A tutorial on GiNaCDE-GUI to solve Differential Equations

GiNaCDE-GUI (V1.0.0)

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The usage of GiNaCDE-GUI for solving differential equations is described in this tutorial. The following two examples demonstrate the usage of GiNaCDE-GUI to solve differential equations.

1 Example 1

Let us consider the Eckhaus equation

$$iu_t + u_{xx} + 2\Big(|u|^2\Big)_x u + |u|^4 u = 0. \tag{1}$$

For solving Eq. (1) using GiNaCDE library, the C++ codes are

```
// eckhaus_FIM.cpp
#include <GiNaCDE/GiNaCDE.h>
int main()
{
   const ex u=reader("u"), t=reader("t"), x=reader("x"),
            a=reader("a"), b=reader("b"),k=reader("k");
   depend(u, {t, x});
   const ex pde = I*Diff(u,t,1) + Diff(u,x,2) + 2*u*Diff(u*conjugate(u),x,1)
                  + u*u*conjugate(u)*conjugate(u)*u;
   output = mathematica;
   twcPhase=lst{lst{-2*k*a,k},lst{b,a}};
   paraInDiffSolve=lst{};
   filename = "eckhaus_FIM.txt";
   desolve(pde,{u},FIM);
   return 0;
}
```

In the following, we display the screenshots of each step when we implement the above C++ code in GiNaCDE-GUI.

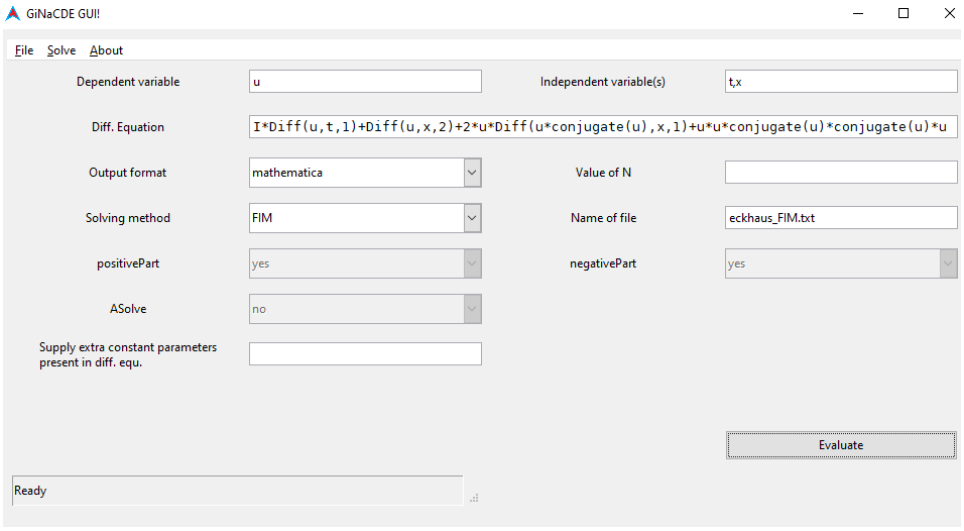

Figure 1: Step 1.

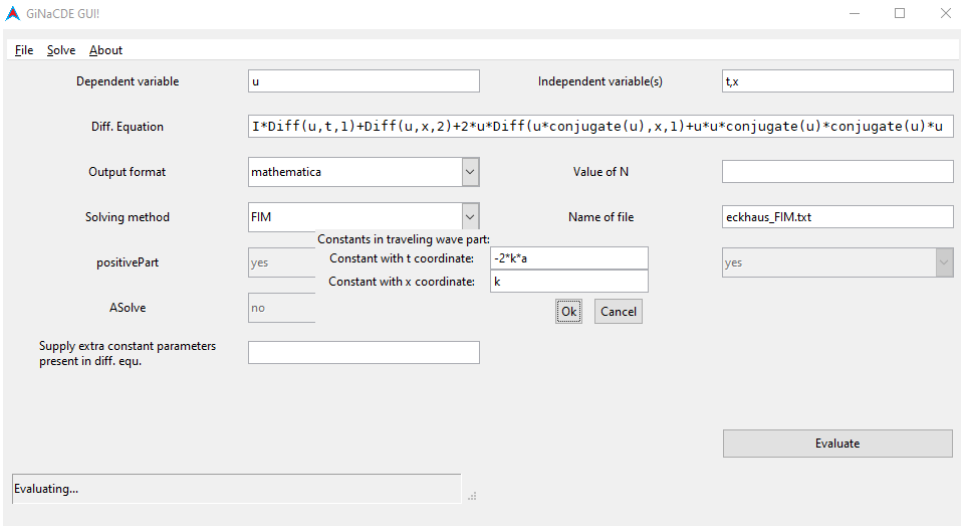

Figure 2: Step 2.

