Numerics of Dynamical Systems

Assignment 3

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1 Exercise a)

Listing 1: main_os_sec2.f

```
c
c  MAIN_OS_SEC1.f
c
c***********************************************************
c       We integrate the harmonic oscillator field with Taylor
c       up to the  FIRST  crossing with the Poincare section: y=0
c                  -----
c
c !!!!   You should enter the code to integrate up to a given
c   'n_crossing'  crossing with the Poincare section: y=0   !!!!!
c
c***********************************************************
        implicit real*8 (a-h,o-z)
        parameter (n=2)
        dimension yf(n),x(n)
        open(10,file='orbit.d',status='unknown')
        write(*,*) 'Initial condition x(1),...,x(n)'
        read(*,*) (x(i),i=1,n)
        write(*,*) 'idir?'
        read(*,*) idir
        write(*,*) 'ncrossing?'
        read(*,*) ncrossing
c
c we assume initial time t=0.d0
c
c

c         i = 0
        do j = 1,ncrossing
        t=0.d0
        write(10,*)t,(x(i),i=1,2)

          call poinc1(n,x,yf,tfinal,idir)

c         i = i + 1
        end do
        end
```

```
C*************************************************************************
c Input:
c n dimension of the vectors yi and yf
c yi initial point
c idirorig: +1 integration forwards in time; -1 backwards
c yf final point
c tfinal final time
c
C*************************************************************************
         SUBROUTINE POINC1(n,YI,YF,tfinal,idirorig)
         IMPLICIT REAL*8 (A-H,O-Z)
         DIMENSION YI(n),YF(n),DGG(n),F(n)
             icont=0
          idir=idirorig
c
c  we assume initial time t=0.
c
          ti=0.D0
C    DETERMINATION OF THE FIRST PASSAGE OF THE ORBIT THROUGH y=0
C
         CALL SECCIO(YI,GG,DGG)
         IF(DABS(GG).LT.1.D-9)GG=0.d0
         GA=GG
          hab=.1e-16
          hre=.1e-16
          pabs=dlog10(hab)
          prel=dlog10(hre)
          istep=1
c reasonable step:
          pas=0.4d0
          ht=0.d0
          t=ti
c |tmax| must be big enough
1          tmax=t+idir*pas
         CALL taylor_f77_eq_os_(t,yi,idir,istep,pabs,prel,
     &   tmax,ht,iordre,ifl)
c computation of first integral to be done
C
         CALL SECCIO(YI,GG,DGG)
         IF(GG*GA.LT.0.D0)go to 22
```

```
         write(10,*)t,(yi(ii),ii=1,2)
         GA=GG
         GO TO 1
C
C   REFINEMENT OF THE INTERSECTION POINT YF(*) USING NEWTON'S METHOD
C   TO GET A ZERO OF THE FUNCTION GG (SEE SUBROUTINE SECCIO)
C
  22    continue
        icont=icont+1
        if (icont.gt.20)then
            write(*,*)'problems finding the section'
            stop
        endif
        CALL FIELD(T,YI,N,F)
        P=0.D0
        DO 3 I=1,N
3       P=P+F(I)*DGG(I)
        H=-GG/P
c check p is not (or very close to) 0:  to be done
        if (h.ge.0.d0)idir=1
        if (h.lt.0.d0)idir=-1
        tmax=t+h
c           write(*,*)icont,'  refining: h and time ',h,tmax
c           write(*,*)'refining  t point ',t,yi(1),yi(2)
        CALL taylor_f77_eq_os_(t,yi,idir,istep,pabs,prel,
     &  tmax,ht,iordre,ifl)
        CALL SECCIO(YI,GG,DGG)
        IF(DABS(GG).GT.1.D-13)GO TO 22
        DO 4 I=1,N
4       YF(I)=YI(I)
        tfinal=t
c check first integral: to be done
        write(*,*)'tfinal point time ',tfinal
        write(*,*)(yf(ii),ii=1,n)
        write(10,*)t,(yf(ii),ii=1,2)
        return
        end


C************************************************************************
C                                                                      *
```

```
C     THE SURFACE g OF SECTION, IN THIS CASE
C          INPUT PARAMETERS:
C     Y(*)        POINT
C          OUTPUT PARAMETERS:
C     GG          FUNCTION THAT EQUATED TO 0 GIVES THE SURFACE OF
C                 SECTION
C     DGG(*)      GRADIENT OF FUNCTION GG
C                                                                           *
C***************************************************************************
         SUBROUTINE SECCIO(Y,GG,DGG)
         IMPLICIT REAL*8(A-H,O-Z)
         DIMENSION Y(2),DGG(2)
         GG=Y(2)
         DO 1 I=1,2
 1       DGG(I)=0.D0
         DGG(2)=1.d0
         RETURN
         END


C
C FIELD.F
C
C***************************************************************************
C
C     EQS OF MOTION IN synodical VARIABLES
C     X           TIME
C     Y(*)        POINT (Y(1),Y(2),....Y(n))
C     NEQ         NUMBER OF EQUATIONS
C          OUTPUT PARAMETERS:
C     F(*)        VECTOR FIELD
C
C***************************************************************************
      subroutine field(t,x,neq,f)
      implicit real*8 (a-h,o-z)
      dimension x(neq),f(neq)
c
      f(1) =x(2)
      f(2)= -x(1)
      return
      end
```

