saqarTvelos teqnikuri universiteti

informatikisa da marTvis sistemebis instituti

gia surgulaZe

obieqt-orientirebuli daprogramebis ena C++

Tbilisi 2005

sarCevi

Sesavali

Sesavali:

C++ daprogramebis ena miRebulia C-enaSi obieqt-orientirebuli meTodis ideologiis damatebiT. C++ enaSi realizebulia klasebisa da obieqtebis, memkvidreobiTobisa da polimorfizmis, inkafsulirebisa da monacemTa abstraqtuli tipebis daprogramebis saSualebani.

es Tvisebebi gansakuTrebul simZlavres da moqnilobas aniWebs enas. dReisaTvis ar arsebobs iseTi Tanamedrove programuli paketi, romelic modelirebisa da daprogramebis obieqt-orientirebul koncefcias ar iyenebdes.

aseTi programuli produqtebia: Visual C++, Borland C++Builder, Visual Basic, Object Pascal, Delphi, Oracle, SQL Server, Access da mravali sxv. obieqt-orientirebuli daprogramebis idea erTia yvelasTvis (Teoriuli sakiTxi), enaSi realizacia ki yvelas specifikurad aqvs gadawyvetili.

1. C++ enis ZiriTadi koncefcia

Cveni mizania aq ganvixiloT obieqt-orientirebuli koncefciis ZiriTadi elementebi da maTi programuli gadawyvetis xerxebi. Tu am sakiTxebSi specialisti gaerkva, maSin igi SedarebiT Tavisuflad daeufleba zemoCamoTvlil programul paketebSi muSaobas.

pirvel TavSi Cven aRvniSneT, rom struqturuli daprogramebis idea mTlianad aris Cadgmuli obieqt-orientirebulSi. amgvarad, oo-daprogrameba berad aRemateba mas programuli biblioTekis simZlavriTa da enis farTo SesaZleblobebiT. mokled rom vTqvaT, C++ enis axali konstruqciebi Tvisobrivad ganasxvavebs mas C enisagan.

paragrafis dasasruls saWiroa aRiniSnos, rom vinaidan C++ ena memkvidrea C enisa, Zveli programuli kodebi muSaobs axal garemoSic. am sakiTxma Zireuli gamarjveba moutana C++ enas konkurenciaSi programebis msoflio bazarze, vinaidan Unix-platforma daWerilia C enaze da mravali firma da organizacia iyenebs mas. C++ enis SemotaniT ar moxda Zvelis uaryofa, Seiqmna e.w. hibriduli mZlavri sistema.

ismis kiTxva, rodis unda gamoviyenoT C++ ena, an yovelTvisaa Tu ara misi gamoyeneba saWiro ? bolo wlebSi gamocemuli literaturis analizi gviCvenebs, rom C++ -is gamoyeneba araa yovelTvis efeqturi, CenasTan SedarebiT. gvaxsovdes principi `beRurebs zarbaznebiT ar xocaven ! ~ .

Tu amocana programulad advili gadasawyveti da martivad realizebadia, maSin misTvis Cenac sakmarisia. naklebi resursebis pirobebSi igi swrafad da damakmayofileblad imuSavebs.

Tu amocana rTulia da moiTxovs sarealizaciod did resursebsa da dros, maSin igi aucileblad unda gadawydes C++ enis konstruqciebis gamoyenebiT. es mogvcems SesaZleblobas, rom saproeqto da sarealizacio stadiebi bevrad swrafad SevasruloT enis iseTi konstruqciebis safuZvelze, rogorebicaa memkvidreobiToba, polimorfizmi da sxv.

ganvixiloT C++ enaze daprogramebis procedurebi. pirobiTad SeiZleba C++ programebi davyoT or kategoriad: pirveli, romlebSic araa gamoyenebuli obieqt-orientirebuli ideologiis elementebi (klasebi, obieqtebi da a.S.), da meore - romlebSic aris. AA

programebis asagebad SeiZleba gamoyenebul iqnes C++ enis nebismieri kompilatori Widows, MsDos an Linux platformaze. programis sawyisi teqsti iqneba identuri samive SemTxvevaSi.

Cveni magaliTebisaTvis gamoviyenebT amjerad Borland C++ kompilators, Tumca mkiTxvels SeuZlia sxva C++ instrumentis gamoyenebac.

2. daprogrameba obieqt-orientirebuli meTodis elementebis gareSe

1-el naxazze motanilia ori patara programis fragmenti, romelTa Sedegebi identuria. pirveli teqsti C enis operatorebiTaa dawerili, meore ki C++ eniT. orive programa muSaobs C++ kompilatoriT da iZleva erTidaimave Sedegebs.

- pirveli striqoni: (/*...*/ da //...) orive komentarebia.
- meore striqoni: <stdio.h> da <iostream.h> C da C++ is header failebia, Sesabamisad.

```
/*Pr50.cpp   My first */
#include <stdio.h>
void main(void)
{
 printf("Hello, I'm C ! \n");
}
```

```
// Pr51.cpp   My second
#include <iostream.h>
void main(void)
{
 cout << "Hello, I'm  C++!"<<endl;
}
```

nax. 1

- mesame striqoni: erTnairia. C enisagan gansxvavebiT C++ ena yovelTvis moiTxovs funqciis da argumentebis tipebis miTiTebas. amjerad main()-s ara aqvs arcerTi, amitomac gamoyenebulia void, rac utipos niSnavs. amgvarad, C++ ena bevrad mkacria, vidre `keTili~-C. tipebis ar-miTiTeba xSiradaa sintaksuri Secdomebis mizezi !

- figurul frCxilebSi moTavsebulia erTi operatori, romelsac ekranze gamoaqvs misalmebis striqoni. pirvel SemTxvevaSi gamoyenebulia formatirebuli gamotanis, CvenTvis kargad cnobili printf() operatori. rogorc vxedavT, C++ enis msgavsi konstruqcia <iostream.h> failidan aris:

cout <<" teqsti " << endl;

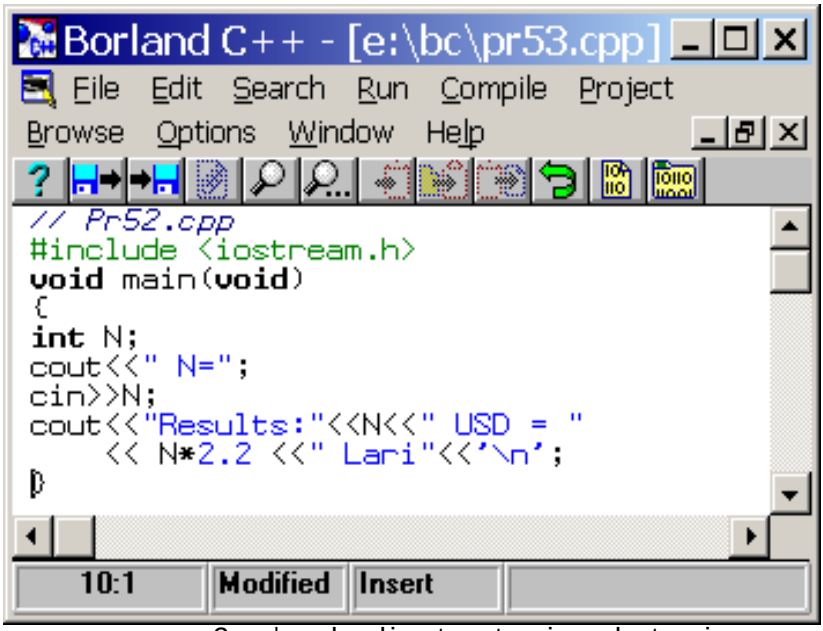
aq endl aris striqonis gadatana (SeiZleba '\n' ic gamoviyenoT).

C++ enaSi monacemebis Setana SeiZleba <stdio.h>-is operatorebiT: scanf(), gets(), getch() da sxv., magram ufro xSirad gamoiyeneben <iostream.h>-isas: cin >> N;

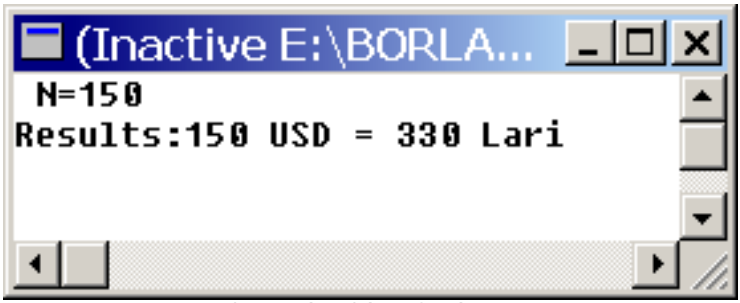
ganvixiloT Borland-is C++ redaqtorSi programis teqsti (nax.2-a) da Sedegi (nax.2-b). gamoyenebuli gvaqvs cout da cin operatorebi.

