O’ZBEKISTON RESPUBLIKASI OLIY VA O’RTA MAXSUS TA’LIM VAZIRLIGI

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MEXANIKA – MATEMATIKA FAKULTETI

INFORMATIKA VA TADBIQIY DASTURLASH KAFEDRASI

KURS ISHI

MAVZU: Inerval analizning arifmetik usullari

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1-kurs magistrant

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Kirish

O’tgan asrning 60-yillarida muayyan masalaning EHMda olingan yechimini qat’iy va to’liq taxlil bilan topish imkonini beradigan – informatika hamda amaliy matematikaning afzal tomonlarini o’zida mujassamlashtirgan yangi yo’nalish – *interval analiz* paydo bo’ldi.

Interval analizning mohiyati kiritiladigan ma’lumotlarda mavjud bo’lgan yoki oraliq hisoblashlarida interval aniqmasliklar masalalarni o’rganishdan hamda olinadigan yechimlarni quyi va yuqoridan baholashdan iboratdir. Interval analizda qo’llaniladigan miqdorlar bitta qiymat bilan emas,balki qiymatning o’zgarish diapozoni – yopiq interval bilan ifodalanadi.Bu diapozon quyi (chap) va yuqori (o’ng) chegaralarga ega bo’lib, interval son tushunchasiga olib keladi.

(Izox:interval sonlarni to’q qora rangda,kichik lotin harflari bilan belgilaymiz. Masalan:**a**,**b**,**c** kabi.)

1-Ta’rif: Interval son deb

$$[a,b]=\{x|x\in R, a\le x\le b\}$$

Ifoda bilan aniqlanadigan R ning chegaralangan va yopiq qism to’plamiga aytiladi.

Interval sonlar to’plamini **I**(R) bilan belgilaymiz.Agar **a** interval **I**(R) ning elementi bo’lsa: $\mathbf{a}\in \mathbf{I}(R)$ hamda **a** ning chap va o’ng chegaralarini mos ravishda, $\underline{a}$ va $\overline{a}$ shaklida yozilsa, u holda **a**=**[** $\underline{a}$, $\overline{a}$] deb yozish matematiklar tomonidan o’zaro kelishib olingan.

Agar **a**=**[** $\underline{a}$, $\overline{a}$] da $\underline{a}=\overline{a}=a$ bo’lsa , ya’ni intervalning chap va o’ng chegaralari ustma-ust tushsa, u holda **a** interval *a* xaqiqiy songa teng deyiladi. Shunday qilib, $R\subset \mathbf{I}(R)$.

2-Ta’rif:Agar **a**=**[** $\underline{a}$, $\overline{a}$] va **b**=**[** $\underline{b}$, $\overline{b}$] intervallar uchun $\underline{a}$ = $\underline{b}$ va $\overline{a}$ = $\overline{b}$ munosabat o’rinli bo’lsa, u holda **a** va **b** intervallar o’zaro teng intervallar deyiladi.

Masalaning qo’yilishi

Oldimizga qo’yilgan masala interval analiz usullari bilan intellektual masalalarni yechish edi. Taqribiy hisoblashlarni EHM larda bajarganda ro’y beradigan quyidagi tipik holatlarni keltiraylik.

1-misol: Faraz qilaylik $x_0 = 1 - 10^{-21}$ va $x_{n+1} = {x_n}^2$ n=0,1,2,… bo’lsin. Bunda x_{75} ning qiymatini hisoblash talab etilsin.

Agar biz verguldan keyin 20 ta raqamli arifmetikada hisoblashlarni bajarsak, u holda $x_0 = 1,\ x_1 = 1, \ldots,\ x_{75} = 1$ ga ega bo’lamiz.

Ammo x_{75} ni aniq qiymatini yuqoridan quyidagicha baholash mumkin:

$$x_{75} = (1 - 10^{-21})^{2^{75}} < (1 - 10^{-21})^{10^{22,2}} < \quad < \{(1 - 10^{-21})^{10^{21}}\}^{31,6} < e^{-31,6} < 10^{-10}$$

.

