DM865 (10 ECTS)

Heuristikker og Approximationsalgoritmer

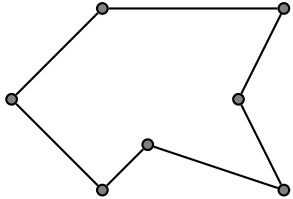
[Heuristics and Approximation Algorithms]

dm865.github.io

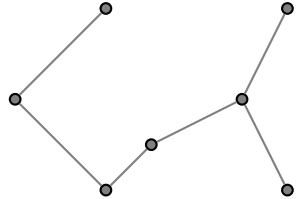
Spring semester
Lene Monrad Favrholdt • Marco Chiarandini
lektorer, IMADA

Approximation Algorithms

A 2-approximation algorithm for TSP



$c(TSP)$



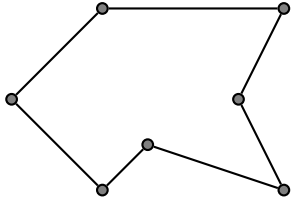
$c(MST)$

Double tree algorithm:

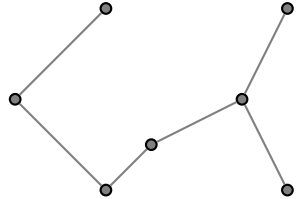
1. $T \leftarrow MST$
2. Double all edges in T
3. $E_{tour} \leftarrow$ Eurler tour
4. $H \leftarrow$ vertices in order of appearance in E_{tour}

Approximation Algorithms

A 2-approximation algorithm for TSP



$c(TSP)$

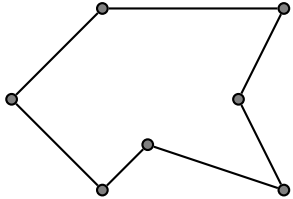


$c(MST)$

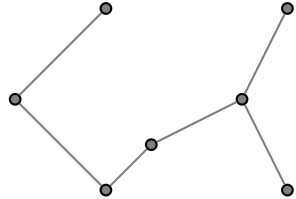
$c(MST) \leq c(TSP)$

Approximation Algorithms

A 2-approximation algorithm for TSP



$c(TSP)$



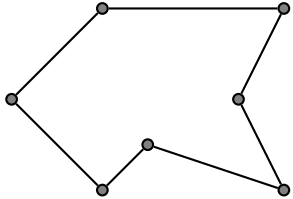
$c(MST)$

$c(MST) \leq c(TSP)$

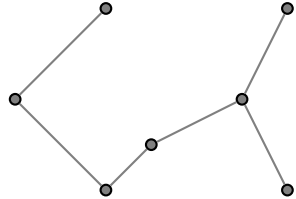
$c(H) \leq 2 \cdot c(MST) \leq 2 \cdot c(TSP)$

Approximation Algorithms

A 3/2-approximation algorithm for TSP



$c(TSP)$



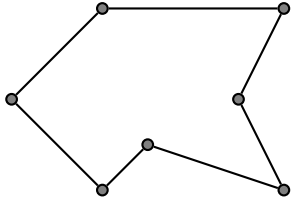
$c(MST)$

Christofide's algorithm:

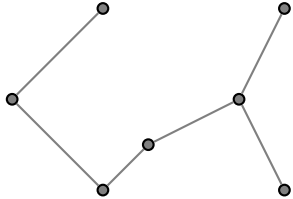
1. $T \leftarrow MST$
2. $M \leftarrow$ minimum perfect matching of odd degree vertices in T
3. $E_{tour} \leftarrow$ Euler tour in the subgraph $(V, E(T) \cup M)$
4. $H \leftarrow$ vertices in order of appearance in the E_{tour}

