```
> restart;
  with(plots):
  with(StringTools):
  with(LinearAlgebra):
  with(DEtools):

  ##########################################################################################

  Region:=`RT`; url:="https://gogov.ru/covid-19/rt#data";

  #valp := [9.23983678911537, 4106.99249310287, 0.0561202293832208, 0.0955371316373221,
  0.116894940185765, 0.183326912973102, #0.140739820704094, 0.119445148372378, 0.123973323916049,
  0.117998388741040, 0.0146398378182489, 0.0882227828533377, #0.00009457354542557790];

  valp:=readdata(cat(Region,`3c.txt`));

  ##########################################################################################

  fdisplay:=proc(f,p)
   print(cat(f,`.jpg`)); #print(cat(f,`.eps`));
   plotsetup(jpeg,plotoutput=cat(f,`.jpg`),plotoptions=`noborder`); print(display(p));
   plotsetup(ps,plotoutput=cat(f,`.eps`),plotoptions=`noborder`); print(display(p));
   plotsetup(default,plotoptions=`noborder`): print(display(p));
  end:

  pr:=proc(x) print(x); x; end:

  grad:=(F,V)->map(q->diff(F,q),V):

  linsplit:=(F,V)->subs(map(q->q=0,V),[op(grad(F,V)),F]):

  corr:=proc(x,y) local i; seq(x[i]=y[i],i=1..nops(x)): end:

  ssum:=(F,V)->convert([seq(F,V)],`+`):

  pprod:=(F,V)->convert([seq(F,V)],`*`):

  Lag:=proc(t,tx,kx) local i,j;
   ssum(kx[i]*pprod(piecewise(j=i,1,(t-tx[j])/(tx[i]-tx[j])),j=1..nops(tx)),i=1..nops(tx)):
  end:
```

```
Lag(t,[ta,tb],[a,b]); Lag(t,[ta,tb,tc],[a,b,c]);

pi:=evalf(Pi);


gM:=evalf(solve((1-x)^2=x,x)[2]):
goldMin:=proc(f,T,epsilon) local a,b,c,d,fa,fb,fc,fd,k;
 a:=op(1,T); b:=op(2,T); fa:=f(a); fb:=f(b); k:=0;
 c:=a+(b-a)*gM; fc:=f(c); d:=b-(b-a)*gM; fd:=f(d);
 while abs(a-b)>epsilon do: k:=k+1;
  if fc>fd then a:=c; fa:=fc; c:=d; fc:=fd; d:=b-(b-a)*gM; fd:=f(d);
  else b:=d; fb:=fd; d:=c; fd:=fc;+ c:=a+(b-a)*gM; fc:=f(c);
  fi;
 od: #print(k);
 (a+b)/2;
end:

findMin1:=proc(F,V) local f,df,f0,f1,f2,V0,V1,V2,ff,t,dt,i,j;
 ff:=V->F(op(evalf(map(exp,V)))); V1:=evalf(map(ln,V)); f1:=F(op(V));
 f:=[seq(F(seq(evalf(exp(V1[j]+piecewise(j=i,0.0001,0))),j=1..nops(V))),i=1..nops(V))];
 df:=[seq((f[j]-f1)/0.1,j=1..nops(V))];
 V0:=V1-0.001*df; f0:=ff(V0);  V2:=V1+0.001*df; f2:=ff(V2);
 dt:=0.0001; while f0<f1 do: V2:=V1; f2:=f1; V1:=V0; f1:=f0; V0:=V0-dt*df; f0:=ff(V0); dt:=dt*
1.5; od;
 dt:=0.0001; while f2<f1 do: V0:=V1; f0:=f1; V1:=V2; f1:=f2; V2:=V2+dt*df; f2:=ff(V2); dt:=dt*
1.5; od;
 t:=goldMin(t->ff(t*V0+(1-t)*V2),0..1,0.001);
 map(exp,t*V0+(1-t)*V2);
end:

findMin:=proc(F,V) local V1,Z1,Z2;
 Z2:=pr(F(op(V))); V1:=findMin1(F,V); Z1:=pr(chi2(op(V1)));
 while abs(1-Z1/Z2)>0.0001 do; Z2:=Z1; V1:=findMin1(F,V1); Z1:=pr(chi2(op(V1))); end;
 V1;
end:
```

$$Region := RT$$

$$url := \text{"https://gogov.ru/covid-19/rt\#data"}$$

$$valp := [9.027883628, 11843.41478, 0.05118252549, 0.08768869384, 0.1219317768, 0.1656771227, 0.1287578269, 0.1090075711,$$

