



— OPTIMIZING EXHIBITION SPACES —

A MULTI-OBJECTIVE APPROACH

INÊS PEREIRA

CATARINA BELÉM

ANTÓNIO LEITÃO

MOTIVATION

KOLDING CAMPUS, HENNING LARSEN ARCHITECTS



ANALYSIS TOOLS

Radiance



catl



K



PERFORMANCE-BASED DESIGN

LONDON CITY HALL, FOSTER + PARTNERS



Photo credit: Josh Perrett

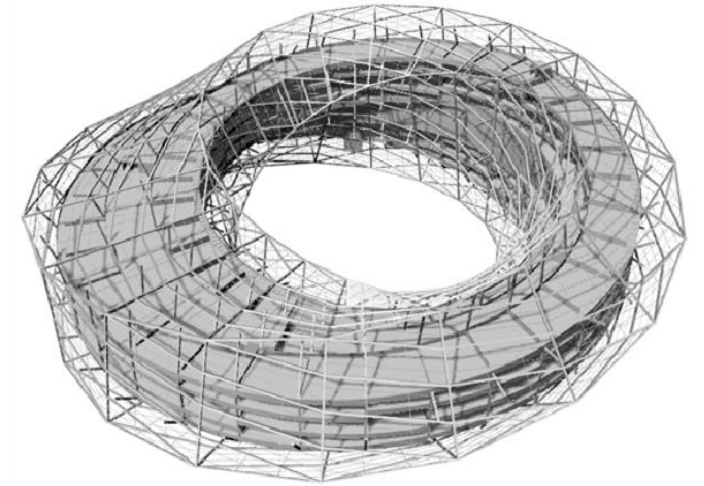
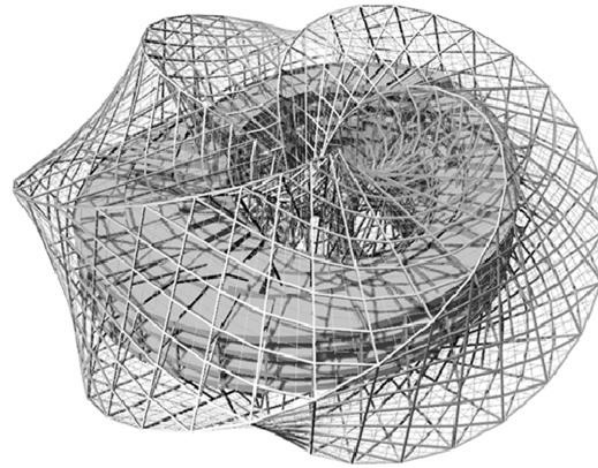
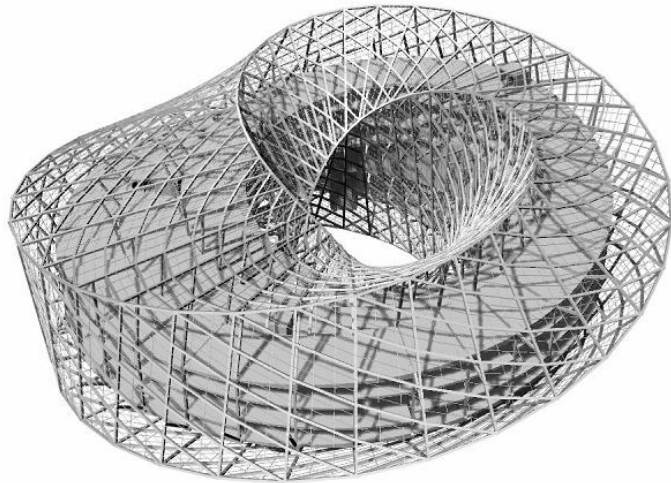