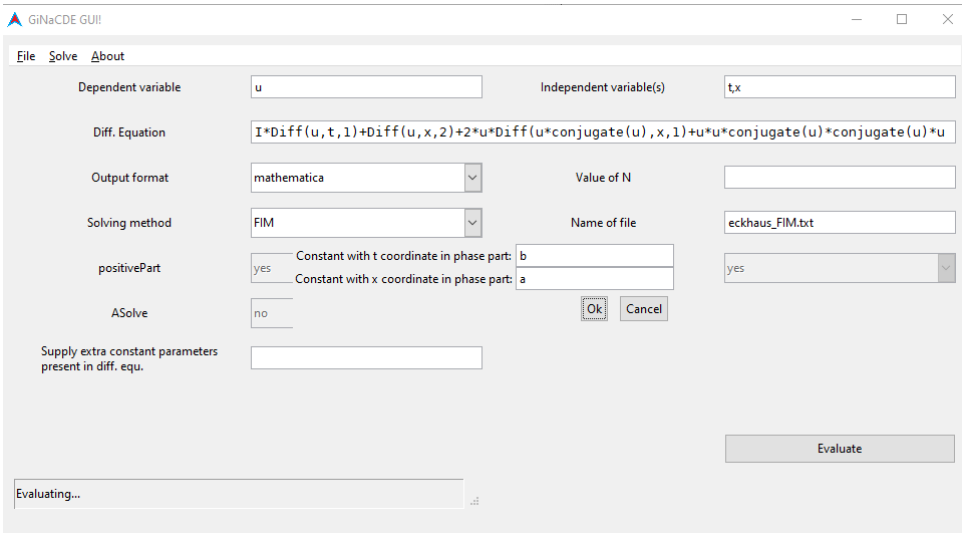

Figure 3: Step 3.

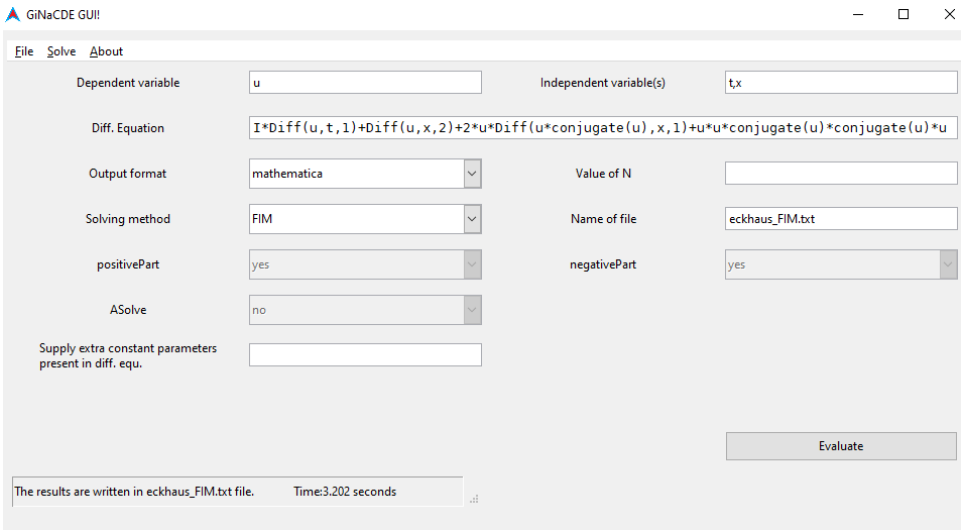

Figure 4: Step 4.

After execution of the last step in fig. 4 the output results are saved in *eckhaus_FIM.txt* file.

