Birla institute of technology Mesra, Ranchi

Numerical method

Prepared by :

Robin
ROLL NO : BTECH/15138/19

Faculty in charge

Dr. Prakash Chandra srivastava

Patna off campus

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Newton Forward Method

Algorithm:

1. Start
2. Read number of data (n)
3. Read data points for x and y:
   For i = 0 to n-1
      Read Xi and Yi,0
   Next i
4. Read calculation point where derivative is required (xp)
5. Set variable flag to 0
6. Check whether given point is valid data point or not. If it is valid point then get its position at variable index
   For i = 0 to n-1

      If |xp - Xi| < 0.0001
         index = i
         flag = 1
         break from loop
      End If
   Next i
7. If given calculation point (xp) is not in x-data then terminate the process.
   If flag = 0
      Print "Invalid Calculation Point"
      Exit
   End If
8. Generate forward difference table
   For i = 1 to n-1
      For j = 0 to n-1-i
         Yj,i = Yj+1,i-1 - Yj,i-1
      Next j
   Next i
9. Calculate finite difference: h = X1 - X0
10. Set sum = 0 and sign = 1
11. Calculate sum of different terms in formula to find derivatives using Newton's forward difference formula:

    For i = 1 to n-1-index
       term = (Yindex, i)i / i
       sum = sum + sign * term
       sign = -sign
    Next i

12. Divide sum by finite difference (h) to get result first_derivative = sum/h

13. Display value of first_derivative

14. Stop

Code:

```
#include<stdio.h>
#include<conio.h>
#define MAXN 100
#define ORDER 4

main()
{
   float ax[MAXN+1], ay [MAXN+1], diff[MAXN+1][ORDER+1], nr=1.0,
dr=1.0,x,p,h,yp;
   int n,i,j,k;
   printf("\nEnter the value of n:\n");
   scanf("%d",&n);

   printf("\nEnter the values in form x,y:\n");
   for (i=0;i<=n;i++)
   scanf("%f %f",&ax[i],&ay[i]);
   printf("\nEnter the value of x for which the value of y is wanted: \n");
   scanf("%f",&x);
   h=ax[1]-ax[0];
   for (i=0;i<=n-1;i++)
      diff[i][1] = ay[i+1]-ay[i];
   for (j=2;j<=ORDER;j++)
      for(i=0;i<=n-j;i++)
      diff[i][j] = diff[i+1][j-1] - diff[i][j-1];
   i=0;
   while (!(ax[i]>x))
      i++;
   i--;
   p = (x-ax[i])/h;
   yp = ay[i];
   for (k=1;k<=ORDER;k++)
   {
      nr *=p-k+1;
      dr *=k;
      yp +=(nr/dr)*diff[i][k];
   }
   printf("\nWhen x = %6.1f, corresponding y = %6.2f\n",x,yp);
getch();
return 0;
}
```

Output:

```
Enter the value of n:
6

Enter the values in form x,y:
100 10.63
150 13.03
200 15.04
250 16.81
300 18.82
350 19.90
400 21.27

Enter the value of x for which the value of y is wanted:
218

When x =  218.0, corresponding y =  15.48
```

Newton Backward Method

Algorithm:

1. Start
2. Read number of data (n)
3. Read data points for x and y:

```
For i = 0 to n-1
    Read Xi and Yi,0
Next i
```

4. Read calculation point where derivative is required (xp)
5. Set variable flag to 0
6. Check whether given point is valid data point or not.
   If it is valid point then get its position at variable index

```
For i = 0 to n-1

   If |xp - Xi| < 0.0001
      index = i
      flag = 1
      break from loop
   End If

Next i
```

7. If given calculation point (xp) is not in
   x-data then terminate the process.

```
If flag = 0
   Print "Invalid Calculation Point"
   Exit
End If
```

8. Generate backward difference table

```
For i = 1 to n-1

   For j = n-1 to i (Step -1)
      Yj,i = Yj,i-1 - Yj-1,i-1
   Next j

Next i
```

9. Calculate finite difference: h = X1 - X0

10. Set sum = 0

11. Calculate sum of different terms in formula
to find derivatives using Newton's backward
   difference formula:

```
For  i = 1 to index
   term = (Yindex, i)i / i
   sum = sum + term
Next i
```