Bu misolni yechish uchun qo’llanilgan interval arifmetikada (verguldan keyin 10 ta raqam saqlagan holda) esa [0,1] intervalga yaqin natijani, 20 ta raqamni saqlagan holda bajarilgan hisoblashlar yanada aniqroq natijani beradi. Misoldan ko’rinib turibdiki hisoblashlar 21 ta raqamdan ko’proq raqamlarni saqlagan holda bajarilishi kerak.

2-misol: Berilgan *a*=77617.0 va *b*=330096.0 qiymatlarda *f*=333.75$b^6 + a^2(11a^2b^2 - b^6 - 121b^4 - 2) + 5.5b^8 + a/(2b)$ ifodaning qiymatini hisoblash talab qilinsin.

Aslida *f* ning aniq qiymati **-0.8273960599468213** ga tengdir. Fortran tilida tuzilgan dasturda oddiy aniqlik (6 ta raqamni saqlagan holda), ikkilangan aniqlik (17 ta raqam) hamda kengaytirilgan aniqlik (34 ta raqam) hisoblashlar bajarilganda quyidagilarga ega bo'lamiz:

- oddiy aniqlikda – *f*=+1.172603…;
- ikilangan aniqlikda – *f*=+1.1726039400531…;
- kengaytirilgan aniqlikda – *f*=+1.172603940053178… .

Yuqorida keltirilgan misollar shuni ko'rsatadiki, EHM da an'anaviy usullar yordamida olingan <<*taqribiy yechim izlangan haqiqiy yechimdan qanchaga farq qiladi?*>> yoki <<*EHM da olingan taqribiy yechimlarimizga qay darajada ishonsak bo'ladi?*>> degan savollarga hamma vaqt javob berolmaydi. Bu savollarga javoblarni izlash ham olimlarimiz va EHM ning tajribali foydalanuvchilari oldida hozirgi kunda *muammo* bo'lib turibdi. Interval analiz apparati yordamida shu muammolarning bazilarini hal etish mumkin.

Endi bevosita bajarilgan ishlar ko'lamiga e'tibor qaratamiz. Men bu kurs ishim davomida interval sonlar ustida arifmetik amallarni bir qator interval arifmetika usullari yordamida bajardim va **C++ tili** yordamida programmasini tuzdim.

Yechish usullari

Agar $*^{\in}\{+,-,*,/\}$ bo'lsa, u holda **a** va **b** intervallar uchun arifmetik amallar quyidagicha ifodalaniladi:

$$\mathbf{a}*\mathbf{b}=\{a*b \mid {}^{a \in}\mathbf{a}, b^{\in \mathbf{b}}\}. \qquad (1)$$

{1}Klassik interval arifmetika: (R.Mur arifmetikasi)

Bu arifmetikada bo'lish amalida $0 \notin \mathbf{b}$.

a=**[** $\underline{a}$, $\overline{a}$ **]** va **b**=**[** $\underline{b}$, $\overline{b}$ **]** bo'lsa , u holda (1) formula mos hollarda, quyidagi formulalarga ekvivalentdir:

a+b=**[** $\underline{a}$, $\overline{a}$ **]** + **[** $\underline{b}$, $\overline{b}$ **]** =**[** $\underline{a}$ **+** $\underline{b}$, $\overline{a}$ +$\overline{b}$ **]**,

a-b=**[** $\underline{a}$, $\overline{a}$ **]** - **[** $\underline{b}$, $\overline{b}$ **]** =**[** $\underline{a}$ **-** $\overline{b}, \overline{a}$ - $\underline{b}$ **]**,

a*b=[$\underline{a}$, $\overline{a}$ **]** ***[** $\underline{b}$, $\overline{b}$ **]**=

=[min{ $\underline{a}$ * $\underline{b}$, $\underline{a}$ * $\overline{b}$, $\overline{a} * \underline{b}$, $\overline{a} * \overline{b}$}, max{ $\underline{a}$ * $\underline{b}$, $\underline{a}$ * $\overline{b}$, $\overline{a} * \underline{b}$, $\overline{a} * \overline{b}$},

a/b=**[** $\underline{a}$, $\overline{a}$ **]** /**[** $\underline{b}$, $\overline{b}$ **]**= **[** $\underline{a}$, $\overline{a}$ **]** ***[** 1/$\overline{b}$,1/ $\underline{b}$ **]**. (2)

Agar **a** va **b** intervallarda chap va o'ng chegaralari o'zaro teng bo'lsa, ya'ni **a**=*a,* **b**=*b* bo'lsa, u holda (2) formulalar haqiqiy sonlar ustidagi arifmetik amallarni aniqlovchi formulalarni ifodalaydi.

