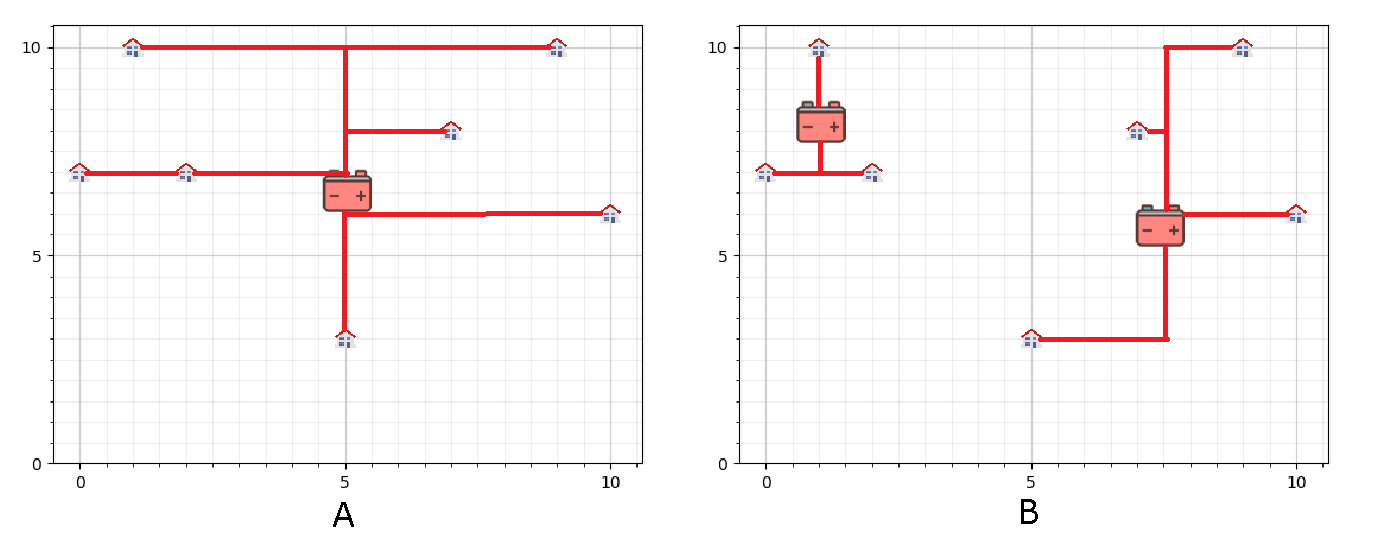
**Introduction**

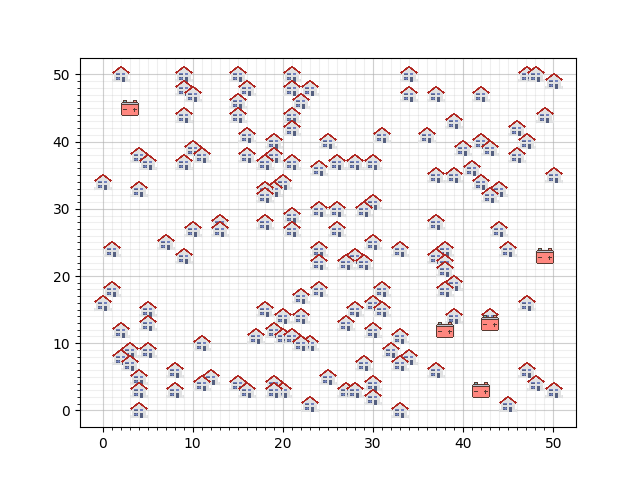
Green energy is the energy of the future. Unfortunately, most means of green energy production do not have a constant output, since the sun doesn’t shine at night and the wind is quite fluctuating as well. With more households getting solar panels and turbines, it makes sense to store the energy in batteries at peak hours so it can still be used when production is low. This way the batteries can be used as a constant energy source on the already existing energy-delivering network (the net). The new infrastructure, a *Smart Grid* of consumption-production, is by no means trivially configured.  So, the challenge is: ‘Which houses should be connected to which batteries, and where should they be placed?’