0.08241319677, 0.3761057629, 0.01199523996, 0.1086118749, 0.2274905321, 0.0002732039562]

$$\frac{a\,(t-tb)}{ta-tb}+\frac{b\,(t-ta)}{tb-ta}$$

$$\frac{a\,(t-tb)\,(t-tc)}{(ta-tb)\,(ta-tc)}+\frac{b\,(t-ta)\,(t-tc)}{(tb-ta)\,(tb-tc)}+\frac{c\,(t-ta)\,(t-tb)}{(tc-ta)\,(tc-tb)}$$

$$\pi := 3.141592654$$

(1

```
> dig:={"0","1","2","3","4","5","6","7","8","9","0"}: val:=proc() global data,i; local j,f; f:=0;
   while not(data[i] in dig) or f=1 and data[i] in {"+"} union dig do:
   if f=1 and not(data[i] in dig) then f:=0; else if data[i]="+" then f:=1; fi fi; i:=i+1: od:
   j:=i; while (data[i] in dig or data[i] in {"-","+"}) do i:=i+1: od: parse(data[j..i-1]);
  end:
  ` `; Region; status,data,headers:=HTTP:-Get(url): HTTP:-Code(status); i:=Search("<th>",data):

  iter:=proc() global i; local r;
   r:=val(); if data[i]<>"." then NULL else [r,val(),val(),val(),val(),val()],iter() fi;
  end:

  [iter()]: tA:=[seq(%[nops(%)+1-i],i=1..nops(%))];
  dd:=tA[1][1]+piecewise(tA[1][2]=2,-29,tA[1][2]=4,31,0)-1;
  T:=map(q->q[4],tA): #writedata(Region || `-i.txt`,%): #
  T3:=map(q->q[5],tA): #writedata(Region || `-m.txt`,%): #
  T1:=map(q->q[6],tA): #writedata(Region || `-r.txt`,%): #
  T2:=[seq(T[i]-(T1[i]+T3[i]),i=1..nops(T))]: #writedata(Region || `-h.txt`,%): #
  i:='i':
  Region; 'T'=T; 'T1'=T1; 'T2'=T2; 'T3'=T3;

  nops(T); [i+dd $ i=1..%];
```

``

RT

"OK"

tA := [[17, 3, 20, 1, 0, 0], [18, 3, 20, 1, 0, 0], [19, 3, 20, 1, 0, 0], [20, 3, 20, 1, 0, 0], [21, 3, 20, 6, 0, 0], [22, 3, 20, 6, 0, 0], [23, 3, 20, 6, 0, 0], [24, 3, 20, 7, 0, 0], [25, 3, 20, 7, 0, 0], [26, 3, 20, 10, 0, 0], [27, 3, 20, 11, 0, 1], [28, 3, 20, 14, 0, 1], [29, 3, 20, 14, 0, 1], [30, 3, 20, 14, 0, 1], [31, 3, 20, 19, 0, 1], [1, 4, 20, 19, 0, 2], [2, 4, 20, 19, 0, 2], [3, 4, 20, 25, 0, 6], [4, 4, 20, 25, 0, 6], [5, 4, 20, 25, 0, 6], [6, 4, 20, 41, 0, 6], [7, 4, 20, 41, 0, 8], [8, 4, 20, 41, 0, 10], [9, 4, 20, 50, 0, 10], [10, 4, 20, 50, 0, 11], [11, 4, 20, 73, 0, 11], [12, 4, 20, 73, 0, 14],

