Algorithm 1 *Shims* heuristic at the node π_k

procedure $SolveNode(Shims, \pi_k, G, time)$
$T_{begin} \leftarrow$ current system time
Let $G(M \cup N_{\pi_k} \cup Q_{\pi_k}, E_{Q_{\pi_k}})$
Sort M by $|D_i^{long}|$ in non-descending order
$E_{N_{\pi_k}} \leftarrow \varnothing$ ▷ An empty set of pallet-item edges
$\tau_{\pi_k} \leftarrow 0$ ▷ Torque at the node π_k
$\tau_{max} \leftarrow W_{max} \times limit_{long}^{CG}$ ▷ Maximum aircraft torque
$vol_i \leftarrow 0,\ 1 \leq i \leq m$
$limit \leftarrow 0.92$
for $i \leftarrow 1$ to m
for $q \leftarrow 1$ to m_{π_k}
if $(i, q) \in E_{Q_{\pi_k}}$
$vol_i \leftarrow vol_i + v_q$
$\tau_{\pi_k} \leftarrow \tau_{\pi_k} + w_q \times D_i^{long}$
Let E be an array of n_{π_k} possibles edges of the pallet i sorted by $\theta_{ij}^{\pi_k}$ in non-ascending order
$\eta_1 \leftarrow 1$
repeat
$e_{ij} \leftarrow E_{\eta_1}$ ▷ e_{ij} is the allocation of the item j to the pallet i
if $(E_{N_{\pi_k}} \cup \{e_{ij}\}$ is feasible$)$ **and** $(vol_i \leq V_i \times limit)$ **and** $(|\tau_{\pi_k} + w_j \times D_i^{long}| \leq W_{max} \times limit_{long}^{CG})$
$E_{N_{\pi_k}} \leftarrow E_{N_{\pi_k}} \cup \{e_{ij}\}$
$vol_i \leftarrow vol_i + v_j$
$\tau_{\pi_k} \leftarrow \tau_{\pi_k} + w_j \times D_i^{long}$
$\eta_1 \leftarrow \eta_1 + 1$
until $(vol_i > V_i \times limit)$ **or** $(\eta_1 > n_{\pi_k})$ ▷ End of the first phase
$slack_i \leftarrow V_i - vol_i$
$\eta_2 \leftarrow \eta_1$
while $(\eta_2 \leq n_{\pi_k})$ **and** $(vol_i < (1 + 3 \times (1 - limit)) \times V_i))$
$e_{ij} \leftarrow E_{\eta_2}$
$vol_i \leftarrow vol_i + v_j$
$\eta_2 \leftarrow \eta_2 + 1$ ▷ End of the second phase
$vol \leftarrow 0,\ b \leftarrow 1,\ shims_b \leftarrow \varnothing,\ Set \leftarrow \{shims_b\}$
for $x \leftarrow \eta_1$ to η_2
if $T_{current} - T_{begin} > time$
break ▷ Time limit exceeded
$NewShims \leftarrow$ **True**
$e_{ij} \leftarrow E_x$
for $shims \in Set$
if $(e_{ij} \notin (E_{N_{\pi_k}} \cup shims))$ **and** $(e_{ij}$ is feasible$)$ **and** $((v_j + vol) \leq slack_i)$
$shims \leftarrow shims \cup \{e_{ij}\}$
$vol \leftarrow vol + v_j$
$NewShims \leftarrow$ **False**
break
if $NewShims$
$vol \leftarrow 0$
$b \leftarrow b + 1$
$shims_b \leftarrow \{\ \}$
$shims_b \leftarrow shims_b \cup \{e_{ij}\}$
$Set \leftarrow Set \cup \{\ shims_b\ \}$
$sh_w \leftarrow shims$, where $shims \in Set$ and $\sum_{e_{ab} \in shims} w_b$ is maximum
$sh_v \leftarrow shims$, where $shims \in Set$ and $\sum_{e_{ab} \in shims} v_b$ is maximum
$sh_{best} \leftarrow shims$, where $shims \in \{sh_w, sh_v\}$ and $\sum_{e_{ab} \in x} s_b$ is maximum
$E_{N_{\pi_k}} \leftarrow E_{N_{\pi_k}} \cup sh_{best}$ ▷ End of the third phase
return $G(M \cup N_{\pi_k} \cup Q_{\pi_k}, E_{Q_{\pi_k}} \cup E_{N_{\pi_k}})$

Initially, Q_{π_k} (line 3) corresponds to the packed contents that remain on board. It is important to remember that $E_{Q_{\pi_k}}$ and M were modified by $UpdatePacked(M, Q_{\pi_k}, \pi_k)$ and $SetPalletsDestinations(M, \pi_k)$. Then, the pallets i are considered in non-descending order of $|D_i^{long}|$.

For each pallet i, its n_{π_k} possible edges $e_{ij}^{\pi_k}$ are considered in non-increasing order of $\theta_{ij}^{\pi_k}$:

- In the *greedy phase* (lines 4-24), a partial solution for each pallet i is constructed by edges inclusion, until its volume $V_i \times limit$ is reached. The value $limit = 0.92$ (line 9) was empirically determined by the *iRace* tool [**?**].

  From lines 9 to 24, as items are inserted, the value of η_1 is incremented and stops when the pallet volume reaches 92% of its capacity.

  When it stops, this is the initial value of η_2, line 26. η_2, then it is incremented until the volume exceeds the pallet capacity with a factor of 1 + (2 x [1 - limit]). This factor of was obtained empirically, through many test with different problem instances. Higher values can improve the solution, but at the expense of performance. So we tried to keep it as low as possible, a trade-off between quality and performance.

- In the *composition phase* (lines 25-30), a set of shims named *Set* is created for each pallet i, where each shim is formed by a set of edges in the range $[\eta_1, \eta_2]$, whose total volume is limited by $slack_i$.

  After the η_2 index, there may be items with little probability of being in the optimal solution because their low value of $\theta_{ij}^{\pi_k}$, being not considered for inclusion.

  In line 31 the initial *Shim* and *Set* are created.

  In this phase, the heuristic that provided the best results, both in terms of time and quality, is based on *First-Fit Decreasing*, which is an approximation algorithm for the *Bin Packing Problem* [**?**]. Basically, shims are created by accumulating the following edges, taking $slack_i$ as a limit.

- In the *selection phase* (lines 31-52), the best shim in *Set* is chosen. Initially, two shims are found: sh_w with larger weight, and sh_v with larger volume. Between the two, the one with the highest score will be chosen and its edges are inserted into $E_{N_{\pi_k}}$.