1. Define

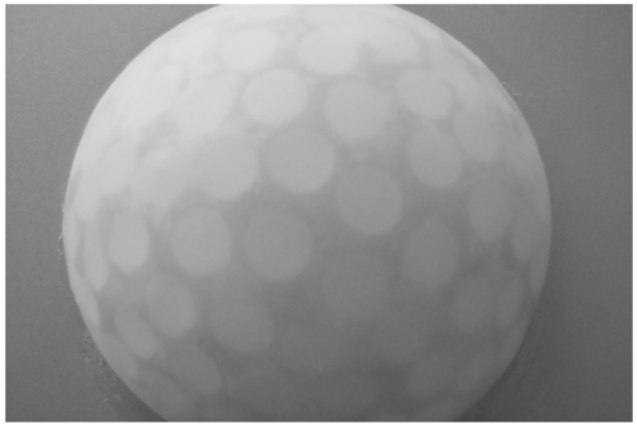
In studio project we are working on material system actuated by air [inflation and/or suction].

In current stage of our research, we are using suction to 'morph' surface in order to create dimples on it, which are helping to reduce air drag around the shape. The main parameters to take in consideration for this material system are - size of the dimples [width and depth] and air pressure needed for the specific behavior. As we need energy to preform suction, one of our main concerns is how much energy we input for the result we are gaining.

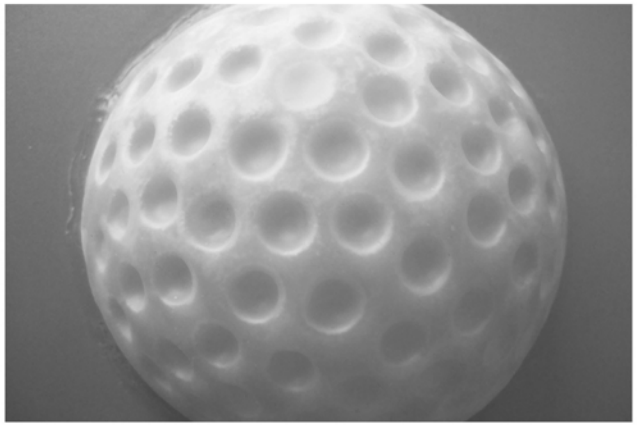
In order to minimize energy consumption we need to calculate what are the factors in our design proposal that influence it and how we can change them while still keeping the same performance.

Initial test are conducted with hemisphere containing pattern of circles that are, due to theirs material properties, able to form dimples.
Parameter of interest is air pressure [energy consumption], that will be defined by width and depth of the dimple and constrained by specific relation between these two that is allowing surface to perform in a way to reduce air drag.

| before air pressure [suction]

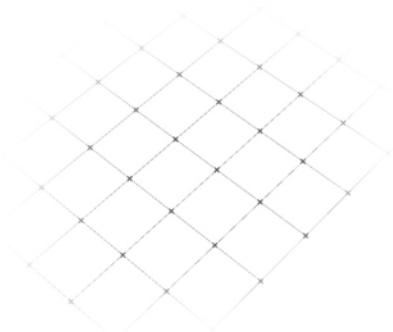


| after air pressure [suction]

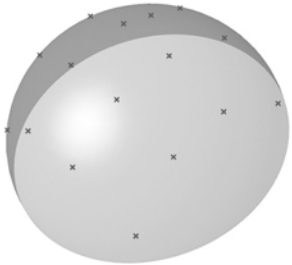


Creating set-up for defining genomes and fitnes.

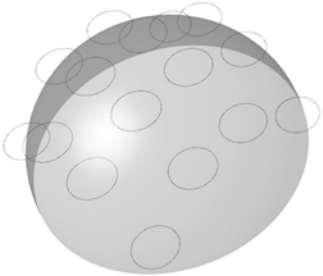
| hemisphere



| grid with points



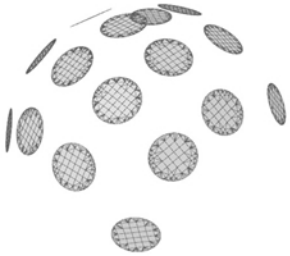
| points projected on hemi-sphere - pulled to mesh closest points