ALGORITHMIC DESIGN AND ANALYSIS

HEYDAR ALIYEV CENTER, ZAHA HADID ARCHITECTS

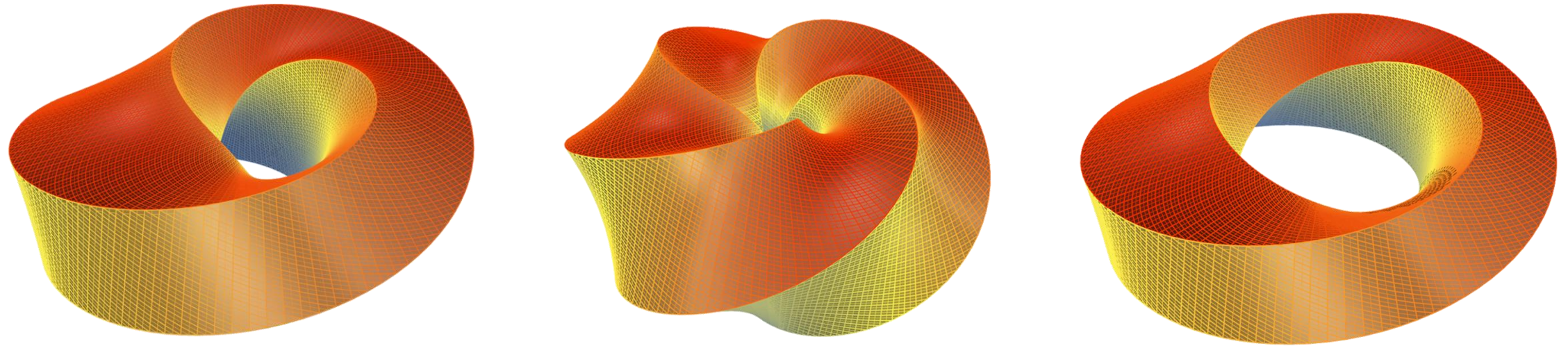
ALGORITHMIC DESIGN AND ANALYSIS

PARAMETRIC MODEL



ALGORITHMIC DESIGN AND ANALYSIS

ANALYTICAL MODEL + ANALYSIS

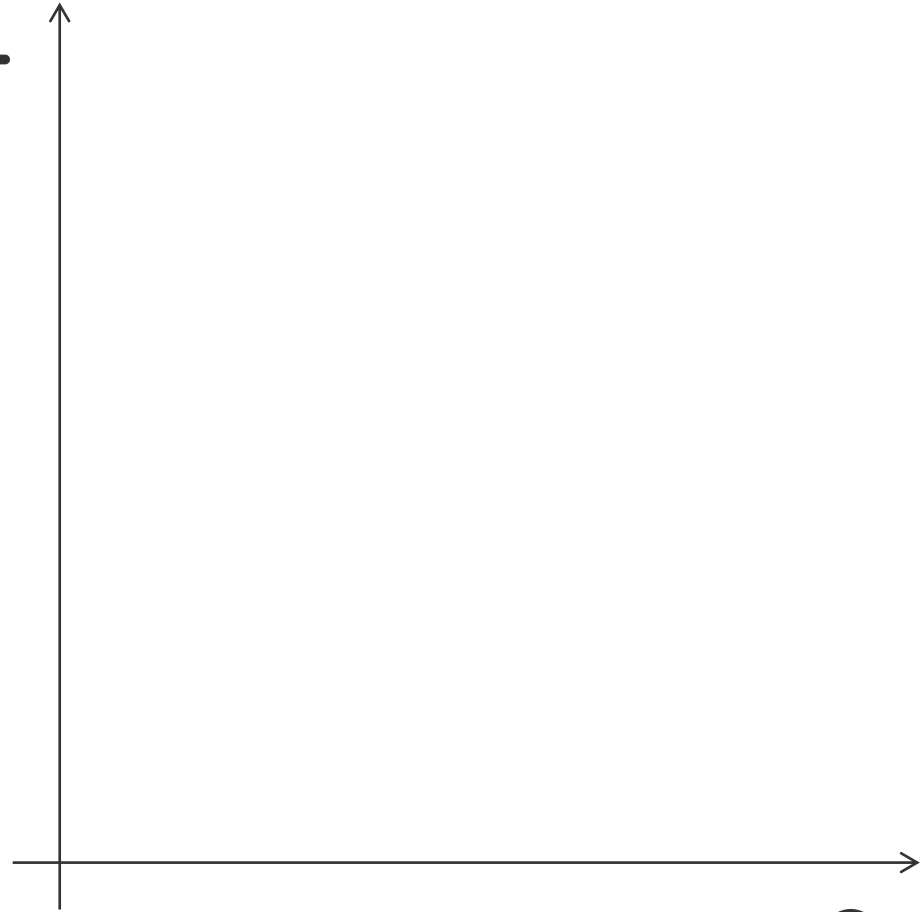


MULTI-OBJECTIVE OPTIMIZATION



PARETO OPTIMIZATION

OBJECTIVES



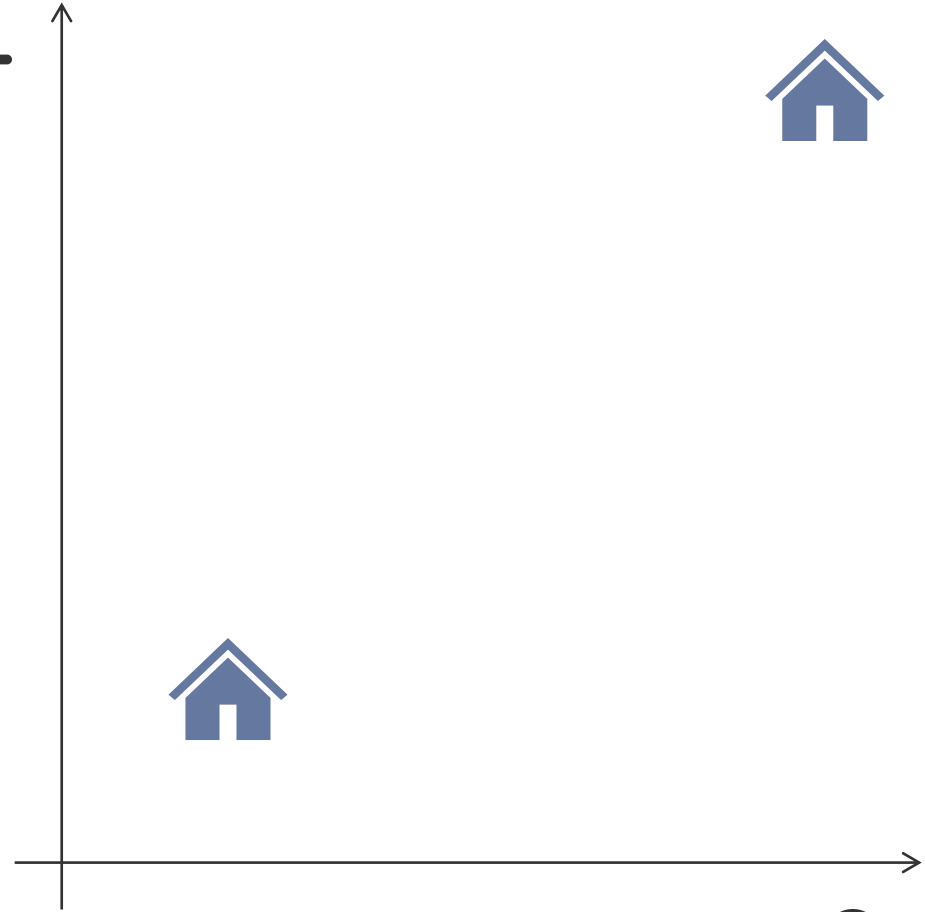
PARETO OPTIMIZATION

OBJECTIVES



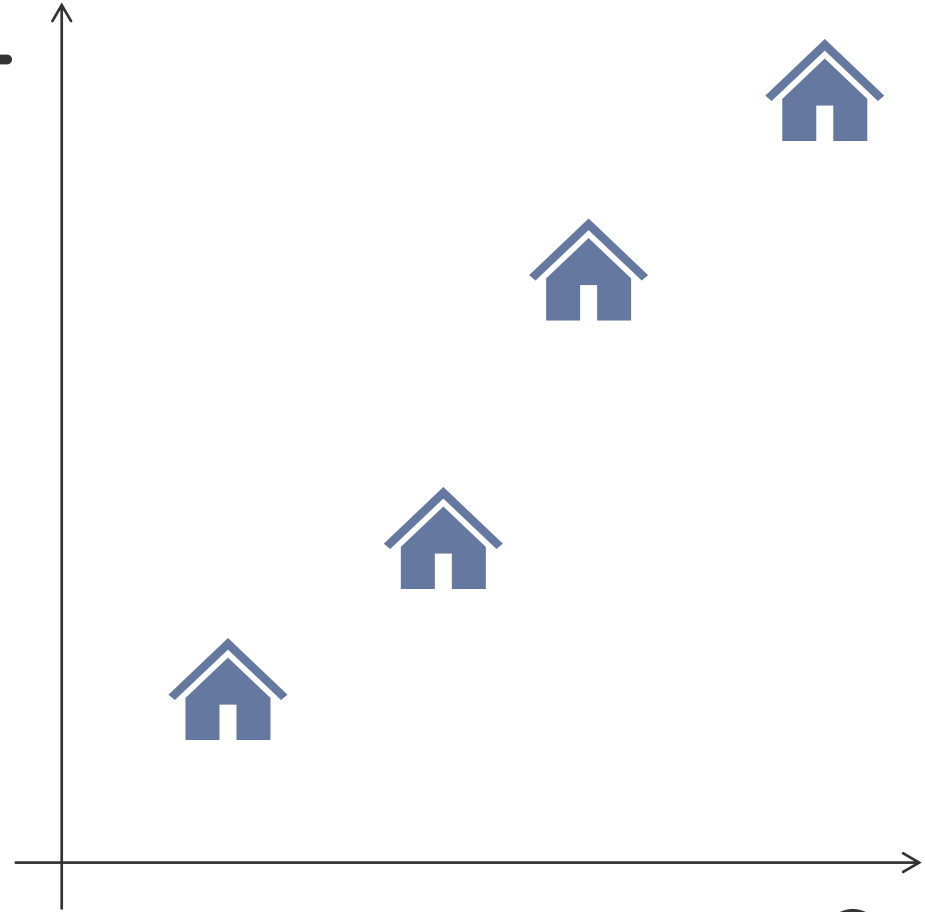
PARETO OPTIMIZATION

OBJECTIVES



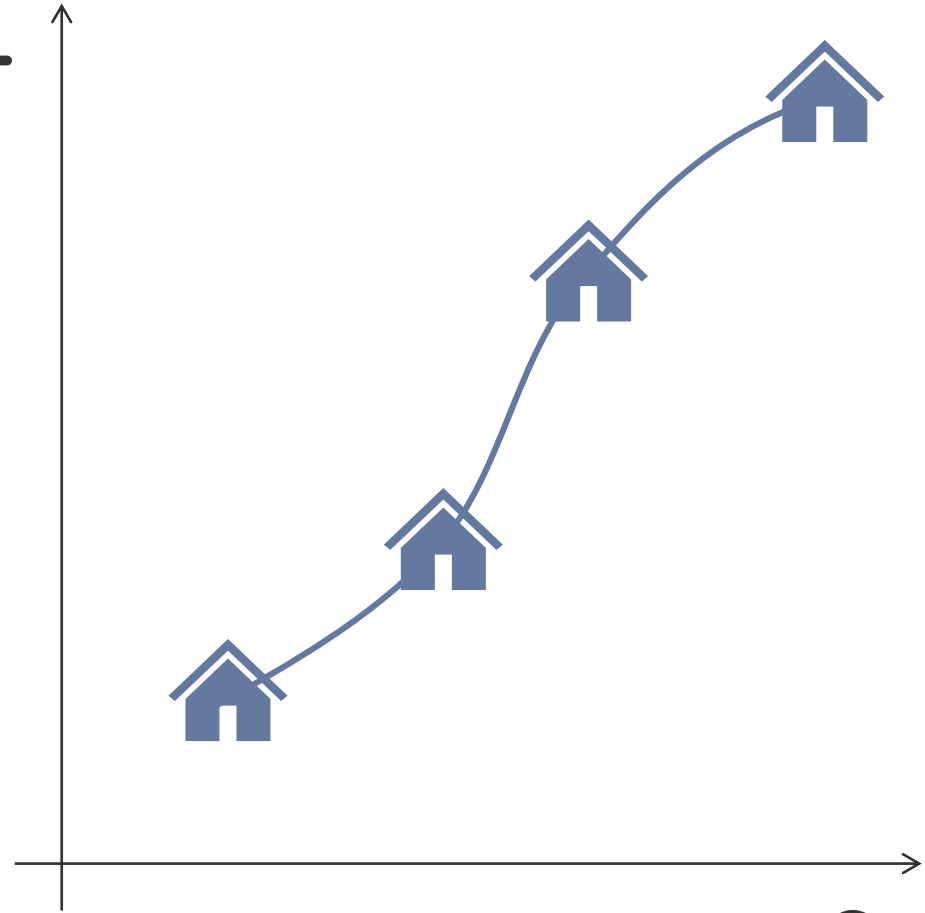
PARETO OPTIMIZATION

OBJECTIVES



PARETO OPTIMIZATION

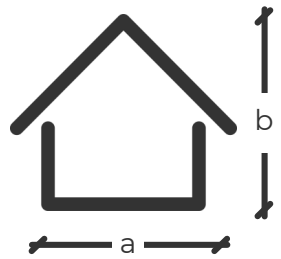
OBJECTIVES



METHODOLOGY



OBJECTIVE



parametric
model



analysis
tools



optimization
processes



performance-based
design solution(s)

WORKFLOW

WORKFLOW

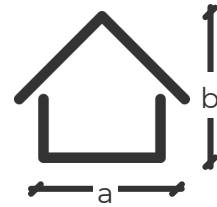


architect

WORKFLOW



architect

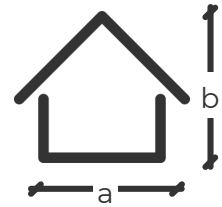


parametric
model

WORKFLOW



architect



parametric
model



analysis 1



analysis 2

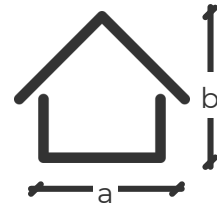


analysis ...

WORKFLOW



architect



parametric
model



optimization
algorithm



analysis 1

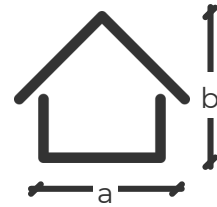


analysis 2



analysis ...