[13, 4, 20, 84, 0, 14], [14, 4, 20, 107, 0, 14], [15, 4, 20, 107, 0, 14], [16, 4, 20, 128, 0, 14], [17, 4, 20, 144, 0, 18], [18, 4, 20, 160, 0, 25], [19, 4, 20, 191, 0, 25], [20, 4, 20, 230, 0, 25], [21, 4, 20, 280, 0, 30], [22, 4, 20, 355, 0, 33], [23, 4, 20, 412, 0, 33], [24, 4, 20, 426, 0, 37], [25, 4, 20, 491, 0, 48], [26, 4, 20, 562, 0, 51], [27, 4, 20, 632, 0, 54], [28, 4, 20, 697, 0, 72], [29, 4, 20, 752, 1, 78], [30, 4, 20, 823, 1, 83], [1, 5, 20, 894, 1, 88], [2, 5, 20, 960, 2, 100], [3, 5, 20, 1031, 2, 115], [4, 5, 20, 1117, 3, 130], [5, 5, 20, 1208, 3, 149], [6, 5, 20, 1310, 3, 168], [7, 5, 20, 1415, 4, 184], [8, 5, 20, 1498, 4, 228], [9, 5, 20, 1586, 5, 340], [10, 5, 20, 1671, 5, 360], [11, 5, 20, 1761, 5, 460], [12, 5, 20, 1832, 6, 640], [13, 5, 20, 1919, 6, 740], [14, 5, 20, 1980, 6, 890], [15, 5, 20, 2064, 6, 1006], [16, 5, 20, 2148, 7, 1108], [17, 5, 20, 2232, 7, 1173], [18, 5, 20, 2312, 7, 1195], [19, 5, 20, 2400, 8, 1301], [20, 5, 20, 2475, 8, 1452], [21, 5, 20, 2546, 8, 1452], [22, 5, 20, 2621, 8, 1698], [23, 5, 20, 2697, 9, 1825], [24, 5, 20, 2787, 9, 1907], [25, 5, 20, 2849, 9, 1959], [26, 5, 20, 2912, 9, 2092], [27, 5, 20, 2966, 9, 2226], [28, 5, 20, 3026, 10, 2350], [29, 5, 20, 3079, 10, 2482], [30, 5, 20, 3142, 10, 2585], [31, 5, 20, 3194, 10, 2616], [1, 6, 20, 3244, 10, 2690], [2, 6, 20, 3297, 10, 2814], [3, 6, 20, 3351, 10, 2991], [4, 6, 20, 3402, 10, 3130], [5, 6, 20, 3452, 10, 3235], [6, 6, 20, 3504, 10, 3450], [7, 6, 20, 3558, 10, 3477], [8, 6, 20, 3611, 10, 3543], [9, 6, 20, 3665, 10, 3563], [10, 6, 20, 3720, 10, 3586], [11, 6, 20, 3774, 10, 3607], [12, 6, 20, 3823, 10, 3611], [13, 6, 20, 3868, 10, 3614], [14, 6, 20, 3914, 10, 3617], [15, 6, 20, 3958, 10, 3621], [16, 6, 20, 4001, 10, 3624], [17, 6, 20, 4040, 10, 3628], [18, 6, 20, 4078, 10, 3632], [19, 6, 20, 4114, 11, 3635], [20, 6, 20, 4152, 11, 3640], [21, 6, 20, 4192, 11, 3645], [22, 6, 20, 4231, 11, 3647], [23, 6, 20, 4271, 11, 3652]]

$dd := 16$

RT

T = [1, 1, 1, 1, 6, 6, 6, 7, 7, 10, 11, 14, 14, 14, 19, 19, 19, 25, 25, 25, 41, 41, 41, 50, 50, 73, 73, 84, 107, 107, 128, 144, 160, 191, 230, 280, 355, 412, 426, 491, 562, 632, 697, 752, 823, 894, 960, 1031, 1117, 1208, 1310, 1415, 1498, 1586, 1671, 1761, 1832, 1919, 1980, 2064, 2148, 2232, 2312, 2400, 2475, 2546, 2621, 2697, 2787, 2849, 2912, 2966, 3026, 3079, 3142, 3194, 3244, 3297, 3351, 3402, 3452, 3504, 3558, 3611, 3665, 3720, 3774, 3823, 3868, 3914, 3958, 4001, 4040, 4078, 4114, 4152, 4192, 4231, 4271]

T1 = [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 2, 2, 6, 6, 6, 6, 8, 10, 10, 11, 11, 14, 14, 14, 14, 14, 18, 25, 25, 25, 30, 33, 33, 37, 48, 51, 54, 72, 78, 83, 88, 100, 115, 130, 149, 168, 184, 228, 340, 360, 460, 640, 740, 890, 1006, 1108, 1173, 1195, 1301, 1452, 1452, 1698, 1825, 1907, 1959, 2092, 2226, 2350, 2482, 2585, 2616, 2690, 2814, 2991, 3130, 3235, 3450, 3477, 3543, 3563, 3586, 3607, 3611, 3614, 3617, 3621, 3624, 3628, 3632, 3635, 3640, 3645, 3647, 3652]

T2 = [1, 1, 1, 1, 6, 6, 6, 7, 7, 10, 10, 13, 13, 13, 18, 17, 17, 19, 19, 19, 35, 33, 31, 40, 39, 62, 59, 70, 93, 93, 114, 126, 135, 166, 205, 250, 322, 379, 389, 443, 511, 578, 625, 673, 739, 805, 858, 914, 984, 1056, 1139, 1227, 1266, 1241, 1306, 1296, 1186, 1173, 1084, 1052, 1033, 1052, 1110, 1091, 1015, 1086, 915, 863, 871, 881, 811, 731, 666, 587, 547, 568, 544, 473, 350, 262, 207, 44, 71, 58, 92, 124, 157, 202, 244, 287, 327, 367, 402, 436, 468, 501, 536, 573, 608]