| circles from center points

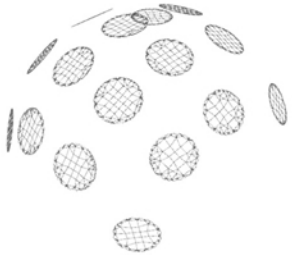
| pattern of circles oriented properly by defining them with normals from hemisphere - curves pulled to mesh

| patch circles

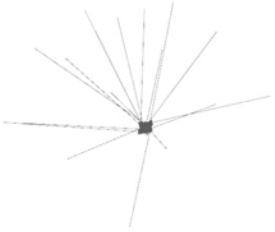


| turn patches (brep) to mesh

| isolating edges for anchor points during air pressure

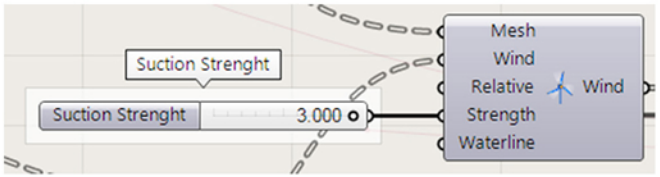


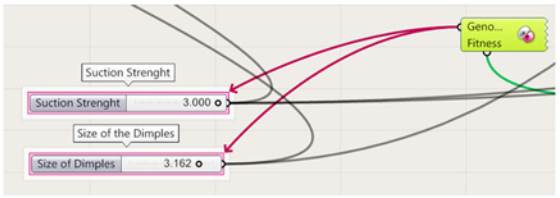
| inner edges for connections for material properties



vectors for wind direction

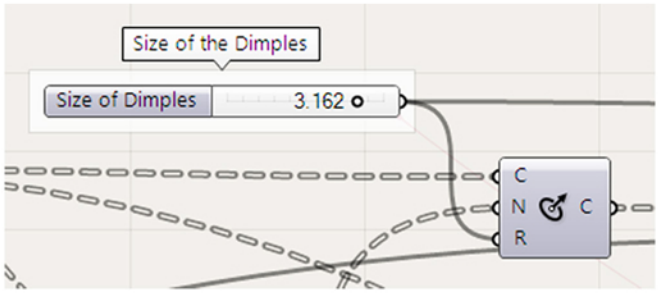
Setting genomes and fitness.



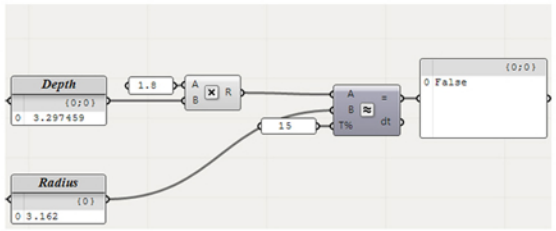


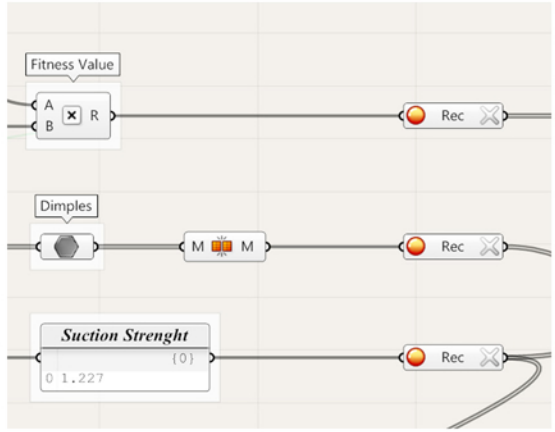
| genomes

1 - pressure of air through strength of wind [air force]
2 - width of the dimples through radius of circles on the mesh