WORKFLOW



parametric
model



optimization
algorithm



analysis 1

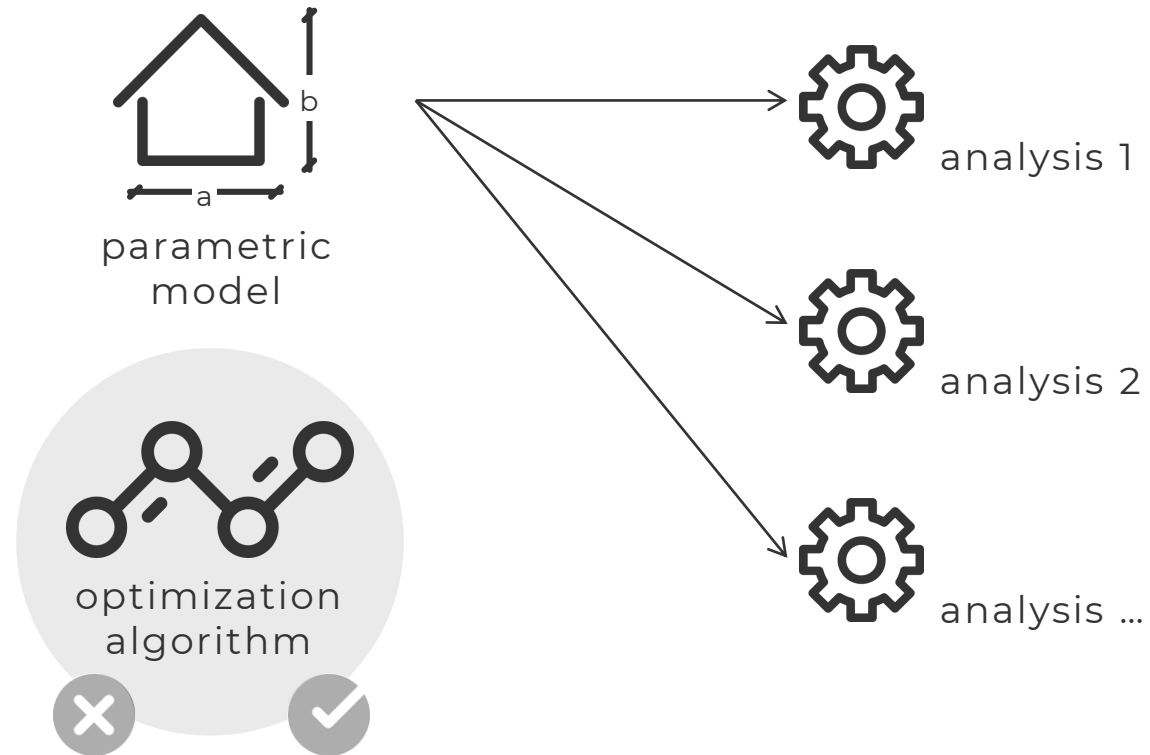


analysis 2

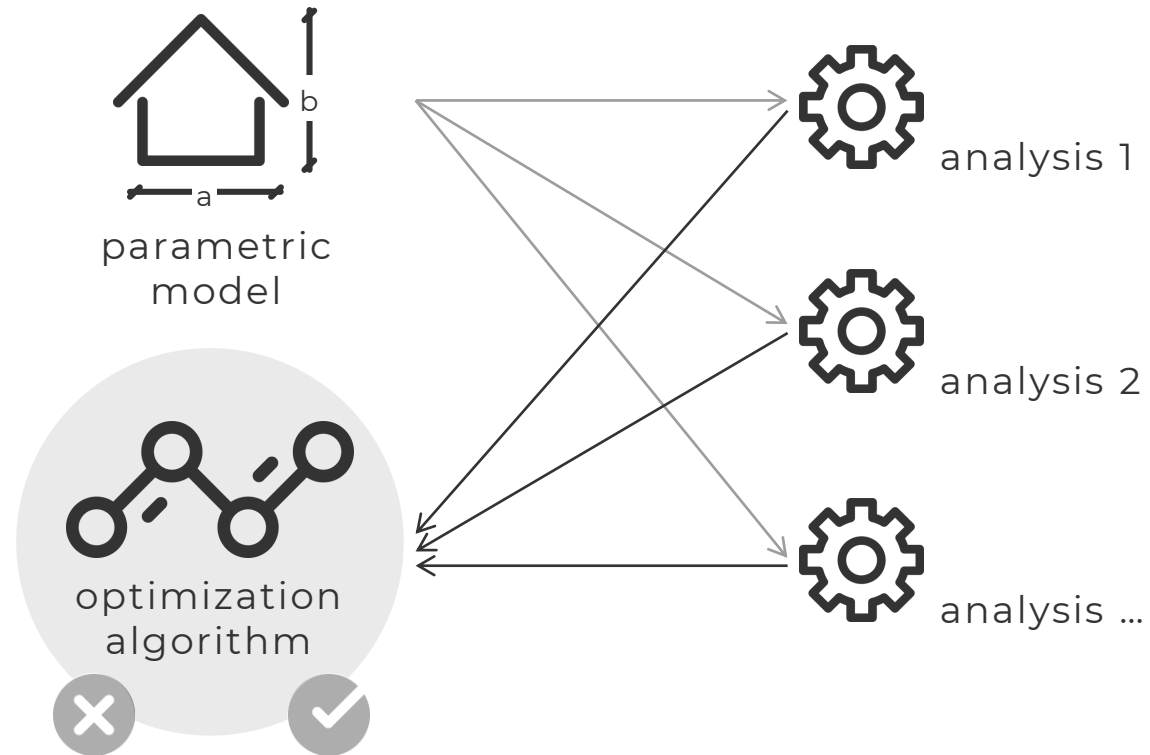


analysis ...

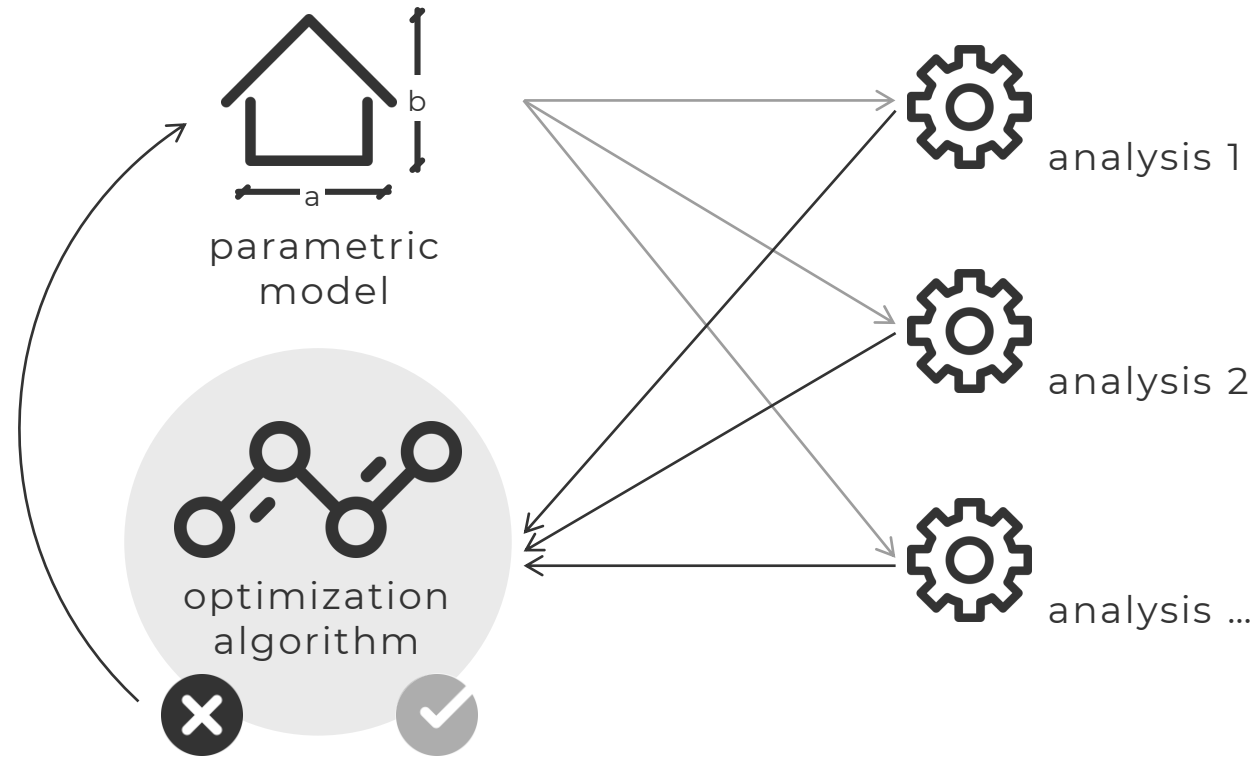
WORKFLOW



WORKFLOW



WORKFLOW

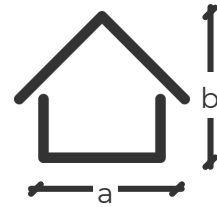


METHODOLOGY

MULTI-OBJECTIVE WORKFLOW



architect



parametric
model



optimization
algorithm



results



analysis 1



analysis 2

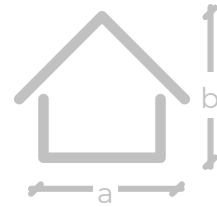


analysis ...

WORKFLOW



architect



parametric
model



optimization
algorithm



analysis 1



analysis 2



analysis ...



