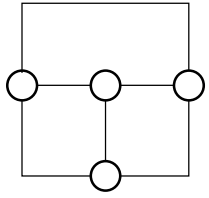


# Orthogonal Drawings of Graphs and Their Relatives

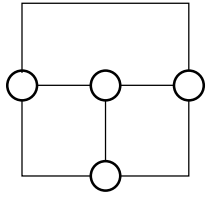
## Part 0 - Introduction

Walter Didimo  
University of Perugia  
[walter.didimo@unipg.it](mailto:walter.didimo@unipg.it)



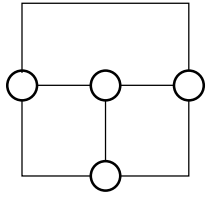
# What this seminar is

- An introduction to orthogonal graph drawing
  - focus on specific problems and classical techniques
  - practical considerations
  - some recent results
  - extensions to related topics
  - some open problems



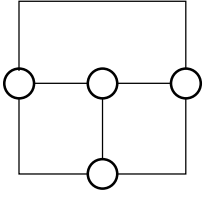
## What this seminar is NOT

- A comprehensive survey on orthogonal graph drawing
  - some results are only mentioned
  - some proofs/techniques are only sketched



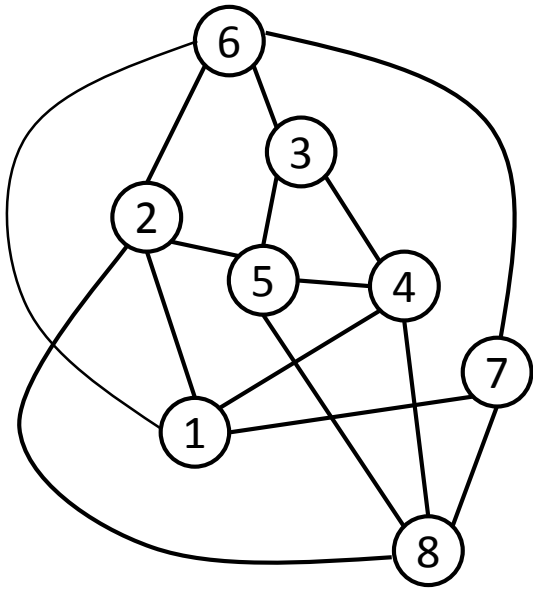
# Prerequisites

- Basic concepts of graph theory and planarity
  - graph connectivity
  - planar graphs and planar embeddings