Interval sonni butun darajaga ko'tarish quyidagi formula asosida amalga oshiriladi:

$$\mathbf{a}^{\mathrm{n}}=[\underline{a}, \overline{a}\,]^{\mathrm{n}} = \begin{cases} [\underline{a}^{n}, \overline{a}^{n}], & \text{agar n=2i+1 bo'lsa} \\ [\underline{a}^{n}, \overline{a}^{n}], & \text{agar n=2i va } \underline{a} > 0 \text{ bo'lsa} \end{cases}$$

$[\bar{a}^n , \underline{a}^n]$, agar n=2i va $\bar{a} < 0$ bo'lsa

[0 , max($\underline{a}^n , \bar{a}^n$), agar n=2i va $0 \in$ **a** bo'lsa

{2}Nostandart interval arifmetika:

Bu arifmetika Bolgariyalik olim S. Markov tomonidan taklif etilgan. Bu arifmetika interval analizga <<nostandart ayirish va bo'lish amali qo'llanilgan arifmetika>> nomi bilan kirib keldi.

Agar **a** va **b** intervallar **I(R)** to'plamida berilgan hamda (-) – nostandart ayirish amalini, (:) esa nostandart bo;lish amalini anglatsa, u holda

a(-)b =[min{ $\underline{a}$ - $\underline{b}$, $\bar{a}$ - $\bar{b}$},max{ $\underline{a}$ - $\underline{b}$, $\bar{a}$ - $\bar{b}$}] ,

a(:)b =

- [min{ $\underline{a}$ / $\underline{b}$, $\bar{a}$ / $\bar{b}$},max{ $\underline{a}$ / $\underline{b}$, $\bar{a}$ / $\bar{b}$}] ,agar **a,b** >0
- [min{ $\underline{a}$ / $\bar{b}$, $\bar{a}$ / $\underline{b}$ },max{ $\underline{a}$ / $\bar{b}$, $\bar{a}$ / $\underline{b}$ }],agar **a,b** <0
- ($1/\underline{b}$)**a**, agar $0 \in$ **a,b**>0
- ($1/\bar{b}$)**a**, agar $0 \in$ **a,b**<0

munosabatlar o'rinli bo'ladi. Qo'shish va ko'paytirish amallari klassik arifmetika bilan bir-xil.

{3}Kaxan interval arifmetikasi:

Interval arifmetikaning yana biri bu Kaxanning kengaytirilgan interval arifmetikasidir.

Bunda **I(R)** intervallar to'plami chegaralangan intervallar bilan bir qatorda $]-\infty,p] \cup [q,+\infty[$ $p \le q$, $]-\infty,p]$, $[q,+\infty[$ ko'rinishdagi intervallar bilan kengaytirilgan.

Intervallarni qo'shish,ayirish,ko'paytirish hamda $0 \notin \mathbf{b}$ shart ostidagi bo'lish amali Kaxan interval arifmetikasida klassik interval arifmetikadagi kabi bajariladi. Ammo Kaxan interval arifmetikasida bo'luvchi interval o'zida nolni olgan holda, ya'ni $0 \in \mathbf{b}$ bo'lganda ham **a** va **b** intervallar uchun bo'lish amali aniqlangan va quyidagiga teng:

$$\mathbf{a/b} = \frac{[\underline{a},\overline{a}]}{[\underline{b},\overline{b}]},$$