visualization



evaluate
solutions

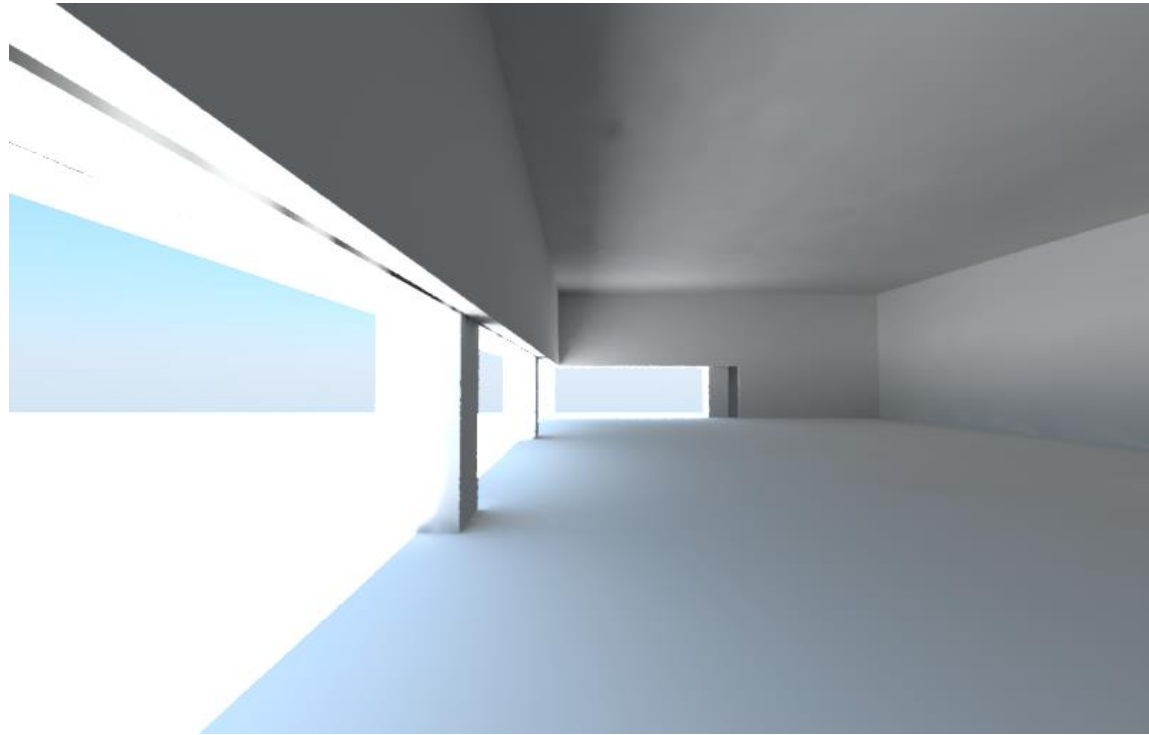
CASE STUDY

— BLACK PAVILION

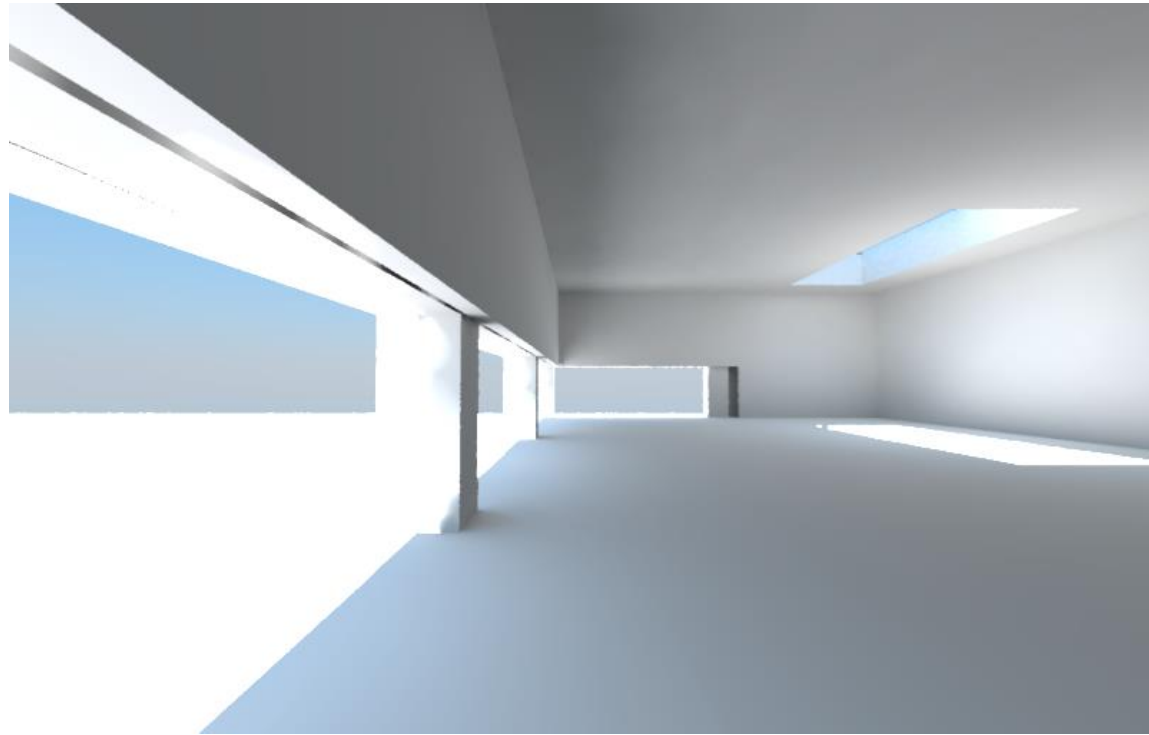
— PIMENTA PALACE



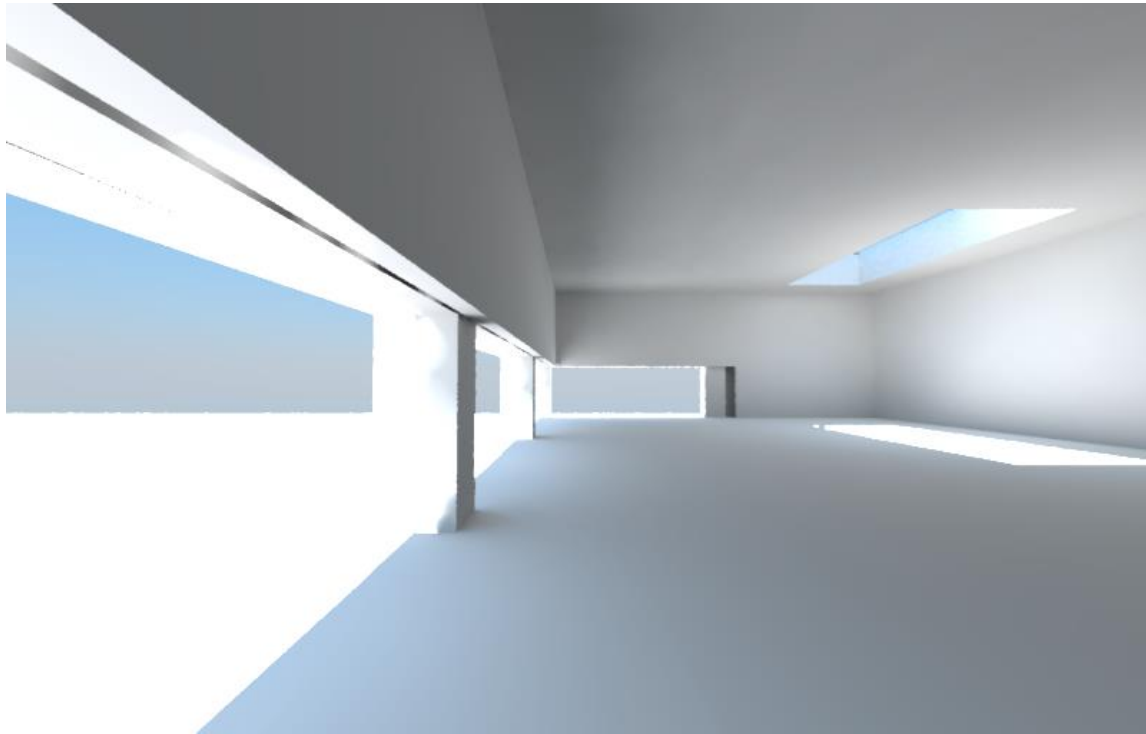
CASE STUDY



CASE STUDY



CASE STUDY



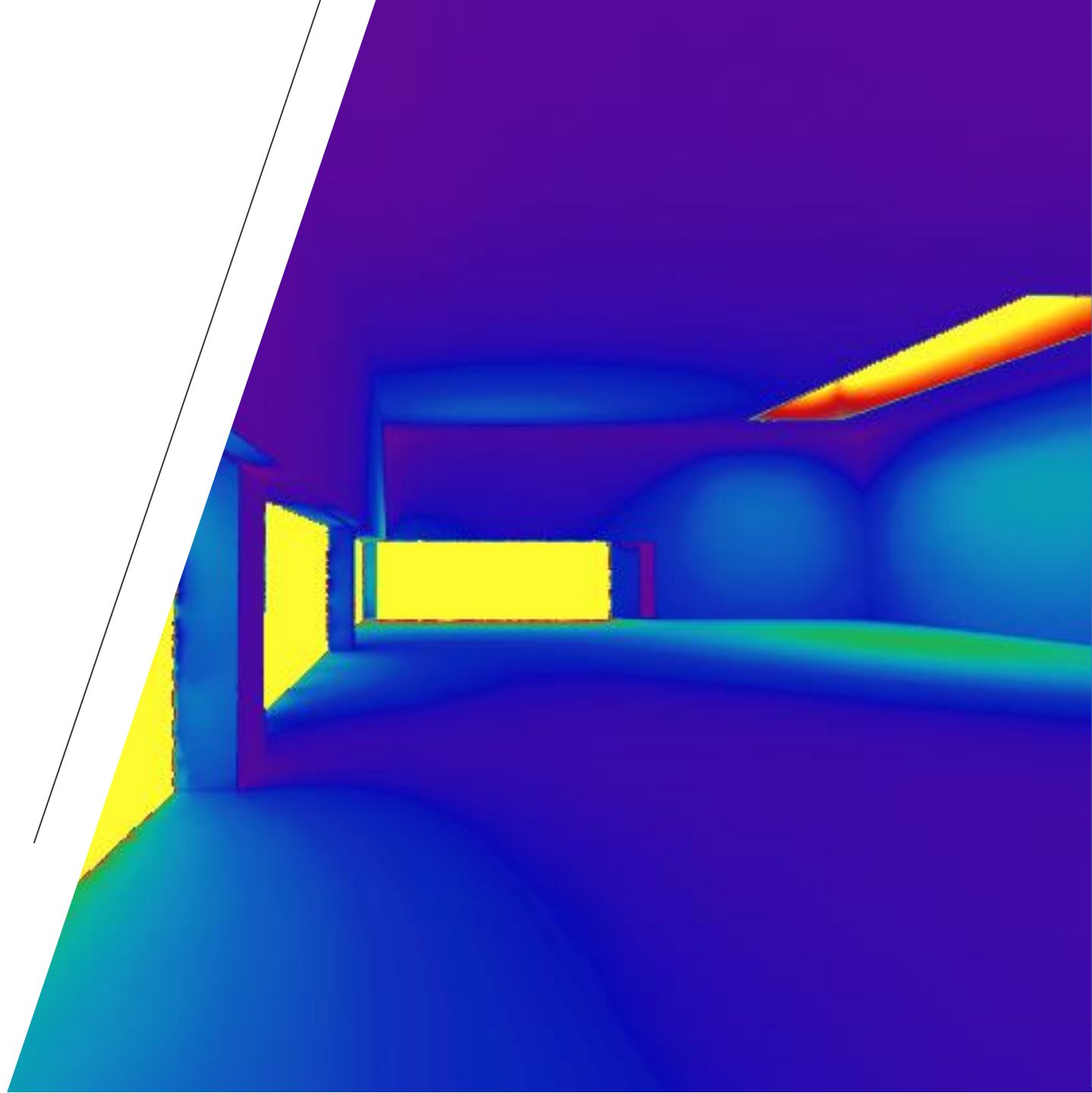
VARIABLE PARAMETERS

length

width

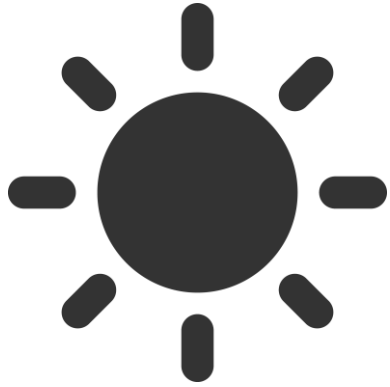
material

EVALUATION



———— OPTIMIZATION OBJECTIVES ————

OPTIMIZATION OBJECTIVES

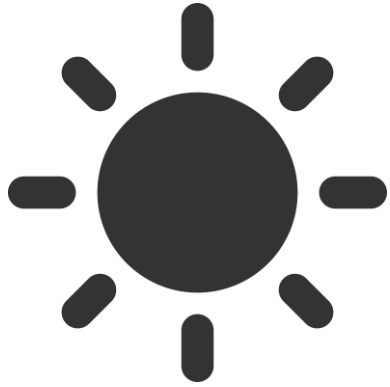


daylight performance

spatial useful daylight illuminance
(sUDI)

maximize

OPTIMIZATION OBJECTIVES



daylight performance

spatial useful daylight illuminance
(sUDI)

