ARK-E2515 Parametric Design

Optimization

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Aalto University
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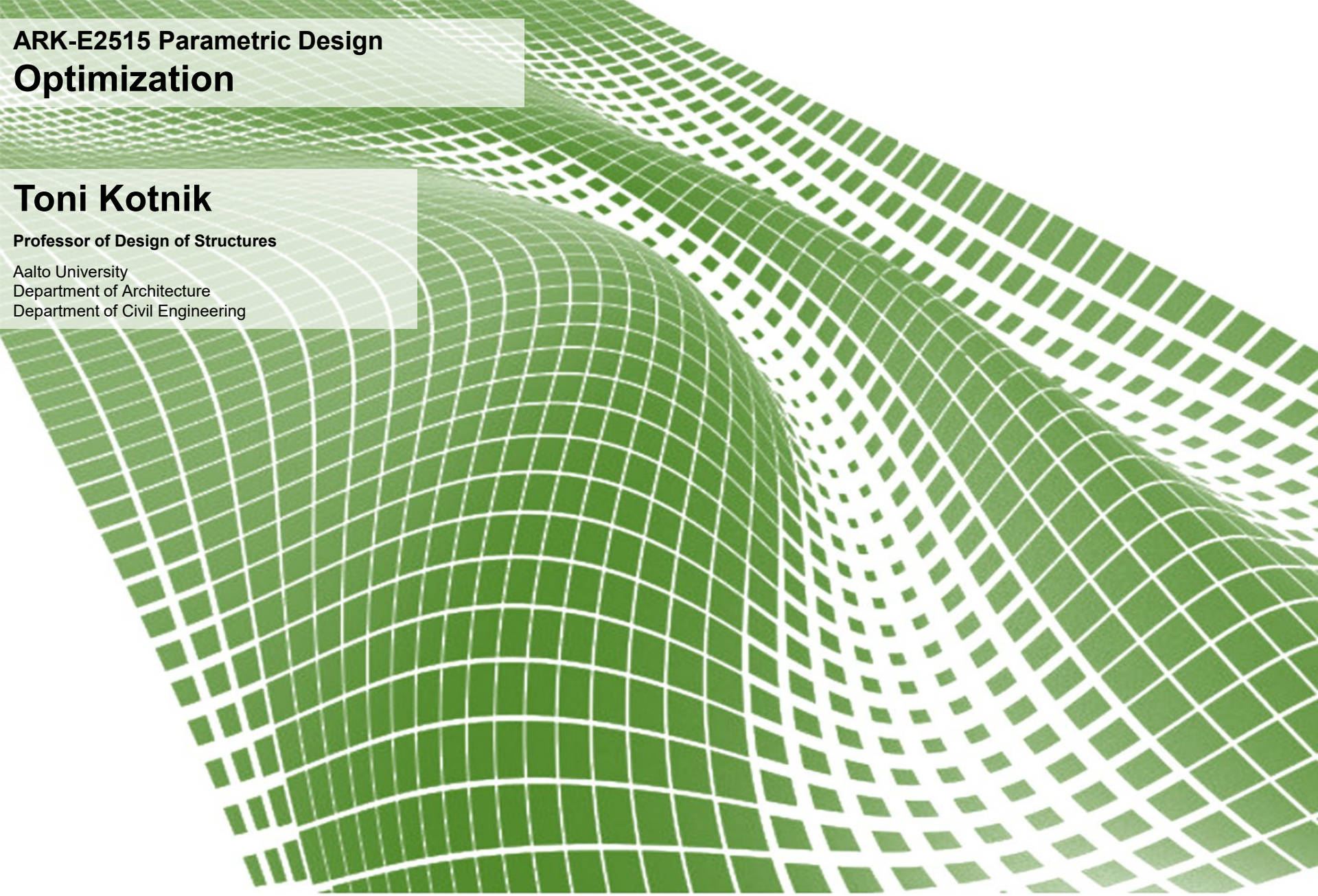
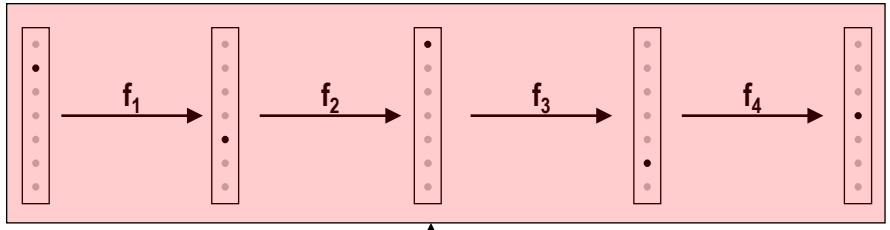
Department of Civil Engineering



architectural form
as
mathematical function

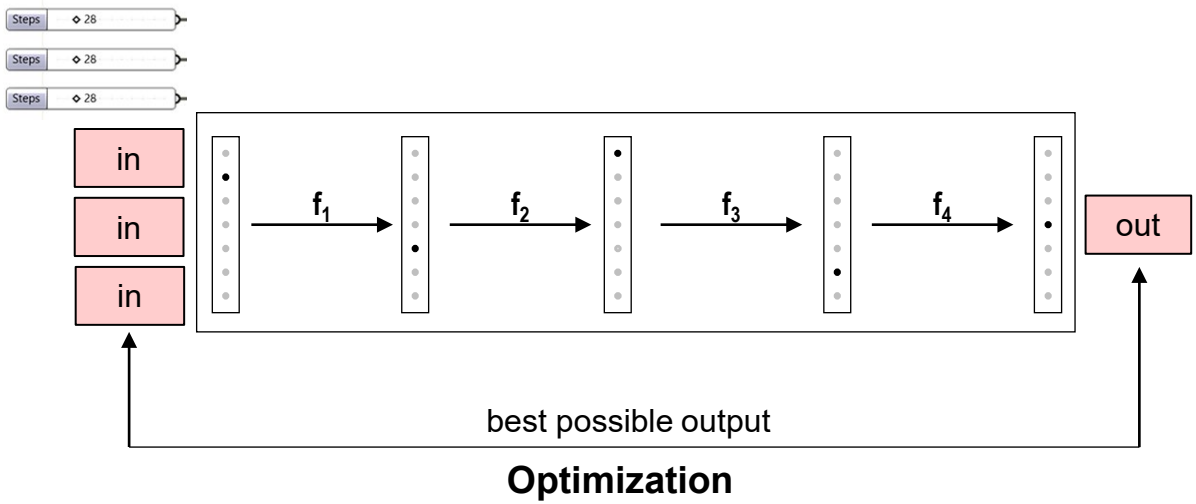
defined by
Associative Geometry
Data Handling



build-up of function

architectural form
as
mathematical function

defined by
Associative Geometry
Data Handling



Optimization


How much area can be fenced in with a 1000m long wall?