T3 = [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 2, 2, 3, 3, 3, 4, 4, 5, 5, 5, 6, 6, 6, 6, 7, 7, 7, 8, 8, 8, 8, 9, 9, 9, 9, 9, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 11, 11, 11, 11,

11]

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[17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, (2
55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91,
92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115]

```
> `====================================`;
  `VERHULST FItAING`;
  `====================================`;
```

==========

VERHULST FItAING

========== (3

```
> h:=x->x;

  [seq(h(T[i])-h(T[i-1]),i=2..nops(T))]; [seq(%[i]-%[i-1],i=2..nops(%))]; [seq(%[i]-%[i-1],i=2..
  nops(%))];
  [seq([i+dd+1,%%%[i]],i=1..nops(%%%))]: [seq([i+dd+2,%%%[i]],i=1..nops(%%%))]: [seq([i+dd+3,%%%[i]
  ],i=1..nops(%%%))]:
  display(
   plot([%%%,%%,%],style=point),
    plot([%%%,%%,%],legend=[``,``,``]),
    title=`   N[i]`,titlefont=[roman,15]   ,gridlines=true
  );

  [seq((h(T[i])-h(T[i-5]))/5.,i=6..nops(T))]: [seq((%[i]-%[i-3])/3.,i=4..nops(%))]: [seq((%[i]-%
  [i-3])/3.,i=4..nops(%))]:
  [seq([i+dd+2,%%%[i]],i=1..nops(%%%))]: [seq([i+dd+4,%%%[i]],i=1..nops(%%%))]: [seq([i+dd+6,%%%[i]
  ],i=1..nops(%%%))]:
  display(
   plot([%%%,%%,%],style=point),
    plot([%%%,%%,%],legend=[``,``,``]),
     title=`     N[i]              `,titlefont=[roman,15],gridlines=true
  );
```

$$h := x \mapsto x$$

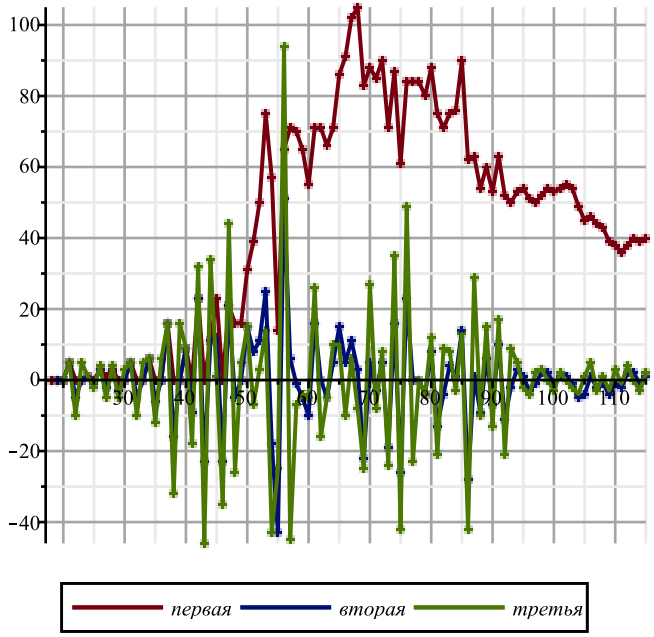
[0, 0, 0, 5, 0, 0, 1, 0, 3, 1, 3, 0, 0, 5, 0, 0, 6, 0, 0, 16, 0, 0, 9, 0, 23, 0, 11, 23, 0, 21, 16, 16, 31, 39, 50, 75, 57, 14, 65, 71, 70, 65, 55, 71, 71, 66,
71, 86, 91, 102, 105, 83, 88, 85, 90, 71, 87, 61, 84, 84, 84, 80, 88, 75, 71, 75, 76, 90, 62, 63, 54, 60, 53, 63, 52, 50, 53, 54, 51, 50, 52, 54,