maximize



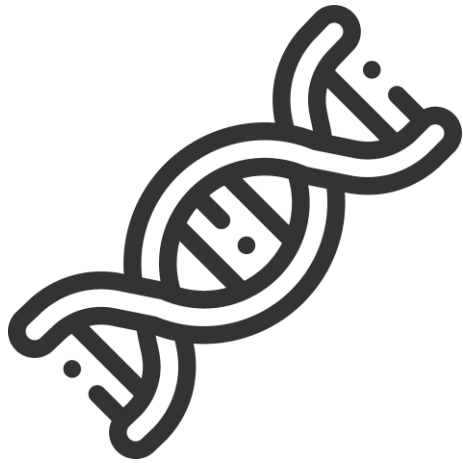
skylight material cost

material area and cost per m²

minimize

— OPTIMIZATION ALGORITHM —

— OPTIMIZATION ALGORITHM —



genetic algorithm
NSGA-II

population size of 10

20 iterations

mutation probability of 30%

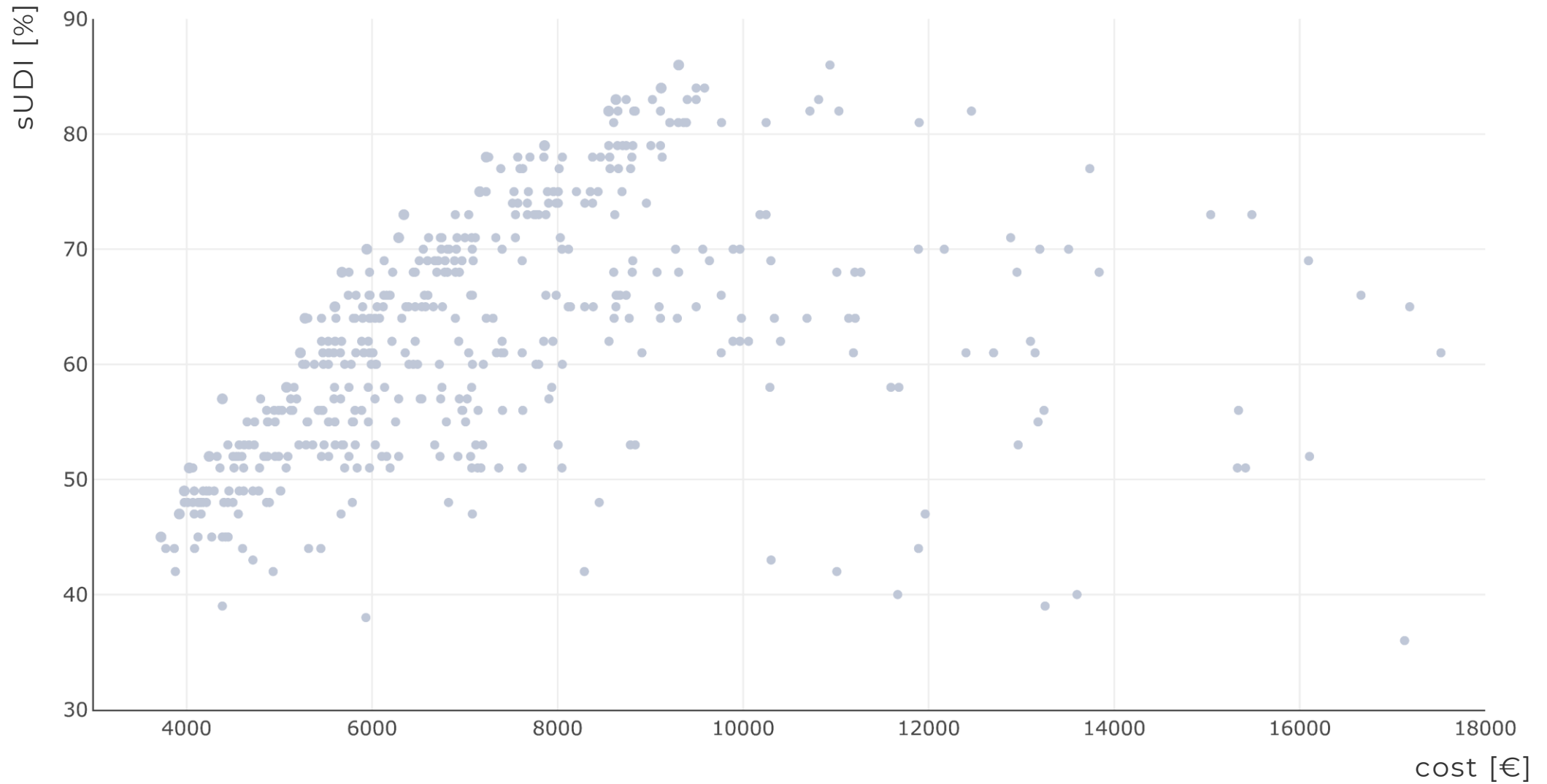
3 runs of the algorithm

VISUALIZATION

PARETO FRONT

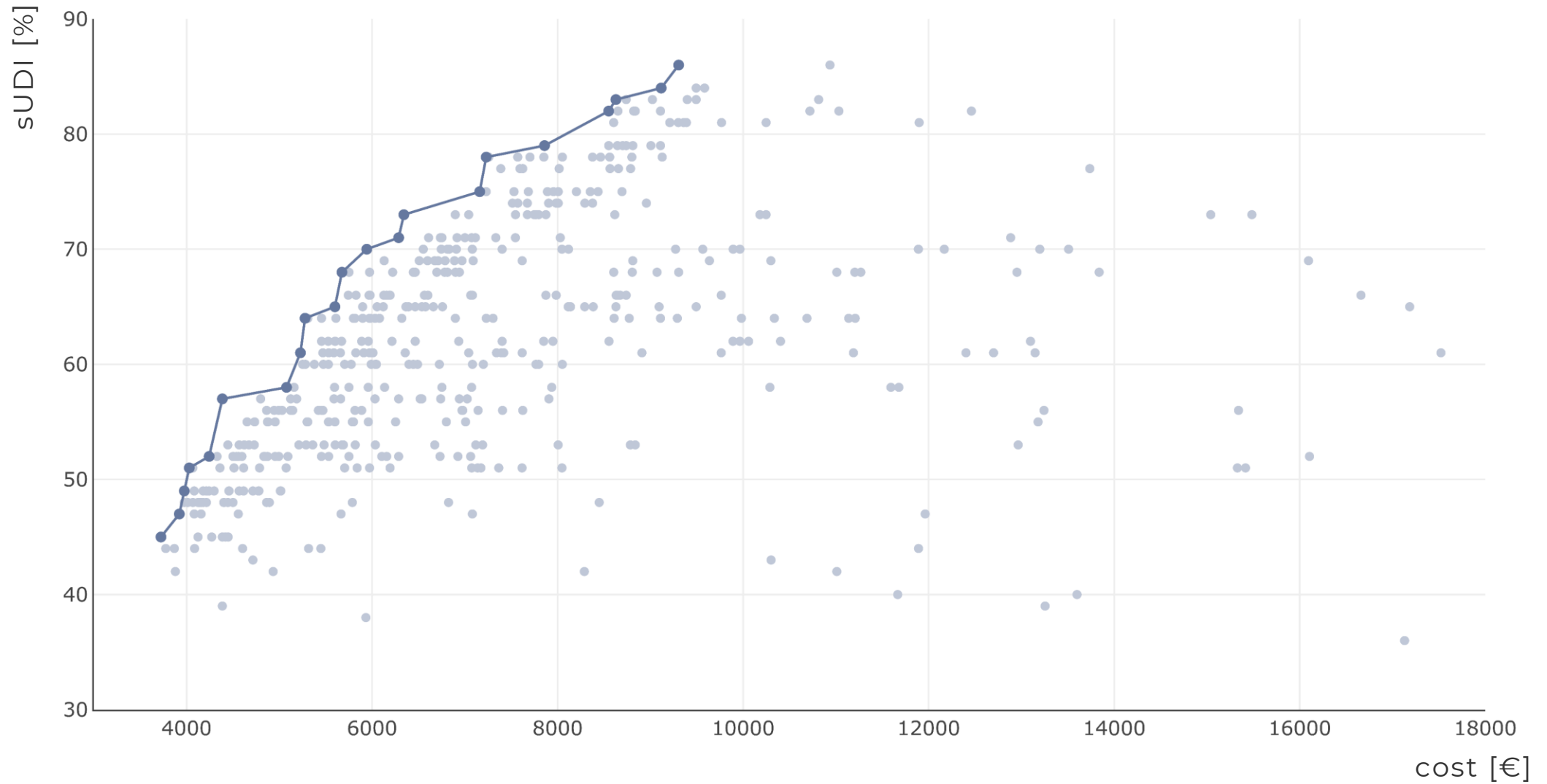
VISUALIZATION

PARETO FRONT



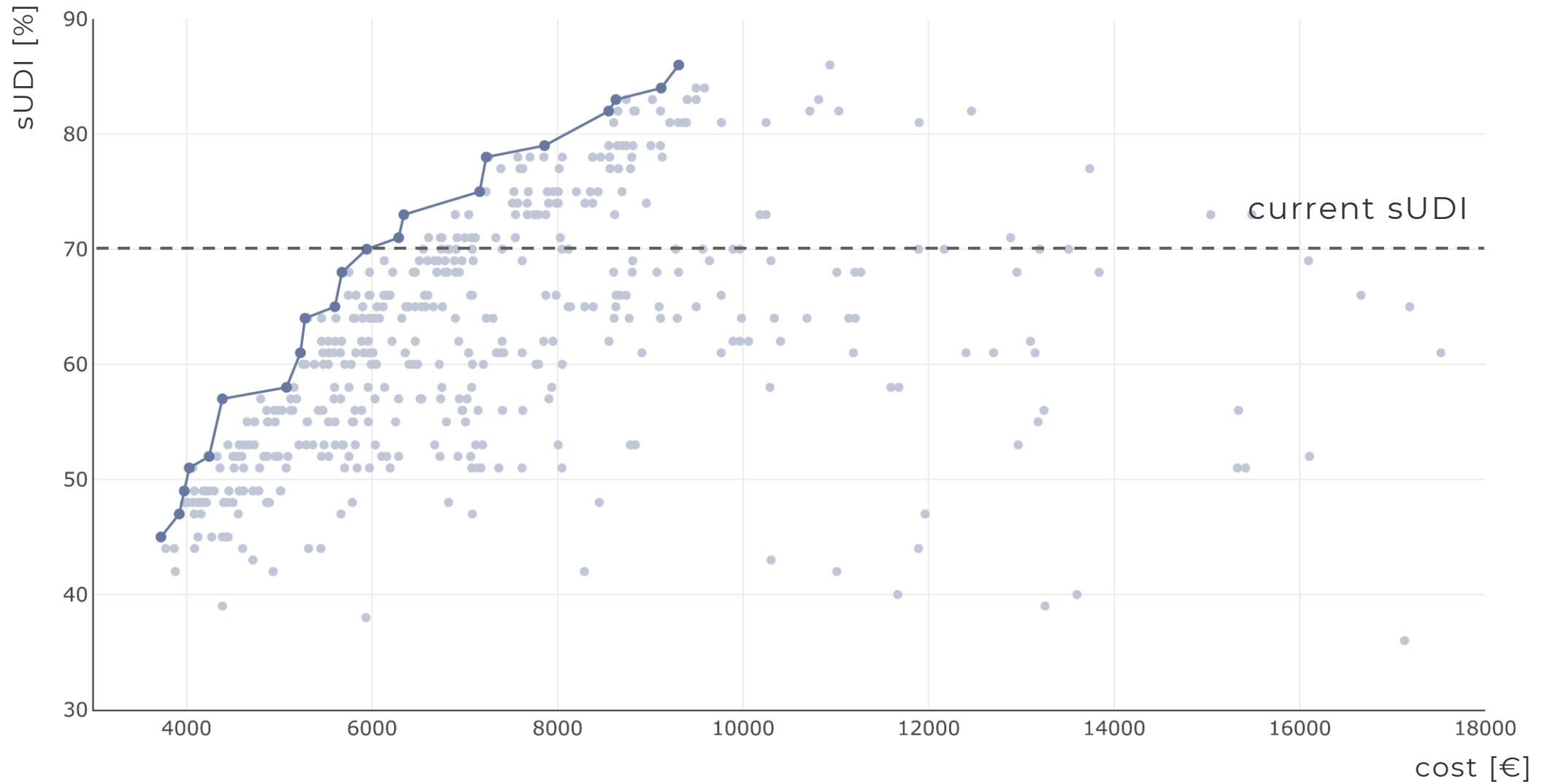
VISUALIZATION

PARETO FRONT



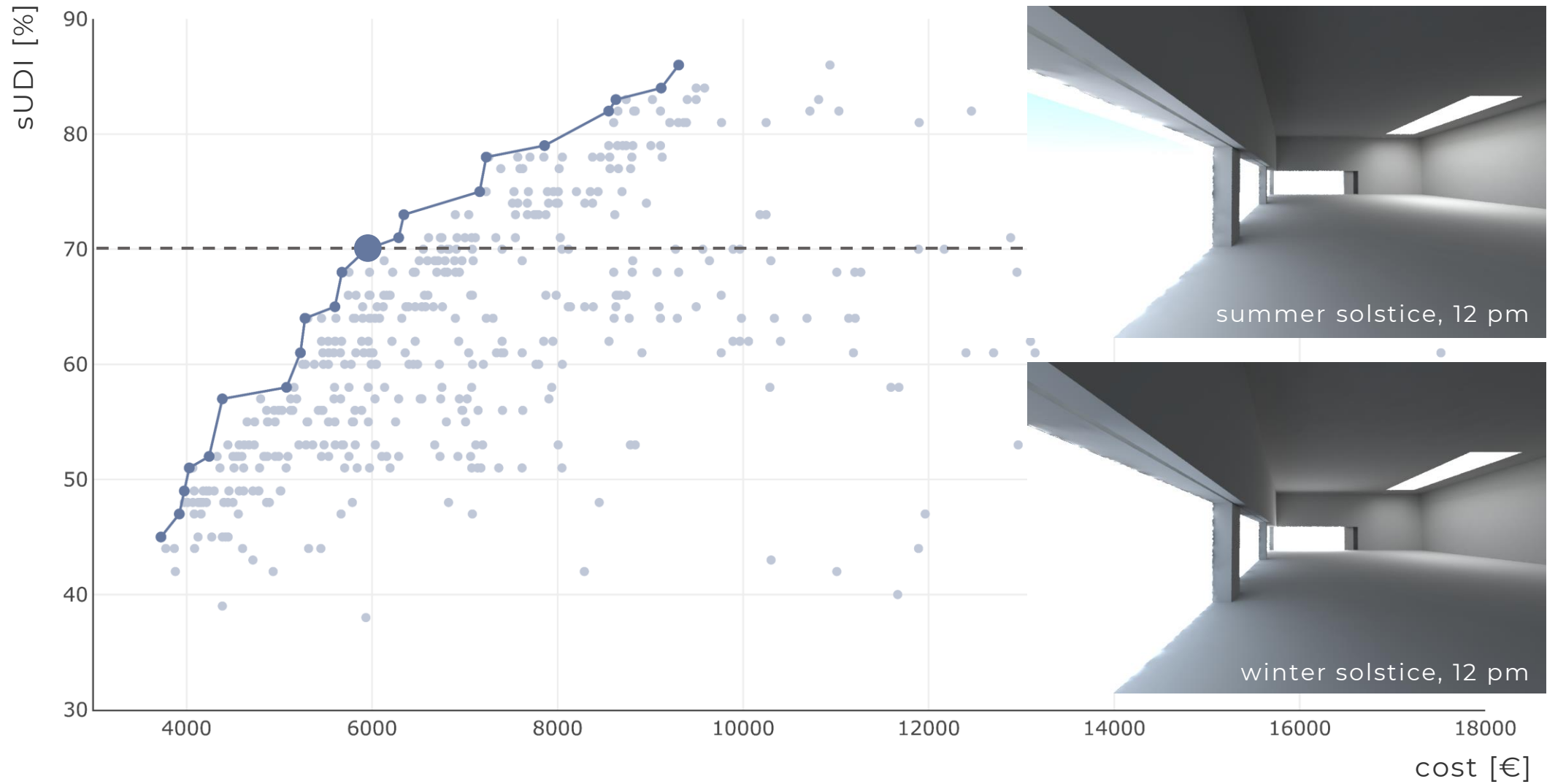