3. monacemTa nakadis Setana-gamotana

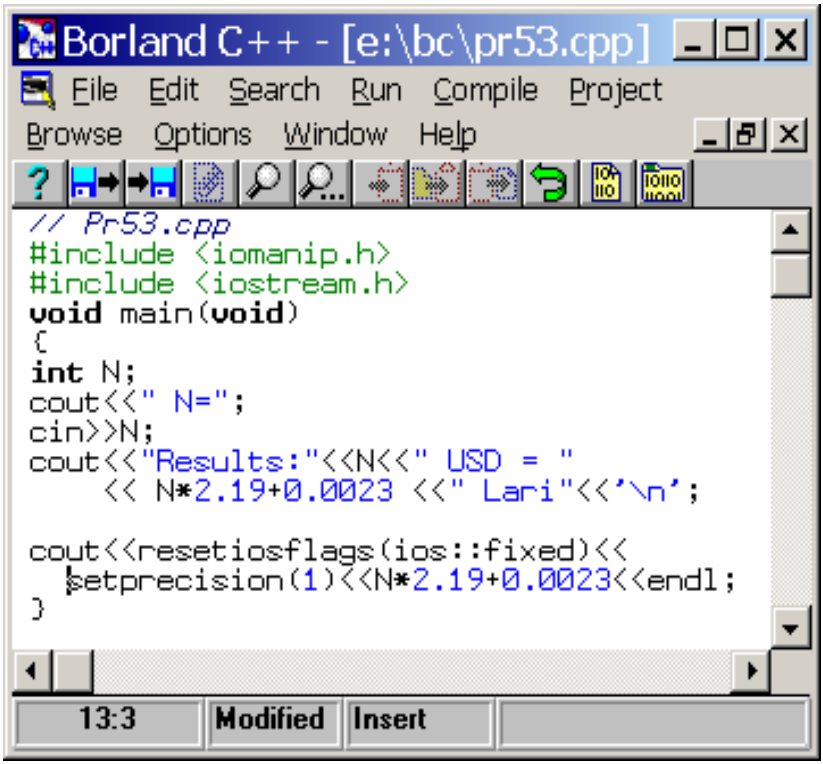
momdevno 3-a da b naxazebze ilustrirebulia namdvili ricxvebis formatirebuli gamotanis SemTxveva specialuri manipulatorebis gamoyenebiT (aq esaa setprecision(1), romelic aris <iomanip.h> failSi). 1 miuTiTebs ricxvis damrgvalebas meaTedamde, amitomac SedegSi miRebulia 32.9 nacvlad 32.8523.



nax.2-a. borlandis teqsturi redaqtori



nax.2-b. Sedegebis fanjara



nax.3-a. Sedegebis gamotanis sizustis manipulatori setprecision(1) aris <iomanip.h> failSi

nax.3-b. Sedegi damrgvalebulia meaTedis sizustiT

monacemTa formatirebuli Setana-gamotanis detalurad gasacnobad saWiroa gavaanalizoT iostream.h failis maRali da dabali donis mTavari sabazo klasebi ios da streambuf. am ukanaskneli Siaris xSirad gamoyenebadi subklasi conbuf, romelic iyenebs constream.h fails da Seicavs monitoris marTvis funqciebs (rogorc <conio.h>). es funqciebia, magaliTad:

funqcia	daniSnuleba
void clreol ( )	Slis teqsts kursoris poziciidan striqonis bolomde
void clrscr ( )	wmends ekrans mTlianad
void delline ( )	Slis striqons
void gotoxy(int x, int y)	gadaaadgilebs kursors
void textbackground(int Color)	fonis feri
void textcolor(int Color)	teqstis feri
void window(int x1,inty1,intx2,inty2)	fanjris parametrebi
int wherex(), int wherey()	kursoris poziciis koordinatebi

4. funqciebs Soris parametrebis gadacema fsevdonimebiT

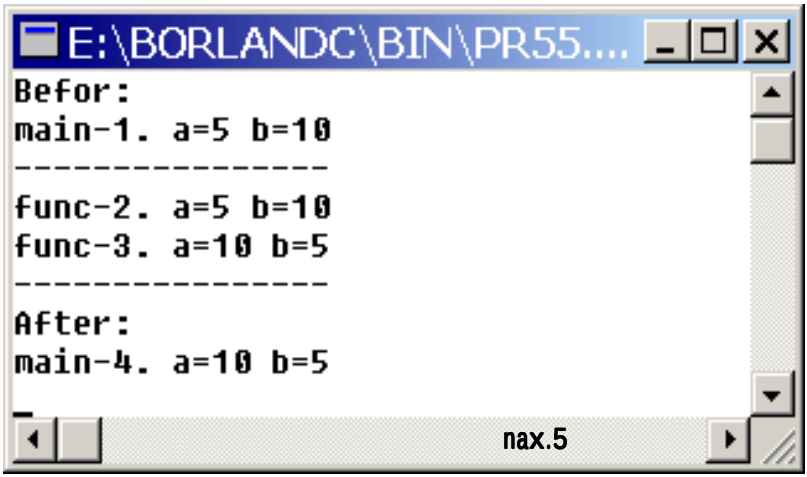
CenaSi Cven ganvixileT funqciebs (qveprogramebs) Soris monacemebis gadacema mniSvnelobebiT da misamarTebiT, avxseniT maTi daniSnuleba. C++ enas garda am ori saSualebisa gaaCnia mesame xerxic, romelsac fsevdonimebiT (alias) mimarTvas uwodeben (reference). es ukanaskneli iyenebs cnebas `monacemis tipis misamarTi~ (data_type& ...) anu iribi (arapirdapiri) mimarTva monacemze. amgvarad, gvaqvs SesaZlebloba monacemebs mivmarToT ori saxeliT: namdviliT (mTavarSi) da fsevdonimiT (gamoZaxebulSi). sinamdvileSi es fizikurad erTi da imave monacemis mniSvnelobaa mexsierebaSi. amitomac &date da &alias_date erT mniSvnelobas iZleva.

axla ganvixiloT igive amocana, rac me-3 TavSi, ori ricxvis gadacemiT meore funqciaze, mniSvnelobebis urTierTSecvliT da ukan dabrunebiT, oRondac fsevdonimebis gamoyenebiT.

```
// Pr55.cpp   reference transfer
#include <iostream.h>
#include <conio.h>
void func(int&, int&);
void main(void)
{ int a=5, b=10;
 cout<<“Befor:”<<endl;
 cout<<“main-1. a=”<<a<<“ b=”<<b<<endl;
  func(a,b);
 cout<<“After:”<<endl;
 cout<<“main-4. a=”<<a<<“ b=”<<b<<endl;
  getch();
}
//------------------------------
void func(int& u, int& v)
{ int temp;
 cout<<"———————————"<<endl;
 cout<<"func-2. a="<<u<<" b="<<v<<endl;
```

```
 temp=u;
u=v;
v=temp;
cout<<"func-3. a="<<u<<" b="<<v<<endl;
cout<<"————————————"<<endl;
}
```

Sedegebi mocemulia me-5 naxazze.



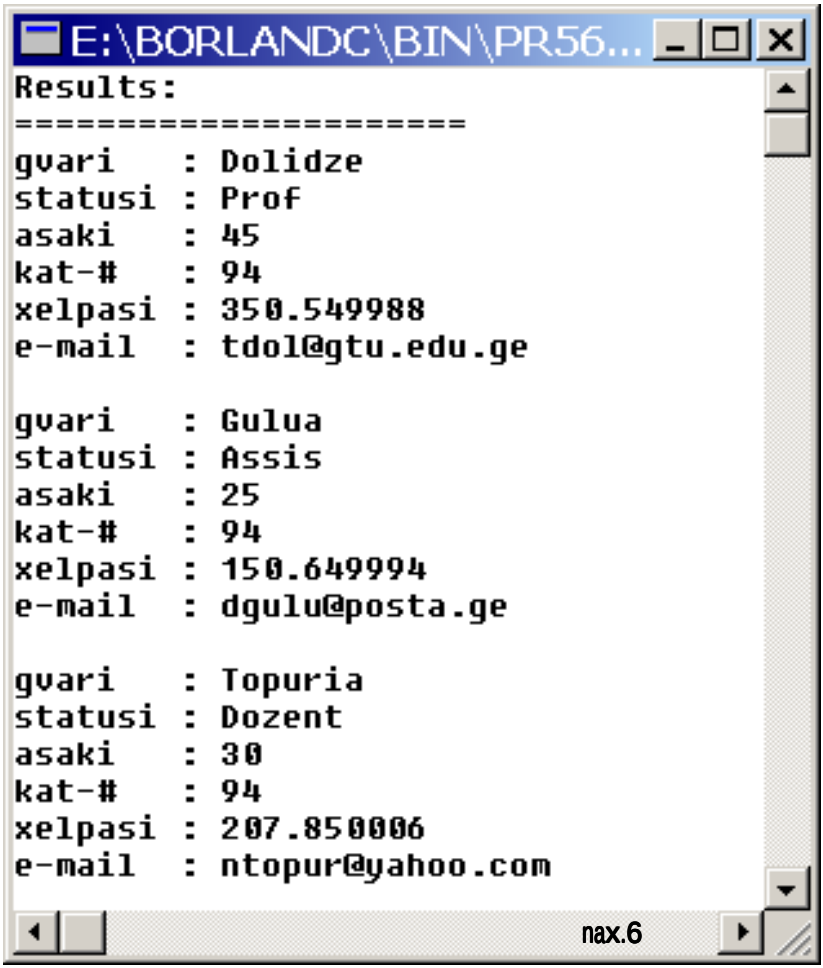
5. struqturebis gadacema maCveneblebiT

C++ enaSi xSirad gamoiyeneba funqciebs (qveprogramebs) Soris struqturebis gadacema maCveneblebiT. wina paragrafSi Cven gamoviyeneT tipebis misamarTebiT (fsevdonimebiT) data_type& gadacema. struqtura ki, rogorc viciT aris axali tipis monacemi da igi C++ enis klasia. amitomac SeiZleba int&-is msgavsad, magaliTad, Person& gamoyenebac, sadac Person struqturis saxelia.