Optimization
best possible output

Formalization

x = y = 250

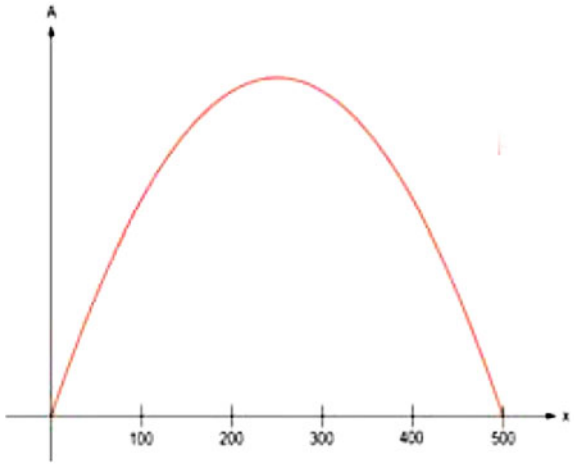
square

How much area can be fenced in with a 1000m long wall?

max A = x·y under the condition 1000 = 2·x + 2·y

A = x·(500 – x)

fitness function
measure for quality of solution



fitness landscape
field of all possible solutions


How much area can be fenced in with a 1000m long wall?

Optimization
best possible output

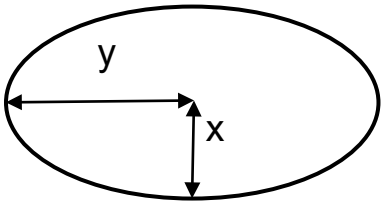
Formalization

x = y = 160

circle

How much area can be fenced in with a 1000m long wall?

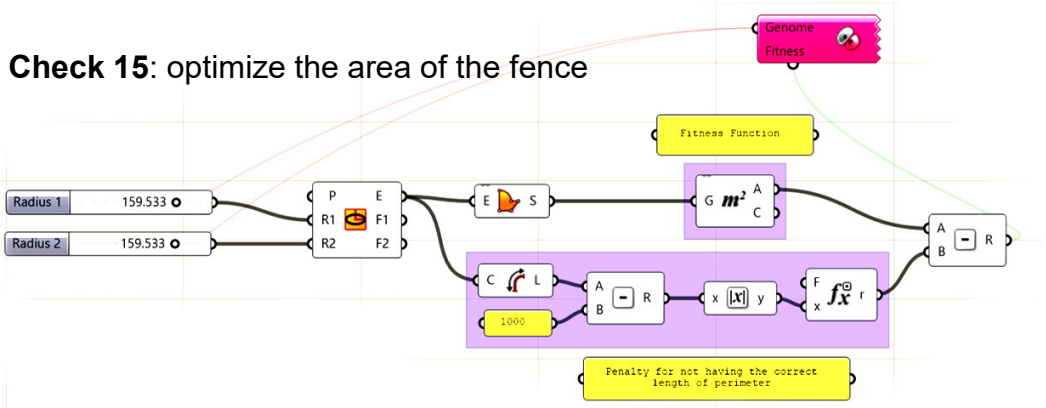
max A = π·x·y under the condition 1000 ≈ π· √(2·x² + 2·y²)



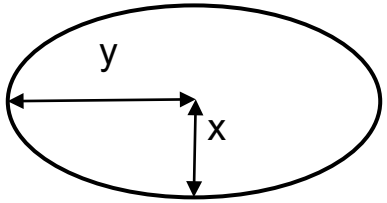
A = ?