VISUALIZATION

PARETO FRONT



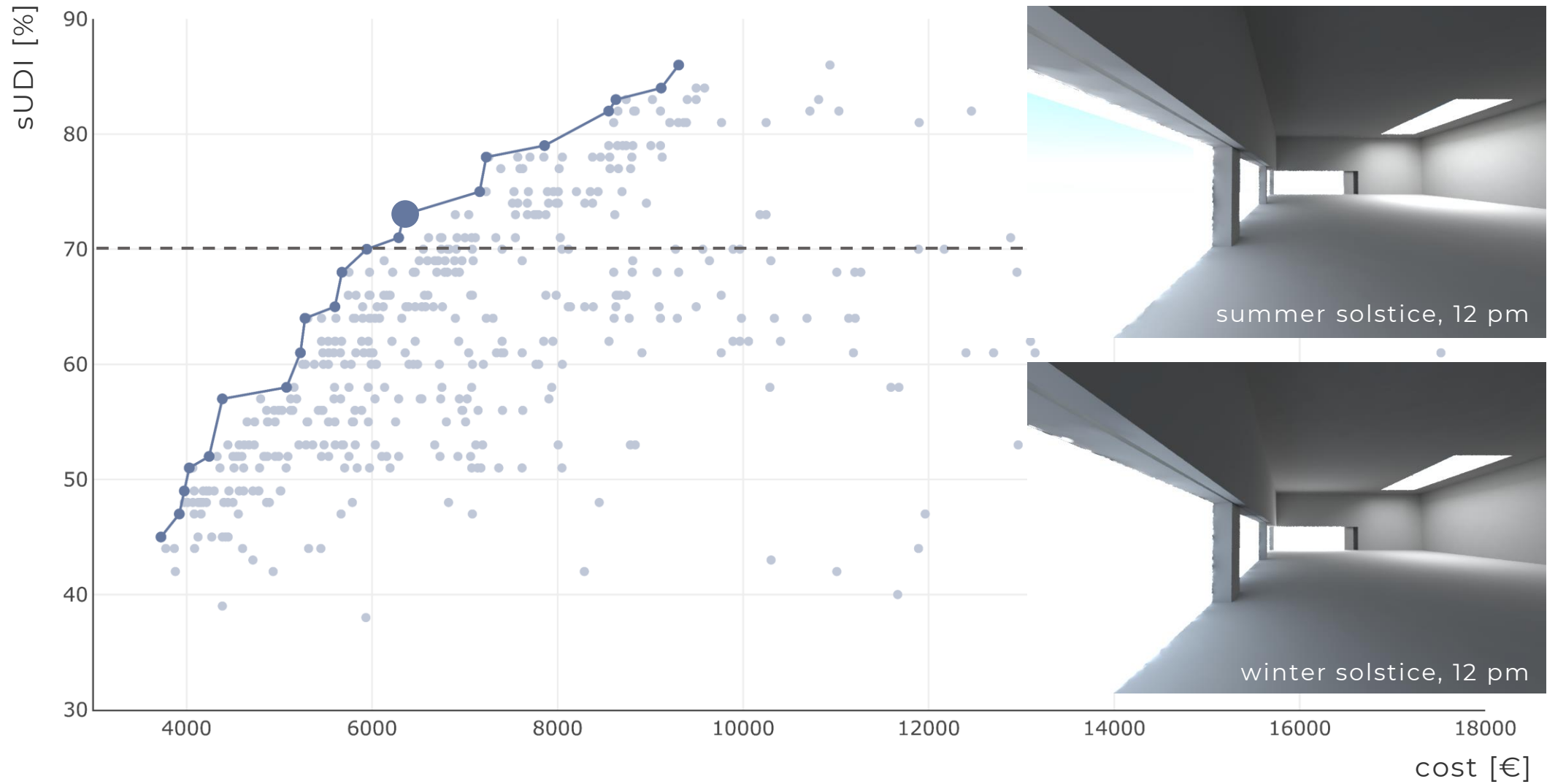
VISUALIZATION

PARETO FRONT



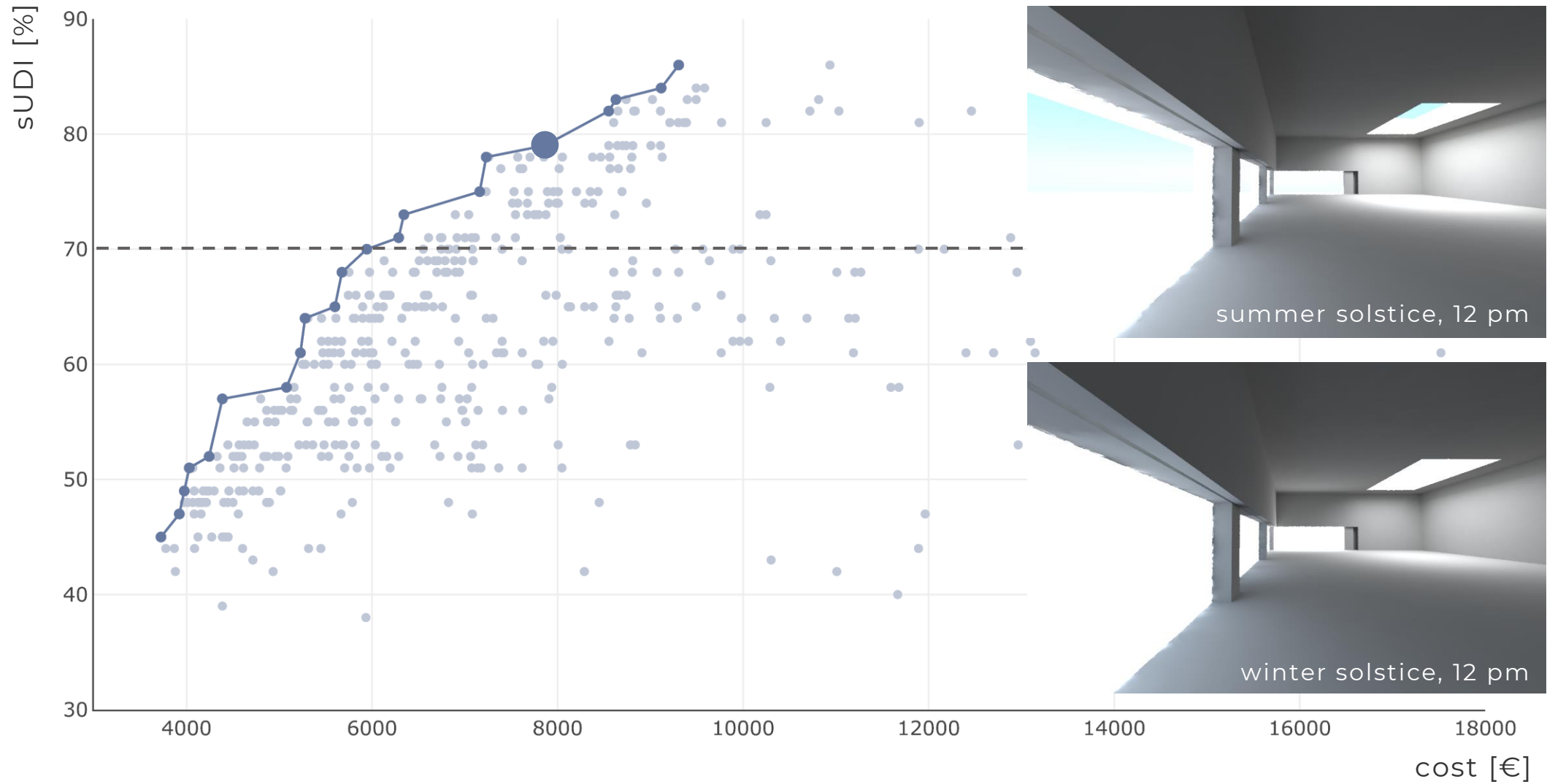
VISUALIZATION

PARETO FRONT



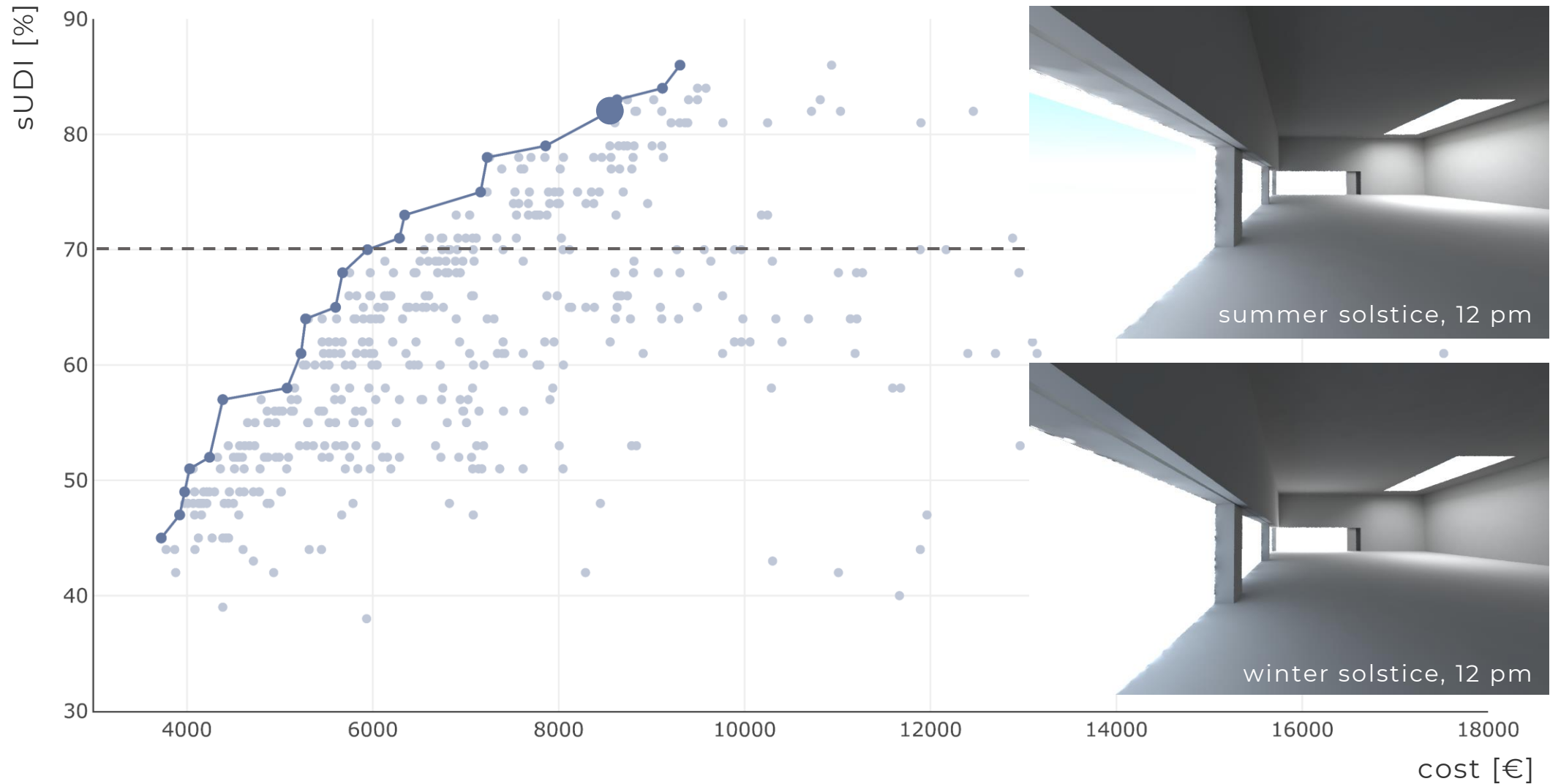
VISUALIZATION

PARETO FRONT



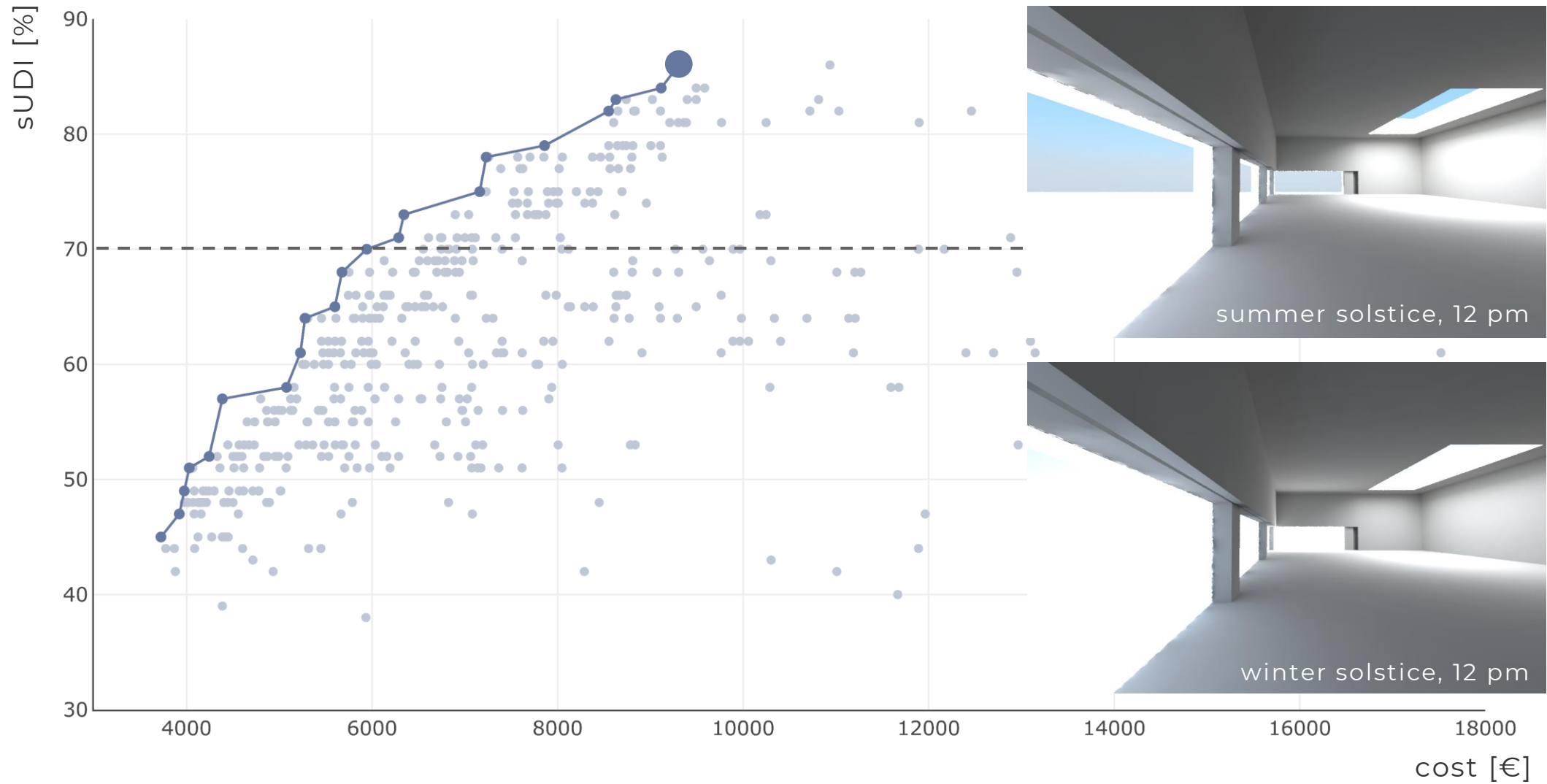
VISUALIZATION

PARETO FRONT



VISUALIZATION

PARETO FRONT



CONCLUSION

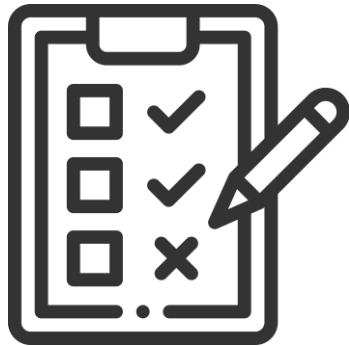


CONCLUSION

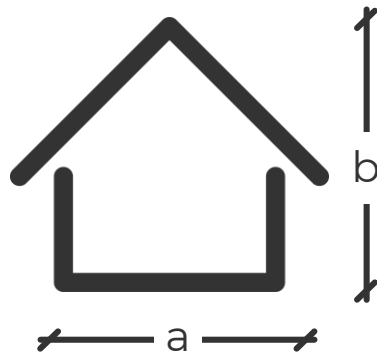


importance of
evaluate performance

CONCLUSION

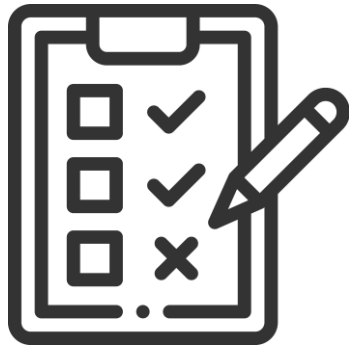