**Example**

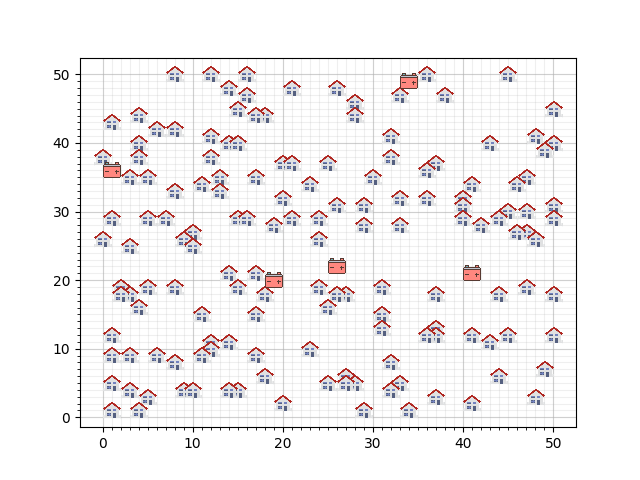


This neighbourhood has seven houses with solar panels. As you can see in setup A the total wire length used for the setup is nearly twice the amount in B because the tactical placement of an extra battery. Do these savings in total wire length amount to the cost of placing an extra battery however?

**Boards**

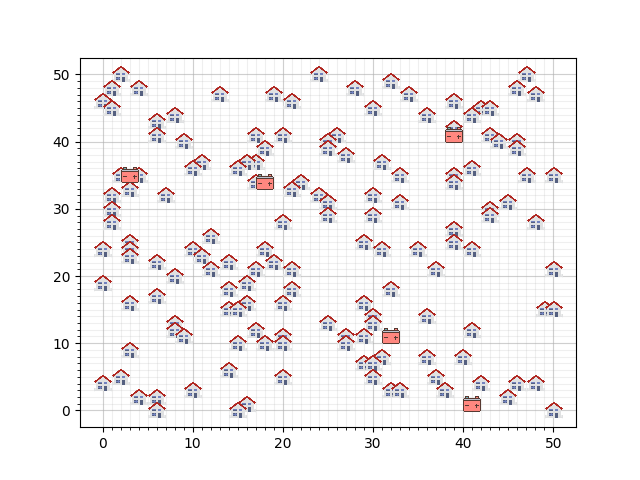


**I)**

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**III)**

**II)**



**Assignment**

To keep things a bit manageable a few simplifications have been made. The variable time has been taken out of the equation for example and all houses are on a grid. The assignment is to find a setup that gives an optimal cost for wires and batteries. Wire length is measured in *Manhattan distance* and its price is 9 per segment*.* There is one *hard constraint* however, each battery has a maximum capacity and is not allowed to be over-capacitated output to avoid explosion danger.

***A)*** The city council of the neighbourhoods that opted for a smart grid have proposed a few favourable spots

where the batteries must be placed. Connect all houses (same as the maps above) to one of the batteries.

Apart from the feasibility, costs are also an issue. These fixed batteries all cost 5000. The cost function is given by:

Cost = sum(battery \* battery type’s price)  + (wire length \* 9)

***B)*** Calculate the cost of your setup and try to optimize it further (if possible)

It is figured out that the batteries might not have been in the best place to begin with. It is voted to choose new positions for the batteries.

***C)*** Try to improve the results found in exercise B by moving the positions of the batteries.

Due to the research done earlier in A, B and C, SomeBatteryCompany Inc. saw some feasible business opportunities. They made three new types of batteries which are listed below. The residents of the neighbourhoods ask you to come up with a plan to store all their energy as cost-efficiently as possible. You can place batteries anywhere, and use as many of each battery type as you think you need.

Battery types:

#1           Cap: 450              Price: 900

#2           Cap: 900              Price: 1350

#3           Cap: 1800            Price: 1800

***D)***  Configure a new set up for the Smart Grid, for as low as possible cost.

New legislations enact that residents having to tolerate cables run underneath their houses are entitled to a compensation of 10.000 euro. This seriously changes the cost scheme for any configuration.

***E)*** Configure a new set up for the Smart Grid, for as low as possible cost.

***Advanced)*** Create a series of new battery-schemes, when are they harder to solve and when is it harder to choose which battery to place?