

**S1 Table. Approximation accuracy of different smooth functions and the convergence rate of the model.**

Smooth support vector machine (SSVM)	Smooth function $f_{smooth}(x, k)$	Approximation accuracy $f_{smooth}(x, k)^2 - x_+^2 \leq$	Convergence speed $\ \bar{x}^k - \bar{x}\ _2^2 \leq$
Sigmoid-SSVM	$x + \frac{1}{k} \log(1 + e^{-kx})$	$0.6927/k^2$	$0.3463m/k^2$
P2-SSVM	$\frac{k}{4}x^2 + \frac{x}{2} + \frac{1}{4k}$	$0.0909/k^2$	$0.0455m/k^2$
P4-SSVM	$-\frac{1}{16k}(kx+1)^3(kx-3)$	$0.0526/k^2$	$0.0263m/k^2$
T3-SSVM	$\begin{cases} \frac{k^2}{6}x^3 + \frac{k}{2}x^2 + \frac{1}{2}x + \frac{1}{6k}, -\frac{1}{k} < x < 0 \\ -\frac{k^2}{6}x^3 + \frac{k}{2}x^2 + \frac{1}{2}x + \frac{1}{6k}, 0 \leq x < \frac{1}{k} \end{cases}$	$0.04167/k^2$	$0.0208m/k^2$
T5-SSVM	$\begin{cases} -\frac{k^4}{10}x^5 - \frac{k^3}{4}x^4 + \frac{k}{2}x^2 + \frac{1}{2}x + \frac{3}{20k}, -\frac{1}{k} < x < 0 \\ \frac{k^4}{10}x^5 - \frac{k^3}{4}x^4 + \frac{k}{2}x^2 + \frac{1}{2}x + \frac{3}{20k}, 0 \leq x < \frac{1}{k} \end{cases}$	$0.03333/k^2$	$0.0167m/k^2$
Padé22-SSVM	$\frac{1}{2k} \cdot \frac{1+10k^2x^2+5k^4x^4}{5+10k^2x^2+k^4x^4} + \frac{x}{2}$	$0.0139/k^2$	$0.0069m/k^2$
Padé33-SSVM	$\frac{7(1-k^2x^2)^3 - 56(1-k^2x^2)^2 + 112(1-k^2x^2) - 64}{2k((1-k^2x^2)^3 - 24(1-k^2x^2)^2 + 80(1-k^2x^2) - 64)} + \frac{x}{2}$	$0.0051/k^2$	$0.0026m/k^2$