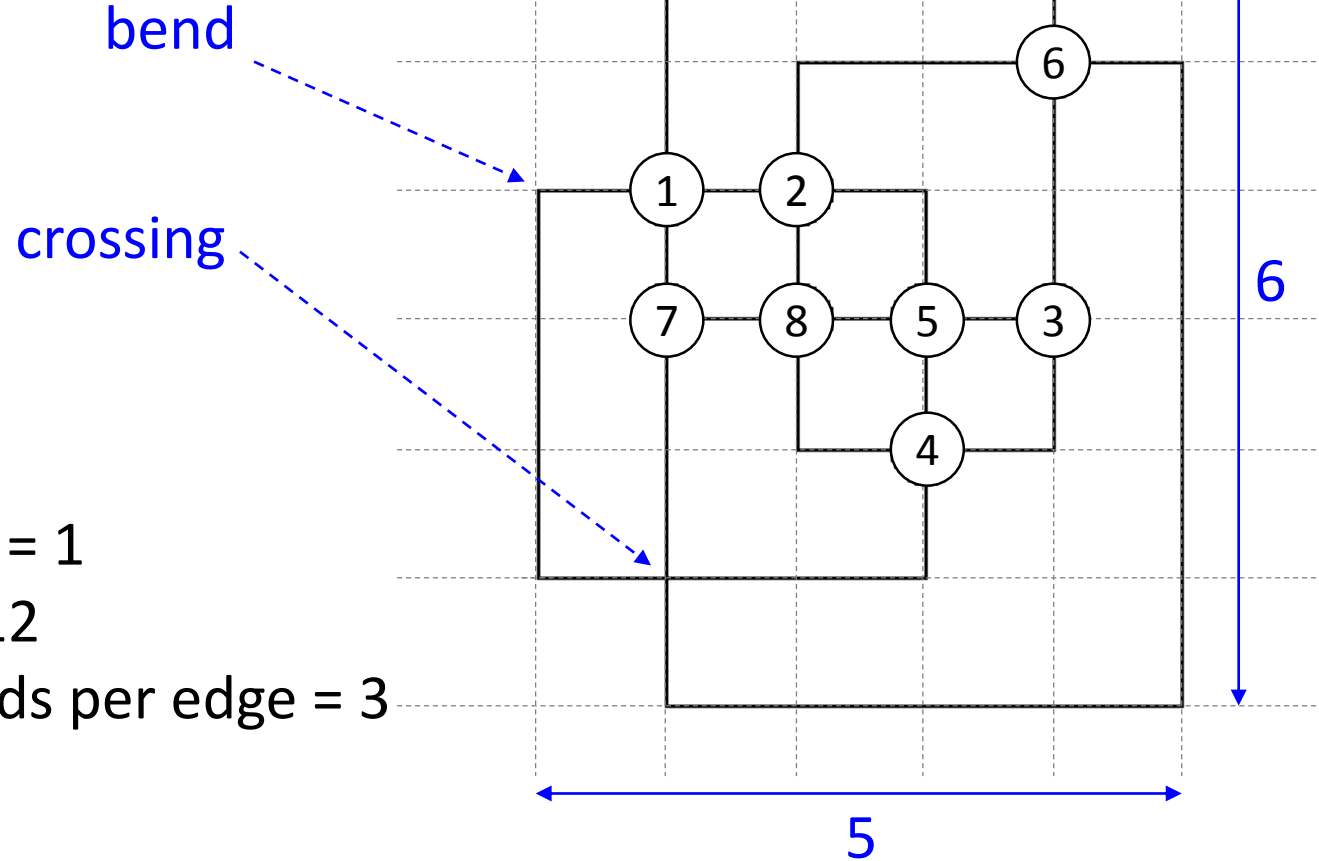


# Orthogonal drawings: Definition

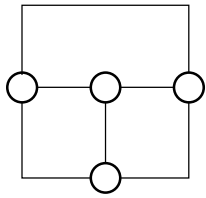