ganvixiloT konkretuli magaliTi. davuSvaT gvaqvs dokumenti pirovneba normalizebuli formiT (struqturiT), romelsac Semdegi atributebi axasiaTebs: gvari, statusi, asaki, kaTedris_#, Semosavali, el-fostis-misam. struqtura deklarirebulia Person saxeliT, romlis {...} nawilSi Tavsdeba atributTa aRwera:

```
// Pr56.cpp    struct - transfer
#include <iostream.h>
#include <conio.h>
struct Person {
              char Name[20];
              char Status[15];
              int Age;
              int Deprtm_N;
              float Money;
              char E_mail[30]; };

Person& Person_info(Person& P)   //  !!!
{
 cout<<"gvari   : " <<P.Name<<endl<<
         "statusi : " <<P.Status<<endl<<
         "asaki   : " <<P.Age<<endl<<
         "kat-#   : " <<P.Deprtm_N<<endl<<
        "xelpasi : " <<P.Money<<endl<<
        "e-mail  : " <<P.E_mail<<endl<<endl;
 return P;
}

int main()   // aqedan miewodeba
{              // konkretuli mniSvnelobebi
 Person P1={“Dolidze”,”Prof”,45,94,350.55,”tdol@gtu.edu.ge”};
 Person P2={“Gulua”,”Assis”,25,94,150.65,”dgulu@posta.ge”};
 Person P3={“Topuria”,”Doz”,30,94,207.85,”ntopur@yahoo.com”};
  clrscr();
 cout<<“Results:”<<endl<<“======================”<<endl;
  Person_info(P1);
  Person_info(P2);
  Person_info(P3);
 getch();
}
```

Sedegebi mocemulia me-6 naxazze.



Person& tipiT ganisazRvreba Person_info() funqcia, romlis **P**-argumentic aseTive tipisaa Person& P. am funqciis daniSnulebaa struqturis striqonebis (obieqtebis) beWdva. mTavar programaSi Person-tipis obieqtebia P1, P2, P3, romlebic konkretul mniSvnelobebs gadascemen Person_info(Person& P) funqcias, sadac P struqturis maCvenebelia. me-6 naxazze gamotanilia sami obieqtis Sedegebi.

6. klasebi da obieqtebi

C++ enas aqvs struqturebi (struct) da klasebi (class). struqtura igive klasia, oRond "yvelasTvis". mis atributebze mimarTva SeuZlia struqturis gareT mdebare yvela funqcias, vinaidan gamoucxadeblad mis atributebs aqvs public ofcia.

klasi struqturaa, romelsac qmnis momxmarebeli da mis atributebze mimarTva yvelas ar SeuZlia, vinaidan gamoucxadeblad mis atributebs aqvs private ofcia, e.i. isini `damalulia~. klasis komponentebi (atributebi da funqciebi) SeiZleba cxadi saxiT aRiweros: public, private da protected specifikatorebiT. bolo niSnavs SezRudul mimarTvas `mxolod megobrebisTvis, memkvidreobiTi kavSiris mqoneebsTvis~.

klasis atributebi (data_members) gansazRvravs misi obieqtebis mdgomareobas, xolo wevri-funqciebi (member_functions) eTanadeba klasis meTodebs da gansazRvravs mis qcevas. C++ enis funqciebi SeiZleba davyoT sam jgufad:

1. sabazo klasis (superklasis) wevri-funqciebi da am klasis megobari-funqciebi (friend_functions);
2. warmoebuli klasis (subklasis) wevri-funqciebi da misi megobari-funqciebi. maT SeuZlia damatebiT gamoiyenos superklasis protected atributiT gansazRvruli komponentebi;
3. yvela danarCeni funqcia, romelTac ufleba aqvs gamoiyenos mxolod public atributiT gansazRvruli komponentebi.

funqciebis gansazRvra xdeba " :: " - mikuTvnebis operatoriT. oTxi wertilis marcxniv Tavsdeba klasis saxeli, marjvniv - wevri-funqcia. kavSiris calsaxoba aq aucilebelia, vinaidan sxvadsxxva klass SeiZleba hqondes erTnairi saxelis wevri-funqciebi. axla ganvixiloT C++ programis teqsti klasiTa da obieqtebiT.

```
// Pr57.cpp   class and objects --------
#include <conio.h>
class University {   // klasis saxeli
  private:    // klasis lokaluri atributebi
        char Name[40];
        char Yubilee[];
```

```
    public:    // klasis globaluri funqciebis gamocxadeba
          void Set_Uni(char*);
          void Pc_Uni(void);
          char* return_Uni(void); };

// ------   klasis funqciebia aRwera -------
void University :: Set_Uni(char *s)
                    {
                   strcpy(Name, s);
                    }
void University :: Pc_Uni(void)
                    {
                  cout<<Name<<endl;
                       }
char* University :: return_Uni(void){ Name;}

//---- mTavari funqcia ---------
void main(void)
{
  University Uni_name;   //  Uni_name obieqtis gamocxadeba
 Uni_name.Set_Uni("Georgian Technical University");
 Uni_name.Pc_Uni();
 clrscr();
cout<<Uni_name.return_Uni()<<endl;
 cout<<«         80 Year !»;
}
```

Sedegebi mocemulia me-7 naxazze.

7. klasis megobrebi (friend)

C++ enaSi klasis megobari SeiZleba iyos funqcia (friend-function) an sxva klasi (friend-class). pirvel SemTxvevaSi es funqcia araa klasis wevri-funqcia, magram mas aqvs ufleba gamoiyenos am klasis damaluli (private) da daculi (protected) atributebi. meore SemTxvevaSi megobari klasis yvela funqcias aqvs ufleba gamoiyenos ZiriTadi klasis yvela atributi.

risTvisaa saWiro aseTi konstruqciis gamoyeneba ?

C++ enaSi erTi da igive funqcia ar SeiZleba iyos ori sxvadasxva klasis wevri-funqcia. magram xSirad saWiroa am erTi funqciidan mimarTvis ganxorcieleba sxvadasxva klasis lokalur monacemebze. aseT dros gamoiyeneba specifikatori friend, romelic qmnis megobar-funqcias am klasisaTvis.

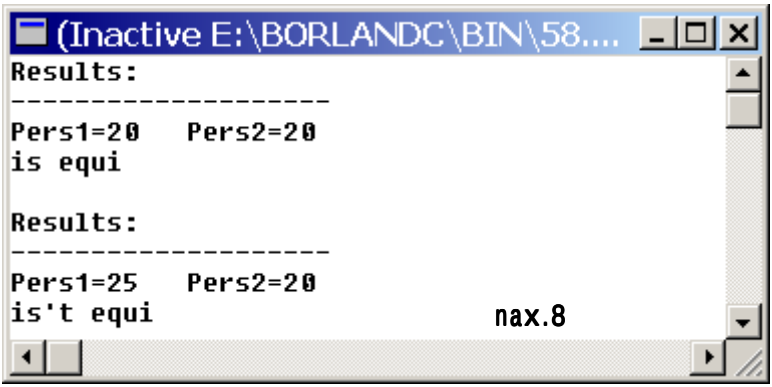
friend funqcias aqvs Semdegi Tvisebebi:

- araa klasis wevri-funqcia;
- miekuTvneba zogadad globalur funqciebs;
- SeuZlia gamoiyenos klasis wevri-monacemebi private, public da protected atributebiT;
- aratranzitiulia, anu Tu A megobaria B-si da B megobaria C-si, es ar niSnavs, rom A megobaria C-si.

ganvixiloT sailustracio programa ori klasiT Student da Magistr. megobari funqcia aRirewereba friend F_F()-iT.