$$\mathbf{a/b} = \begin{cases} \mathbf{a}*[1/\overline{b},1/\underline{b}], & \text{agar } 0 \notin \mathbf{b} \\ ]-\infty,+\infty[, & \text{agar } 0 \in \mathbf{a} \text{ va } 0 \in \mathbf{b} \\ [\overline{a}/\underline{b},+\infty[, & \text{agar } \overline{a} < 0 \text{ va } \underline{b} < \overline{b} = 0 \\ ]-\infty,\overline{a}/\overline{b}] \cup [\overline{a}/\underline{b},+\infty[, & \text{agar } \overline{a} < 0 \text{ va } \underline{b} < 0 < \overline{b} \\ ]-\infty,\overline{a}/\overline{b}], & \text{agar } \overline{a} < 0 \text{ va } 0 = \underline{b} < \overline{b} \\ ]-\infty,\underline{a}/\underline{b}], & \text{agar } 0 < \underline{a} \text{ va } \underline{b} < \overline{b} = 0 \\ ]-\infty,\overline{a}/\underline{b}] \cup [\underline{a}/\underline{b},+\infty[, & \text{agar } 0 < \underline{a} \text{ va } \underline{b} < 0 < \overline{b} \\ [\underline{a}/\overline{b},+\infty[, & \text{agar } 0 < \underline{a} \text{ va } 0 = \underline{b} < \overline{b} \\ \varnothing. & \text{agar } 0 \notin \mathbf{a} \text{ va } 0 = \mathbf{b} \end{cases}$$

Kaxanning interval arifmetikasi nazariy tadqiqotlarda, ayniqsa zanjirli kasrlar bilan hisoblashlar olib borganda, interval funksiyalarni

integrallash nazariyasida hamda chiziqsiz algebraik tenglamalarni Nyuton usuli bilan yechish jarayonida ancha qo’l keladi.

Qo’yilgan masalani yechish programmasi

```
UNIT1(ASOSIY FORMA)//-----------------------------------------------------
----------------------

#include <vcl.h>
#pragma hdrstop

#include "Unit1.h"
#include "Unit2.h"
#include "Unit3.h"
#include "Unit4.h"
//---------------------------------------------------------------------------
---
#pragma package(smart_init)
#pragma resource "*.dfm"
TForm1 *Form1;
//---------------------------------------------------------------------------
---
__fastcall TForm1::TForm1(TComponent* Owner)
        : TForm(Owner)
{
}
//---------------------------------------------------------------------------
---

void __fastcall TForm1::ComboBox1Change(TObject *Sender)
{
if(ComboBox1->ItemIndex == 0)

Form2->Show();
Form1->Hide();
if(ComboBox1->ItemIndex == 1)
//ShowMessage("KLASSIK interval arifmetika");
```

```
Form3->Show();
Form1->Hide();
if(ComboBox1->ItemIndex == 2)
Form4->Show();
Form1->Hide();

}
//---------------------------------------------------------------------------

void __fastcall TForm1::Button1Click(TObject *Sender)
{
  Form1->Close();

}
//---------------------------------------------------------------------------
```