12. Divide sum by finite difference (h) to get result

```
first_derivative = sum/h
```

13. Display value of first_derivative

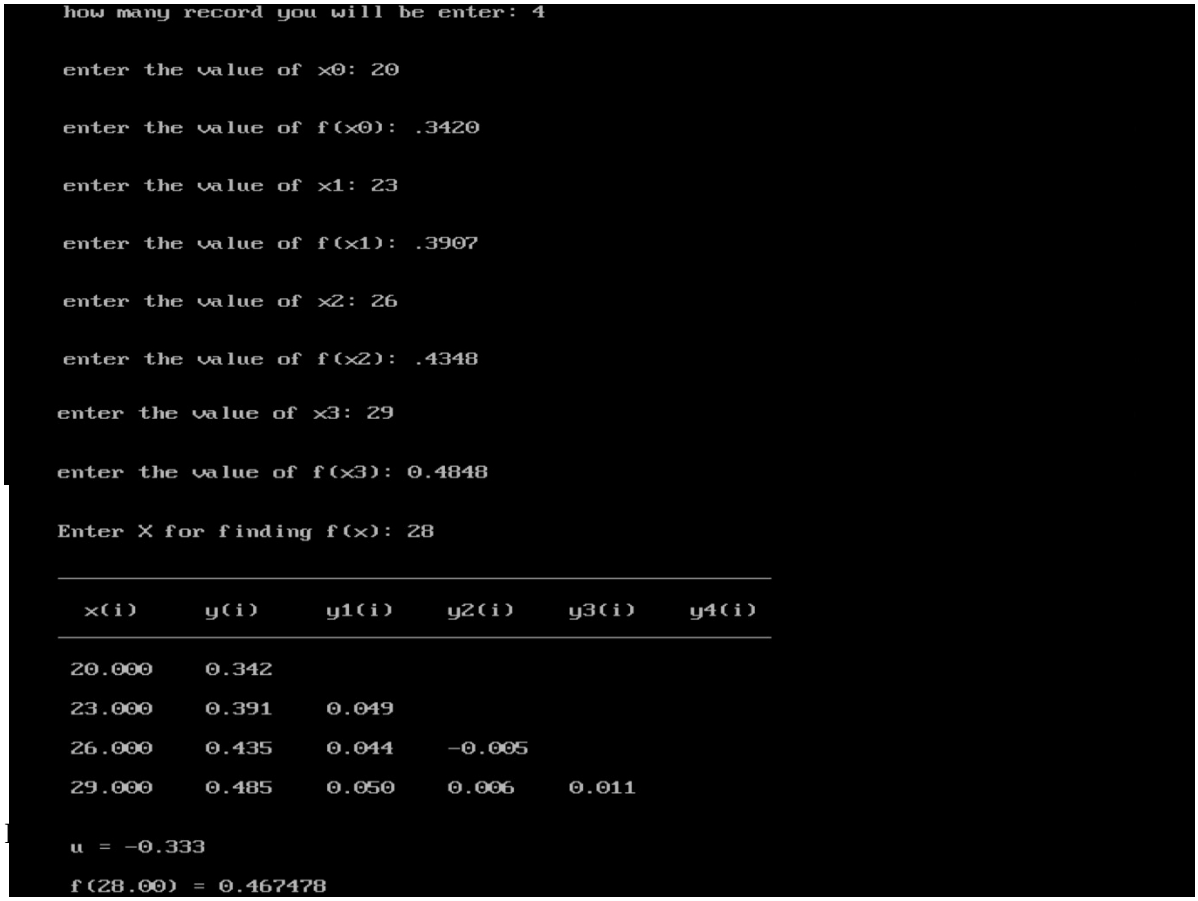
14. Stop

Code:

```
#include<stdio.h>
#include<conio.h>
#include<math.h>
void main()
{
  float x[10],y[10][10],sum,p,u,temp;
  int i,n,j,k=0,f,m;
  float fact(int);
  clrscr();
  printf("\nhow many record you will be enter: ");
  scanf("%d",&n);
  for(i=0; i<n; i++)
  {
   printf("\n\nenter the value of x%d: ",i);
   scanf("%f",&x[i]);
   printf("\n\nenter the value of f(x%d): ",i);
   scanf("%f",&y[k][i]);
  }
  printf("\n\nEnter X for finding f(x): ");
  scanf("%f",&p);

  for(i=1;i<n;i++)
  {
    for(j=i;j<n;j++)
    {
     y[i][j]=y[i-1][j]-y[i-1][j-1];
    }
  }
  printf("\n_____\n");
  printf("\n  x(i)\t   y(i)\t    y1(i)    y2(i)    y3(i)    y4(i)");
  printf("\n_____\n");
  for(i=0;i<n;i++)
  {
    printf("\n %.3f",x[i]);
    for(j=0;j<=i;j++)
    {
     printf("    ");
     printf(" %.3f",y[j][i]);
    }
   printf("\n");
  }

  i=0;
  do
  {
```

```
   if(x[i]<p && p<x[i+1])
    k=1;
   else
    i++;
  }while(k != 1);
  f=i+1;
  u=(p-x[f])/(x[f]-x[f-1]);
  printf("\n\n u = %.3f ",u);

  n=n-i+1;
  sum=0;
  for(i=0;i<n;i++)
  {
   temp=1;
   for(j=0;j<i;j++)
   {
    temp = temp * (u + j);
   }
    m=fact(i);
    sum = sum + temp*(y[i][f]/m);
  }
  printf("\n\n f(%.2f) = %f ",p,sum);
  getch();
}

float fact(int a)
{
  float fac = 1;

  if (a == 0)
   return (1);
  else
   fac = a * fact(a-1);

  return(fac);
}
```