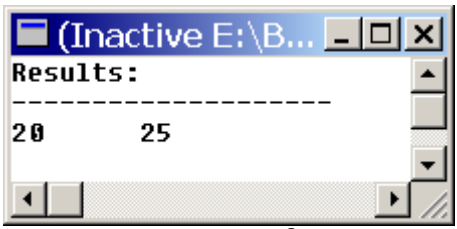
```
// Pr58.cpp   friend function ----------
#include <iostream.h>
#include <conio.h>
class Student;    // pirveli klasis gamocxadeba
class Magistr{    // meore klasis gamocxadeba da aRwea
  private:
     int Age;
     friend void F_F(Magistr&, Student&);
  public:
     Magistr(int P) : Age(P){}; };
```

```
class Student{       // pirveli klasis aRwera
   private:
         int Age;
         friend void F_F(Magistr&, Student&);
   public:
     Student(int P) : Age(P){}; };
  // ----- megobari funqciis aRwera ——
void F_F(Magistr& M1, Student& M2)
 {       // --- monacemTa kontroli --------
  cout<<"Pers1="<<M1.Age<<"   Pers2="<<M2.Age<<endl;
  if(M1.Age == M2.Age)
    cout<<"is equi \n";
    else
    cout<<"is't equi \n";
 }
// —— mTavari funqcia ————————
void main(void)
  {clrscr();
   Magistr Person1=20, Person3=25;
   Student Person2=20;
    F_F(Person1, Person2);
    Person1=Person3;
    F_F(Person1, Person2);
  }   Sedegebi mocemulia me-8 naxazze.
```



momdevno programa ixilavs megobari-klasis gamoyenebis SemTxvevas igive programis cvlilebis bazaze.

```
// Pr59.cpp   friend class ----------
#include <iostream.h>
#include <conio.h>
class Student;
class Magistr {
     private:
             int Age;
     public:
             Magistr(int P) : Age(P){};
            void Result(Student* pStudent);
      };
class Student {
    private:
             int Age;
   public:
            Student(int P) : Age(P){};
            friend class Magistr;                    // !!!
   };
// megobari funqciis aRwera ——
void Magistr :: Result(Student* pStudent)
 {
  cout<<“Results:\n————————————\n”;
 cout<<pStudent->Age<<‘\t’<<this->Age<<endl;
 }

void main(void)
  {
   clrscr();
   Student Person1(20);
   Magistr Person2(25);
    Person2.Result(&Person1);
  }
```



nax.9

Sedegi mocemulia me-9 naxazze.

8. konstruqtorebi da destruqtorebi

konstruqtori aris funqcia, romelic gamoiyeneba klasis obieqtis inicializaciisaTvis misi gamocxadebis dros. igi mianiWebs Tavis wevr-monacemebs (atributebs) sawyis mniSvnelobebs (cxadad an gamoucxadeblad).

konstruqtor-funqciaa aqvs igive saxeli, rac klass. amiT igi gansxvavdeba klasis sxva wevri-funqciebisa da misi megobrebisgan. magaliTad:

```
class Lector {
      char Name[20];
 public:
      Lector(char* s) {strcpy(Name, s); } // es konstruqtoria
  . . .
```

arsebobs wesebi:

- konstruqtors SeiZleba hqondes an ar hqondes argumentebi;
- igi arasdros ar abrunebs ukan mniSvnelobebs;
- klass SeiZleba hqondes ramdenime konstruqtori, anu misi obieqtebis sainicializod arsebobs ramdenime varianti.

magaliTad:

```
class New_Class {
      int i, j, k;
  public:
      New_Class(int I=2, int J=15, int K=47)
          { i=I; j=J; k=K;};
an
      New_Class(int I, int J, int K) : i(I),  j(J),  k(K) {};
};
// obieqtebis gamocxadeba
New_Class object1;                          // i=2,   j=15,  k=47
New_Class objec2(13);                       // i=13, j=15,   k=47
New_Class object3(1,250);                   // i=1,  j=250,  k=47
New_Class object4(int i, int=33, int k);    // Secdomaa
New_Class object4(11, 33, 99);              // i=11, j=33,  k=99
```

yovel konstruqtors aqvs Sesabamisi destruqtori, romlis funqciaa obieqtis ganadgureba, anu mexsierebidan misi waSla. igi aTavisuflebs obieqtis mier dakavebul dinamikur mexsierebas. destruqtors aqvs igive saxeli, rac mis Sesabamis konstruqtors, oRondac saxelis win prefiqsi (~) tilda gamoiyeneba. mas argumentebi ar aqvs. Tu destruqtori cxadad araa miTiTebuli, maSin kompilatori TviTon qmnis mas gamoucxadeblad. yovel klass SeiZleba hqondes mxolod erTi destruqtori.

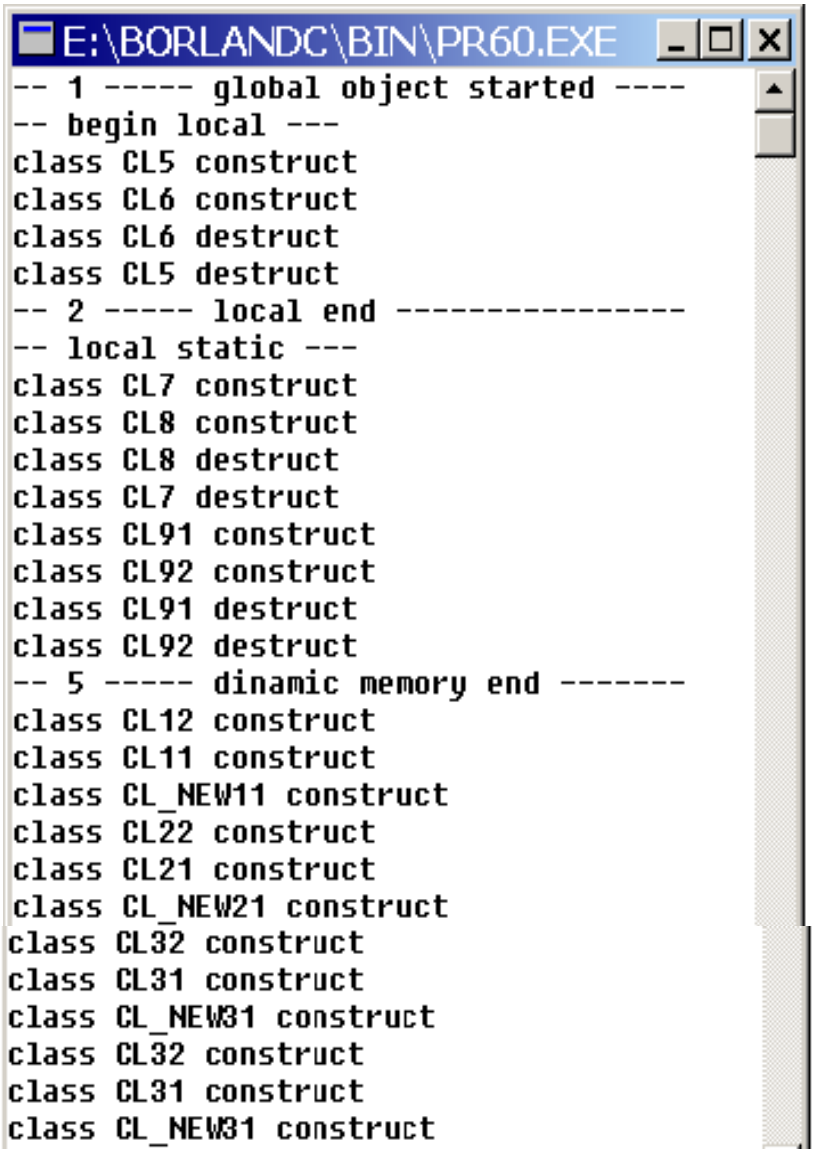
gamoyeneba gansazRvravs obieqtebis aqtiuri moqmedebis dros, anu periods misi inicializebidan ganadgurebamde. obieqtebi SeiZleba iyos globaluri, lokaluri, statikuri, dinamikurad gamoyofil mexsierebaSi myofi (new, delete operatorebiT), sxva klasis wevrTa obieqtebi da bolos, masivis elementi-obieqtebi.

ganvixiloT konstruqtor-destruqtoris TemasTan dakavSirebuli programa.

