1 Algorithm

Algorithm 1: Distributionally Robust Path Integral Algorithm

Input : $\mathbf{x}(0)$: Initial state
$\lambda_1, \lambda_2, \ldots, \lambda_M$: M candidate λ's
$\hat{\mu}^N, \hat{\Sigma}^N$: Sample mean vector and covariance based on N historical data $\hat{\Xi}^N$
γ: Robustness parameter
K: Number of generated sample trajectories
T_Δ: Number of time steps;
Output: Optimal Control $u^*(t)$ for $t = 0, 1, \ldots, T_\Delta - 1$

for $k = 1, 2, \ldots, K$ **do**
  Sample $\{\xi^k(0), \xi^k(1), \ldots, \xi^k(T_\Delta - 1)\}$
end
for $t = 0, 1, ..., T_{\Delta-1}$ **do**
  $\mathbf{x}(t+1) = f(\mathbf{x}(t)) + \Delta \cdot G(\mathbf{x}(t))\xi^k(t)$
  if $t < T_\Delta - 1$ **then**
    $S^k += s(\mathbf{x}(t))$
  else
    $S^k += \psi(\mathbf{x}(t))$
  end
end
for $m = 1, \ldots, M$ **do**
  Compute $\eta_m = \log\left(\frac{1}{K}\sum_{k=1}^{K} \exp\left(-\frac{1}{\lambda_m} S^k\right)\right)$
end
$m^* = \arg\min_{m=1,2,\ldots,M} \eta_m$
for $k = 1, 2, \ldots, K$ **do**
  $w^k = \frac{1}{\eta_{m^*}} \exp(-\frac{1}{\lambda_m} S^k)$
end
for $t = 0, 1, ..., T_{\Delta-1}$ **do**
  $\mathbf{u}^*(t) = \sum_{k=1}^{K} w^k \xi^k(t)$
end