Output:



Gauss Forward method

Algorithm:

Step-1. Start of the program.
Step-2. Input number of terms n
Step-3. Input the array ax
Step-4. Input the array ay

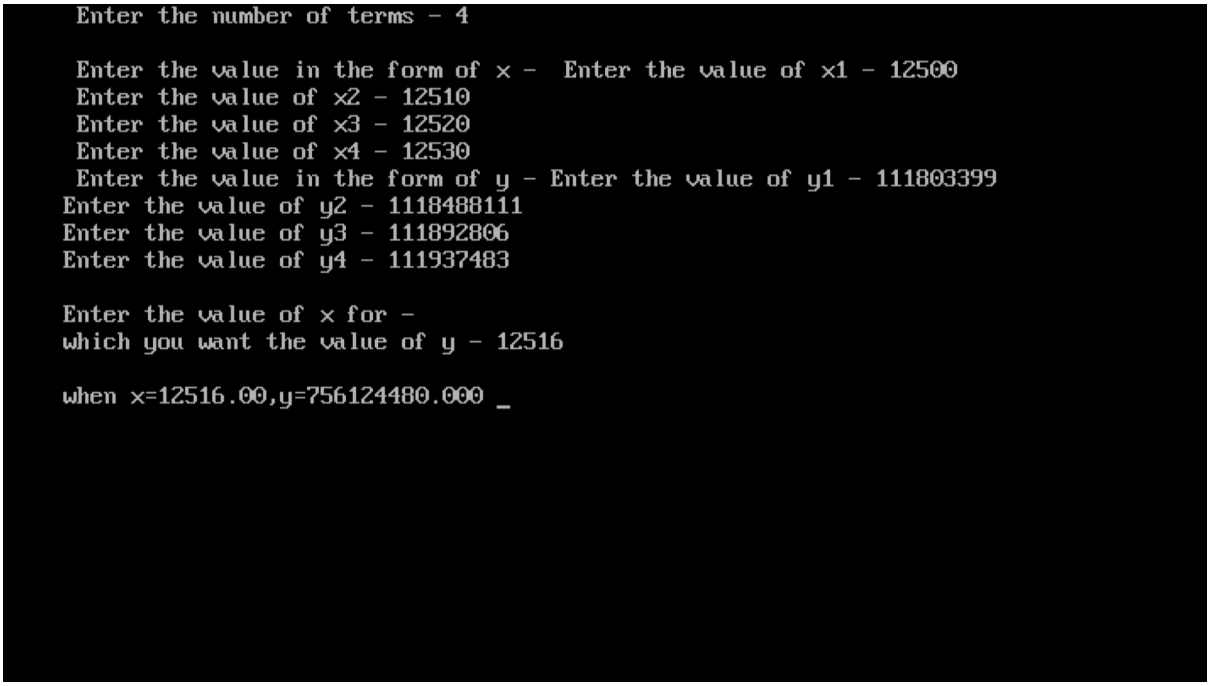
Step-5. h=ax[1]-ax[0]
Step-6.fori=0;i<n–1;i++
Step-7.diff[i][1]=ay[i+1]-ay[i]
Step-8. End Loop i
Step-9.for j=2;j<=4;j++
Step-10.fori=0;i<n–j;i++
Step-11.diff[i][j]=diff[i+1][j–1]–diff[i][j–1]
Step-12. End Loop i
Step-13. End Loop j
Step-14.i=0
Step-15. Repeat Step 16 until ax[i]<x
Step-16.i=i+1
Step-17.i=i–1;
Step-18. p=(x–ax[i])/h
Step-19. y1=p*diff[i][1]
Step-20. y2=p*(p–1)*diff[i–1][2]/2
Step-21. y3=(p+1)*p*(p-1)*diff[i–2][3]/6
Step-22. y4=(p+1)*p*(p–1)*(p–2)*diff[i–3][4]/24
Step-23. y=ay[i]+y1+y2+y3+y4
Step-24. Print Output x,y
Step-25.End of Program.