importance of
evaluate performance

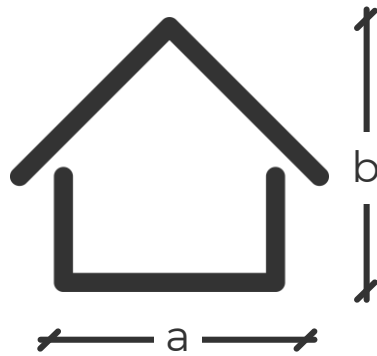


relevance of
parametric models

CONCLUSION



importance of
evaluate performance



relevance of
parametric models



small scale buildings
also benefit from AD

FUTURE WORK

FUTURE WORK



test different
optimization algorithms



add more
objectives



THANK YOU
QUESTIONS?

ines.pereira@tecnico.ulisboa.pt

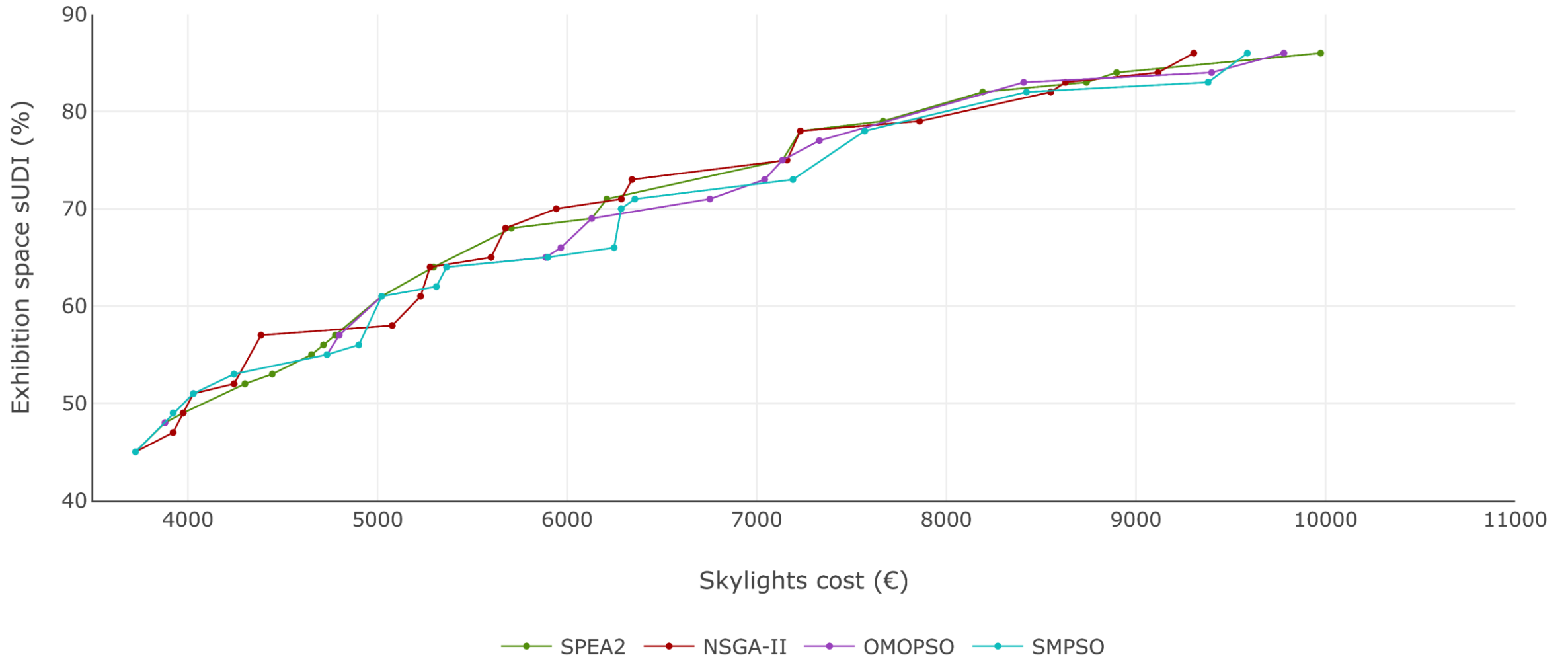
catarina.belem@tecnico.ulisboa.pt

antonio.menezes.leitao@tecnico.ulisboa.pt