Approximation Algorithms

A 3/2-approximation algorithm for TSP



$c(TSP)$

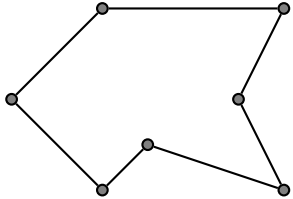


$c(MST)$

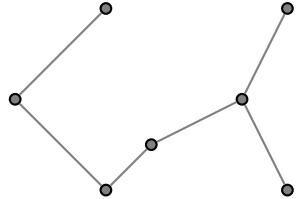
$c(MST) \leq c(TSP)$

Approximation Algorithms

A 3/2-approximation algorithm for TSP



$c(TSP)$



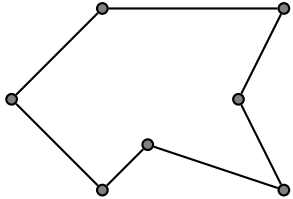
$c(MST)$

$c(MST) \leq c(TSP)$

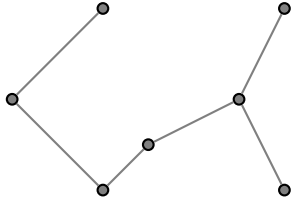
$c(H) \leq c(MST) + c(M)$

Approximation Algorithms

A 3/2-approximation algorithm for TSP



$c(TSP)$



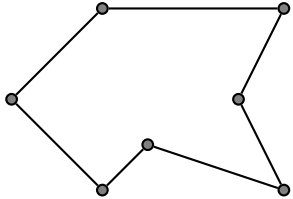
$c(MST)$

$$c(MST) \leq c(TSP)$$

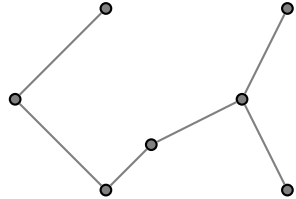
$$c(H) \leq c(MST) + c(M) \leq c(TSP) + \frac{1}{2}c(TSP)$$

Approximation Algorithms

A 3/2-approximation algorithm for TSP



$c(TSP)$



$c(MST)$

$$c(MST) \leq c(TSP)$$

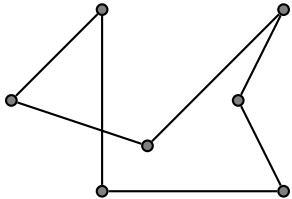
$$c(H) \leq c(MST) + c(M) \leq c(TSP) + \frac{1}{2}c(TSP) = \frac{3}{2} \cdot c(TSP)$$

Approximation Algorithms

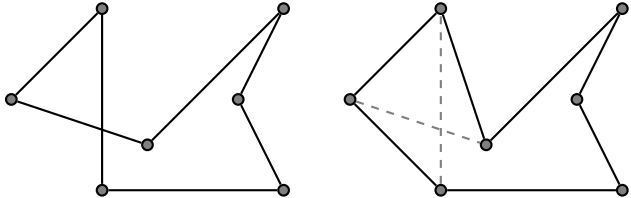
Theorem (2015)

For $\alpha < \frac{185}{184}$, there does not exist an α-approximation algorithm for the TSP.

