Algorithm 1: Hybrid Prior Posterior Update with Distribution Shift Adapter

Input: Support set embeddings Z_s, support labels Y_s; Base priors $\mathcal{B} = \{(\mu_b, \sigma_b^2)\}$; Distribution Shift Adapter f_{adapt} (optional); Precision scalar λ; Hybrid mixing factor λ_{mix}; Temperature T.

Output: Posterior mean μ_{post}^c and variance $\sigma_{\text{post}}^{c2}$ for each class c; Query predictions.

for *each class c in the support set or novel classes* **do**
- $Z_s^c \leftarrow \{z_i \in Z_s \mid y_i = c\}$;
- $N_c \leftarrow |Z_s^c|$;
- `// -- Step 1: Compute Self Prior --`
- $\mu_{\text{self}} \leftarrow \text{mean}(Z_s^c)$;
- **if** $N_c > 1$ **then**
  - $\sigma_{\text{self}}^2 \leftarrow \text{variance}(Z_s^c)$
- **else**
  - $\sigma_{\text{self}}^2 \leftarrow \epsilon \cdot \mathbf{1}$
- **end**
- `// -- Step 2: Compute Base-driven Prior if available --`
- **if** $\mathcal{B} \neq \emptyset$ **then**
  - **for** *each base class* $(\mu_b, \sigma_b^2) \in \mathcal{B}$ **do**
    - $s_b \leftarrow \text{cosine\_similarity}(\mu_{\text{self}}, \mu_b)$
  - **end**
  - $w_b \leftarrow \text{softmax}(\beta \cdot s_b)$ `// Similarity weights`
  - $\mu_{\text{base}} \leftarrow \sum_b w_b \mu_b$;
  - $\sigma_{\text{base}}^2 \leftarrow \sum_b w_b \sigma_b^2$;
- **end**
- **else**
  - $\mu_{\text{base}} \leftarrow \mathbf{0}$, $\sigma_{\text{base}}^2 \leftarrow \mathbf{1}$
- **end**
- `// -- Step 3: Hybrid Prior --`
- $\mu_{\text{hybrid}} \leftarrow (1 - \lambda_{\text{mix}}) \cdot \mu_{\text{self}} + \lambda_{\text{mix}} \cdot \mu_{\text{base}}$;
- $\sigma_{\text{hybrid}}^2 \leftarrow (1 - \lambda_{\text{mix}}) \cdot \sigma_{\text{self}}^2 + \lambda_{\text{mix}} \cdot \sigma_{\text{base}}^2$;
- `// -- Step 4: Optional Adapter Adjustment --`
- **if** *f_{adapt} is not None* **then**
  - $\Sigma_{\text{hybrid}} \leftarrow \text{diag}(\sigma_{\text{hybrid}}^2)$;
  - $(\mu_{\text{prior}}, \Sigma_{\text{prior}}) \leftarrow f_{\text{adapt}}(\mu_{\text{hybrid}}, \Sigma_{\text{hybrid}})$;
  - $\sigma_{\text{prior}}^2 \leftarrow \text{diag}(\Sigma_{\text{prior}})$;
- **end**
- **else**
  - $\mu_{\text{prior}} \leftarrow \mu_{\text{hybrid}}$;
  - $\sigma_{\text{prior}}^2 \leftarrow \sigma_{\text{hybrid}}^2$
- **end**
- `// -- Step 5: Posterior Update --`
- $\text{prec}_{\text{prior}} \leftarrow 1/(\sigma_{\text{prior}}^2 + \epsilon)$;
- $\text{prec}_{\text{likelihood}} \leftarrow \lambda$;
- $\text{prec}_{\text{post}} \leftarrow \text{prec}_{\text{prior}} + N_c \cdot \text{prec}_{\text{likelihood}}$;
- $\mu_{\text{post}}^c \leftarrow (\text{prec}_{\text{prior}} \cdot \mu_{\text{prior}} + \text{prec}_{\text{likelihood}} \cdot N_c \cdot \mu_{\text{self}})/\text{prec}_{\text{post}}$;
- $\sigma_{\text{post}}^{c2} \leftarrow 1/\text{prec}_{\text{post}}$;

end

for *each query embedding z_q* **do**
- $\hat{z}_q \leftarrow z_q / \|z_q\|$;
- **for** *each class c* **do**