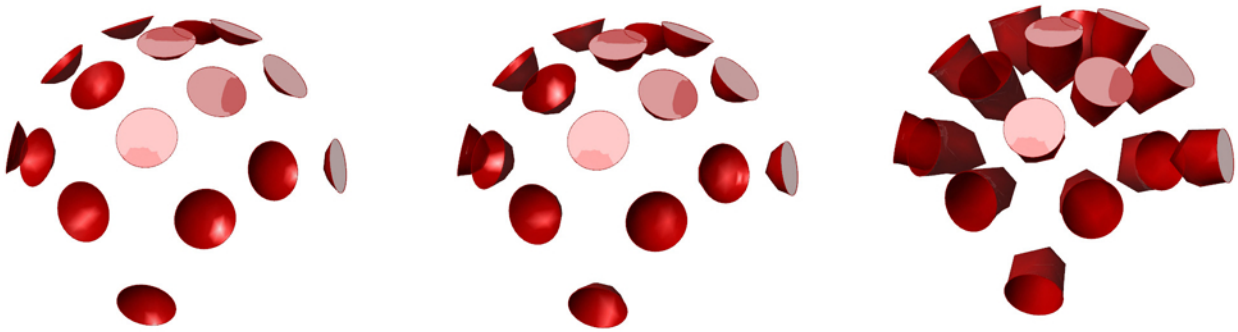


| relation between depth and width of dimple is calculated from similar researches and set up for checking the efficiency of dimples in reducing the air drag through similarity component

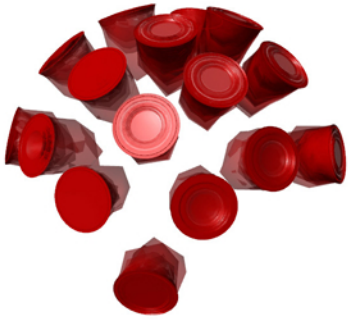




| fitness value is obtained as multiplication of suction strength and value 1 if the relation depth-width of dimple is true, or 1000000 if this relation is false [in order to eliminate those results as they don't belong to solution space]



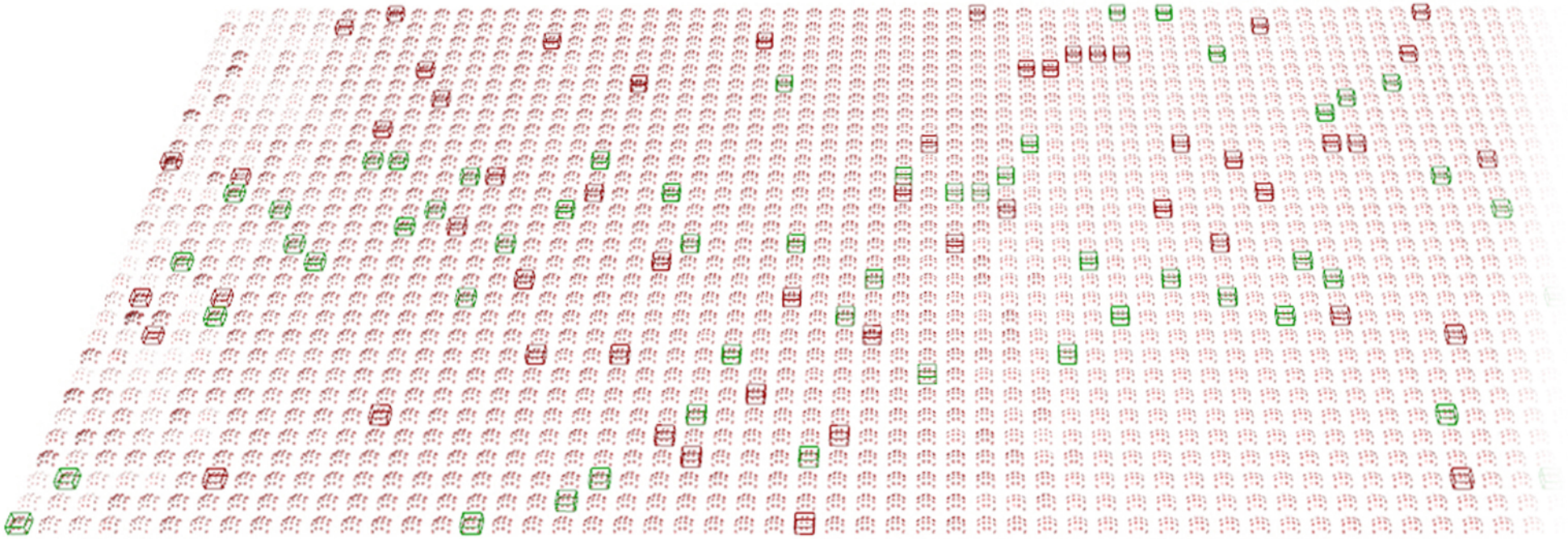
| change in depth of dimples during kangaroo simultion controlled by strength of wind



| overlapped results during Galapagos

Results of Galapagos are showing grater variety of sizes and depth of dimples at first few generations, while the rest of the generations look very similar as the differences are very small because its closer to the optimal result. Out of the results it can be concluded that smaller circles in pattern need more air pressure in order to form dimple with certain depth-width relation.

