Summer 2020 Research: Simulations

Nadia Aiaseh

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1 Kawahara, Perturbation Testing

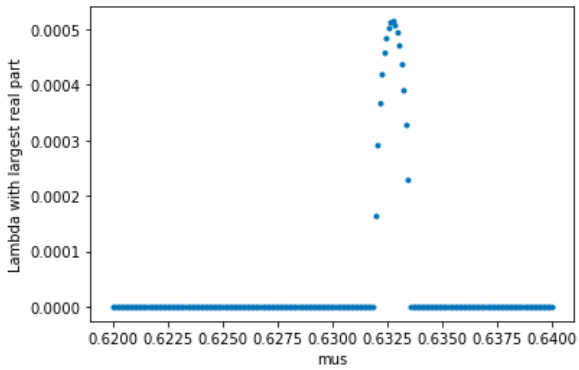
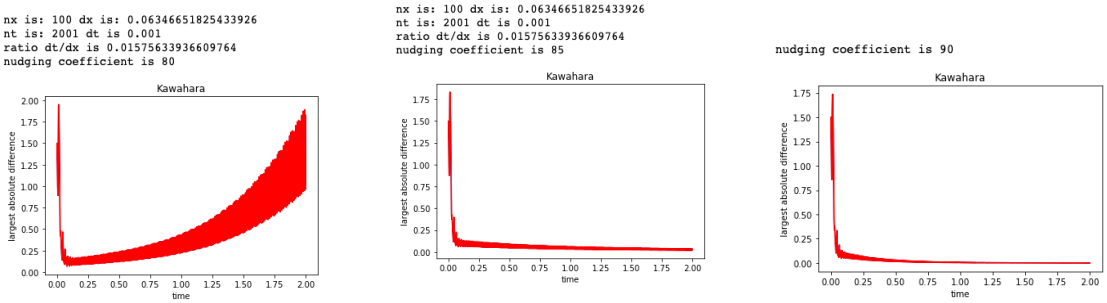


Figure 1: $\alpha = 1, \beta = \frac{1}{4}, \sigma = 1$

Various stable and unstable mus from the instability bubbles were tested with the latest solver version 1.8 but none showed a blow up, they all seemed stable over time. More testing is needed.

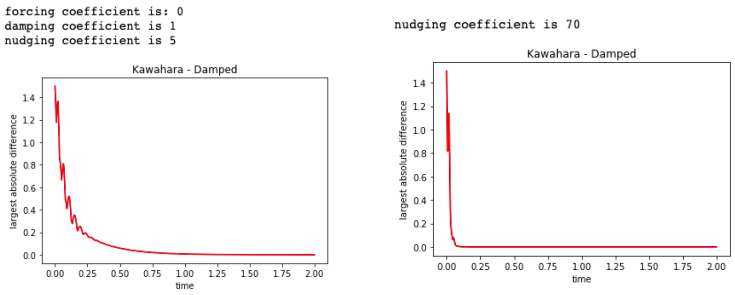
1.0.1 Resonant with $h = 2dx$



(a) nudging coefficient $\eta = 80$ (b) nudging coefficient $\eta = 85$ (c) nudging coefficient $\eta = 90$

Figure 2: There is no convergence with $\eta = 80$ but we can see complete convergence at $\eta = 90$, therefore the breaking point is somewehere in between

Damped Kawahara
Values of η tried were: $5, 15, 20, 30, 40, 70$ and they all showed convergence.