fitness function
measure for quality of solution

Check 15: optimize the area of the fence

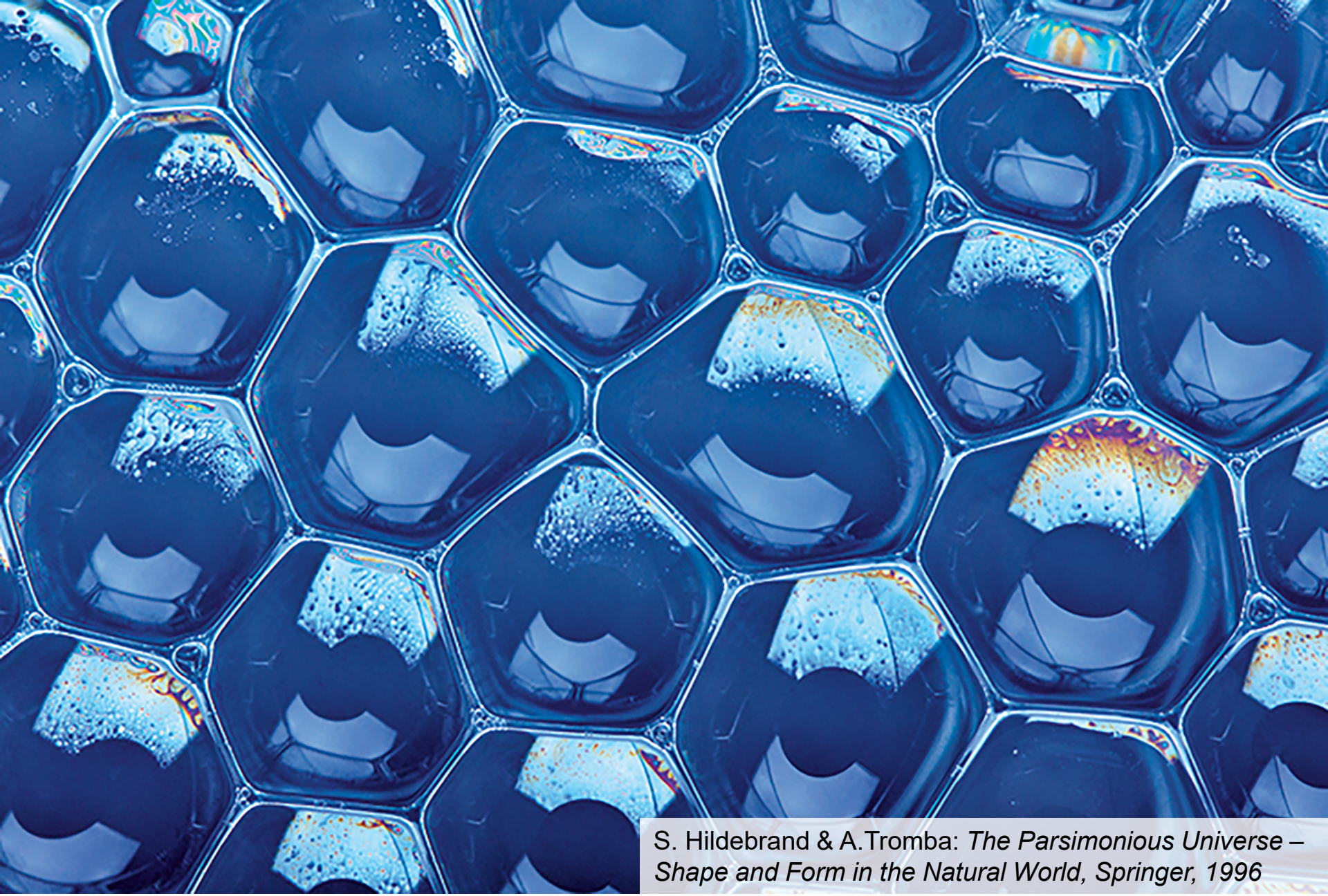


How much area can be fenced in with a 1000m long wall?



x = y = 250	x = y = 160
A = 62´500 m^2	A = 80´424 m^2 **+28%**

Formalization of the problem is of central importance



S. Hildebrand & A.Tromba: *The Parsimonious Universe – Shape and Form in the Natural World, Springer, 1996*

Optimization
best possible output

Formalization

x = y = 250

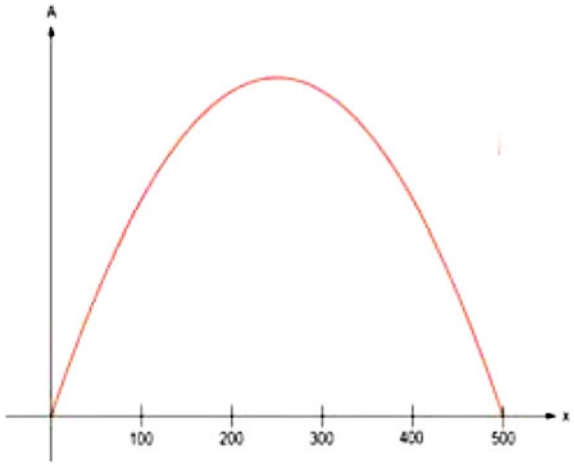
square

How much area can be fenced in with a 1000m long wall?

max A = x·y under the condition 1000 = 2·x + 2·y

A = x·(500 – x)