Other parameters that can be added to the definition to influence the optimization results are disposition of circles on the surface, different material properties and initial shape for testing (degree of curvature in relation to air pressure).



| matrix of galapagos results [30 generations]
showing more diverse reults at the beginning towards more similar at the end

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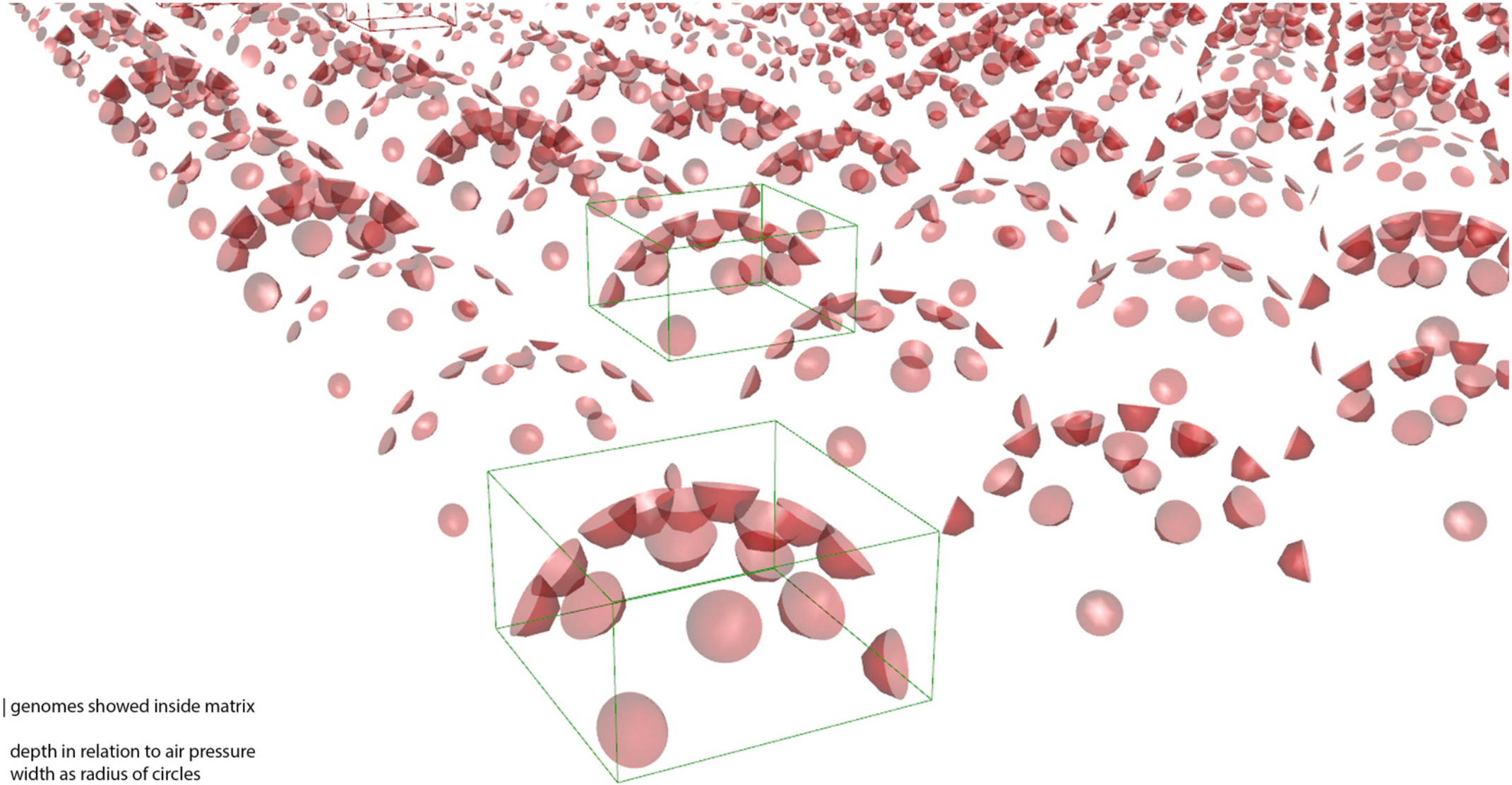

| genomes showed inside matrix

depth in relation to air pressure
width as radius of circles