graph



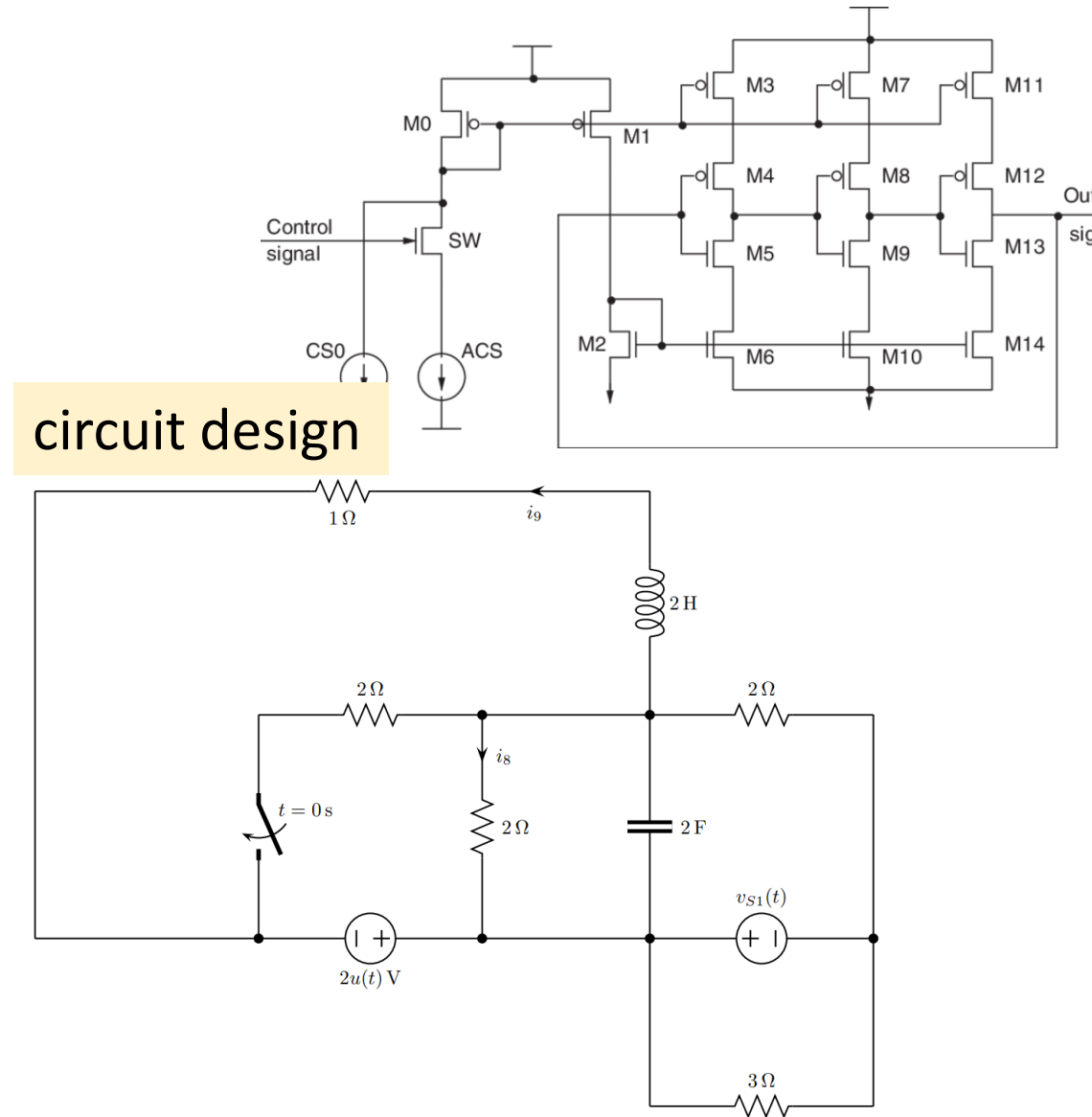
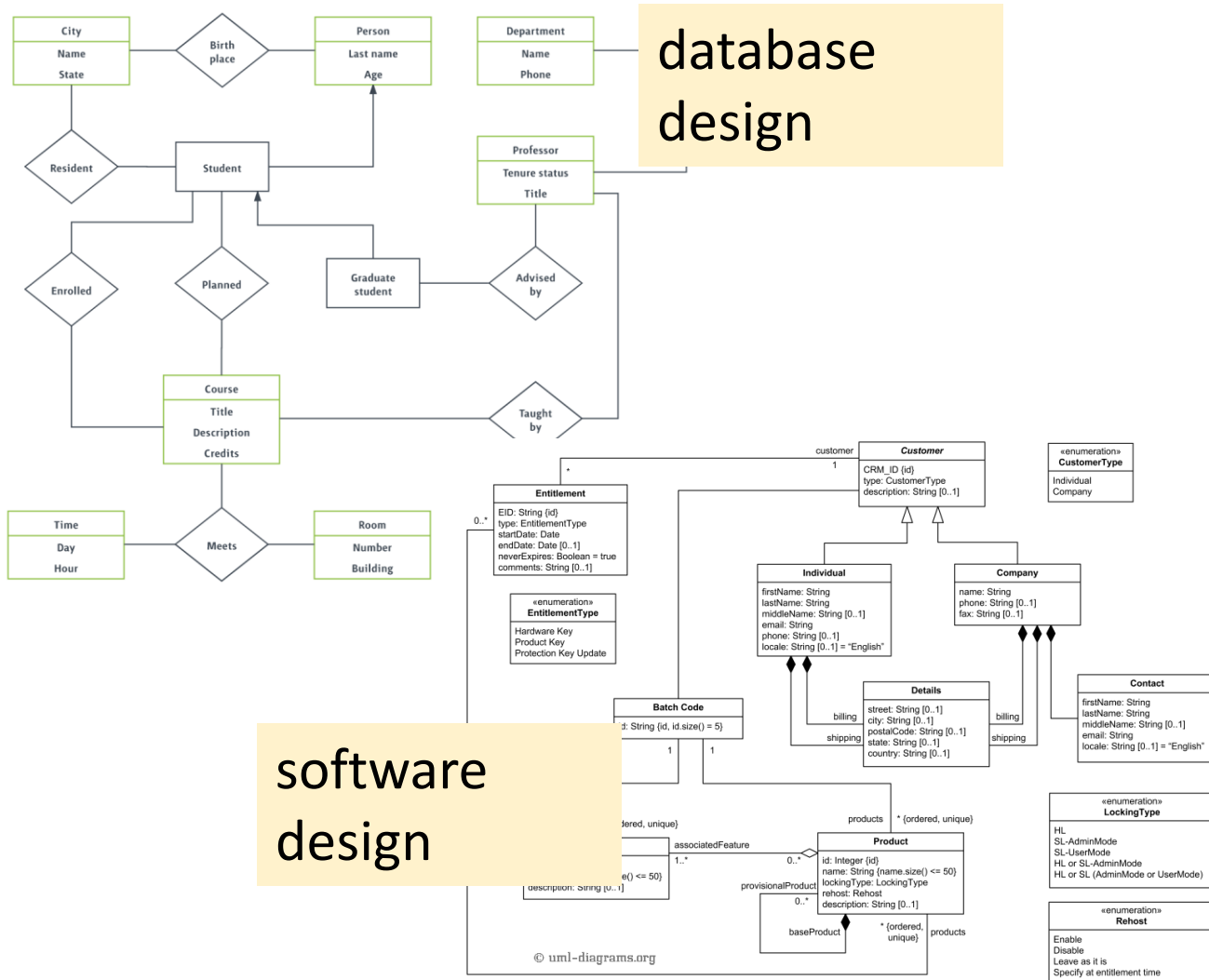
orthogonal drawing