(a) nudging coefficient $\eta = 5$ (b) nudging coefficient $\eta = 70$

Figure 3: Both have damping coefficient of $\gamma = 1$

Forced

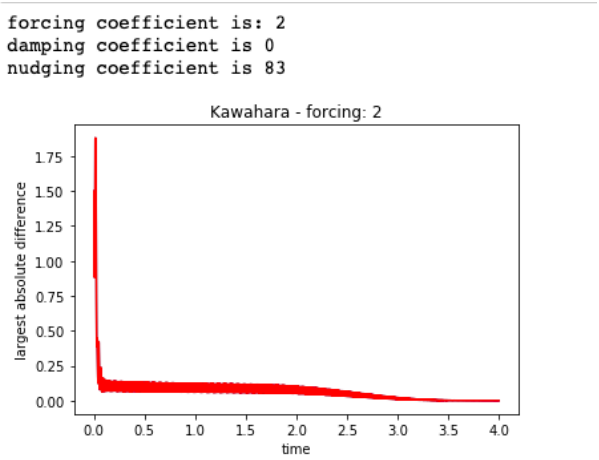


Figure 4: nudging coefficient $\eta = 83$ and the forcing term is $t\cos(x)$

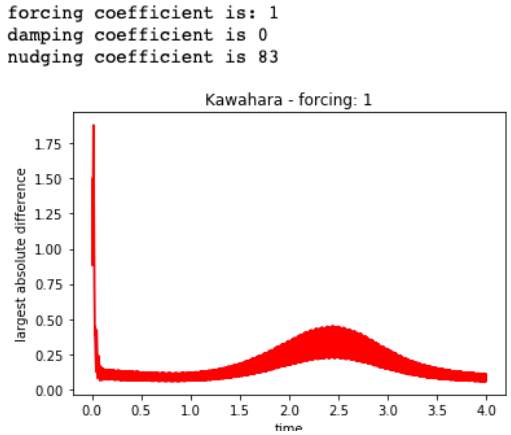
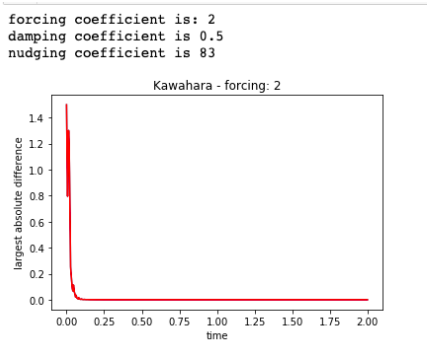
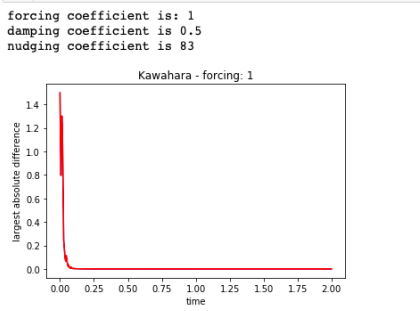


Figure 5: nudging coefficient $\eta = 83$ and the forcing term is $\cos(x - t)$

Both



(a) forcing term is $t\cos(x)$



(b) forcing term is $\cos(x-t)$

Figure 6: Both have nudging coefficient of $\eta = 83$ and damping coefficient of $\gamma = 0.5$

1.0.2 Resonant with $h = 3dx$

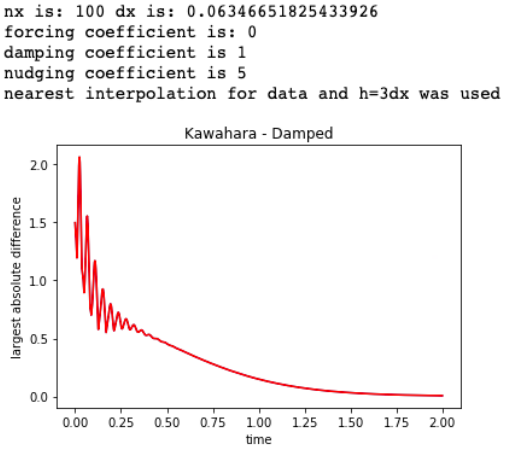
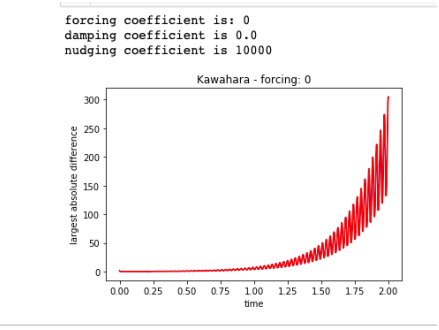
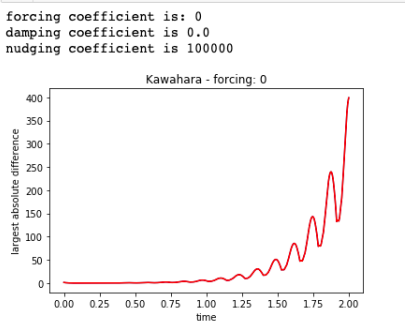


Figure 7: nudging coefficient $\eta = 5$ and despite a wider spacing of $h = 3dx$ we can see convergence since there is damping with coeffcient $\gamma = 0.5$

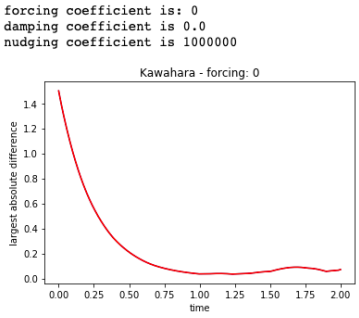
1.0.3 Resonant with $h = 4dx$



(a) Nudging coefficient $\eta = 10000$

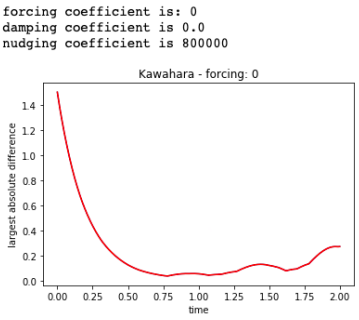


(b) Nudging coefficient $\eta = 100000$

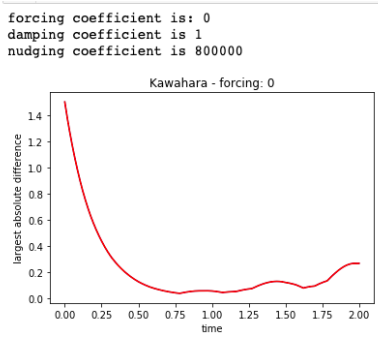


(c) Nudging coefficient $\eta = 1000000$

Figure 8: These figures show that in the resonance regime for the Kawahara only a high value of nudging coefficient yields convergence