fitness function
measure for quality of solution

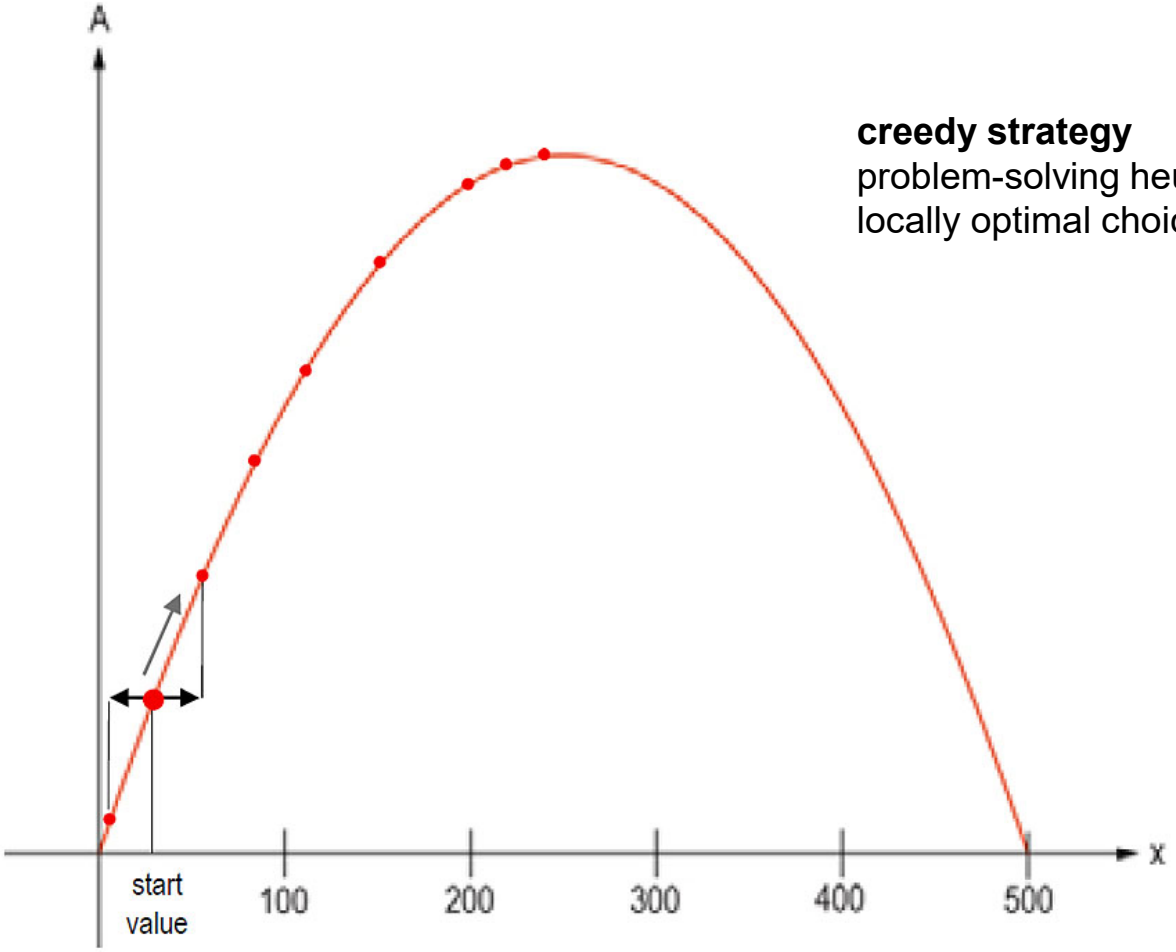


fitness landscape
field of all possible solutions

Optimization
best possible output

fitness landscape
field of all possible solutions

basic intention in optimization process
stepwise improvement of solution by variation of parameter

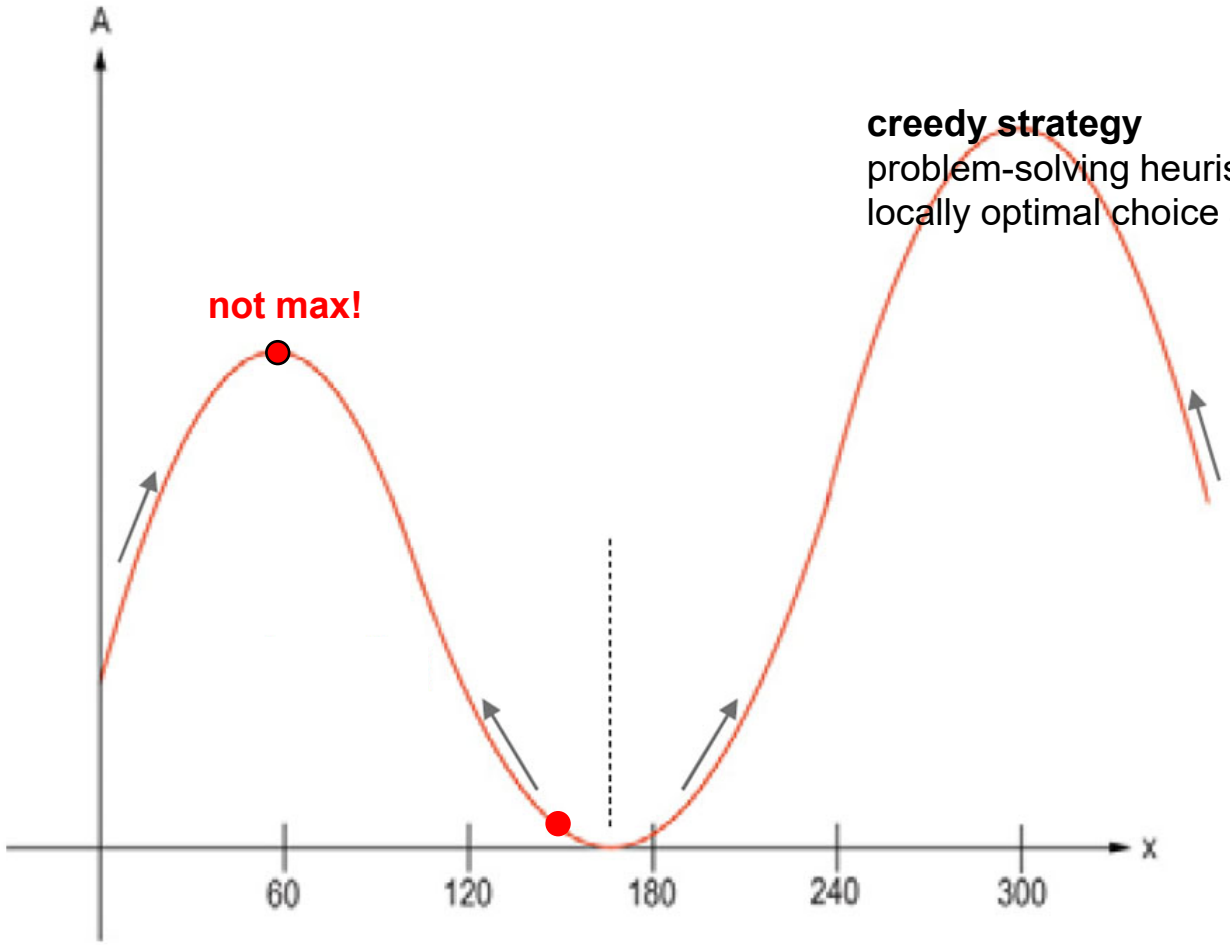


creedy strategy
problem-solving heuristic of making the locally optimal choice at each stage

Optimization
best possible output

fitness landscape
field of all possible solutions

basic intention in optimization process
stepwise improvement of solution by variation of parameter

