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**Algorithm 1** OncoMark Algorithm

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**Require:** Training data  $(X_{\text{train}}, Y_{\text{train}}, T_{\text{train\_one\_hot}})$ , Validation data  $(X_{\text{val}}, Y_{\text{val}}, T_{\text{val\_one\_hot}})$ , Input shape input\_shape, Number of tasks num\_tasks, Training hyperparameters (batch\_size batch\_size, epochs epochs, learning rate lr, patience patience, etc.).

**Ensure:** Trained model  $\mathcal{M}$  and loss history.

- 1: Initialize shared base network with input layer and dense layers.
  - 2: **for**  $t = 1$  to num\_tasks **do**
  - 3:   Add task-specific dense layer to shared base.
  - 4:   Add output layer with sigmoid activation for task  $t$ .
  - 5: **end for**
  - 6: Compile model  $\mathcal{M}$  with Adam optimizer and task-specific losses.
  - 7: Initialize variables: best\_val\_loss  $\leftarrow \infty$ , patience\_counter  $\leftarrow 0$ , lr\_patience\_counter  $\leftarrow 0$ .
  - 8: **for**  $e = 1$  to epochs **do**
  - 9:   Divide training data into batches.
  - 10:   **for** each batch **do**
  - 11:     Compute predictions  $\hat{\mathcal{Y}}$  and task-specific losses.
  - 12:     Combine losses using task indicators and backpropagate gradients.
  - 13:   **end for**
  - 14:   Compute validation losses and update best validation loss if improved.
  - 15:   **if** patience exceeded **then**
  - 16:     Stop training.
  - 17:   **end if**
  - 18:   **if** learning rate patience exceeded **then**
  - 19:     Reduce learning rate.
  - 20:   **end if**
  - 21: **end for**
  - 22: **return** Trained model  $\mathcal{M}$  and loss history.
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