1.

$$f(s) = \frac{\left|\sum_1^{120} w_{s_i} x_i\right| + 5 * \left|\sum_1^{120} w_{s_i} y_i\right|}{\sum_1^{120} w_{s_i}}$$

2.

$$t_i(s, a, b) = \begin{cases} s_a, & i = b \\ s_b, & i = a \\ s_i, & \text{otherwise} \end{cases}$$

3. Move the container at position a to an empty position b.

4. b=a+60 or a=b+60   Those two container are at the same position

    a=b   Swap the container with itself

    $w_{s_a} = w_{s_b}$ Swap two containers which have the same weight

5. N(s)=t(s,a,b) where $|a - b| \neq 60, a \neq b \text{ and } w_{s_a} \neq w_{s_b}, a, b \in \{1,2,\dots,120\}$

6. $\Delta dx = w_{s_a} x_b + w_{s_b} x_a - w_{s_a} x_a - w_{s_b} x_b$

   $\Delta dy = w_{s_a} y_b + w_{s_b} y_a - w_{s_a} y_a - w_{s_b} y_b$

   $f(t(s, a, b)) = |dx(s) + \Delta dx| + 5 * |dy(s) + \Delta dy|$

   dx(s) is the center of gravity in the x direction for solution s

   dy(s) is the center of gravity in the y direction for solution s

7. For this problem, a 2D array can be used to flag whether two containers are baned. Thus, each time we don't need to iterate the ban list and we can directly access the 2D array. Only when one iteration finished, two container swaped and the array need to be freshed, we use the ban list to update the array with a very short time.

8. Banning random pair of containers can be a suitable approach because we want to use tabu search to leave local minimum and banning random pair can achieve this goal