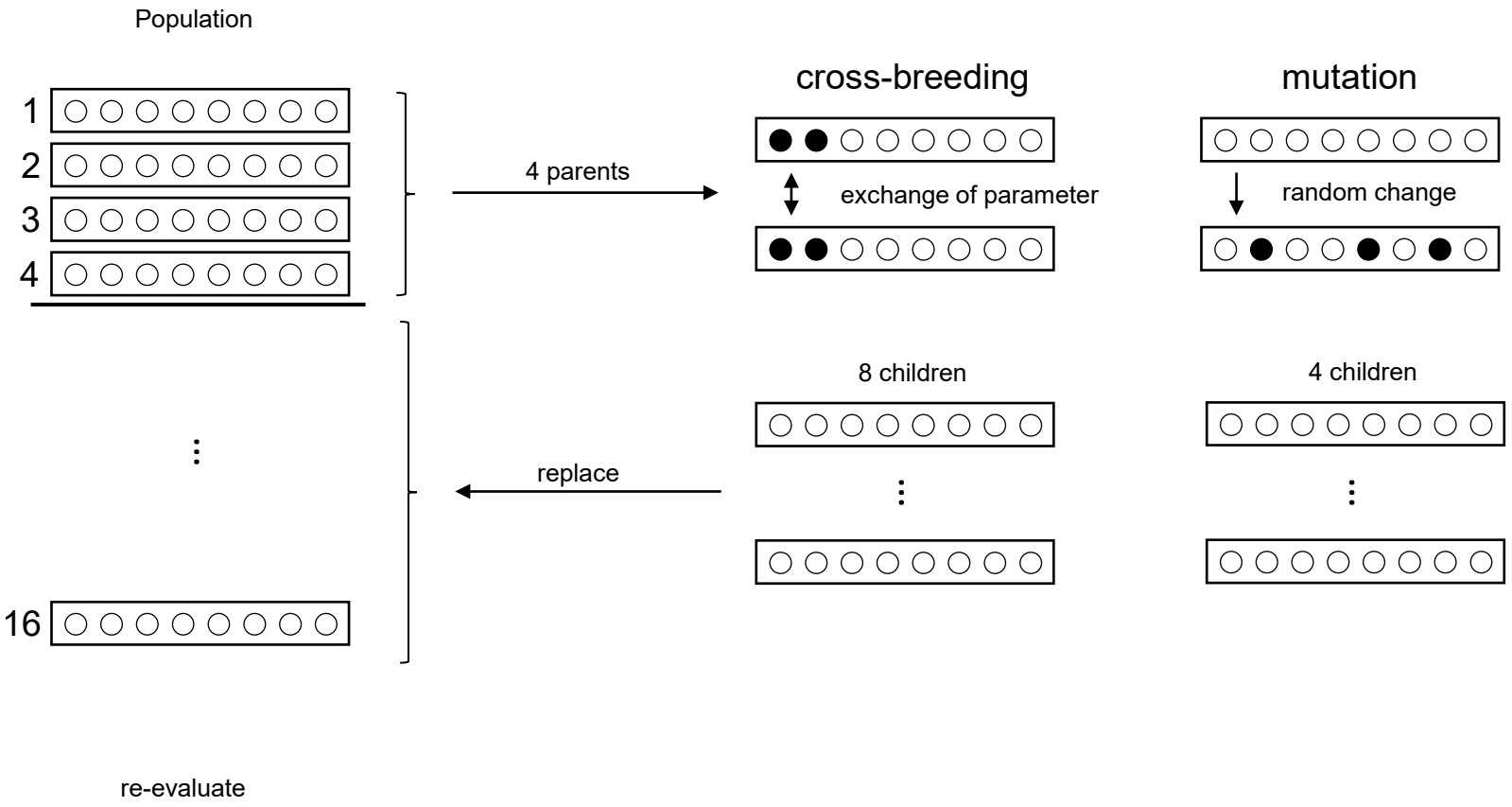


creedy strategy
problem-solving heuristic of making the locally optimal choice at each stage

Optimization
best possible output

fitness landscape
field of all possible solutions

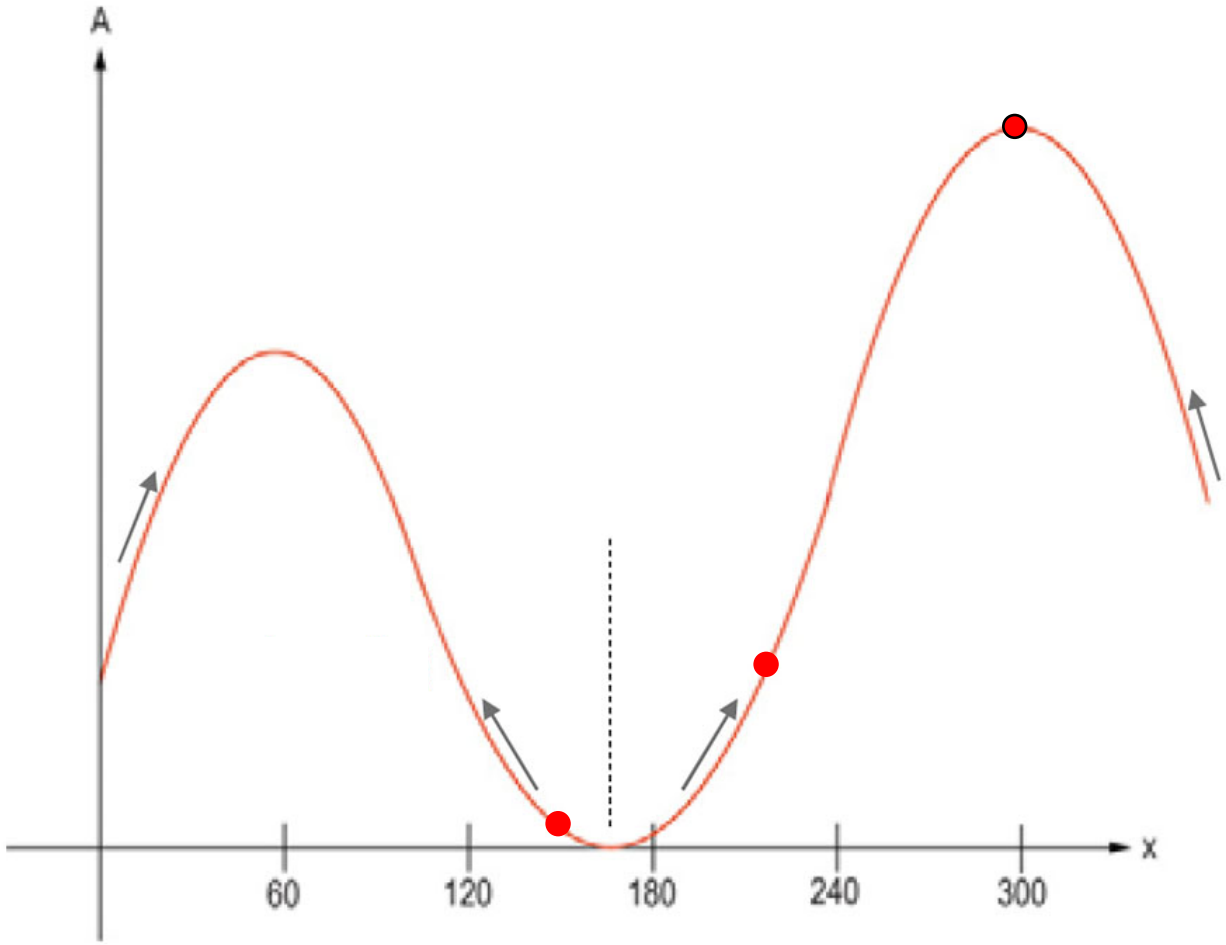
evolutionary strategy
stepwise improvement of solution by recombination of parameter