UNIT2(KLASSIK INTERVAL ARIFMETIKA)//-------------------------------------

```
#include <vcl.h>
#pragma hdrstop

#include "Unit2.h"
#include "Unit1.h"
//---------------------------------------------------------------------------
#pragma package(smart_init)
#pragma resource "*.dfm"
TForm2 *Form2;

float a1,a2,b1,b2;
float c1,c2;


//---------------------------------------------------------------------------
__fastcall TForm2::TForm2(TComponent* Owner)
        : TForm(Owner)
{
}
//---------------------------------------------------------------------------

void __fastcall TForm2::Button1Click(TObject *Sender)
{
Form2->Close();
Form1->Show();

}
//---------------------------------------------------------------------------
```

```
void __fastcall TForm2::Button2Click(TObject *Sender)
{
Edit1->Clear();
Edit2->Clear();
Edit3->Clear();
Edit4->Clear();
Edit5->Clear();
Edit6->Clear();
}
//---------------------------------------------------------------------------
---
void __fastcall TForm2::Button3Click(TObject *Sender)
{

  c1=a1+b1;c2=a2+b2;
  Edit5->Text=FloatToStr(c1);
  Edit6->Text=FloatToStr(c2);
}
//---------------------------------------------------------------------------
---


void __fastcall TForm2::Button4Click(TObject *Sender)
{

  c1=a1-b2;c2=a2-b1;
  Edit5->Text=FloatToStr(c1);
  Edit6->Text=FloatToStr(c2);
}
//---------------------------------------------------------------------------
---

void __fastcall TForm2::Button5Click(TObject *Sender)
{

  float b,d,d1,d2,d3,d4;
 d1=a1*b1;d2=a1*b2;d3=a2*b1;d4=a2*b2;

 if(d1>d2){d=d2;d2=d1;d1=d;};
 if(d2>d3){d=d3;d3=d2;d2=d;};
 if(d3>d4){d=d4;d4=d3;d3=d;};c2=d4;

 if(d4<d3){d=d4;d4=d3;d3=d;};
 if(d3<d2){d=d3;d3=d2;d2=d;};
 if(d2<d1){d=d2;d2=d1;d1=d;};c1=d1;
  Edit5->Text=FloatToStr(c1);
  Edit6->Text=FloatToStr(c2);
}
//---------------------------------------------------------------------------
---

void __fastcall TForm2::Button6Click(TObject *Sender)
{  float b,d,d1,d2,d3,d4;

  if(b1<=0&&b2>=0)
  {Edit5->Text="bo'lish ";
  Edit6->Text="amali aniqlanmagan";
  }
 else
{ b=1/b2;b2=1/b1;b1=b;
 d1=a1*b1;d2=a1*b2;d3=a2*b1;d4=a2*b2;
```

```
 if(d1>d2){d=d2;d2=d1;d1=d;};
 if(d2>d3){d=d3;d3=d2;d2=d;};
 if(d3>d4){d=d4;d4=d3;d3=d;};c2=d4;

 if(d4<d3){d=d4;d4=d3;d3=d;};
 if(d3<d2){d=d3;d3=d2;d2=d;};
 if(d2<d1){d=d2;d2=d1;d1=d;};c1=d1;

 Edit5->Text=FloatToStr(c1);
 Edit6->Text=FloatToStr(c2);
}
}
//---------------------------------------------------------------------------

void __fastcall TForm2::Button7Click(TObject *Sender)
{
  a1=StrToFloat(Edit1->Text);
  a2=StrToFloat(Edit2->Text);
  b1=StrToFloat(Edit3->Text);
  b2=StrToFloat(Edit4->Text);
}
//---------------------------------------------------------------------------
UNIT3(NOSTANDART ITERVAL ARIFMETIKA)//-------------------------------------
---------------------------------------

#include <vcl.h>
#pragma hdrstop

#include "Unit3.h"
#include "Unit1.h"
//---------------------------------------------------------------------------
#pragma package(smart_init)
#pragma resource "*.dfm"
TForm3 *Form3;

float a1,a2,b1,b2;
float c1,c2;

//---------------------------------------------------------------------------
__fastcall TForm3::TForm3(TComponent* Owner)
        : TForm(Owner)
{
}
//---------------------------------------------------------------------------

void __fastcall TForm3::Button1Click(TObject *Sender)
{
 Form3->Close();
 Form1->Show();

}
//---------------------------------------------------------------------------

void __fastcall TForm3::Button3Click(TObject *Sender)
```

```
{

  c1=a1+b1;c2=a2+b2;
  Edit5->Text=FloatToStr(c1);
  Edit6->Text=FloatToStr(c2);
}
//---------------------------------------------------------------------------
---
void __fastcall TForm3::Button5Click(TObject *Sender)
{

  float b,d,d1,d2,d3,d4;
 d1=a1*b1;d2=a1*b2;d3=a2*b1;d4=a2*b2;

 if(d1>d2){d=d2;d2=d1;d1=d;};
 if(d2>d3){d=d3;d3=d2;d2=d;};
 if(d3>d4){d=d4;d4=d3;d3=d;};c2=d4;

 if(d4<d3){d=d4;d4=d3;d3=d;};
 if(d3<d2){d=d3;d3=d2;d2=d;};
 if(d2<d1){d=d2;d2=d1;d1=d;};c1=d1;
  Edit5->Text=FloatToStr(c1);
  Edit6->Text=FloatToStr(c2);
}
//---------------------------------------------------------------------------
---
void __fastcall TForm3::Button4Click(TObject *Sender)
{ float b;

  c1=a1-b1;c2=a2-b2;
 if(c1>=c2){b=c2;c2=c1;c1=b;}

 Edit5->Text=FloatToStr(c1);
 Edit6->Text=FloatToStr(c2);


}
//---------------------------------------------------------------------------
---
void __fastcall TForm3::Button6Click(TObject *Sender)
{ float b,d,d1,d2,d3,d4;


 if(b1<=0&&b2>=0)
 {Edit5->Text="bo'lish ";
  Edit6->Text="amali aniqlanmagan";