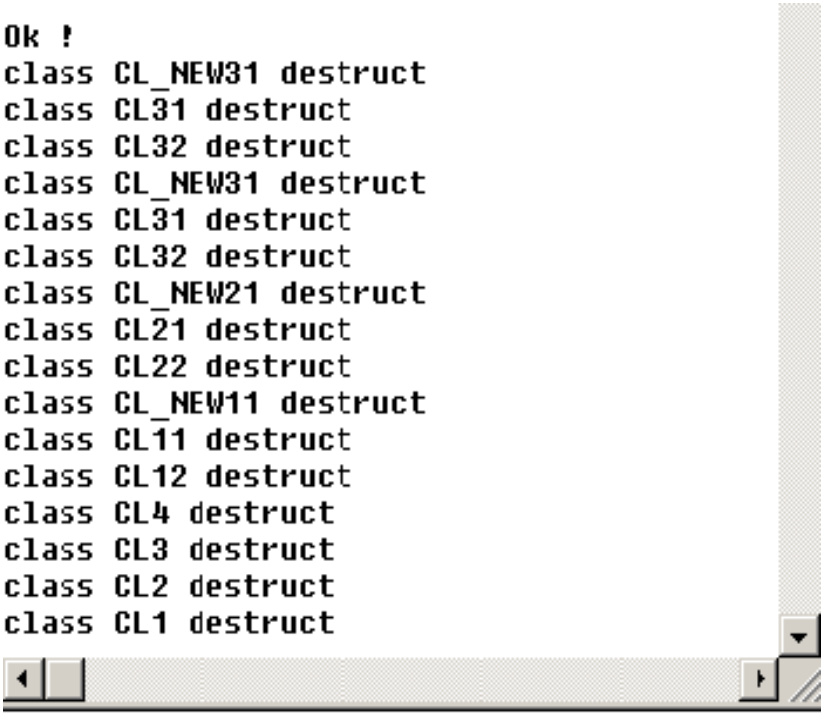
```
// Pr60.cpp   Constr + Destr ——-
#include <iostream.h>
#include <conio.h>
class CL {
   int i;
public:
   CL(int I) : i(I){cout<<“class CL”<<i<<“ construct\n”; }
   ~CL(){cout<<“class CL”<<i<<“ destruct\n”; }
};

CL g1(1), g2(2); // globaluri obieqtebi
static CL s1(3), s2(4);  // statikuri globaluri obieqtebi

void func1(void){
   cout<<“— begin local —\n”;
   CL L1(5), L2(6); }   // lokaluri obieqtebi
void func2(void){
   cout<<“— local static —\n”;
   CL s3(7), s4(8); }    // statikuri lokaluri obieqtebi
```

```
class CL_NEW {       // axali klasi
     int j;
     CL c1, c2;   // sxva klasis wevri obieqtebi
 public:
    CL_NEW(int J=31, int I=32, int K=33) : c1(I),c2(J), j(J)
          {cout<<“class CL_NEW”<<j<<“ construct\n”;}
   ~CL_NEW(){cout<<“class CL_NEW”<<j<<“ destruct\n”;}
 };

 void main(void)
  {
   clrscr();
   cout<<“— 1 —— global object started ——\n”;
   func1();   // funqciis gamoZaxeba
   cout<<“— 2 —— local end ————————\n”;
   getch();
   func2();
  //---- dinamikuri mexsierebis obieqtebi -----
   CL *d1=new CL(91);
   CL *d2=new CL(92);
   delete d1;
   delete d2;
   cout<<“— 5 —— dinamic memory end ———\n”;

  // ---- sxva klasis wevri obieqtebi ---
  CL_NEW c1(11,12,13);
  CL_NEW c2(21,22,23);
  getch();

  //---- masivis elementi obieqtebi -----
  CL_NEW mas[2];
  getch(); clrscr();
  cout<<“Ok ! \n”;
}
```

Sedegi mocemulia me-10 naxazze.


E:\BORLANDC\BIN\PR60.EXE
-- 1 ----- global object started ----
-- begin local ---
class CL5 construct
class CL6 construct
class CL6 destruct
class CL5 destruct
-- 2 ----- local end ----------------
-- local static ---
class CL7 construct
class CL8 construct
class CL8 destruct
class CL7 destruct
class CL91 construct
class CL92 construct
class CL91 destruct
class CL92 destruct
-- 5 ----- dinamic memory end -------
class CL12 construct
class CL11 construct
class CL_NEW11 construct
class CL22 construct
class CL21 construct
class CL_NEW21 construct
class CL32 construct
class CL31 construct
class CL_NEW31 construct
class CL32 construct
class CL31 construct
class CL_NEW31 construct

nax.10



nax.10. gagrZeleba

9. sabazo da warmoebuli klasebi

obieqt-orientirebuli daprogramebis gamoyenebis efeqturoba mdgomareobs imaSi, rom arsebuli programuli produqti, saWiroebis SemTxvevaSi SeiZleba gafarTovdes (axali klasebiT, funqciebiT) misi xelaxali gadaprogramebis gareSe.

klasi SeiZleba iyos ori tipis: sabazo da warmoebuli. sabazo (anu superklasi, `mSobeli~) klasis safuZvelze iqmneba warmoebuli (subklasi, `Svili~) klasebi. grafikulad es procesi gamoisaxeba isriT, romelic mimarTulia warmoebuli klasidan sabazosaken:

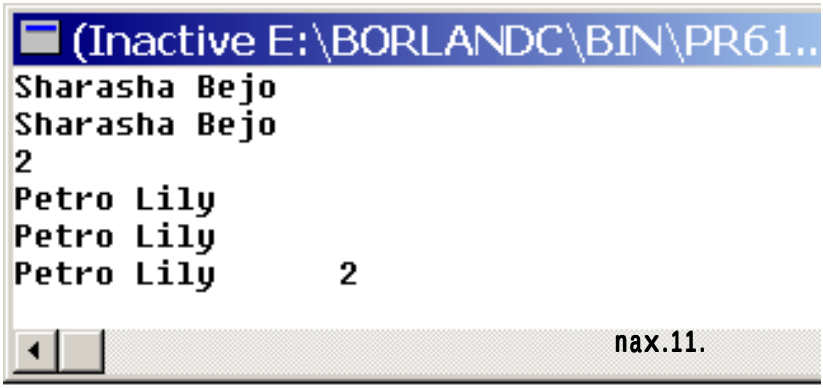
sabazo_klasi ← warmoebuli_klasi

warmoebuli anu `Svili~-klasi memkvidreobiT Rebulobs sabazo anu `mSobeli~-klasisagan mis yvela atributze da funqciaze mimarTvis uflebas (piriqiT ki ara !). amasTanave warmoebul klass SeiZleba hqondes sxva damatebiTi atributebi da funqciebi (rac ar gaaCnia mSobels). ganvixiloT magaliTi.

```
// Pr61.cpp   Based and Derived class ——-
#include <iostream.h>
#include <conio.h>

class Person {   // based class
       char *Name;
 public:
     void inform(char *n){ Name=n; }
     void disp() {cout<<endl<<Name;}
      char* ret_name(){return Name; }
  };

  class Doctor : public Person { // derived class
                  int status;
        public:
            void inform(char *n, int s)
                 {
                  Person :: inform(n);
                  status=s;
                 }
            void disp()
                 {
                  Person :: disp;
              cout<<‘\t’<<status<<endl;
              }
               char* ret_status() {return status;}
            };
```

```
void main(void)
 {
  Person p. *pp;
  Doctor d, *pd;
  p.inform("Sharasha Bejo");
  d.inform("Petro Lily", 2);
  pp=&p;
    cout<<pp->ret_name();   // Sharasha Bejo
  pp->disp();  // Sharasha Bejo
  pp=pd=&d;
  cout<<endl<<pd->ret_status()<<endl;    // 2
  cout<<pd->ret_name();   // Petro Lily
  pp->disp();   // Petro Lily
  pd->disp();   // Petro Lily   2
 }
```

Sedegi mocemulia me-11 naxazze.

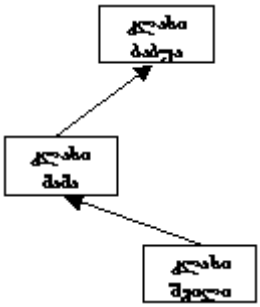


nax.11.

naxazze mocemulia programis operatorebis mimdevrobiT Sesrulebuli Sedegebis striqonebi. mTavar programaSi Semotanilia sabazo da warmoebul klasTa obieqtebi. aqedan maTi daxmarebiT konkretuli mniSvnelobebi gadaecama klasTa funqciebs Sesasruleblad. Person mSobeli klasi mxolod gvars beWdavs, Doctor Svili klasi - ki statuss, gvars da gvars da statuss erTad.

10. klasTa memkvidreobiTobis ierarqia

obieqt-orientirebuli daprogramebis meTodi moicavs sabazo da warmoebul klasebs Soris genealogiuri kavSirebis realizebis saSualebas. wina paragrafSi Cven ganvixileT kerZo SemTxveva erTi `mSobel-Svili~ klasiT. SeiZleba arsebobdes SenTxveva: `babua, mama, Svili~. aseT dros `mama~ aris warmoebuli klasi `babua~-sTvis, magram sabazoa `Svili~-sTvis. me-12 naxazze naCvenebia es sqema.



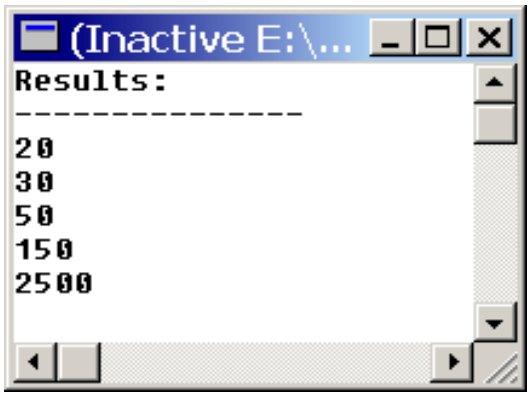
nax.12.

ganvixiloT programuli magaliTi.

```
// Pr62.cpp    class hierarchye ——-
#include <iostream.h>
#include <conio.h>
class Babu  {    // based class
  int b1;
 public:
  void sum(int a){ b1=a; }
  void disp() {cout<<b1<<endl;}
 };
    class Mama : public Babu { // derived and based class
                int b2;
           public:
                void sum(int a){ Babu :: sum(5*a); b2=a;}
                void disp(){ cout<<b2<<endl;}
            };
```

```
class Shvili : public Mama { // derived class
                int b3;
            public:
              void sum(int a){ Mama :: sum(10*a); b3=a;}
              void disp(){ cout<<b3<<endl;}
            };

void main(void)
 {
  Babu b, *sb;
  Mama m;
 Shvili s;
  b.sum(20);
  m.sum(30);
  s.sum(50);

  cout<<"Results:\n ————————————\n";
  b.disp(); // 20
  m.disp(); // 30
  s.disp(); // 50

  sb=&m;
  sb->disp();  // 150

  sb=&s;
  sb->disp();  // 2500

 }
```

Sedegebi mocemulia me-13 naxazze.



nax.13.