Abbildung 1: x1=1,x2=0,t=1.

```
conny.schweigert@fme-desktop:~$ ./main_os_sec2
 Initial condition x(1),...,x(n)
1,0
 idir?
1
 ncrossing?
2
 tfinal point time    3.1415926535898913
  -1.0000000000000000        9.8059608393333275E-014
 tfinal point time    3.1415926535897936
   1.0000000000000002       -9.8226141847027049E-014
```

Abbildung 2: x1=1,x2=0,t=1.

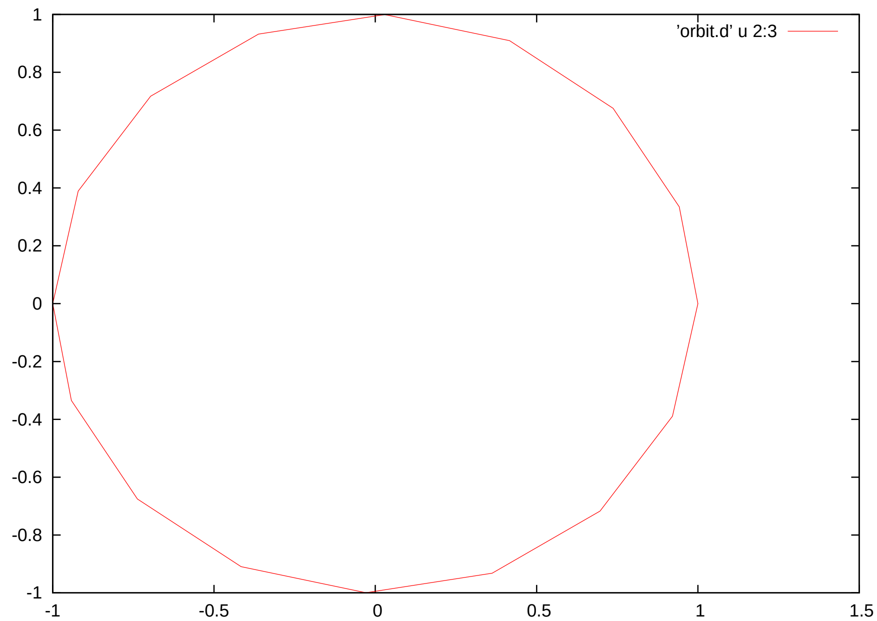


Abbildung 3: x1=1,x2=0,t=-1.

```
conny.schweigert@fme-desktop:~$ ./main_os_sec2
 Initial condition x(1),...,x(n)
1,0
 idir?
1
 ncrossing?
2
 tfinal point time    3.1415926535898913
  -1.0000000000000000        9.8059608393333275E-014
 tfinal point time    3.1415926535897936
   1.0000000000000002       -9.8226141847027049E-014
```

Abbildung 4: x1=1,x2=0,t=-1.