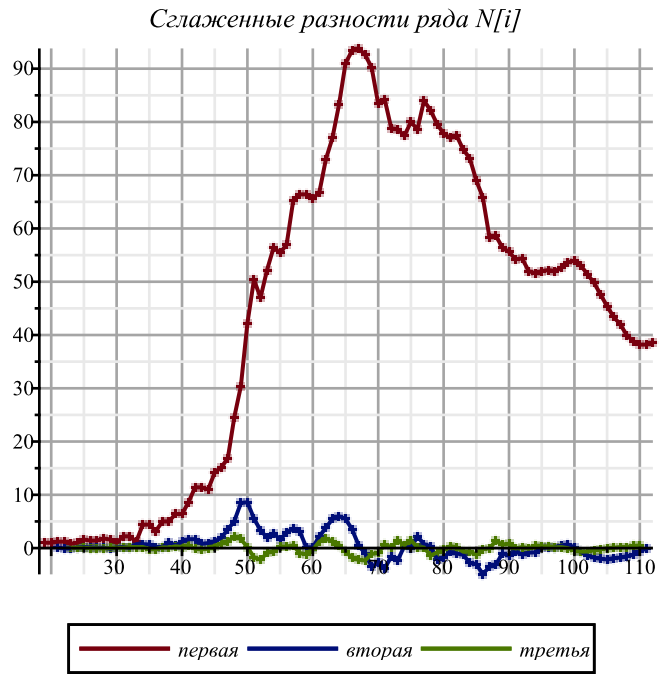
53, 54, 55, 54, 49, 45, 46, 44, 43, 39, 38, 36, 38, 40, 39, 40]

[0, 0, 5, −5, 0, 1, −1, 3, −2, 2, −3, 0, 5, −5, 0, 6, −6, 0, 16, −16, 0, 9, −9, 23, −23, 11, 12, −23, 21, −5, 0, 15, 8, 11, 25, −18, −43, 51, 6, −1, −5, −10, 16, 0, −5, 5, 15, 5, 11, 3, −22, 5, −3, 5, −19, 16, −26, 23, 0, 0, −4, 8, −13, −4, 4, 1, 14, −28, 1, −9, 6, −7, 10, −11, −2, 3, 1, −3, −1, 2, 2, −1, 1, 1, −1, −5, −4, 1, −2, −1, −4, −1, −2, 2, 2, −1, 1]

[0, 5, −10, 5, 1, −2, 4, −5, 4, −5, 3, 5, −10, 5, 6, −12, 6, 16, −32, 16, 9, −18, 32, −46, 34, 1, −35, 44, −26, 5, 15, −7, 3, 14, −43, −25, 94, −45, −7, −4, −5, 26, −16, −5, 10, 10, −10, 6, −8, −25, 27, −8, 8, −24, 35, −42, 49, −23, 0, −4, 12, −21, 9, 8, −3, 13, −42, 29, −10, 15, −13, 17, −21, 9, 5, −2, −4, 2, 3, 0, −3, 2, 0, −2, −4, 1, 5, −3, 1, −3, 3, −1, 4, 0, −3, 2]

Разности ряда N[i]






```
> h:=x->evalf(ln(x));

  [seq(h(T[i])-h(T[i-1]),i=2..nops(T))]; [seq(%[i]-%[i-1],i=2..nops(%))]; [seq(%[i]-%[i-1],i=2..
  nops(%))];
  [seq([i+dd+1,%%%[i]],i=1..nops(%%%))]: [seq([i+dd+2,%%%[i]],i=1..nops(%%%))]: [seq([i+dd+3,%%%[i]
  ],i=1..nops(%%%))]:
  display(
   plot([%%%,%%,%],style=point),
    plot([%%%,%%,%],legend=[``,``,``]),
    title=`  ln(N[i])`,titlefont=[roman,15]   ,gridlines=true
  );

  [seq((h(T[i])-h(T[i-5]))/5.,i=6..nops(T))]: [seq((%[i]-%[i-3])/3.,i=4..nops(%))]: [seq((%[i]-%
  [i-3])/3.,i=4..nops(%))]:
  [seq([i+dd+2,%%%[i]],i=1..nops(%%%))]: [seq([i+dd+4,%%%[i]],i=1..nops(%%%))]: [seq([i+dd+6,%%%[i]
  ],i=1..nops(%%%))]:
  display(
   plot([%%%,%%,%],style=point),
    plot([%%%,%%,%],legend=[``,``,``]),
```

```
    t i t l e = `                    ln(N[i])`,titlefont=[roman,15],gridlines=true
  );
```