11. polimorfizmi da virtualuri funqciebi

polimorfizmi (polymorphism) obieqt-orientirebuli daprogramebis erT-erTi ZiriTadi da aucilebeli meqanizmia. igi mravalformianobas niSnavs. misi arsi mdgomareobs SemdegSi: esaa klasis obieqtis Tviseba, romelic mis reaqcias gamoxatavs mosuli Setyobinebis (moTxovnis) gadasamuSaveblad.

gaanalizebuli tipebis safuZvelze obieqtma unda airCios klasis Sesabamisi wevri-funqcia (meTodi). aseTi amocana aratrivialuria, radgan xSirad programis kompilaciis etapzec ki araa cnobili obieqtis tipi, romelsac exeba moTxovna.

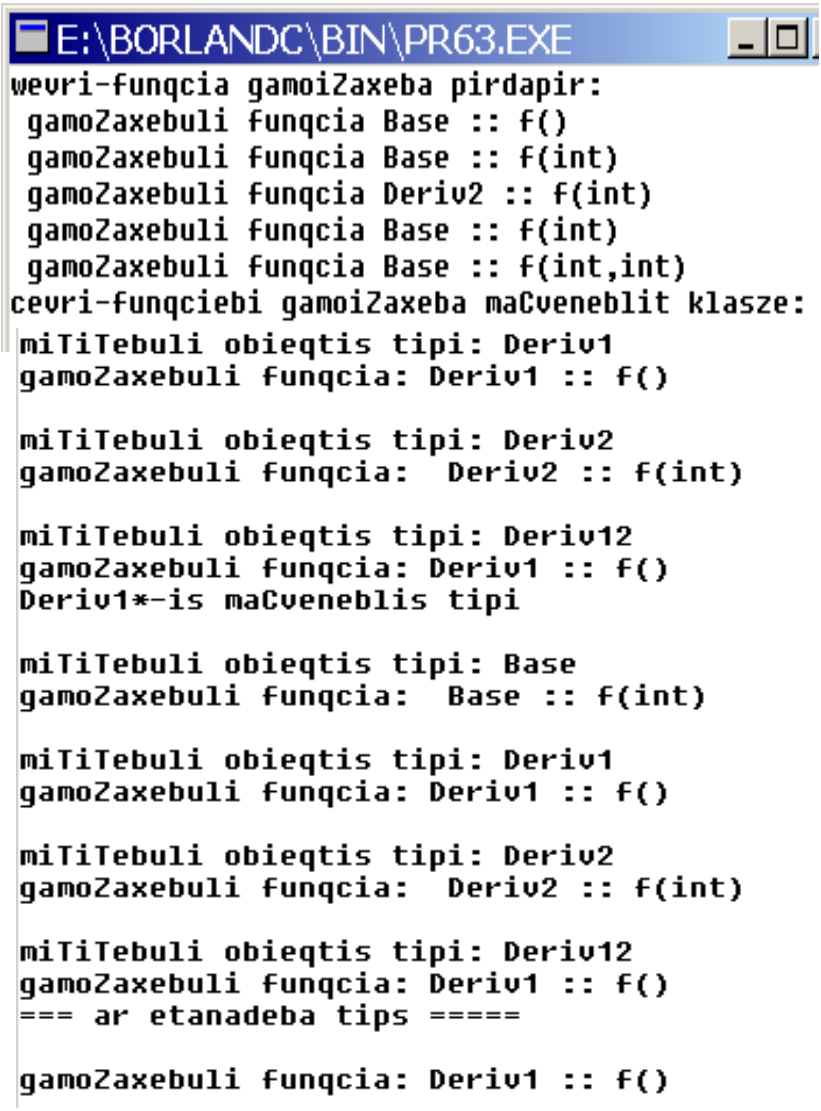
am sakiTxTan uSualo kavSirSia klasis virtualuri funqciis cneba. esaa klasis Cveulebrivi (araglobaluri da arastatikuri) wevri-funqcia virtual-prefiqsiT. virtualuri funqciis daniSnulebaa sabazo da warmoebul klasebSi ganasaxieros erTi saxelis mqone sxvadasxva tipis funqciebi. magaliTad, Tu sabazo klasSi aris funqcia , maSin misgan warmoebul klasSi SesaZlebelia am funqciis gamoZaxeba striqoniT, romelsac eqneba gansxvavebuli mniSvneloba. amis Semdeg mimarTva sabazo klasis virtualur funqciaze xdeba sabazo klasis obieqtis maCvenebliT. xolo warmoebul klasis funqciaze - misi obieqtis maCvenebliT.

ganvixiloT programis teqsti.

```
// Pr63.cpp  virtual function ——-
#include <iostream.h>
#include <conio.h>
const char *const f_msg=" \ngamoZaxebuli funqcia";
class Base {
  int d;
public:
  void f(){ cout<<f_msg<<" Base :: f()\n"; }
  virtual void f(int i) {cout<<f_msg<<" Base :: f(int)\n";}
  void f(int i, int j) {cout<<f_msg<<" Base :: f(int,int)\n";}
};
```

```
class Deriv1 : public Base
    {   char d1;
    public:
       void f(){ cout<<f_msg<<" deriv1 :: f()\n"; }
      virtual void f(int i) {cout<<f_msg<<"Deriv1 :: f()\n";}
    };

class Deriv2 : public Base
    {
    public:
       void f(){ cout<<f_msg<<" deriv2 :: f()\n"; }
      virtual void f(int i) {cout<<f_msg<<" Deriv2 :: f(int)\n";}
    };

class Deriv12 : public Deriv1 {int d;};
//———————————————————————————————-

typedef Base *pBase;
typedef Deriv1* pDeriv1;
int main()
 {
  Base b_obj;
  Deriv1 d1_obj;
  Deriv2 d2_obj;
  Deriv12 d12_obj;
  cout<<"wevri-funqcia gamoiZaxeba pirdapir: \n";
  b_obj.f();
  b_obj.f(1);
  d2_obj.f(1);
  d2_obj.Base::f(1);
  d2_obj.Base::f(1,1);
  pBase b_ptr[4];  // masivi Base-s sami maCveneblisTis
  b_ptr[0]=&b_obj;
  b_ptr[1]=&d1_obj;  // Deriv1-is aracxadad gardaqmna Base-Si
  b_ptr[2]=&d2_obj;  // Deriv2-is aracxadad gardaqmna Base-Si
```

```
 // Deriv12-is aracxadad gardaqmna Base-Si
  b_ptr[3]=&d12_obj;
 // --------
char *types[4]={“Base”,”Deriv1",”Deriv2",”Deriv12"};
 char *msg=”\nmiTiTebuli obieqtis tipi: “;
 cout<<“cevri-funqciebi gamoiZaxeba maCveneblit klasze:\n”;
 getch();
 cout<<“aravirtualuri funqcia f() ———\n”;
int c;
 cout<<“Base-s maCveneblis tipi \n”;
 //————————-
 for(c=0; c<4; c++)
  {  cout<<msg<<types[c];
     b_ptr[c]->f();   }

 cout<<“Deriv1*-is maCveneblis tipi\n”;
 for(c=0; c<4; c++)
  {  cout<<msg<<types[c];
    (pDeriv1(b_ptr[c]))->f();  }

 cout<<“virtualuri funqcia f(int)———\n”;
 cout<<“maCveneblis tipi Base* \n”;
 for(c=0; c<4; c++)
   { cout<<msg<<types[c];
    b_ptr[c]->f(1);   }

 cout<<“Deriv1*-is maCveneblis tipi\n”;
 for(c=0; c<4; c++)
  {  cout<<msg<<types[c];
   (pDeriv1(b_ptr[c]))->f(1);  }

// virt-funqciis gamoZaxeba, romelic ar eTanadeba
 (pDeriv1(b_ptr[2]))-> Deriv1:: f(1);    // obieqtis tips
 return 0;
 }          Sedegebi mocemulia  me-14 naxazze.
```


E:\BORLANDC\BIN\PR63.EXE
wevri-funqcia gamoiZaxeba pirdapir:
gamoZaxebuli funqcia Base :: f()
gamoZaxebuli funqcia Base :: f(int)
gamoZaxebuli funqcia Deriv2 :: f(int)
gamoZaxebuli funqcia Base :: f(int)
gamoZaxebuli funqcia Base :: f(int,int)
cevri-funqciebi gamoiZaxeba maCveneblit klasze:
miTiTebuli obieqtis tipi: Deriv1
gamoZaxebuli funqcia: Deriv1 :: f()
miTiTebuli obieqtis tipi: Deriv2
gamoZaxebuli funqcia: Deriv2 :: f(int)
miTiTebuli obieqtis tipi: Deriv12
gamoZaxebuli funqcia: Deriv1 :: f()
Deriv1*-is maCveneblis tipi
miTiTebuli obieqtis tipi: Base
gamoZaxebuli funqcia: Base :: f(int)
miTiTebuli obieqtis tipi: Deriv1
gamoZaxebuli funqcia: Deriv1 :: f()
miTiTebuli obieqtis tipi: Deriv2
gamoZaxebuli funqcia: Deriv2 :: f(int)
miTiTebuli obieqtis tipi: Deriv12
gamoZaxebuli funqcia: Deriv1 :: f()
=== ar etanadeba tips =====
gamoZaxebuli funqcia: Deriv1 :: f()

nax.14.