2 Example 2

We now discuss an another example considering generalized Camassa-Holm equation

$$u_t + 2ku_x - u_{xxt} + auu_x - 2u_xu_{xx} - uu_{xxx} = 0. \tag{2}$$

The following C++ code solve Eq. (2) applying modified F-expansion method.

```
// Generalized_Camassa-Holm_mF.cpp
#include <GiNaCDE/GiNaCDE.h>
int main()
{
   const ex u=reader("u"),t=reader("t"), x=reader("x"),
            k=reader("k"),a=reader("a"),k_0=reader("k_0"),
            k_1=reader("k_1"),A_1=reader("A_1"),A_3=reader("A_3");
   depend(u, {t,x});
   const ex pde = Diff(u,t,1)+2*k*Diff(u,x,1)-Diff(Diff(u,x,2),t,1)
                 +a*u*Diff(u,x,1)-2*Diff(u,x,1)*Diff(u,x,2)
                 -u*Diff(u,x,3);
   output = maple;
   twcPhase = lst{lst{k_0,k_1},lst{}};
   degAcoeff = lst{3,0,A_1,0,A_3};
   NValue = 2;
   filename = "Generalized_Camassa-Holm_mF.txt";
   ASolve=false;
   positivePart = true;
   negativePart = true;
   paraInDiffSolve = lst{k,a};
   desolve(pde, {u}, mF_expansion);
   return 0;
}
```

The following screenshots express each step to implement the above C++ code in GiNaCDE-GUI.

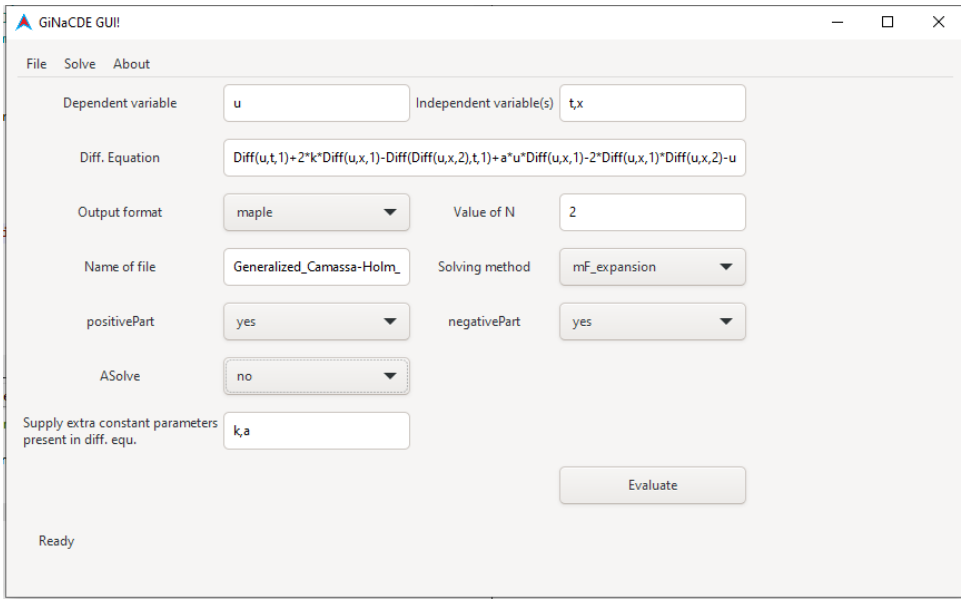

Figure 5: Step 1.