$$h := x \mapsto evalf(\ln(x))$$

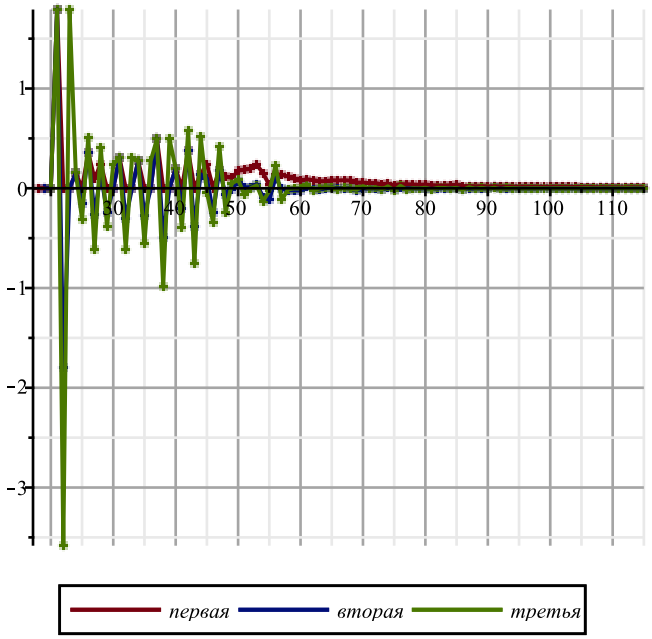
[0., 0., 0., 1.791759469, 0., 0., 0.154150680, 0., 0.356674944, 0.095310180, 0.241162057, 0., 0., 0.305381649, 0., 0., 0.274436845, 0., 0.,
0.494696243, 0., 0., 0.198450938, 0., 0.378436436, 0., 0.140357358, 0.242012035, 0., 0.179201430, 0.117783036, 0.105360515,
0.177099613, 0.185805881, 0.196710294, 0.237328186, 0.148905560, 0.033415997, 0.142004782, 0.135057722, 0.117387544,
0.097896017, 0.075950913, 0.090219877, 0.082749574, 0.071227509, 0.071351200, 0.080117315, 0.078319579, 0.081061038,
0.077102394, 0.057001354, 0.057084238, 0.052207127, 0.052459579, 0.039526437, 0.046395951, 0.031292628, 0.041549003,
0.039891329, 0.038360868, 0.035214906, 0.037355786, 0.030771659, 0.028283104, 0.029032424, 0.028584120, 0.032825704,
0.022002307, 0.021872075, 0.018374114, 0.020027371, 0.017363254, 0.020254671, 0.016414510, 0.015533086, 0.016205828,
0.016245845, 0.015104685, 0.014590279, 0.014951400, 0.015293416, 0.014786153, 0.014843593, 0.014895333, 0.014411779,
0.012900008, 0.011702123, 0.011822291, 0.011178978, 0.010805483, 0.009700362, 0.009361980, 0.008789119, 0.009194355,
0.009587801, 0.009260425, 0.009409620]

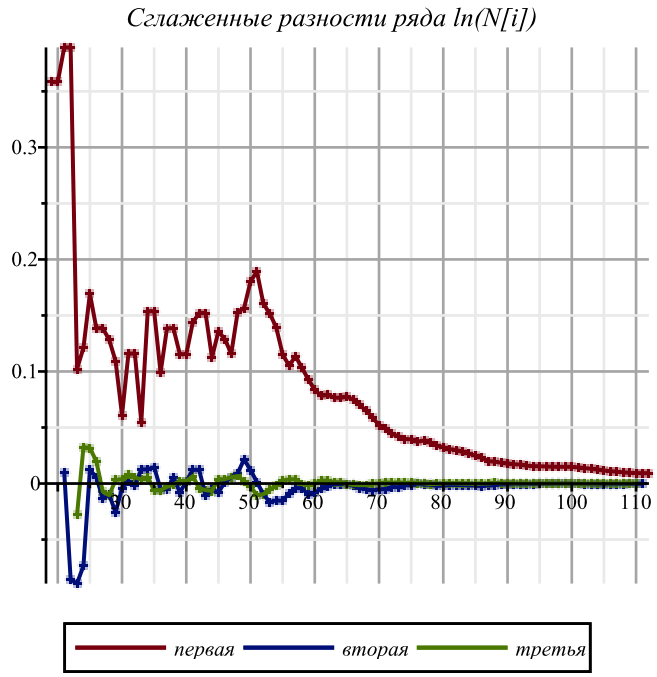
[0., 0., 1.791759469, −1.791759469, 0., 0.154150680, −0.154150680, 0.356674944, −0.261364764, 0.145851877, −0.241162057, 0.,
0.305381649, −0.305381649, 0., 0.274436845, −0.274436845, 0., 0.494696243, −0.494696243, 0., 0.198450938, −0.198450938,
0.378436436, −0.378436436, 0.140357358, 0.101654677, −0.242012035, 0.179201430, −0.061418394, −0.012422521, 0.071739098,
0.008706268, 0.010904413, 0.040617892, −0.088422626, −0.115489563, 0.108588785, −0.006947060, −0.017670178,
−0.019491527, −0.021945104, 0.014268964, −0.007470303, −0.011522065, 0.000123691, 0.008766115, −0.001797736,
0.002741459, −0.003958644, −0.020101040, 0.000082884, −0.004877111, 0.000252452, −0.012933142, 0.006869514,
−0.015103323, 0.010256375, −0.001657674, −0.001530461, −0.003145962, 0.002140880, −0.006584127, −0.002488555,
0.000749320, −0.000448304, 0.004241584, −0.010823397, −0.000130232, −0.003497961, 0.001653257, −0.002664117,
0.002891417, −0.003840161, −0.000881424, 0.000672742, 0.000040017, −0.001141160, −0.000514406, 0.000361121, 0.000342016,
−0.000507263, 0.000057440, 0.000051740, −0.000483554, −0.001511771, −0.001197885, 0.000120168, −0.000643313,
−0.000373495, −0.001105121, −0.000338382, −0.000572861, 0.000405236, 0.000393446, −0.000327376, 0.000149195]