 }
 else
{ if(a1>0&&b1>0)
{{ d1=a1/b1;d2=a2/b2;}
 if(d1>=d2) {c1=d2;c2=d1;}
 else {c1=d1;c2=d2;}}
 if(a2<0&&b2<0)
 {{d1=a1/b2;d2=a2/b1;}
 if(d1>=d2) {c1=d2;c2=d1;}
 else {c1=d1;c2=d2;}}
 if(a1<=0&&a2>=0&&b1>0){b=1/b1;c1=b*a1;c2=b*a2;}
 if(a1<=0&&a2>=0&&b2<0){b=1/b2;c2=b*a1;c1=b*a2;}

 Edit5->Text=FloatToStr(c1);
 Edit6->Text=FloatToStr(c2);
```

```
  }
}
//---------------------------------------------------------------------------
---
void __fastcall TForm3::Button2Click(TObject *Sender)
{
Edit1->Clear();
Edit2->Clear();
Edit3->Clear();
Edit4->Clear();
Edit5->Clear();
Edit6->Clear();
}
//---------------------------------------------------------------------------
---
void __fastcall TForm3::Button7Click(TObject *Sender)
{
  a1=StrToFloat(Edit1->Text);
  a2=StrToFloat(Edit2->Text);
  b1=StrToFloat(Edit3->Text);
  b2=StrToFloat(Edit4->Text);
}
//---------------------------------------------------------------------------
---
UNIT4(KAXAN INTERVAL ARIFMETIKASI)//-----------------------------------------
-------------------------------------

#include <vcl.h>
#pragma hdrstop

#include "Unit4.h"
#include "Unit1.h"
//---------------------------------------------------------------------------
---
#pragma package(smart_init)
#pragma resource "*.dfm"
TForm4 *Form4;

float a1,a2,b1,b2;
float c1,c2;

//---------------------------------------------------------------------------
---
__fastcall TForm4::TForm4(TComponent* Owner)
        : TForm(Owner)
{

}
//---------------------------------------------------------------------------
---

void __fastcall TForm4::Button1Click(TObject *Sender)
{
Form4->Close();
Form1->Show();

}
//---------------------------------------------------------------------------
---

void __fastcall TForm4::Button2Click(TObject *Sender)
```

```
{
Edit1->Clear();
Edit2->Clear();
Edit3->Clear();
Edit4->Clear();
Edit5->Clear();
Edit6->Clear();
}
//---------------------------------------------------------------------------
---
void __fastcall TForm4::Button3Click(TObject *Sender)
{

  c1=a1+b1;c2=a2+b2;
  Edit5->Text=FloatToStr(c1);
  Edit6->Text=FloatToStr(c2);
}
//---------------------------------------------------------------------------
---
void __fastcall TForm4::Button4Click(TObject *Sender)
{

  c1=a1-b2;c2=a2-b1;
  Edit5->Text=FloatToStr(c1);
  Edit6->Text=FloatToStr(c2);
}
//---------------------------------------------------------------------------
---
void __fastcall TForm4::Button5Click(TObject *Sender)
{

  float b,d,d1,d2,d3,d4;
 d1=a1*b1;d2=a1*b2;d3=a2*b1;d4=a2*b2;

 if(d1>d2){d=d2;d2=d1;d1=d;};
 if(d2>d3){d=d3;d3=d2;d2=d;};
 if(d3>d4){d=d4;d4=d3;d3=d;};c2=d4;

 if(d4<d3){d=d4;d4=d3;d3=d;};
 if(d3<d2){d=d3;d3=d2;d2=d;};
 if(d2<d1){d=d2;d2=d1;d1=d;};c1=d1;
  Edit5->Text=FloatToStr(c1);
  Edit6->Text=FloatToStr(c2);
}
//---------------------------------------------------------------------------
---
void __fastcall TForm4::Button6Click(TObject *Sender)
{

  float b,d,d1,d2,d3,d4;
  if(b1>0||b2<0)
{ b=1/b2;b2=1/b1;b1=b;
  d1=a1*b1;d2=a1*b2;d3=a2*b1;d4=a2*b2;

 if(d1>d2){d=d2;d2=d1;d1=d;};
 if(d2>d3){d=d3;d3=d2;d2=d;};
 if(d3>d4){d=d4;d4=d3;d3=d;};c2=d4;

 if(d4<d3){d=d4;d4=d3;d3=d;};
 if(d3<d2){d=d3;d3=d2;d2=d;};
 if(d2<d1){d=d2;d2=d1;d1=d;};c1=d1;
```

```
 Edit5->Text=FloatToStr(c1);
 Edit6->Text=FloatToStr(c2);
}
 if((a1<=0&&a2>=0)&&(b1<=0&&b2>=0))

{ Edit5->Text="- cheksizlikdan ";
  Edit6->Text="+ cheksizlikkacha";
}
 if(a2<0&&(b1!=0&&b1<b2))
{c1=a2/b1;

 Edit5->Text=FloatToStr(c1);
 Edit6->Text="+ cheksizlik";
}
 if(a2<0&&(b1<0&&b2>0))
{c1=a2/b2;c2=a2/b1;
 Edit5->Text="]- cheksizlik,"+FloatToStr(c1)+"]"  +  "birlashma";
 Edit6->Text="["+FloatToStr(c2)+",+ cheksizlik[";
}
 if(a2<0&&(b1==0&&b2>b1))
{c2=a2/b2;
  Edit5->Text="- cheksizlik ";
  Edit6->Text=FloatToStr(c2);
}
 if(a1>0&&(b1<b2&&b2==0))
{c2=a1/b1;
  Edit5->Text="- cheksizlik ";
  Edit6->Text=FloatToStr(c2);
}
 if(a1>0&&(b1<0&&b2>0))
{c1=a1/b1;c2=a2/b1;
 Edit5->Text="]- cheksizlik,"+FloatToStr(c1)+"]"  +  "birlashma";
 Edit6->Text="["+FloatToStr(c2)+",+ cheksizlik[";
}
 if(a1>0&&(b1==0&&b2>b1))
{c1=a1/b2;
 Edit5->Text=FloatToStr(c1);
 Edit6->Text="+ cheksizlik";
}
 if((a1>0||a2<0)&&(b1==0&&b2==0))
{Edit5->Text="bo'lish ";
 Edit6->Text="amali aniqlanmagan";
}
}
//---------------------------------------------------------------------------
---

void __fastcall TForm4::Button7Click(TObject *Sender)
{
  a1=StrToFloat(Edit1->Text);
  a2=StrToFloat(Edit2->Text);
  b1=StrToFloat(Edit3->Text);
  b2=StrToFloat(Edit4->Text);
}
//---------------------------------------------------------------------------
---
```