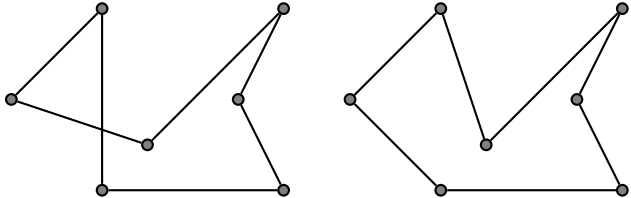
Local Search



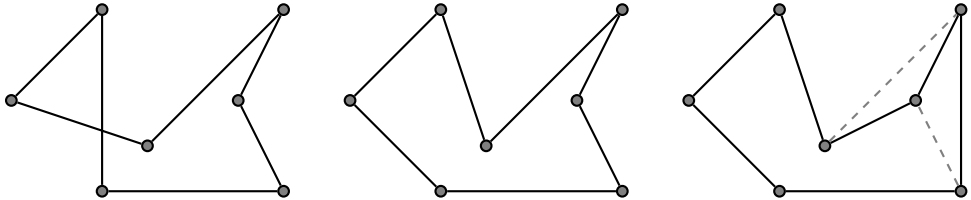
Local Search



Local Search



Local Search



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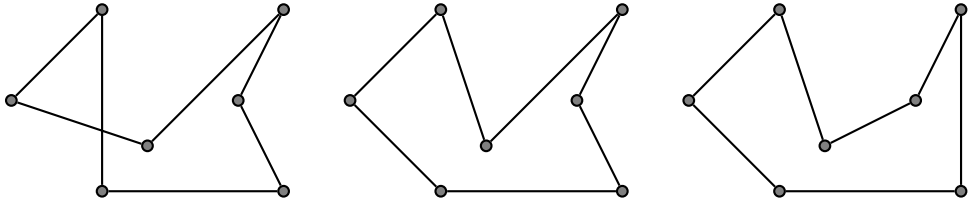
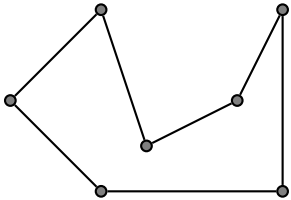


Metaheuristics

Accepting worsening changes



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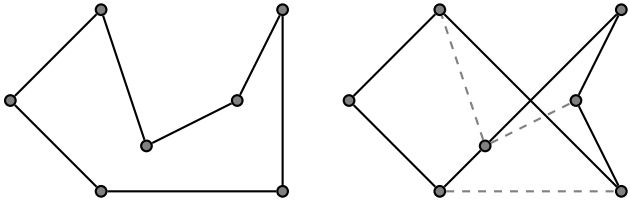

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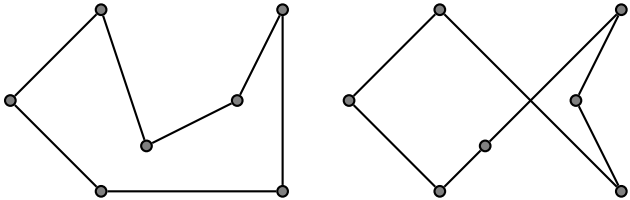

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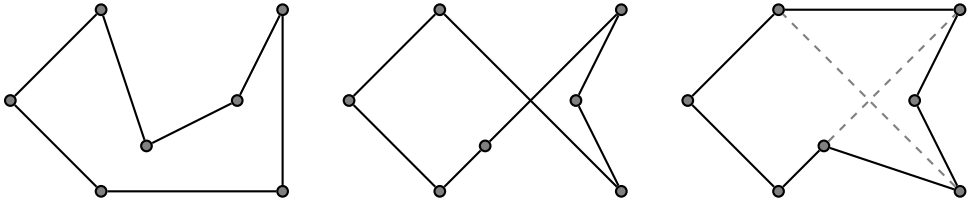

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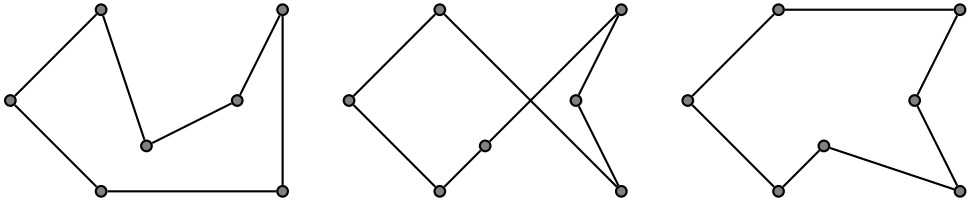