[0., 1.791759469, −3.583518938, 1.791759469, 0.154150680, −0.308301360, 0.510825624, −0.618039708, 0.407216641, −0.387013934,
0.241162057, 0.305381649, −0.610763298, 0.305381649, 0.274436845, −0.548873690, 0.274436845, 0.494696243, −0.989392486,
0.494696243, 0.198450938, −0.396901876, 0.576887374, −0.756872872, 0.518793794, −0.038702681, −0.343666712, 0.421213465,
−0.240619824, 0.048995873, 0.084161619, −0.063032830, 0.002198145, 0.029713479, −0.129040518, −0.027066937, 0.224078348,
−0.115535845, −0.010723118, −0.001821349, −0.002453577, 0.036214068, −0.021739267, −0.004051762, 0.011645756,

0.008642424, −0.010563851, 0.004539195, −0.006700103, −0.016142396, 0.020183924, −0.004959995, 0.005129563,
−0.013185594, 0.019802656, −0.021972837, 0.025359698, −0.011914049, 0.000127213, −0.001615501, 0.005286842,
−0.008725007, 0.004095572, 0.003237875, −0.001197624, 0.004689888, −0.015064981, 0.010693165, −0.003367729, 0.005151218,
−0.004317374, 0.005555534, −0.006731578, 0.002958737, 0.001554166, −0.000632725, −0.001181177, 0.000626754, 0.000875527,
−0.000019105, −0.000849279, 0.000564703, $-5.700\ 10^{-6}$, −0.000535294, −0.001028217, 0.000313886, 0.001318053,
−0.000763481, 0.000269818, −0.000731626, 0.000766739, −0.000234479, 0.000978097, −0.000011790, −0.000720822, 0.000476571]

Разности ряда ln(N[i])






```
> f_:=d->sum(a[j]*d^j,j=0..n); fe_:=d->sum(a[j]*d^j,j=0..ne);

  M:='M':
  ff:=x->M*(1-1/(exp(x)+1)); ff_:=unapply(solve(y=ff(x),x),y); diff(ff_(x),x); dff_:=unapply
  (simplify(%,x),x);
  ffe:=x->exp(x); ffe_:=unapply(solve(y=ffe(x),x),y); diff(ffe_(x),x); dffe_:=unapply(simplify(%,
  x),x);

  sigma:=x->simplify(sqrt(x));

  chi2:=(T,f_)->simplify(sum(evalf(ff_(T[k])-f_(k))^2/dff_(T[k])^2/sigma(T[k])^2,k=1..nops(T)));
  chi2e:=(T,f_)->simplify(sum(evalf(ffe_(T[k])-f_(k))^2/dffe_(T[k])^2/sigma(T[k])^2,k=1..nops(T)));

  F:=proc(T,chi2,f_) chi2(T,f_);
   indets(%); grad(%%,%); subs(solve(%,%%),f_(i)); unapply(%,i);
  end:
```