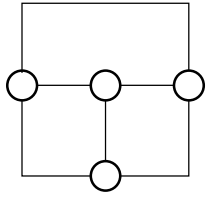


crossings = 1  
bends = 12  
max. bends per edge = 3  
area = 30



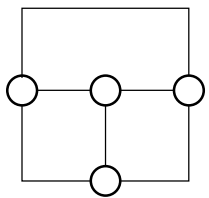
# Orthogonal drawings: Motivation





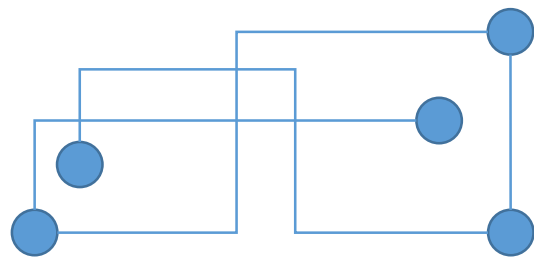
## Quality metrics (aesthetics)

- Metrics used to evaluate the "quality" (readability) of a drawing

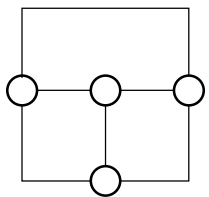


# Quality metrics (aesthetics)

Crossings

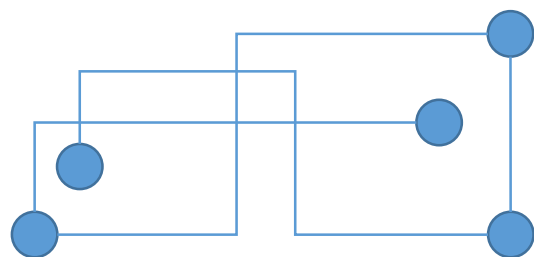




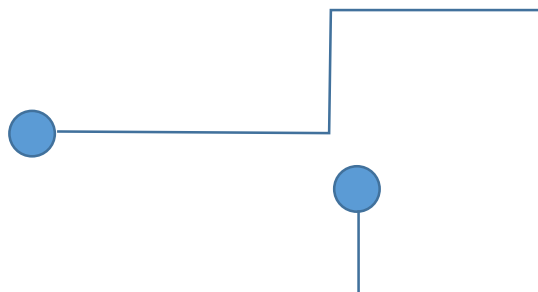


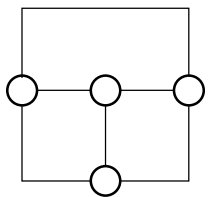
# Quality metrics (aesthetics)