12. abstraqtuli klasebi

abstraqtulia klasi, romelic Seicavs abstraqtul virtualur funqcias. aseTi klasi arsebobs mxolod ideis doneze, abstraqtulad. mas ar SeuZlia obieqtis Seqmna. abstraqtulia virtualuri funqcia, romelic 0-is tolia. magaliTad, klasi grafikuli figura:

```
//Pr64.cpp  Abstact class ----
class Graph_Figur // virtualuri klasi
 {
. . .
public:
   virtual void draw()=0;  // daxazva
   virtual void move()=0;  // gadatana
  virtual void rotate()=0;  // mobruneba
  virtual void resize()=0;  // zomis Secvla
    virtual void copy()=0;  // dublireba
};
```

abstraqtulia klasebi gamoiyeneba rogorc sabazo klasebi sxva warmoebuli klasebis misaRebad. aseTi warmoebuli klasebi iqneba konkretuli, obieqtebis Seqmnis unariT da isini gamoiyenebs abstraqtul virtualur funqciebs. magaliTad:

```
class Circle : public Graph_Figur  // warmoebuli klasi
  {
  int x, y, radius;
public:
   void draw(void);
   void move(void);
   void rotate(void);
   void resize(void);
   void copy(void);
};
```

aseve SeiZleba damuSavdes sxva konkretuli obieqtebi: elifsi, marTkuTxedi, kubi da sxv.

13. mravaljeradi memkvidreobiToba da virtualuri sabazo klasebi

Tu warmoebuli klasi agebulia ori an meti sabazo klasis safuZvelze, maSin gvaqvs mravaljeradi memkvidreobiTi kavSirebi. programuli realizaciis fragmenti me-15 naxazze naCvenebia ori sabazo klasisi magaliTze.

```
//Pr65.cpp multiple inheritances -----
class Base_Class1 {. . .}
class Base_Class2 {. . .}
. . .
class New_Class :
    public Base_Class1{};
    public Base_Class2{};
```

mravaljeradi memkvidreobiTi kavSirebis mqone warmoebuli klasi, garda sakuTari atributebisa da funqciebisa gamoiyenbs misi yvela sabazo klasis Sesabamis komponentebs.

warmoebul klasSi SesaZlebelia erTi da igive sabazo klasis ramdenjerme dafiqsireba. magaliTad:

```
 //Pr66.cpp mult- inher2 -----
class Base_ClassT {. . .}
. . .
class Base_Class1 : public Base_ClassT{. . .}
class Base_Class2 : public Base_ClassT{. . .}
. . .
class New_Class :
    public Base_Class1{};
    public Base_Class2{};
```

erTi da igive sabazo klasi SeiZleba gamocxaddes rogorc erTi virtualuri sabazo klasi;

```
   //Pr67.cpp mult- inher3 -----
class Base_ClassT {. . .}
. . .
class Base_Class1 : virtual public Base_ClassT{. . .}
class Base_Class2 : virtual public Base_ClassT{. . .}
```

```
. . .
class New_Class :
    public Base_Class1{};
    public Base_Class2{};
```

virtualuri sabazo klasis gamoyeneba saSualebas iZleva misTvis agebul iqnes am klasis mxolod erTi obieqti. winaaRmdeg SemTxvevaSi, Tu erTi saxelis ori an meti aravirtualuri sabazo klasi gvaqvs, maSin misTvis agebul unda iqnes erTze meti obieqti am erTi klasisaTvis.

14. failebTan muSaoba

C++ enaSi failebTan samuSaod gamoiyenba <fstream.h> saTavo faili, romelSic inaxeba sami ZiriTadi klasi: ifstream (obieqtis Sesaqmnelad `mxolod wasakiTx~-faili sTvis), ofstream (obieqtis Sesaqmnelad `Casawer~-faili sTvis), fstream (obieqtis Sesaqmnelad `kiTxva-Caweris~-faili sTvis).

- failebTan muSobisas dacul unda iqnes maTi sruli saxelebi da wvdomis (direqtoriebis) gza.
- failebis daxurva warmoebs close operatoriT, romelic filebuf klasis funqciaa.

ganvixiloT sailustracio programis fragmentebi:

```
//Pr68.cpp files-0 -----
// . . .
ifstream rd("c:\bc\Students.dat");    // rd - obieqtia
//. . .
ofstream wr("d:\UNI\Groups\108935.dat"); // wr - obieqtia
```

```
// Pr69.cpp   files 1 ———-
#include <iostream.h>
#include <fstream.h>
#include <stdlib.h>
#include <conio.h>
#define S1 sizeof(languages)/14
#define S2 4
```

```
void error(char* str1, char* str2="")
    {cerr<<str1<<'\t'<<str2<<endl;
     exit(1); }
char languages[][14]={"Borland_C++",
                      "Delphi_Pascal",
                     "Eiffel","Smalltalk"};
char Micro_s[14]="Visual_C++";
void main(int argc, char* argv[])
{
 char c;
 clrscr();
 if(argc != 3) // sami argumentis moTxovna brZanebis striqonSi
   error("number of arguments is uncorrect !");

 ifstream rd(argv[1]);
 if(!rd)
   error("file not opened !", argv[1]);

 ofstream wr(argv[2]);
 if(!wr)
   error("file not opened !", argv[2]);

 while(rd.get(c)) wr.put(c);   // teqstis gadaweris cikli
   if(!rd.eof() || wr.bad())
      error("error for read-write-1 ");

  cout<<"Ok !"<<endl;
}
```

winaswar direqtoriaSi unda arsebobdes ori faili (wasakiTxad da Casawerad). 69-programis pirveli kompilaciis Semdeg Seiqmneba misi muSa faili (Pr69.exe) da gamova informacia

saWiroa programis Semdgomi amuSavebisas brZanebis striqonidan, magaliTad Semdegi argumentebis micema:

e:\bc\Pr69.exe file1.txt file2.txt

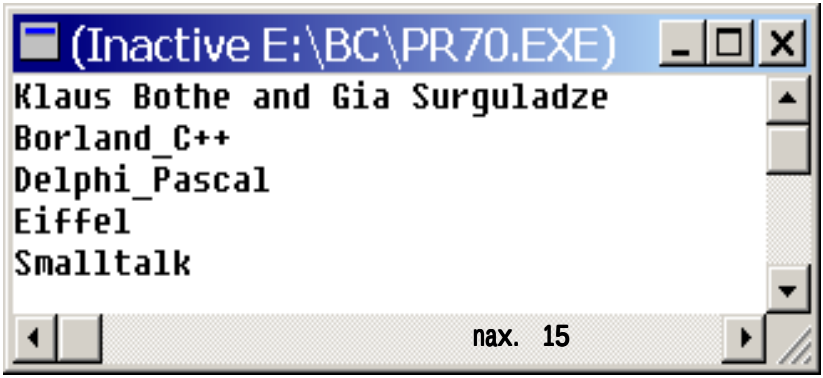
programa Seasrulebs Tavis funqcias, anu Cvens SemTxvevaSi 1-eli failidan teqsts gadawers me-2 failSi.

davamatoT am programas "-- 2 --" da "-- 3 -- " nawilebi da avamuSavoT. teqsti mocemulia Pr70.cpp-Si.

```
// Pr70.cpp   files 2 ———-
#include <iostream.h>
#include <fstream.h>
#include <stdlib.h>
#include <conio.h>
#define S1 sizeof(languages)/14
#define S2 4
void error(char* str1, char* str2="")
   {cerr<<str1<<'\t'<<str2<<endl;
    exit(1); }
char languages[][14]={"Borland_C++",
                      "Delphi_Pascal",
                         "Eiffel","Smalltalk"};
char Micro_s[14]="Visual_C++";
void main(int argc, char* argv[])
{
 char c;
 clrscr();
 if(argc != 3)
   error("number of arguments is uncorrect !");
 ifstream rd(argv[1]);
 if(!rd)
   error("file not opened !", argv[1]);

 ofstream wr(argv[2]);
 if(!wr)
   error("file not opened !", argv[2]);
```

```
 while(rd.get(c)) wr.put(c);
   if(!rd.eof() || wr.bad())
      error("error for read-write-1 ");
  cout<<"Ok !"<<endl;
//———— 2 ————-
fstream in;
char line[80];
in.open("e:\\bc\\file1.txt",ios::in);
if(!in)
  { cerr<<"false ! file not found for read \n";
   abort();  }
clrscr();
while(in.getline(line, 80))
 cout<<line<<endl;
getch();

//———— 3 ————-
fstream out;
out.open("e:\\bc\\file2.txt", ios::out);
 if(!out)
   { error("false ! file not found for write \n   ");
    abort();  }
 for(int i=0; i< S1; i++)
   out.write(languages[i],14);    // progr. enebis Cawera failSi
 out.close();
 out.open("e:\\bc\\file2.txt", ios::in);
 if(!out)
   { error("false ! file not found for read \n");
    abort();  }
 for(i=0; i<S1; i++)
   {  out.read(line, 14);
   cout<<line<<endl;   }
 getch();
}
```