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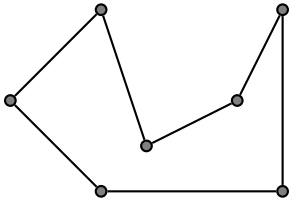
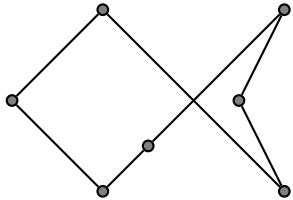
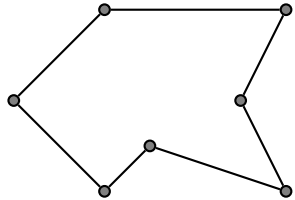
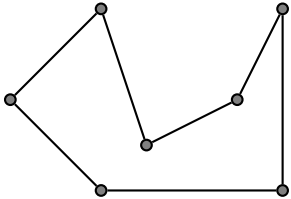






Trying different changes



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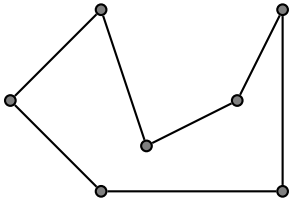

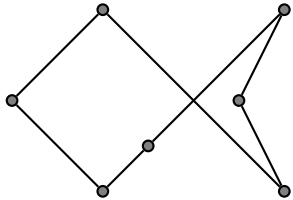

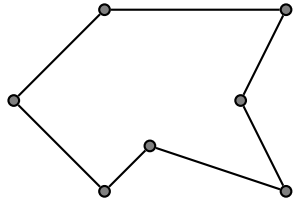

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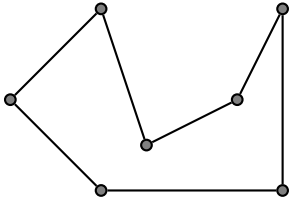

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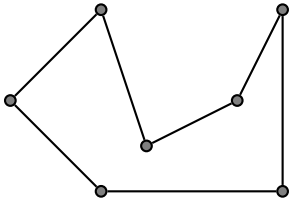

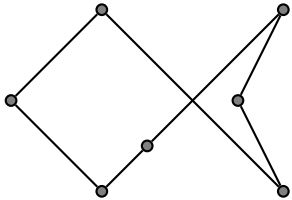

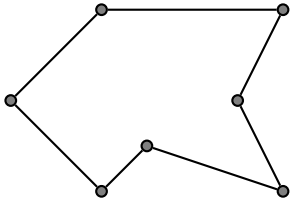

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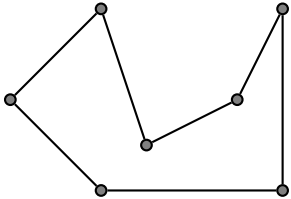

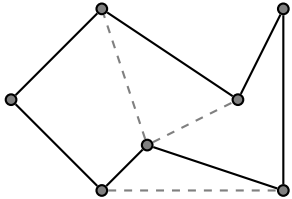

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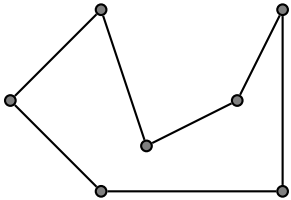

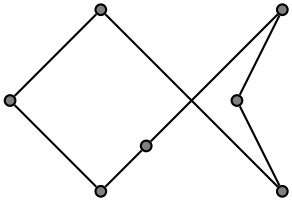

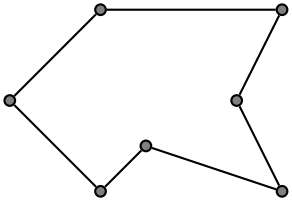

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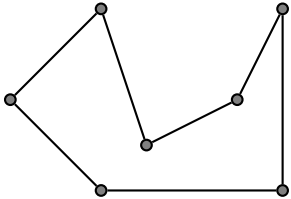

