Path changing actions

Figure 1: Initial Path

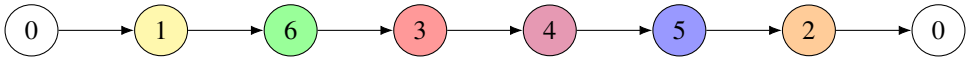

Figure 2: Switch two cities (2 & 6)

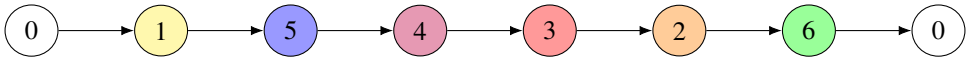

Figure 3: Invert path between two cities (2 & 6)

Figure 4: Insert city into random position (2 & 5)

Figure 5: Swap sub route to random position (route 2-4 to 4th position)

Algorithm 1 Simulated Annealing

function ANNEAL(distance_mat, α, X_0)
    $T \leftarrow$ INIT_TEMP(X_0) ▷ Compute initial temperature
    current_path $\leftarrow$ INITIAL() ▷ $[0, 1, 2, ..., N, 0]$
    current_dist $\leftarrow$ OBJECTIVE(current_path) ▷ Calculate path distance
    best_dist, best_path $\leftarrow$ current_dist, current_path

    while stopping criteria not reached **do**
        new_path $\leftarrow$ CHOOSE_APPLY_CHANGE(current_path)
        new_dist $\leftarrow$ OBJECTIVE(new_path)
        $E \leftarrow$ current_dist - new_dist

        if new_dist $<$ best_dist **then**
            best_path, best_dist $\leftarrow$ new_path, new_dist
        end if

        if $E > 0$ **then**
            current_path, current_dist $\leftarrow$ new_path, new_dist
        else

            $p \leftarrow e^{E/\alpha_t T}$ ▷ where α_t is a decreasing function of time

            if BINOMIAL$(1, p) = 1$ **then**
                current_path, current_dist $\leftarrow$ new_path, new_dist
            end if
        end if
    end while

    return best_path, best_dist
end function

function INIT_TEMP(X_0)
    $\omega \leftarrow$ SAMPLE_SIZE(dist_mat) ▷ Choose appropriate sample size
    $\Omega \leftarrow$GEN_SAMPLE(ω, X_0) ▷ Costs of S simulated bad transitions
    $T \leftarrow n > 1$ ▷ Initialize temperature for recursion

    while $|X_T - X_0| < \epsilon$ **do** ▷ for some $\epsilon > 0$
        $T \leftarrow T\left(\frac{\ln X_T}{\ln X_0}\right)$
        $X_T \leftarrow \frac{\sum_{i\in\Omega} e^{\left(-E_{a_i}/T\right)}}{\sum_{i\in\Omega} e^{\left(-E_{b_i}/T\right)}}$ ▷ a_i, b_i are costs after and before i^{th} trans.
    end while

    return T
end function