Crossings



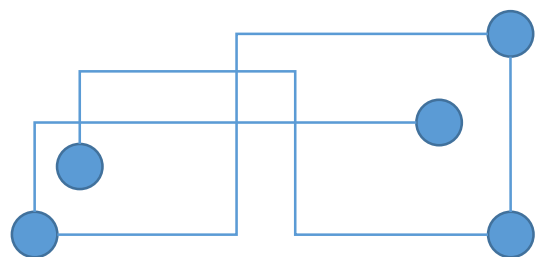
Bends



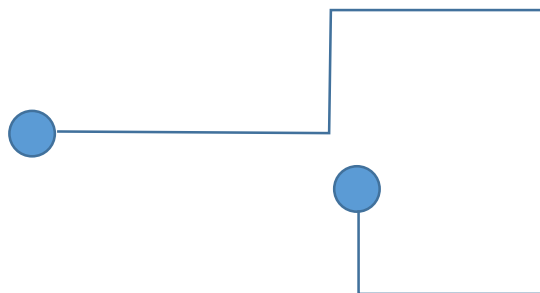


# Quality metrics (aesthetics)

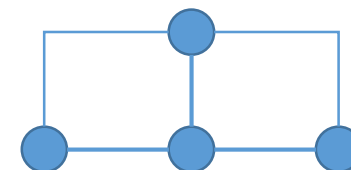
Crossings

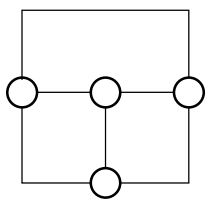


Bends

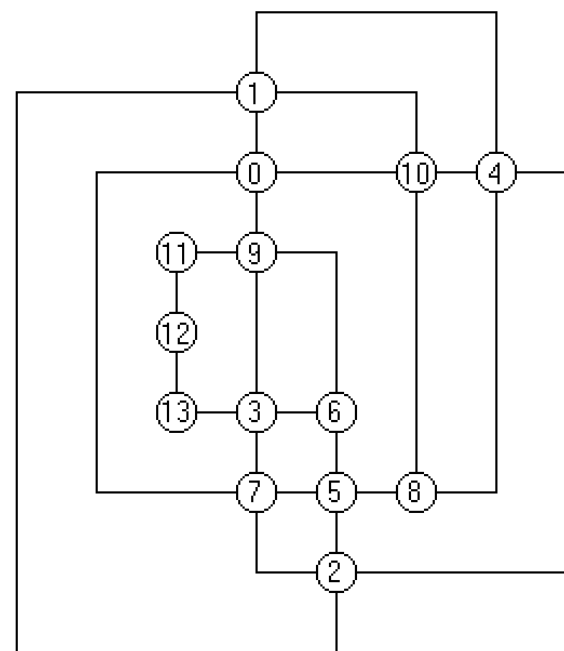
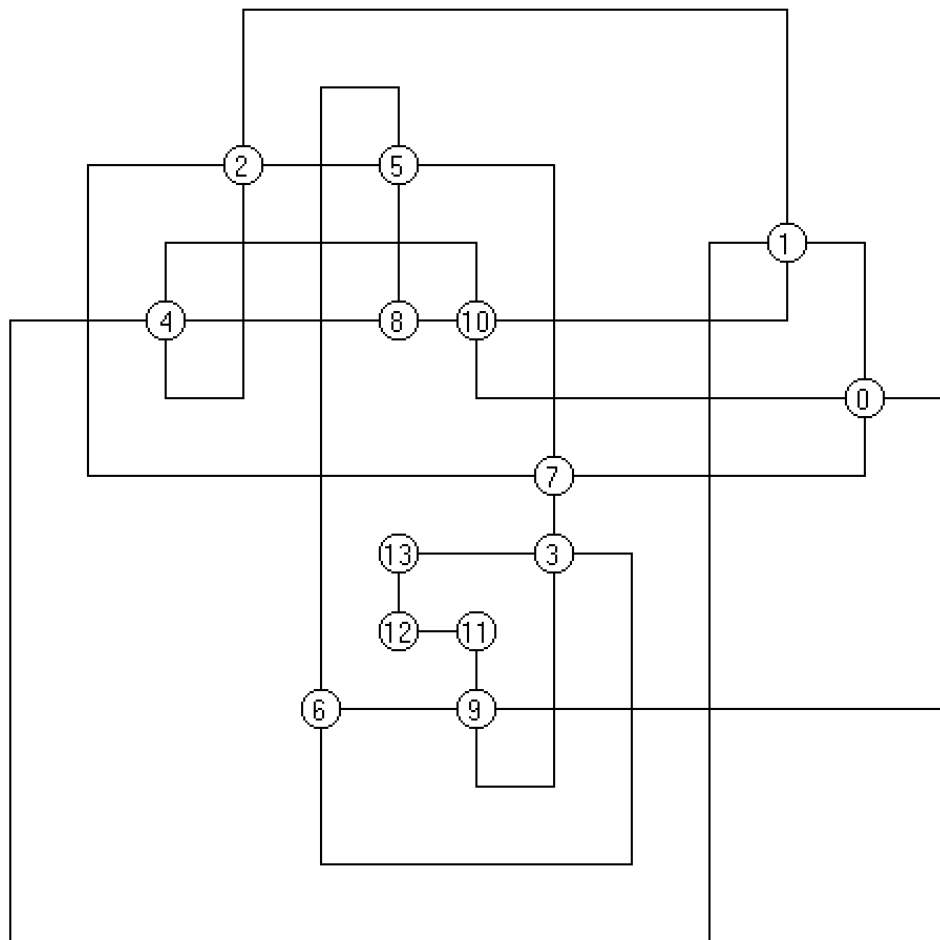