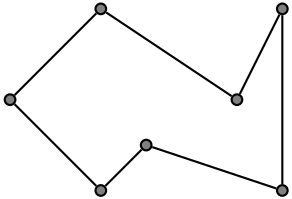

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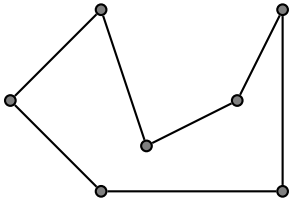

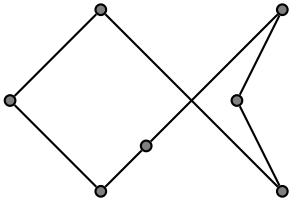

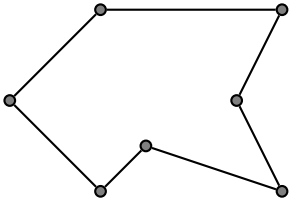

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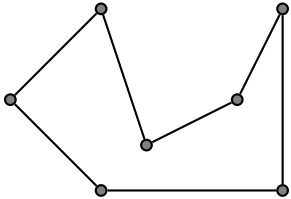

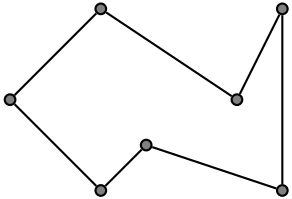

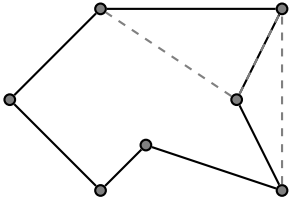

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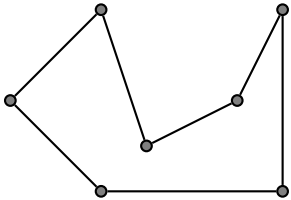

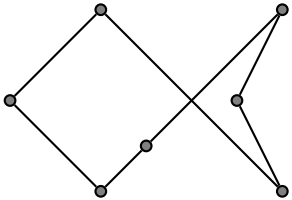

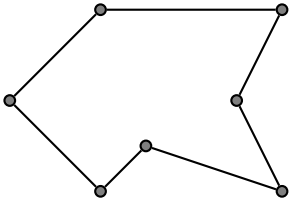

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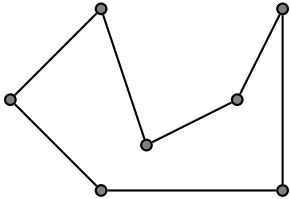

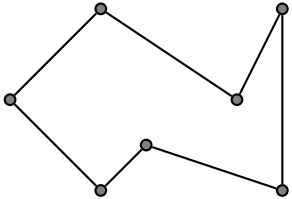

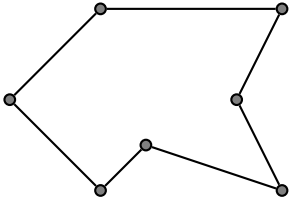

Contents

	Apporx Algorithms	Local Search + Metaheuristics
Set Cover		
Satisfiability		
Traveling Salesman		
Scheduling		
Knapsack		
Bin packing		

Course Formalities

Prerequisites:

- ✔ Programming (DM502, DM503, DM550)
- ✔ Algorithms and Datastructures (DM507)
- ✓ Complexity and Computability (DM508, DM553)
- ✓ Linear and Integer Programming (DM559, DM545, DM554)

Credits: 10 ECTS

Language: English or Danish

Classes: intro: $2h \times 24$; training: $2h \times 24$

Material: slides + text book + articles + starting code

Assessment (10 ECTS)

- Two practical project assignments passed/failed with internal censor by the teacher (include programming in Python)

- Oral exam based on:
  - the theoretical part
  - two practical assignments

  Grading by the Danish 7-mark scale with external examiner. Exam aids allowed.

DM865 (10 ECTS)

Heuristikker og Approximationsalgoritmer

[Heuristics and Approximation Algorithms]

dm865.github.io

Spring semester
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