Test masalalar

Quyida berilgan interval sonlar ustida arifmetik amallarni ko’rib chiqaylik:

1) a=[-5;6] b=[-6;-3]

2) a=[-6;5] b=[-7;8]

3) a=[-4;-3] b=[-5;0]

4) a=[-5;-2,5] b=[-6,5;5,4]

5) a=[-6,56;-4] b=[0;9,8]

6) a=[16;25] b=[-22,34;0]

7) a=[24,6;30,19] b=[-56;75]

8) a=[18;46] b=[0;99,56]

9) a=[-56;-10] b=[0;0]

10) a=[22;28,49] b=[0;0]

Natijalar va taxlil

Klassik interval arifmetika(**c=a{+,−,*,/}b**)

No	Qo'shish	Ayirish	Ko'paytirish	Bo'lish
1)	[-11;3]	[-2;12]	[-36;30]	[-2;1,6666667]
2)	[-13;13]	[-14;12]	[-48;42]	Aniqlanmagan
3)	[-9;-3]	[-4;2]	[0;20]	Aniqlanmagan
4)	[-11,5;2,9]	[-10,399999;4]	[-27;32,5]	Aniqlanmagan
5)	[-6,56;5,800]	[-16,36000;-4]	[-64,28800;0]	Aniqlanmagan
6)	[-6,34000;25]	[16;47,340000]	[-558,5;0]	Aniqlanmagan
7)	[-31,4;105,19000]	[-50,40;86,19]	[-1690,64; 2264,25]	Aniqlanmagan
8)	[18;145,56]	[-81,56;46]	[0;4579,7597]	Aniqlanmagan
9)	[-56;-10]	[-56;-10]	[0;0]	Aniqlanmagan
10)	[22;28,49]	[22;28,49]	[0;0]	Aniqlanmagan