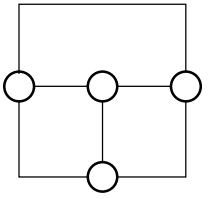
Area





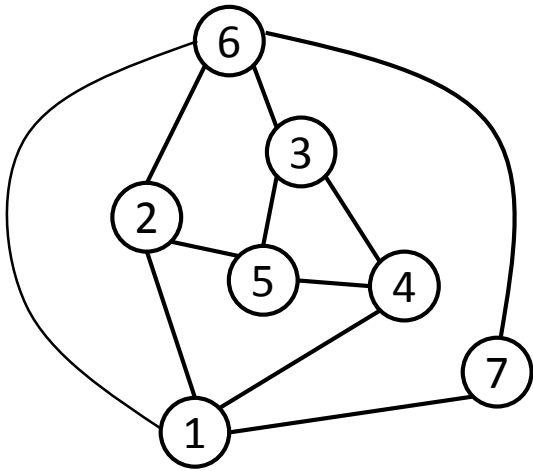
# Orthogonal drawings: Comparison



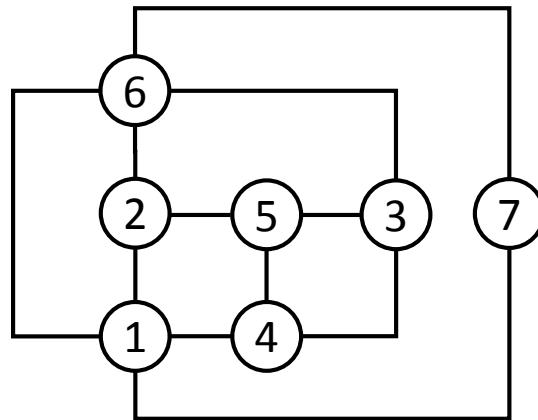


# Orthogonal drawings: Bends

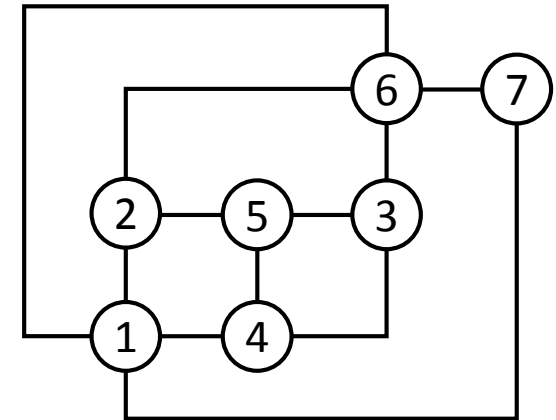
planar graph



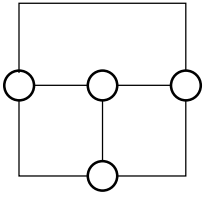
planar orthogonal drawings



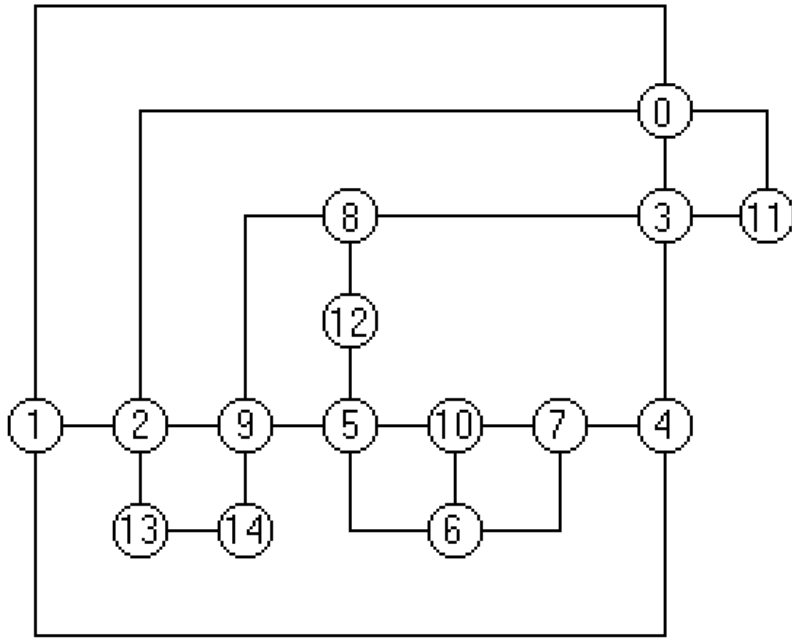
bends = 8  
max. bends per edge = 2



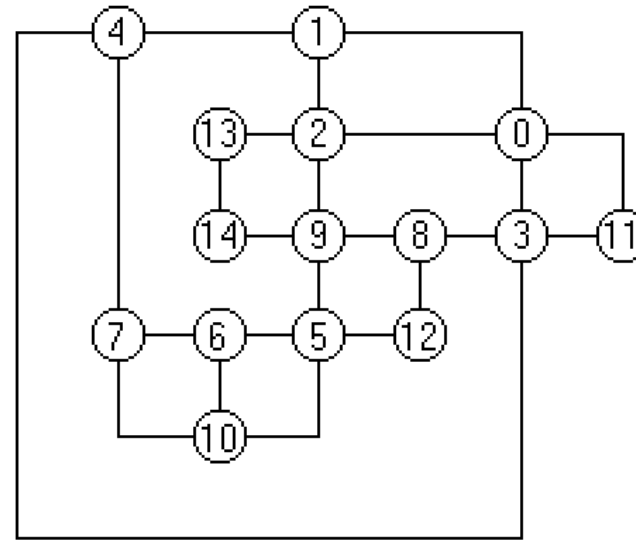
bends = 7  
max. bends per edge = 3



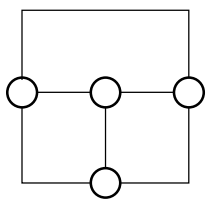
# Orthogonal drawings: Bends



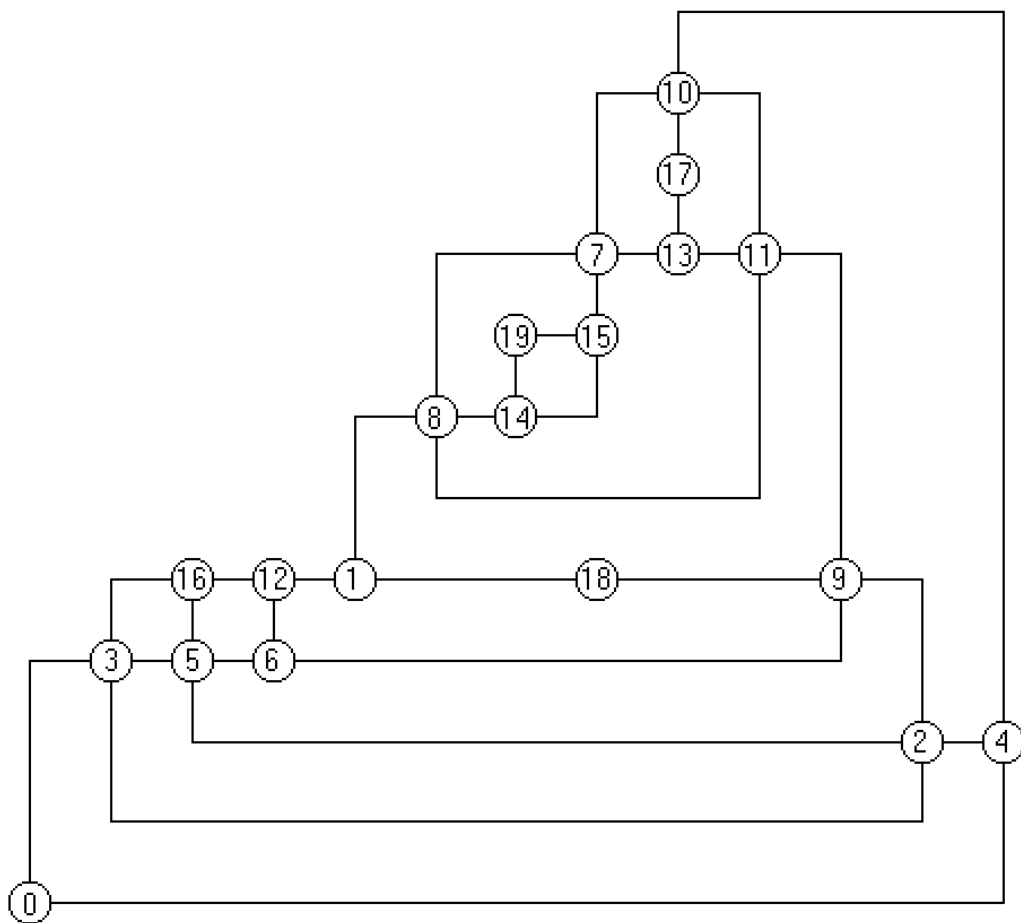
bends = 9  
max. bends per edge = 2



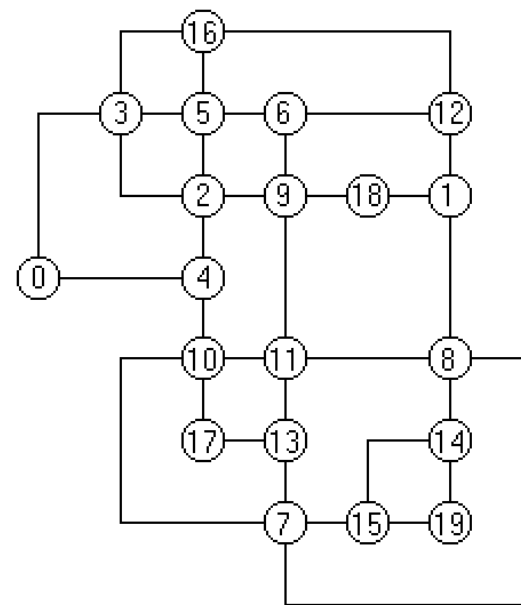
bends = 7  
max. bends per edge = 3



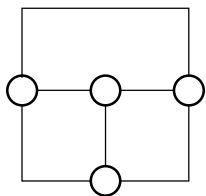
# Orthogonal drawings: Bends



bends = 18  
max. bends per edge = 2

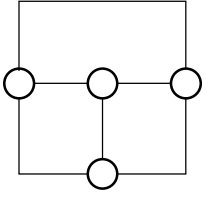


bends = 10  