Sedegebi mocemulia me-15 naxazze.



file1.txt failSi Caweriliyo striqoni "Klaus Bothe and Gia Surguladze", file2.txt-Si gadmoiwera igi da Semdeg daemata programuli enebis dasaxelebebi languages[ ]-masividan.

davamatoT programas me-4 nawili, romelSic gamoyenebulia failSi Zebnis funqcia:

seekp(n, seek_dir), sadac

n - poziciebis raodenobaa gadasaadgileblad;

beg - failis dasawyisidan;

seek_dir - cur - kursoris poziciidan;

end - failis bolodan;

```
// Pr71.cpp   files 3 ——-
#include <iostream.h>
#include <fstream.h>
#include <stdlib.h>
#include <conio.h>
#define S1 sizeof(languages)/14
#define S2 4
void error(char* str1, char* str2="")
   {cerr<<str1<<'\t'<<str2<<endl;
    exit(1); }
char languages[][14]={"Borland_C++",
                      "Delphi_Pascal",
                     "Eiffel","Smalltalk"};
char Microsoft[14]="Visual_C++";
```

```
void main(int argc, char* argv[])
{char c;
 clrscr();
 cout<<"*** 1 ***"<<endl;
 if(argc != 3)
   error("number of arguments is uncorrect !");

 ifstream rd(argv[1]);
 if(!rd)
   error("file not opened !", argv[1]);

  ofstream wr(argv[2]);
  if(!wr)
    error("file not opened !", argv[2]);

  while(rd.get(c)) wr.put(c);
    if(!rd.eof() || wr.bad())
       error("error for read-write-1 ");

  cout<<"Ok !"<<endl;
 getch();
//———— 2 ————————-
fstream in;
char line[80];
cout<<"*** 2 ***"<<endl;
in.open("e:\\bc\\file1.txt",ios::in);
if(!in)
  {
   cerr<<"false ! file not found for read \n";
   abort();
   }

while(in.getline(line, 80))
 cout<<line<<endl;
getch();
```

```
//————————— 3 ————————-
fstream out;
cout<<"*** 3 ***"<<endl;
out.open("e:\\bc\\file2.txt", ios::out);
 if(!out)
   {
    error("false ! file not found for write \n   ");
    abort();
   }
 for(int i=0; i< S1; i++)
    out.write(languages[i], 14);
 out.close();
 out.open("e:\\bc\\file2.txt", ios::in);
 if(!out)
    {
     error("false ! file not found for read \n");
     abort();
    }
 for(i=0; i<S1; i++)
    {
    out.read(line, 14);
    cout<<line<<endl;
    }
  getch();

//————————— 4 ——————————
fstream ff;
ff.open("e:\\bc\\file2.txt", ios::out | ios::in);
cout<<"*** 4 ***"<<endl;
if(!ff)
  { error("errors !");
     abort();  }
 else
  {  cout<<"the end, Ok !"<<endl;
    getch();   }
```

```
ff.seekp(0, ios::beg);
ff.read(line, 14);
cout<<"*** 4-1 ***"<<endl;
 cout<<line<<endl;
  getch();

ff.seekp(0, ios::beg);
ff.write(Microsoft, 14);

ff.seekp(-14, ios::end);
ff.write(line, 14);

ff.seekp(0, ios::beg);
cout<<"*** 4-2 ***"<<endl;
for(i=0; i<S2; i++)
   {
    ff.read(line, 14);
   cout<<line<<endl;
   }
}
```

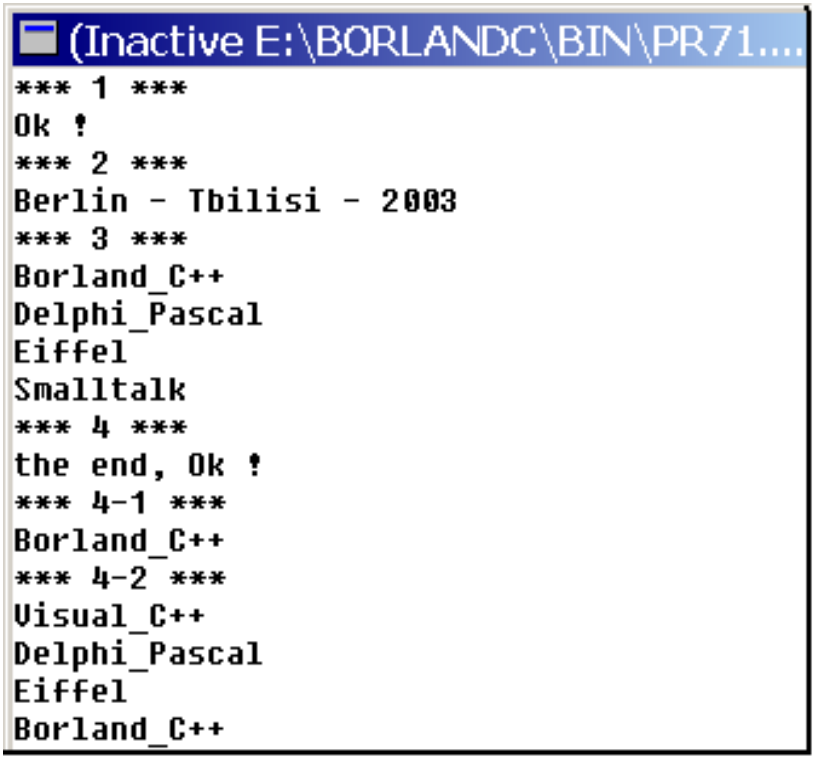
Sedegebi mocemulia me-16 naxazze.

programaSi Semotanili gvaqvs `sakontrolo wertilebi~, romlebic Sedegebis gamotanis striqonebs aidentificirebs. amiT ufro martivdeba programis Sesrulebisas gamosabeWdi striqonebis adgilmdebareobis calsaxa gansazRvra.

* * * * * * *

damTavrda C++ daprogramebis enis safuZvlebis sakiTxebis ganxilva. es masala damwyeb programistebisaTvis aucilebeli da sasargebloa, vinaidan maT sruli warmodgena SeeqmnaT obieqt-orientirebuli modelirebis ZiriTadi komponentebis daprogramebis problemebze.

mkiTxveli, am masalis daufleblis Semdeg, Tavisuflad SeZlebs vizualuri, obieqt-orientirebuli daprogramebis meTodebze da instrumentebze gadasvlas..



nax.16

15. kiTxvebi da savarjiSoebi

1. raSi mdgomareobs C++ daprogramebis enis ZiriTadi koncefcia ?
2. rogoria C++ programis struqtura ?
3. ra aris komentari da romeli konstruqciebi gamoiyeneba daprogramebis C++ enaSi ?
4. ra aris klasi da obieqti ?
5. ras warmoadgens <iostream.h> faili ?
6. monacemebis Setana- gamotanis romeli funqciebi gamoiyeneba C++ enaSi ?

7. ra gansxvavebaa printf(), scanf() da cout, cin konstruqciebs Soris ?
8. rogor gamoiyeneba ricxvTa sizustis manipulatori ?
9. ras warmoadgens subklasi conbuf da risTvis gamoiyeneba ?
10. ras niSnavs monacemTa gadacema funqciebs Soris fsevdonimebiT ?
11. rogor xdeba struqturebis gadacema funqciebs Soris maCvenebl ebiT ?
12. rogor xdeba klasebis da obieqtebis daprogrameba ?
13. ras warmoadgens inkafsulacia da daprogramebis romeli koponentebi gamoiyeneba misTvis ?
14. ras niSnavs klasis atributTa da funqciaTaTvis public, private da protected specifikatorebi ?
15. ras niSnavs klasis megobari funqciebi ?
16. risTvis da rogor gamoiyeneba konstruqtorebi da destruqtorebi ?
17. ras niSnavs lokaluri, globaluri, statikuri, dinamikur mexsierebaSi myofi da masivis obieqtebi ?
18. ra aris sabazo da warmoebuli klasi, rogor programirdeba isini ?
19. ras niSnavs klasTa memkvidreobiTobis ierarqia da rogoria misi daprogramebis xerxi ?
20. ras warmoadgens mravaljeradi memkvidrebiToba klasebs Soris da rogor programirdeba is ?
21. ras niSnavs polimorfizmi da rogor xdeba misi saSualebiT daprogrameba ?
22. ras warmoadgens virtualuri funqcia da risTvisaa igi saWiro ?
23. axseniT abstraqtuli klasebis arsi da maTi gamoyenebis koncefcia ?
24. ra aris virtualuri sabazo klasi da rogor xdeba misi daprogrameba ?
25. monacemTa failebTan muSaobis saSualebani (header failebi) C++ enaSi.
26. failebTan muSaobis ZiriTadi funqciebi C++ enaSi.