Nostandart interval arifmetika(**c=a{+,−,*,/}b**)

No	Qo'shish	Ayirish (-)	Ko'paytirish	Bo'lish (:)
1)	[-11;3]	[1;9]	[-36;30]	[-2;1,6666666]
2)	[-13;13]	[-3;1]	[-48;42]	Aniqlanmagan
3)	[-9;-3]	[-3;1]	[0;20]	Aniqlanmagan
4)	[-11,5;2,9]	[-7,90000;1,5]	[-27;32,5]	Aniqlanmagan
5)	[-6,56;5,800]	[-13,800;-6,56]	[-64,28800;0]	Aniqlanmagan
6)	[-6,34000;25]	[25;38,340000]	[-558,5;0]	Aniqlanmagan
7)	[-31,4;105,19000]	[-44,809;80,6]	[-1690,64; 2264,25]	Aniqlanmagan
8)	[18;145,56]	[-53,55999;18]	[0;4579,7597]	Aniqlanmagan
9)	[-56;-10]	[-56;-10]	[0;0]	Aniqlanmagan
10)	[22;28,49]	[22;28,49]	[0;0]	Aniqlanmagan

Kaxan interval arifmetikasi(**c=a{+,−,*,/}b**)

No	Qo'shish	Ayirish	Ko'paytirish	Bo'lish
1)	[-11;3]	[-2;12]	[-36;30]	[-2;1,6666667]
2)	[-13;13]	[-14;12]	[-48;42]	$[-\infty;+\infty]$
3)	[-9;-3]	[-4;2]	[0;20]	[0,60000; $+\infty$]
4)	[-11,5;2,9]	[-10,399999;4]	[-27;32,5]	$[-\infty;-0,46296295] \cup$

				[0,38461539149; $+\infty$]
5)	[-6,56;5,800]	[-16,36000;-4]	[-64,28800;0]	[$-\infty$; $-0,408163249$]
6)	[-6,34000;25]	[16;47,340000]	[-558,5;0]	[$-\infty$; $-0,7162041068$]
7)	[-31,4;105,19000]	[-50,40;86,19]	[-1690,64; 2264,25]	[$-\infty$; -0,539107144] $\cup$ [-0,439285725355; $+\infty$]
8)	[18;145,56]	[-81,56;46]	[0;4579,7597]	[0,180795505643; $+\infty$]
9)	[-56;-10]	[-56;-10]	[0;0]	Aniqlanmagan
10)	[22;28,49]	[22;28,49]	[0;0]	Aniqlanmagan

Klassik interval arifmetikada aniqlangan (1) va (2) formulalarning taxlili shuni ko'rsatadiki , interval arifmetikada: qo'shish amali, ayirish amaliga, ko'paytirish amali esa bo'lish amaliga teskari emasdir. Ya'ni, **a-a≠[0;0]** , **a/a≠[1;1]** . Ammo, $0 \in$ **a-a** , $1 \in$ **a/a** .

Xulosa

Taxlil natijalariga qarab quyidagicha xulosa qilish mumkin: demak, ko'rib o'tilgan interval arifmetikalarda Kaxan interval arifmetikasining imkoniyat ko'lami ko'rib o'tilgan boshqa arifmetikalarga nisbatan kengroq. Umuman olganda, berilgan masalaga qarab kerakli natijani olish uchun shu masalaga mos interval arifmetika tanlanar ekan. Shunday masalalar borki, kerakli natijaga erishish uchun yuqorida ko'rib o'tilgan arifmetikalar javob bera olmasligi mumkin. Bunday vaziyatlarda interval arifmetikaning boshqa usullariga murojaat qilgan ma'qul. Xususan, *umumlashgan interval arifmetika va to'la interval arifmetika* usullari ko'zlangan maqsadga olib borishi mumkin.

Adabiyotlar

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