max. bends per edge = 3



# Orthogonal drawings: Approaches

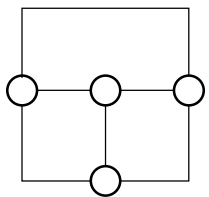
- Efficient heuristics for bend minimization
  - *R. Tamassia and I.G. Tollis*, Planar grid embedding in linear time, IEEE Trans. Circuits Systems 36 (9), 1230-1234 (1989)
  - *A. Papakostas, I. G. Tollis*: Improved Algorithms and Bounds for Orthogonal Drawings. Graph Drawing 1994: 40-51
  - *T. C. Biedl, G. Kant*: A better heuristic for orthogonal graph drawings. Comput. Geom. 9(3): 159-180 (1998)
  - ...
- Exact approach for bend minimization of *plane* graphs
  - *R. Tamassia*: On Embedding a Graph in the Grid with the Minimum Number of Bends. SIAM J. Comput. 16(3): 421-444 (1987)



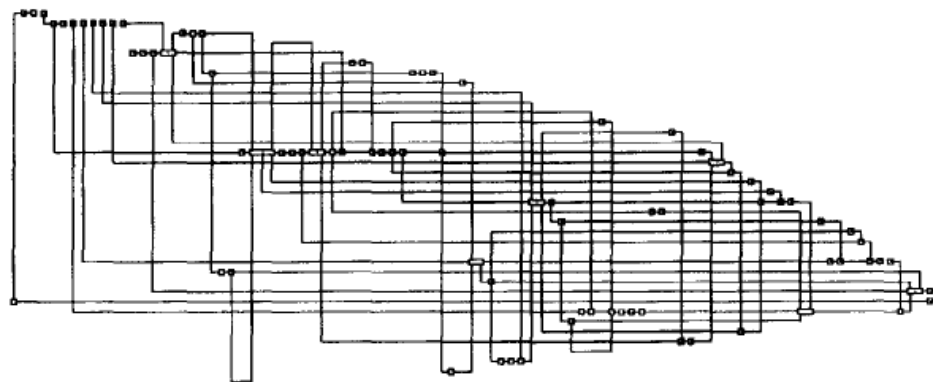
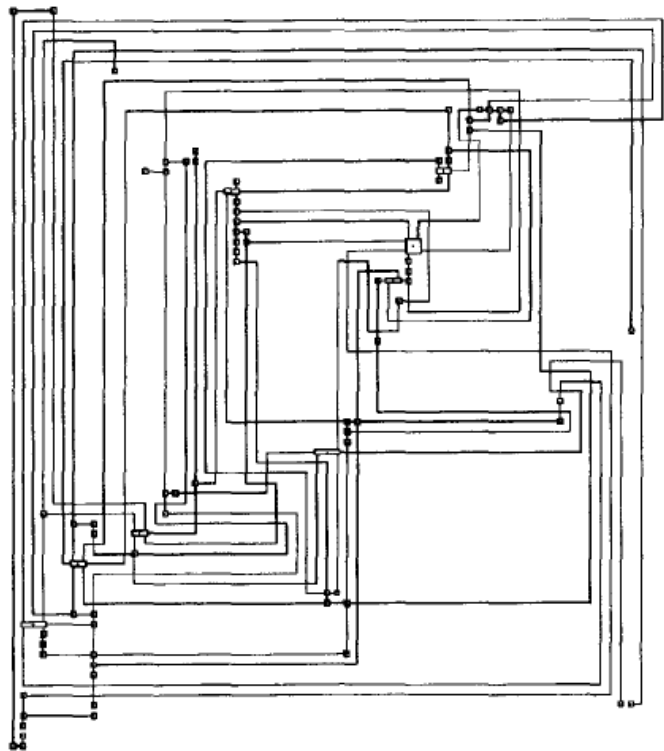
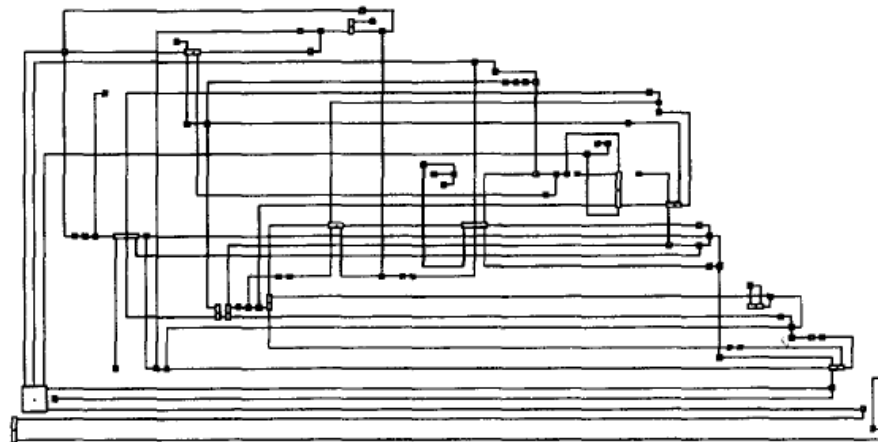
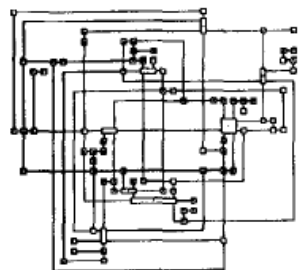
# Orthogonal drawings: Approaches