Optimization
best possible output

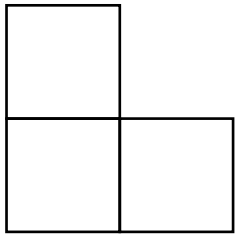
fitness landscape
field of all possible solutions

evolutionary strategy
stepwise improvement of solution by recombination of parameter

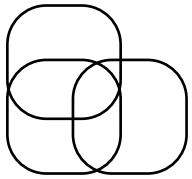


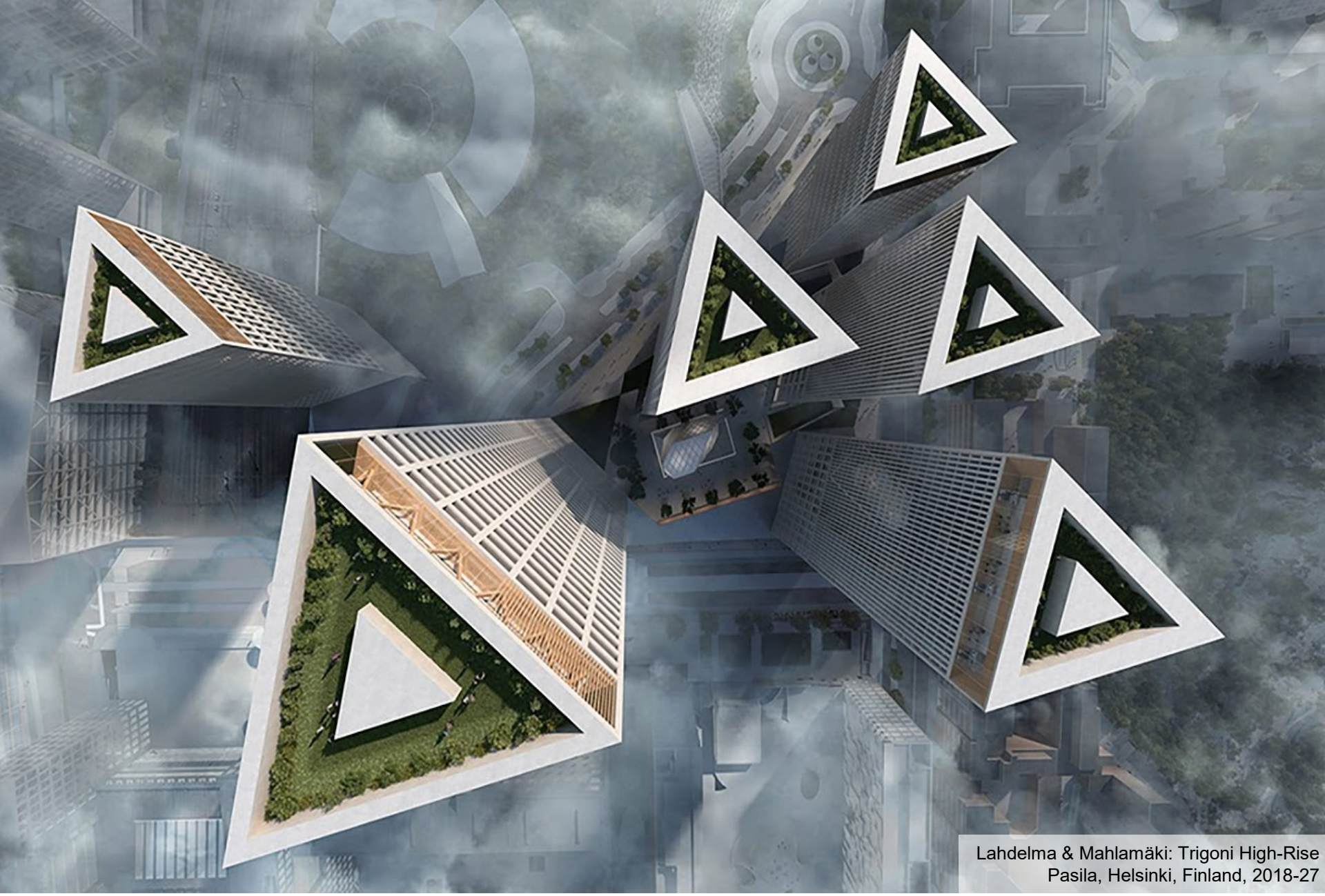
check 16: the task is to build three towers on a given site of 100 m x 100 m. Each tower should have a footprint of 20 m x 20 m. The investor likes to get a maximum of square meter. At the same time, the surface area of the tower needs to be as small as possible in order to reduce the running costs for the building (maintenance & energy). How high should the buildings be and where should they be located on site?