Code:

```
# include <stdio.h>
# include <conio.h>
# include <math.h>
# include <process.h>
# include <string.h>
void main()
{
int n;
int i,j;
float ax[10];
float ay[10];
float x;
float nr,dr;
float y=0; float h;
float p;
float diff[20][20];
float y1,y2,y3,y4;
clrscr();
printf(" Enter the number of terms - ");
scanf("%d",&n);
printf("\n Enter the value in the form of x - ");
for (i=0;i<n;i++)
{
printf(" Enter the value of x%d - ",i+1);
scanf("%f",&ax[i]);
}
printf(" Enter the value in the form of y - ");
```

```
for(i=0;i<n;i++)
{
printf("Enter the value of y%d - ",i+1);
scanf("%f",&ay[i]);
}
printf("\nEnter the value of x for - ");
printf("\nwhich you want the value of y - ");
scanf ("%f",&x);
h=ax[1]-ax[0];
for(i=0;i<n-1;i++)
{
diff[i][1]=ay[i+1]-ay[i];
}
for(j=2;j<=4;j++)
{
for(i=0;i<n-j;i++)
{
diff[i][j]=diff[i+1][j-1]-diff[i][j-1];
} }
i=0;
do {
i++;
}
while(ax[i]<x);
i--;
p=(x-ax[i])/h;
y1=p*diff[i][1];
y2=p*(p-1)*diff[i-1][2]/2;
y3=(p+1)*p*(p-1)*diff[i-2][3]/6;
y4=(p+1)*p*(p-1)*(p-2)*diff[i-3][4]/24;
y=ay[i]+y1+y2+y3+y4;
printf("\nwhen x=%6.2f,y=%6.3f ",x,y);
getch();
}
```

Output:



Sterling's formula

Algorithm:

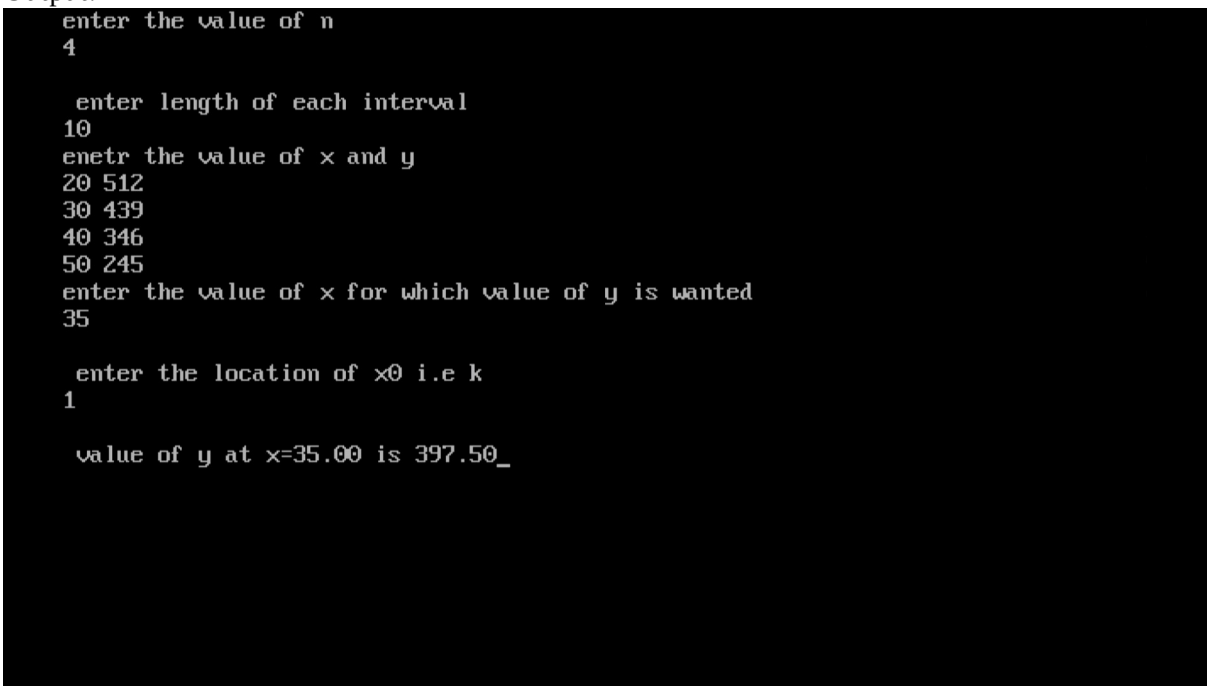
Step-1. Start of the program.
Step-2. Input number of terms n
Step-3. Input the array ax
Step-4. Input the array ay
Step-5. h = ax[1]-ax[0]
Step-6.fori = 1;i < n-1; i++
Step-7.diff [i][1] = ay[i + 1]-ay[i]
Step-8. End loop i
Step-9.for j = 2; j < = 4; j++
Step-10.fori = 0; i< n-j; i++
Step-11.diff[i][j] = diff[i + 1][j-1]-diff[i][j-1]
Step-12. End loop i
Step-13. End loop j
Step-14.i = 0
Step-15. Repeat until ax[i] < x
Step-16.i = i + 1
Step-17.i = i-1;
Step-18. p = (x-ax[i])/h
Step-19. y1= p*(diff[i][1] + diff[i-1][1])/2
Step-20. y2 = p*p*diff[i-1][2]/2
Step-21. y3 = p*(p*p-1)*(diff[i-1][3]+diff[i-2][3])/6
Step-22. y4 = p*p*(p*p-1)*diff[i-2][4]/24
Step-23. y = ay[i]+y1 + y2 + y3 + y4
Step-24. Print output
Step-25. End of program