<https://algorithmicdesign.github.io>

ADDITIONAL ALGORITHMS



GENETIC ALGORITHM

GENETIC ALGORITHM

create
population



GENETIC ALGORITHM

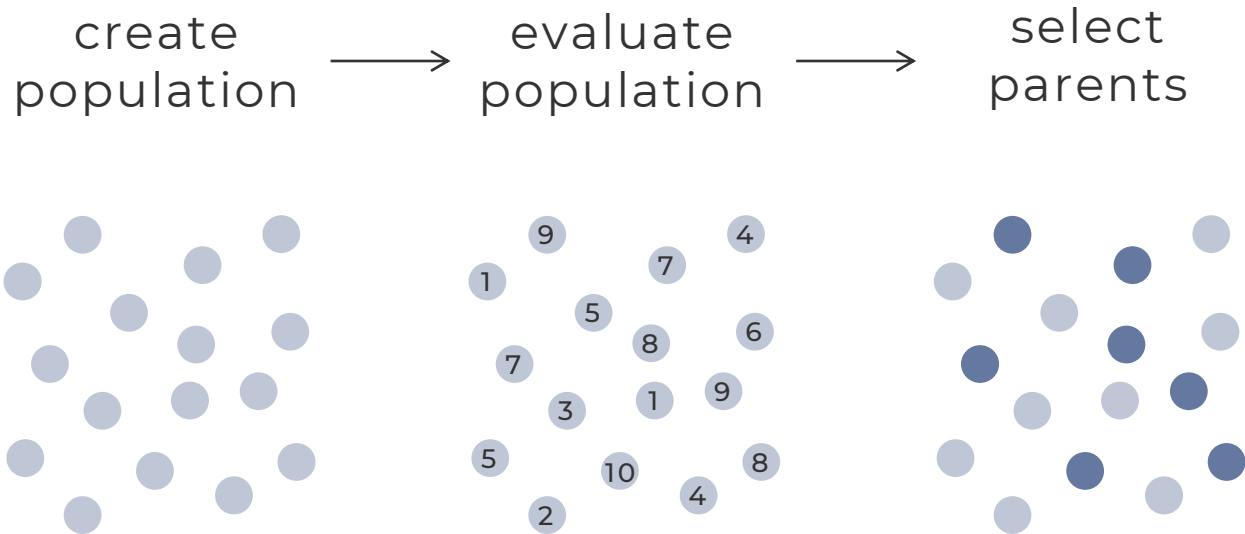
create
population



evaluate
population

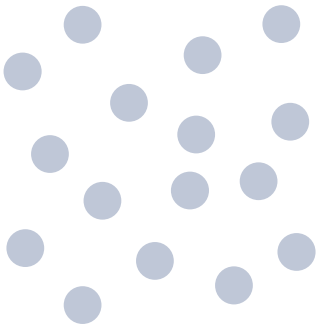


GENETIC ALGORITHM



GENETIC ALGORITHM

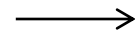
create
population



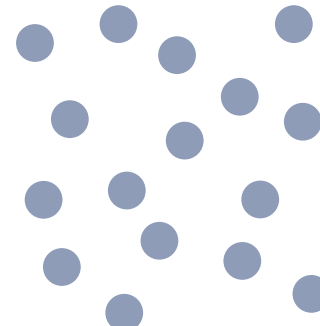
evaluate
population



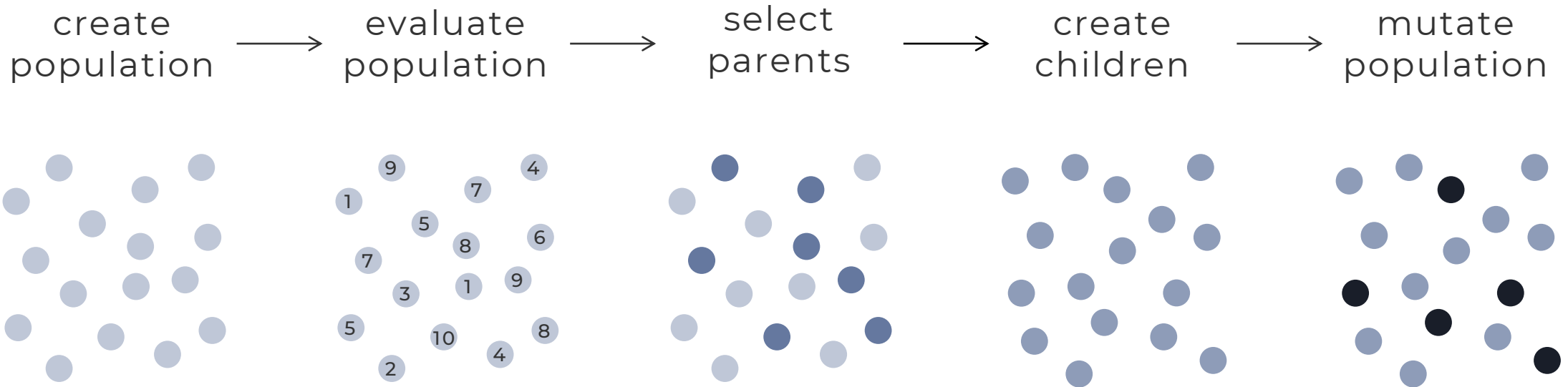
select
parents



create
children



GENETIC ALGORITHM



GENETIC ALGORITHM