$h_1 = h_2 = h_3 = 160$



$h_1 = h_2 = h_3 = 160$





Lahdelma & Mahlamäki: Trigoni High-Rise
Pasila, Helsinki, Finland, 2018-27

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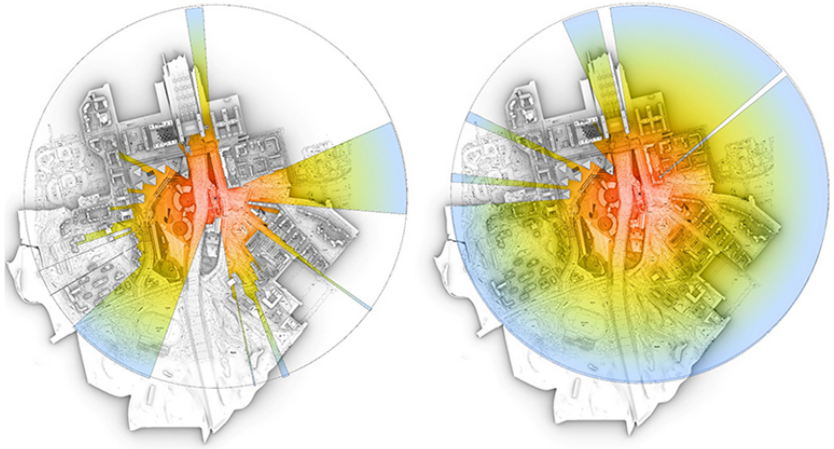
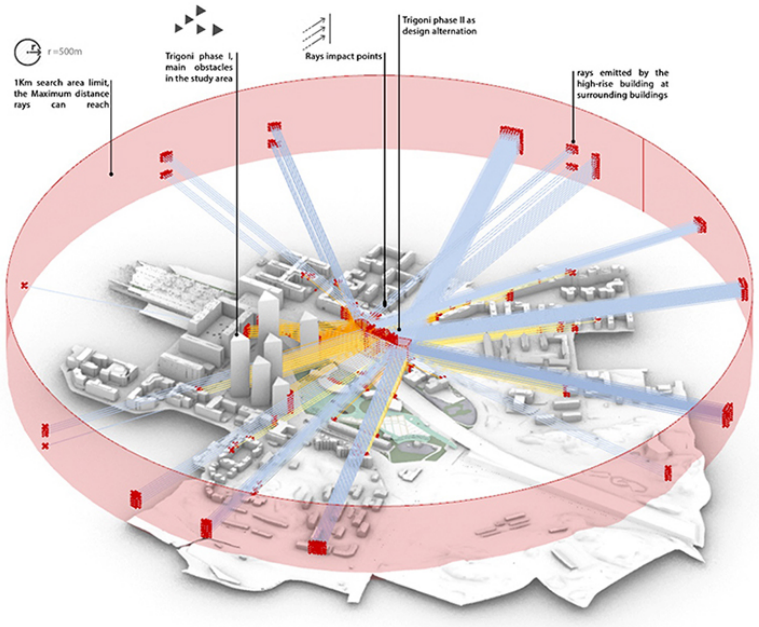
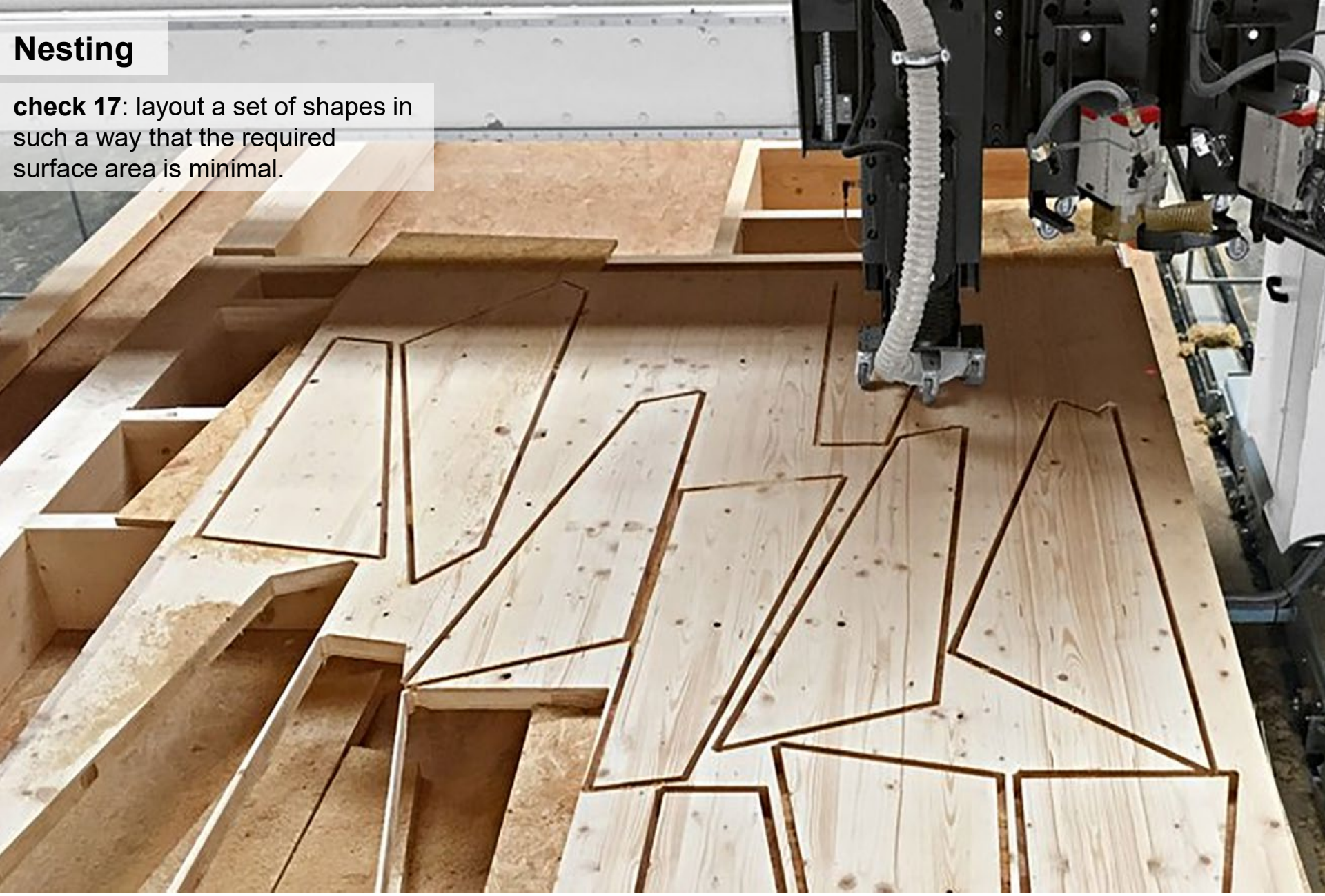