(a) undamped



(b) damped $\gamma = 1$

Figure 9: Nudging coefficient $\eta = 10000$, we can see that damping has little to no effect under the resonance regime

1.0.4 Nonresonant with $h = 4dx$

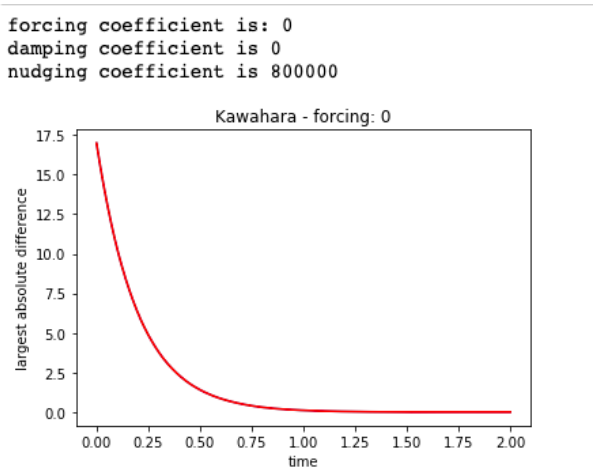
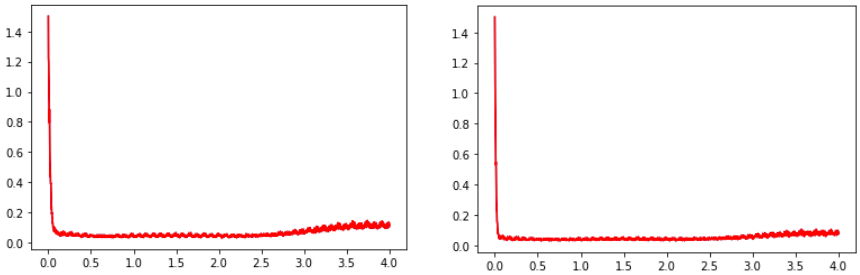


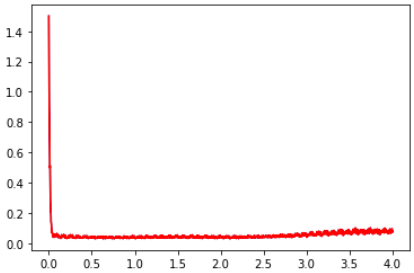
Figure 10: We can see the effect of resonance in convergence. Nudging coefficient is $\eta = 800000$, compare with the resonant regime in Figure 9

1.1 FFT



(a) Nudging coefficient is $\eta = 50$

(b) Nudging coefficient is $\eta = 85$



(c) Nudging coefficient is $\eta = 90$

Figure 11: The FFT solver seems to show some noise, visible as ripples in the animation

2 KDV

2.1 Breaking point when $h = 4dx$

Nudging coefficient η	Convergence
10	no
20	no
30	no
40	no
50	no
60	no
65	no
66	no
67	yes
70	yes
10000	yes
50000	no
90000	no
100000	no

2.2 Different hs

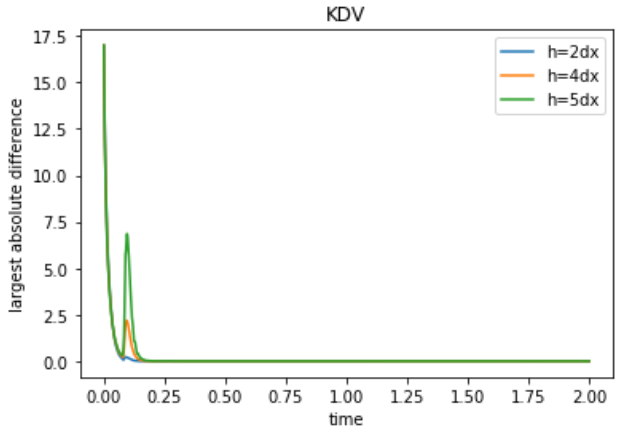


Figure 12: Nudging coefficient is the same for all. Note that $h = 8dx$ was also tested but is not included as there was no convergence and so is not included