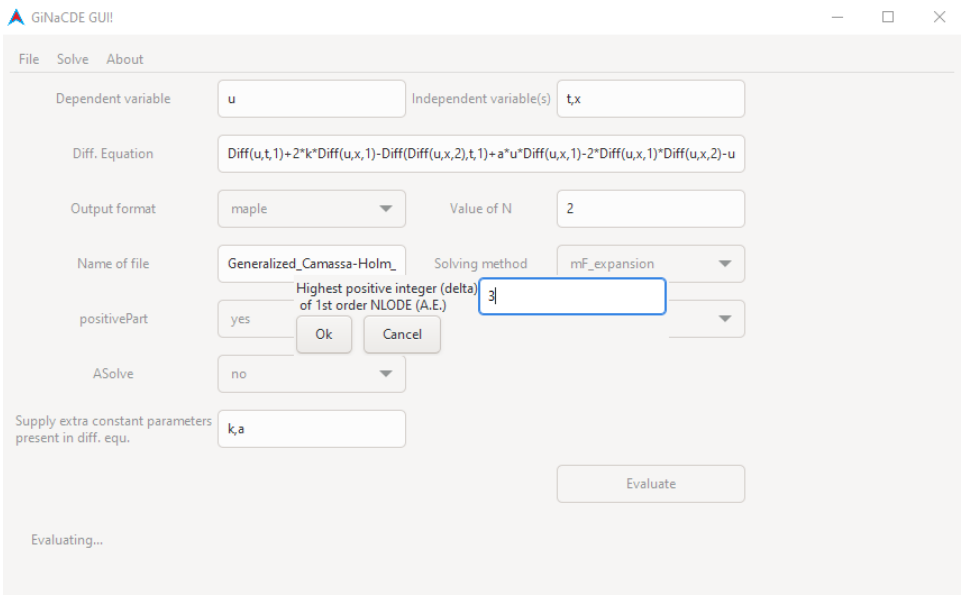

Figure 6: Step 2.

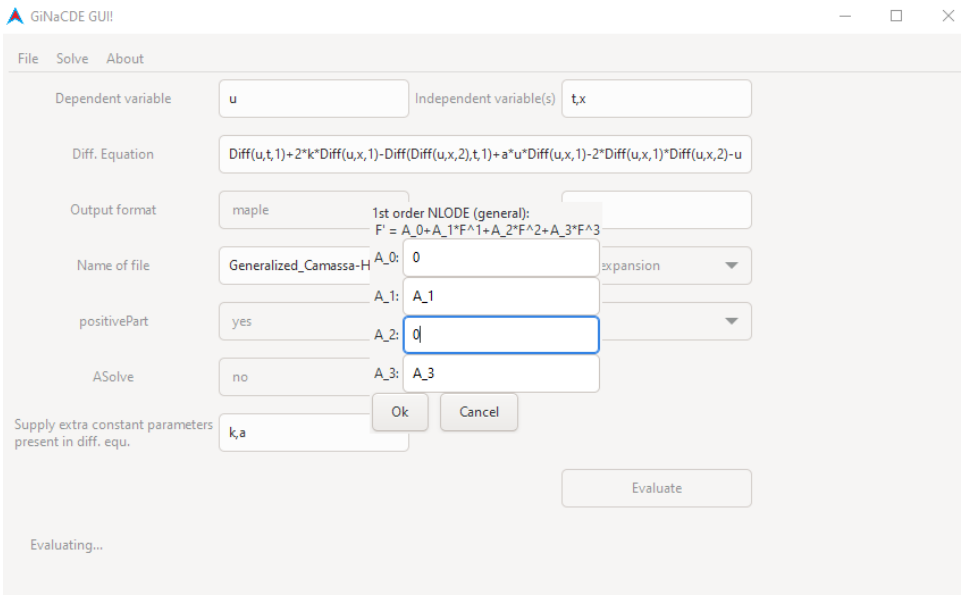

Figure 7: Step 3.

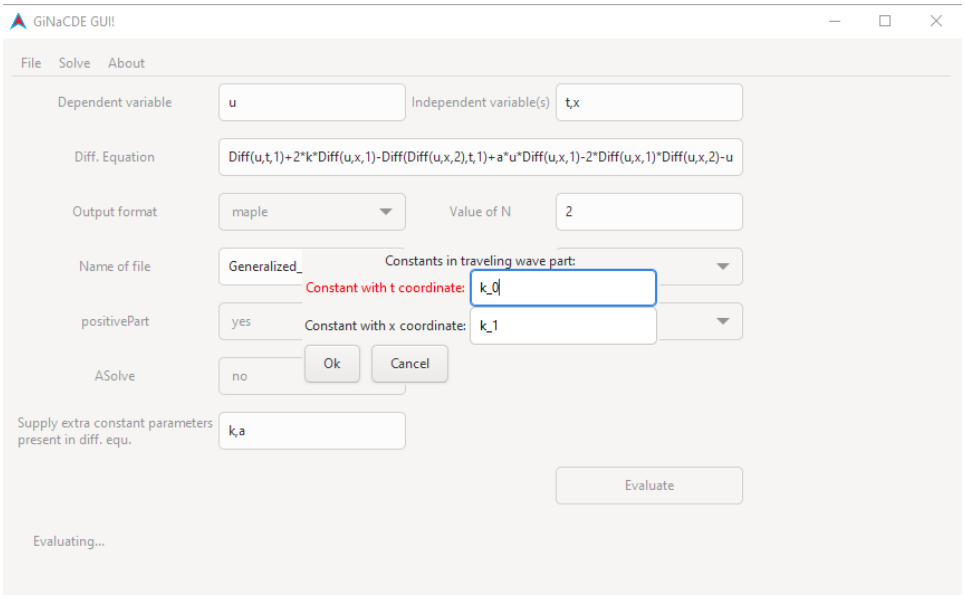

Figure 8: Step 4.

