VISUALIZATION OF THE BOUNDARY SOLUTIONS OF HIGH DIMENSIONAL PARETO-FRONT FROM A DECISION MAKER´S PERSPECTIVE

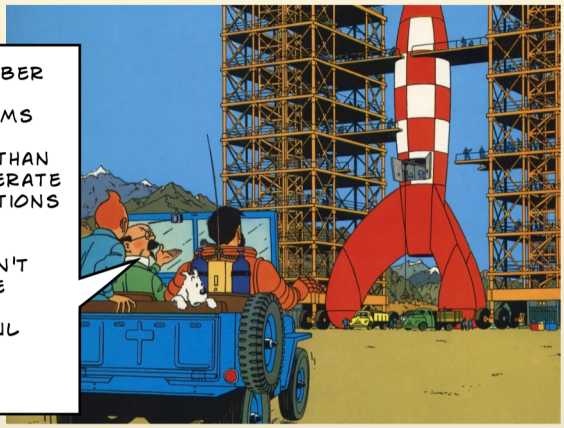
KHALED TALUKDER
TALUKDE1@MSU.EDU

KALYANMOY DEB
KDEB@EGR.MSU.EDU

JULIAN BLANK
BLANKJUL@EGR.MSU.EDU

THERE ARE A GOOD NUMBER OF MANY-OBJECTIVE OPTIMIZATION ALGORITHMS THAT CAN OPTIMIZE PROBLEMS WITH MORE THAN 3 OBJECTIVES AND GENERATE PARETO-OPTIMAL SOLUTIONS (I.E PARETO-FRONT).

HOWEVER, STILL WE DON'T KNOW HOW TO VISUALIZE THEM? SPECIALLY THE INTERESTING AND USEFUL ASPECTS OF A HIGH-DIMENSIONAL PARETO-FRONT.



FOR EXAMPLE, IF WE LOOK AT THE RADVIZ PLOT TO VISUALIZE A 5-DIMENSIONAL PARETO-FRONT ...

ALL THE POINTS ARE SUPER-IMPOSED ON ONE SINGLE PLANE AND YOU LOSE ALL THE GEOMETRIC INFORMATION OF THE SHAPE, LIKE THE "BOUNDARY".

WHAT ABOUT PARALLEL-COORDINATE PLOTS(PCP)?

DOES NOT WORK EITHER, BASICALLY, PCP IS NO BETTER THAN JUST LISTING ALL THE OBJECTIVE VALUES IN A TABLE!! IT DOES NOT SAY ANYTHING ABOUT GEOMETRY OR TRADE-OFF OF THE PARETO-FRONT SOLUTIONS.

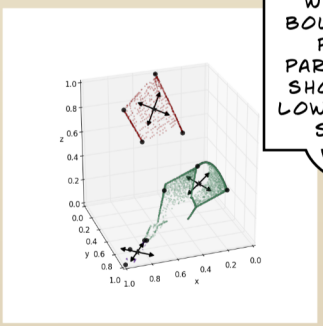
PROFESSOR! WHAT IF WE MAP THE HIGH-DIMENSIONAL DATA POINTS ONTO A LOW DIMENSIONAL SPACE AND VISUALIZE THE TRADE-OFFS AND GEOMETRY THERE?

HMM... INTERESTING IDEA. WE CAN USE STOCHASTIC NEIGHBORHOOD EMBEDDING (SNE), THAT WILL KEEP THE NEIGHBORHOOD RELATIONS CLOSER AS IN THE ORIGINAL DIMENSION.

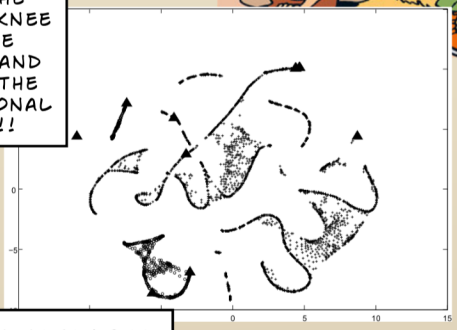
WHAT ABOUT THE TRADE-OFF AMONG THE SOLUTIONS?

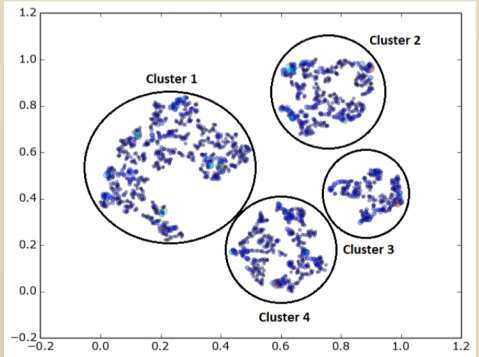
HOW DO WE SEE THEM?

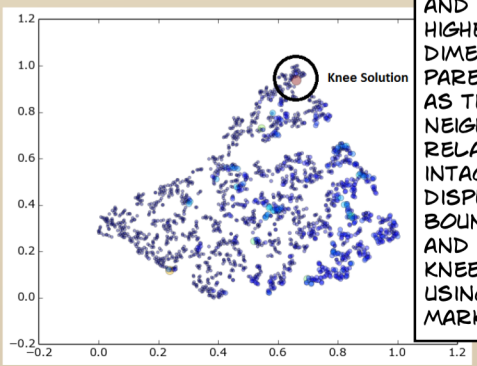
WE NEED TO MAKE DECISIONS!



WE CAN FIND THE BOUNDARY AND KNEE POINTS OF THE PARETO-FRONT AND SHOW THEM ON THE LOWER-DIMENSIONAL SNE MAPPING!!







NOW WE CAN SEE AND NAVIGATE THE HIGHER DIMENSIONAL PARETO-FRONT. AS THE NEIGHBORHOOD RELATIONS ARE INTACT, WE DISPLAY THE BOUNDARY POINTS AND KNEE-SOLUTIONS USING DIFFERENT MARKERS!!

WE CAN VISUALIZE OTHER PROPERTIES, LIKE CLUSTER OF DATA POINTS TOO!!

Computational Optimization and Innovation Laboratory
Michigan State University

MICHIGAN STATE UNIVERSITY