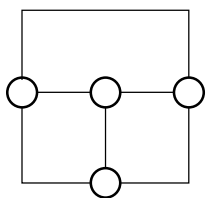
- A seminal experimental work shows that minimizing the total number of bends has a strong impact on several quality metrics
  - *G. Di Battista, A. Garg, G. Liotta, R. Tamassia, E. Tassinari, F. Vargiu: An Experimental Comparison of Four Graph Drawing Algorithms. Comput. Geom. 7: 303-325 (1997)*
- More in general, the approach called **topology-shape-metrics** with **bend-minimization** appears to be superior





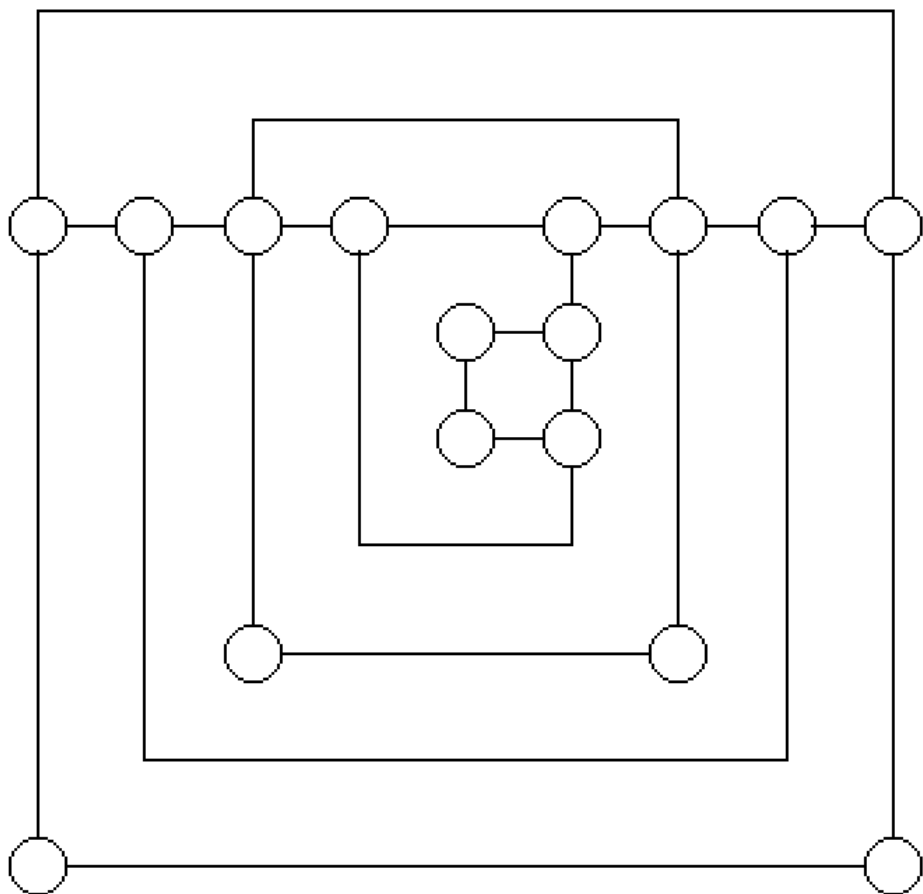
# An old (impressive) picture



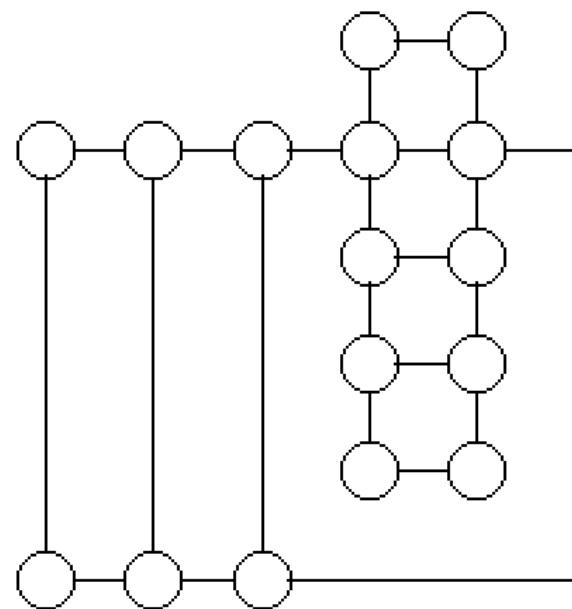


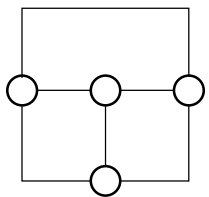
# Orthogonal drawings: Plane vs planar

bend-min for fixed planar embedding



bend-min for variable planar embedding





# Summary

- Part 1
  - Topology-shape-metrics approach: theory and practice
- Part 2
  - Orthogonal drawings in the variable embedding setting
- Part 3
  - Relatives of orthogonal drawings: Right-angle-crossing drawings