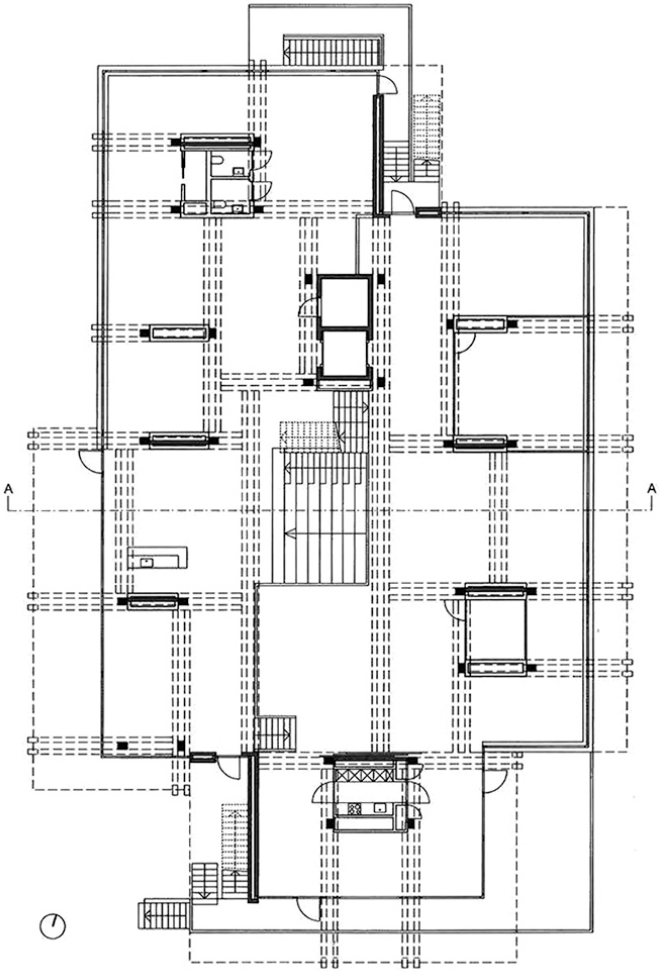
Lahdelma & Mahlamäki: Trigoni High-Rise
Pasila, Helsinki, Finland, 2018-27

Nesting

check 17: layout a set of shapes in such a way that the required surface area is minimal.



Deon Architects: Nolax House
Sempach, Switzerland, 2017



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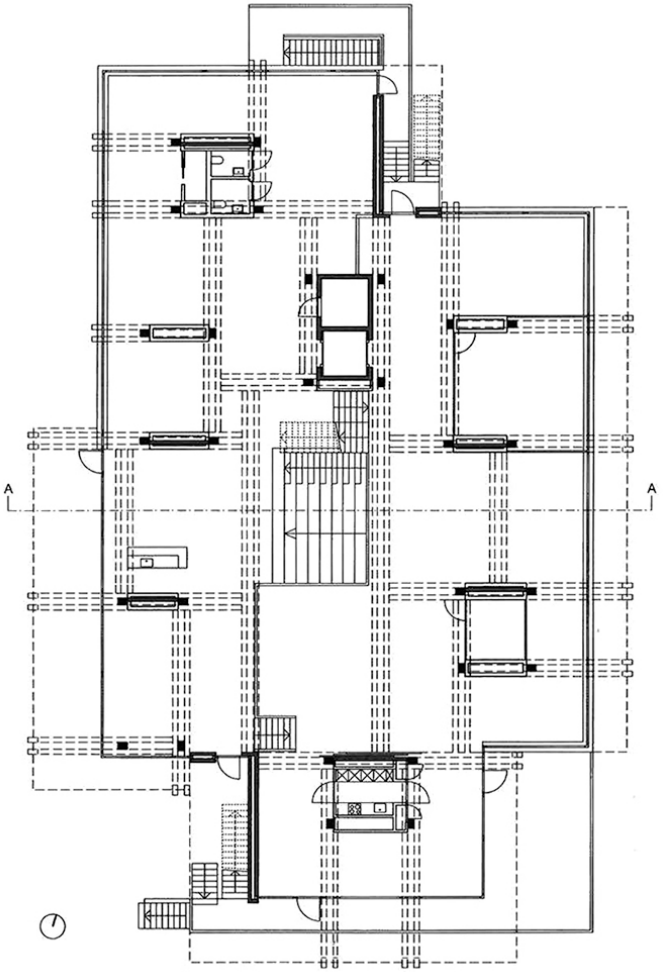
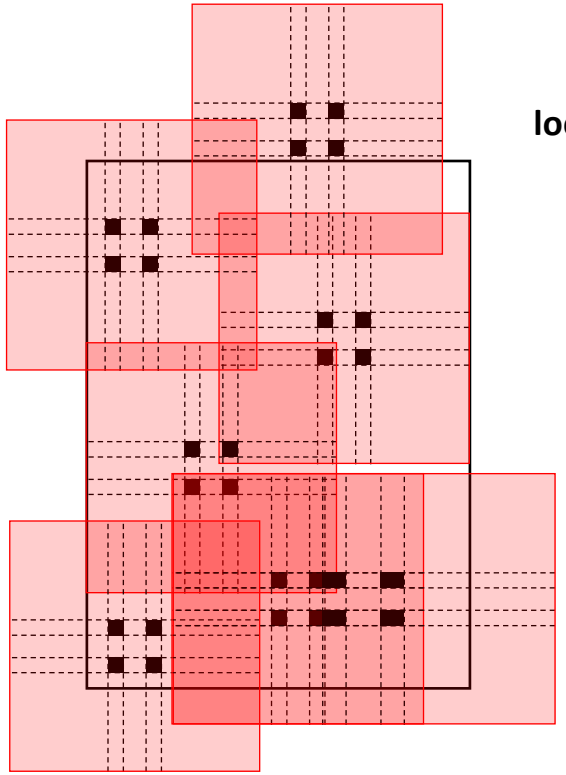
Sempach, Switzerland, 2017

Optimized layout through nesting





location

size

number of elements

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Optimization

problem formalization

evolutionary strategy

part of design strategy