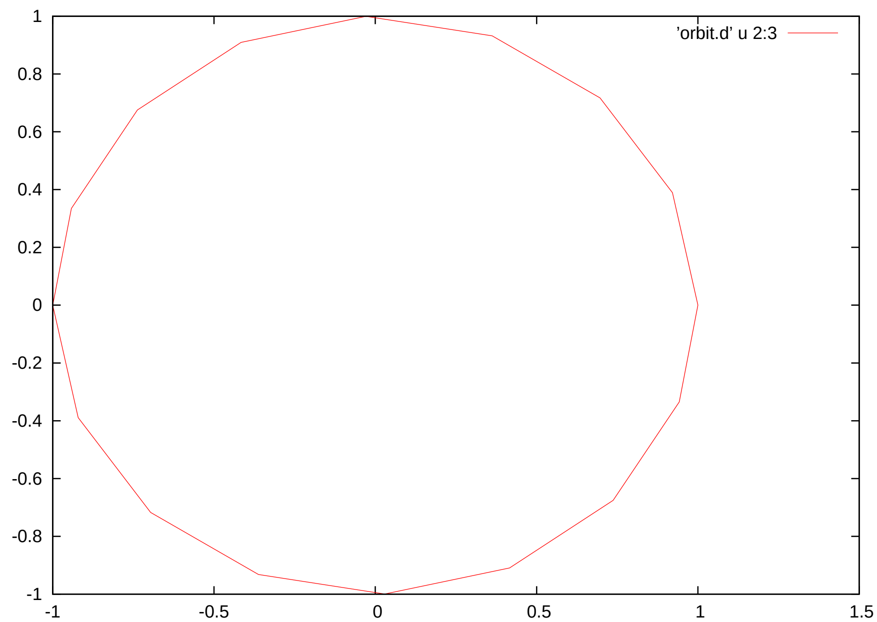
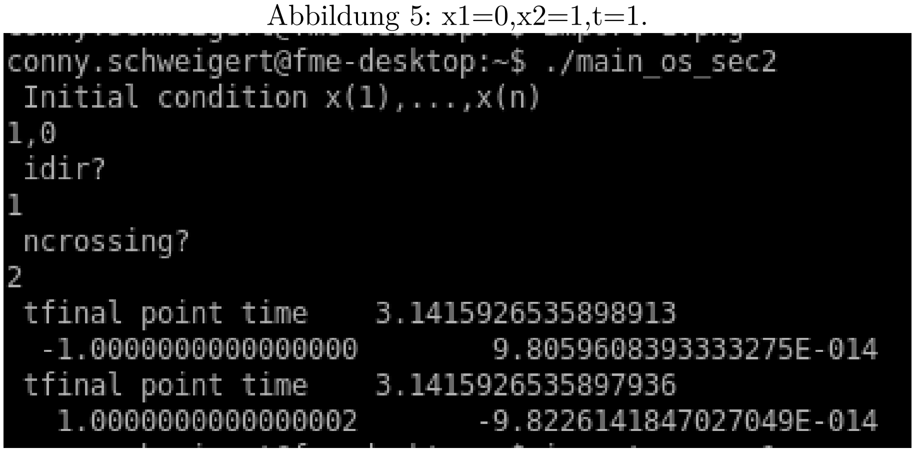


Abbildung 5: x1=0,x2=1,t=1.



```
conny.schweigert@fme-desktop:~$ ./main_os_sec2
 Initial condition x(1),...,x(n)
1,0
 idir?
1
 ncrossing?
2
 tfinal point time    3.1415926535898913
  -1.0000000000000000        9.8059608393333275E-014
 tfinal point time    3.1415926535897936
   1.0000000000000002       -9.8226141847027049E-014
```

Abbildung 6: x1=0,x2=1,t=1.

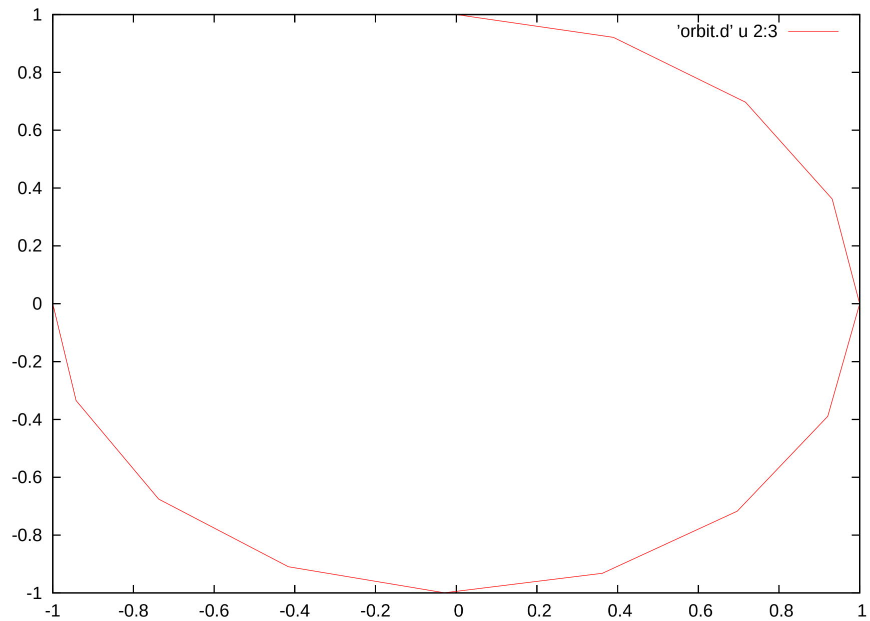


Abbildung 7: x1=0,x2=1,t=-1.

```
conny.schweigert@fme-desktop:~$ ./main_os_sec2
 Initial condition x(1),...,x(n)
1,0
 idir?
1
 ncrossing?
2
 tfinal point time    3.1415926535898913
  -1.0000000000000000        9.8059608393333275E-014
 tfinal point time    3.1415926535897936
   1.0000000000000002       -9.8226141847027049E-014
```

Abbildung 8: x1=0,x2=1,t=1.