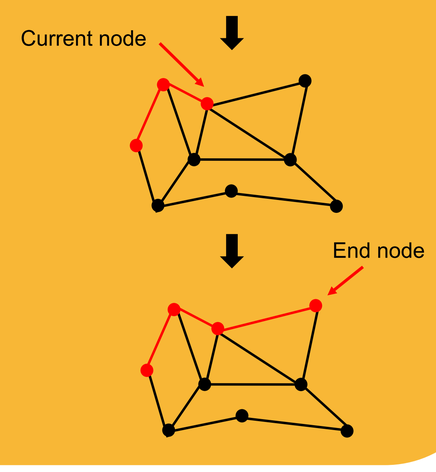

- Network maps are used for **computer networks** or **social networks** to map complex and large scale problems

## 2. Problem🔍

- The **shortest path problem**
- To find the shortest path between two nodes we consider the **edge weightings** (e.g. distance)

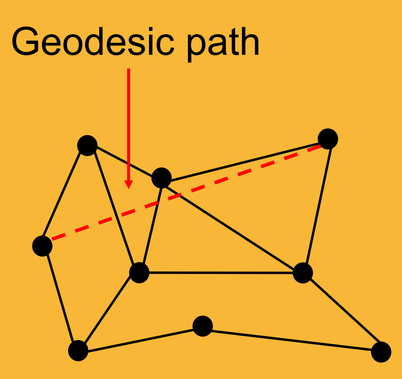



- **Dijkstra** is a popular algorithmic approach
- It considers all possible paths, as a result it is optimal
- It suffers with a **large computational complexity** and **runtime**




## 3. Proposal💡

- To solve the shortest path problem by **imitating humans**
- Humans use a **geodesic path tendency**
- The path closest to the geodesic is chosen by humans
- The path **directed towards the target node** is also chosen
- This approach could reduce the total exploration area of the graph




- **Pros:** Reduced runtime
- **Cons:** Optimal solution not guaranteed

## 4. Results📈

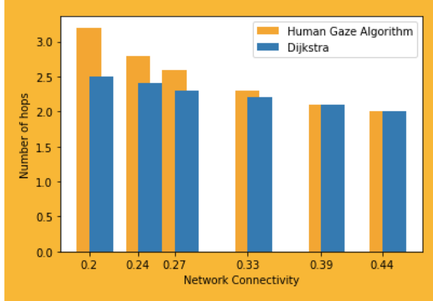
### Simulated Graphs

- 18 graphs with 15 nodes (G1-G18)
- 3 graphs per edge density
- Network connectivity: 0.2 – 0.4
- Edge weighting of 1
- No dead ends or separated graphs

### Real World Networks

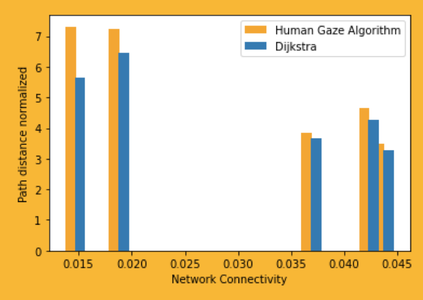
- 5 graphs (World, USA1, Germany, USA2, Europe)
- Nodes: 37 - 100
- Edges: 36 -136
- Network connectivity: 0.01 – 0.04
- Edge weighting in terms of distance

### Number of hops




- Path length decreases with increase in network connectivity
- Human gaze algorithm becomes comparable to Dijkstra with larger network connectivity

### Path distance normalised




- Path distance decreases with increase in network connectivity
- Human gaze algorithm becomes comparable to Dijkstra with larger network connectivity

### Runtime for individual node pairs

| (seconds, Error: $\pm 0.01 \times 10^{-7}$) | Human Gaze Algorithm | Dijkstra |
|---|---|---|
| G3 (0 → 6) (α: 0.17) | $2.85 \times 10^{-7}$ | $6.91 \times 10^{-7}$ |
| G9 (0 → 6) (α: 0.28) | $3.09 \times 10^{-7}$ | $3.81 \times 10^{-7}$ |
| G15 (0 → 6) (α: 0.39) | $2.38 \times 10^{-7}$ | $6.19 \times 10^{-7}$ |

Note: Each was executed ten times and the average value is shown here

- Human Gaze algorithm is up to 2/5 the runtime of Dijkstra

### Runtime for individual node pairs

| (seconds, Error: $\pm 0.01 \times 10^{-7}$) | Human Gaze Algorithm | Dijkstra |
|---|---|---|
| Los Angeles to Bangkok (World) | $2.14 \times 10^{-7}$ | $5.01 \times 10^{-7}$ |
| Flensburg to Kempten (Germany) | $9.53 \times 10^{-8}$ | $4.76 \times 10^{-7}$ |

Note: Each was executed ten times and the average value is shown here

- Human Gaze algorithm is up 1/5 the run time of Dijkstra

### Runtime for all node pairs

| (Error: ±0.1) | Human Gaze Algorithm | Dijkstra |
|---|---|---|
| Seconds | 0.10 | 0.10 |
| MByte | 99.22 | 99.22 |

Note: Both were run on each graph 10 times and the average is shown here

- No difference in runtime for all node pairs

### Runtime for all node pairs

| (Error: ±0.1) | Human Gaze Algorithm | Dijkstra |
|---|---|---|
| Seconds | 0.42 | 0.68 |
| MByte | 135.22 | 135.62 |

Note: Both were run on each graph 10 times and the average is shown here

- Human gaze algorithm is up to 3/5 the runtime of Dijkstra

## 5. Conclusion

### Simulated Graphs

- Worst case: paths are 0.7 hops longer
- Best case: paths are 0 hops longer
- On average is **$2.86 \times 10^{-7}$ seconds faster** for individual node pairs

### Real World Networks

- Worst case: paths are 1.5 units longer
- Best case: paths are 0.1 units longer
- On average is **$3.34 \times 10^{-7}$ seconds faster** for individual node pairs
- **0.26 seconds** faster for all node pairs

### Take away message

The human gaze algorithm performs best for large connectivity, outperforms Dijkstra in runtime but cannot guarantee an optimal solution.

References:
1. https://alumni.blogg.lu.se/a-human-approach-to-networking/

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