Code:

```
#include<stdio.h>
#include<conio.h>
void main()
{
float ax[30],ay[30],h,x,y,t1=1,t2=1,u;
int n,i,j,m,k;
clrscr();
printf("enter the value of n\n");
scanf("%d",&n);
printf("\n enter length of each interval \n");
scanf("%f",&h);
printf("enetr the value of x and y \n");
for(i=0;i<n;i++)
{
 scanf("%f %f",&ax[i],&ay[i]);
}
printf("enter the value of x for which value of y is wanted\n");
scanf("%f",&x);
printf("\n enter the location of x0 i.e k\n");
scanf("%d",&k);
y=ay[k];
u=(x-ax[k])/h;
```

```
m=n;
if (k<=n/2)
 n=2*k;
else
 n=2*(n-k);
for(i=1;i<n;i++)
{
for(j=0;j<m-i;j++)
ay[j]=ay[j+1]-ay[j];
if(i%2!=0)
{
t1=(t1*(u-i/2))/i;
t2=(t2*(u+i/2))/i;
}
else
{
t1=(t1*(u+i/2))/i;
t2=(t2*(u-i/2))/i;
}
y=y+(t1*ay[k-(i+1)/2]+t2*ay[k-i/2])/2;
}
printf("\n value of y at x=%.2f is %.2f",x,y);
getch();
}
```

Output:



Lagrange's Interpolation Formula For Unequal Interval

Algorithm:

Step-1. Start of the program
Step-2. Input number of terms n
Step-3. Input the array ax
Step-4. Input the array ay
Step-5.fori=0; i<n; i++
Step-6.nr=1
Step-7.dr=1
Step-8.for j=0; j<n; j++
Step-9.if j !=i
a. nr=nr*(x-ax[j])
Step-10.b.dr*(ax[i]-ax[j])
Step-11. End Loop j
Step-12. y+=(nr/dr)∗ay[i]
Step-13. End Loop i
Step-14. Print Output x, y
Step-15. End of Program

Code:

```
#include<stdio.h>
#include<conio.h>
#define MAX 10
void main()
{
float x[MAX],y[MAX],k=0,z,nr,dr;
int i,j,m;
//clrscr();
printf("\n enter the range ");
scanf("%d",&m);
printf("\n enter the x value ");
for(i=0;i<m;i++)
scanf("%f",&x[i]);
printf("\n enter the y value ");
for(i=0;i<m;i++)
scanf("%f",&y[i]);
printf("\n enter value of x for which respective y is to be calculated ");
scanf("%f",&z);
for(i=0;i<m;i++)
{ nr=1;dr=1;
for(j=0;j<m;j++)
{
if (j!=i)
{
nr=nr*(z-x[j]);
dr=dr*(x[i]-x[j]);
} }
k=k+((nr/dr)*y[i]);}
printf("\n final result=%f\n",k);
getch();
}
```

Output:


enter the range 4
enter the x value 1
2
3
4
enter the y value 1
8
27
64
enter value of x for which respective y is to be calculated 2.5
final result=15.625000