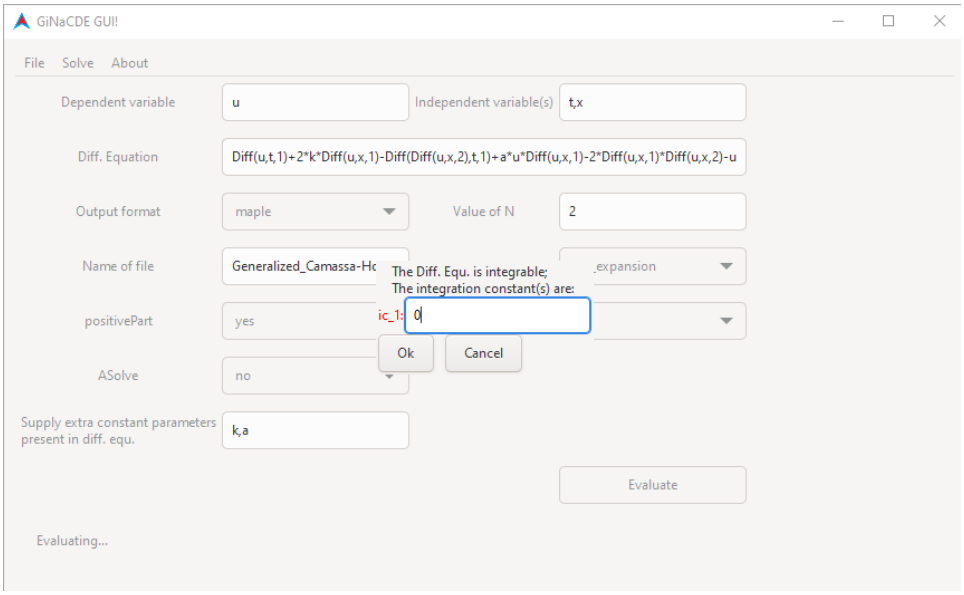

Figure 9: Step 5.

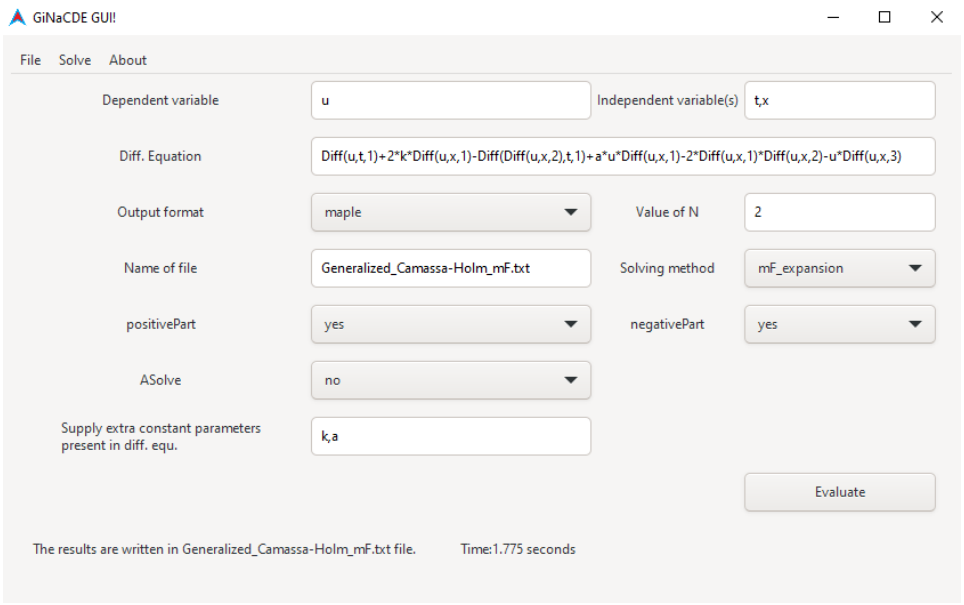

Figure 10: Step 6.

After execution of the last step in fig. 10 the output results are saved in *Generalized_Camassa-Holm.txt* file.