$$f\_ := d \mapsto \sum_{j=0}^{n} a_j \cdot d^j$$

$$fe\_ := d \mapsto \sum_{j=0}^{ne} a_j \cdot d^j$$

$$ff := x \mapsto M \cdot \left(1 - \frac{1}{e^x + 1}\right)$$

$$ff\_ := y \mapsto \ln\left(\frac{y}{M - y}\right)$$

$$\frac{\left(\frac{1}{M-x} + \frac{x}{(M-x)^2}\right)(M-x)}{x}$$

$$dff\_ := x \mapsto \frac{M}{(M-x)\cdot x}$$

$$ffe := x \mapsto e^x$$

$$ffe\_ := y \mapsto \ln(y)$$

$$\frac{1}{x}$$

$$dffe\_ := x \mapsto \frac{1}{x}$$

$$\sigma := x \mapsto simplify\left(\sqrt{x}\right)$$

$$\chi 2 := (T, f\_) \rightarrow simplify\left(\sum_{k=1}^{nops(T)} \frac{evalf\left(ff\_\left(T_k\right) - f\_(k)\right)^2}{dff\_\left(T_k\right)^2 \sigma\left(T_k\right)^2}\right)$$

$$chi2e := (T, f\_) \rightarrow simplify\left(\sum_{k=1}^{nops(T)} \frac{evalf\left(ffe\_\left(T_k\right) - f\_(k)\right)^2}{dffe\_\left(T_k\right)^2 \sigma\left(T_k\right)^2}\right)$$

(4

```
> n:=1: ne:=n: 'f(t)'=Sum(a[j]*t^j,j=0..n);
```

```
fM:=proc(x) global M,chi2,F,T,f_; M:=x; chi2(T,F(T,chi2,f_)); end:

` `; `Approximation of the infection schedule by the solution of the Verhulst equation`; ` `;
M:=goldMin(fM,max(T)+2..max(T)*2,1);
nu:=F(T,chi2,f_): f:=unapply(ff(%(t)),t): N(t)=%(t); Chi2:=chi2(T,%%%);
cat(`Next day forecast:   `,round(f(nops(T)+1)));
cat(`The level of  0.5 M  is reached at   `,round(1+fsolve(f(d)=0.5*M,d=30)+dd-31),`  apr`);
cat(`The level of  0.85 M  is reached at   `,round(1+fsolve(f(d)=0.85*M,d=30)+dd-31),`  apr`);
` `; `Approximation of the infection schedule by solving the Malthus equation`; ` `;
nue:=F(T,chi2e,f_): fe:=unapply(ffe(%(t)),t): N(t)=%(t);

simplify([diff(nu(d-dd),d),diff(nue(d-dd),d)]): [coeff(%[1],d,i) $ i=0..n-1];
plot(%%,d=1+dd..nops(T)+dd,view=[0..nops(T)+dd,0..0.5],legend=[``,``],
linestyle=[solid,dash],title=`  `        ,titlefont=[roman,20],labels=[t,alpha(t)],
gridlines=true);

d1:=fsolve(f(d)=0.5*M,d=30)+dd; K_:=M; alpha_:=coeff(nu(t),t,1);

n:=4: ne:=n: 'f(t)'=Sum(a[j]*t^j,j=0..n);

fM:=proc(x) global M,chi2,F,T,f_; M:=x; chi2(T,F(T,chi2,f_)); end:

` `; `Approximation of the infection schedule by the solution of the Verhulst equation`; ` `;
M:=goldMin(fM,max(T)+2..max(T)*2,1);
nu:=F(T,chi2,f_): f:=unapply(ff(%(t)),t): N(t)=%(t); Chi2:=chi2(T,%%%);
cat(`Next day forecast:   `,round(f(nops(T)+1)));
cat(`The level of  0.5 M  is reached at   `,round(1+fsolve(f(d)=0.5*M,d=30)+dd-31),`  apr`);
cat(`The level of  0.85 M  is reached at   `,round(1+fsolve(f(d)=0.85*M,d=30)+dd-31),`  apr`);
` `; `Approximation of the infection schedule by solving the Malthus equation`; ` `;
nue:=F(T,chi2e,f_): fe:=unapply(ffe(%(t)),t): N(t)=%(t);

[seq([i,(
 (T[i-dd]-T[i-dd-1]) /(T2[i-dd]+T2[i-dd-1]) /((1-T[i-dd]/M)+(1-T[i-dd-1]/M))
)*4],i=1+dd+1..nops(T)+dd)]: [seq([%[i][1],(%[i-1][2]+%[i][2]+%[i+1][2])/3],i=2..nops(%)-1)]:
Palpha:=display(plot([%],color=blue),plot([%],style=point,symbolsize=8,symbol=solidcircle,color=
blue)):

simplify([diff(nu(d-dd),d),diff(nue(d-dd),d)]): [coeff(%[1],d,i) $ i=0..n-1];
plot(%%,d=1+dd..nops(T)+dd,view=[0..nops(T)+dd,0..0.5],legend=[``,``],
linestyle=[solid,dash],title=`  `        ,titlefont=[roman,20],labels=[t,alpha(t)],
```

```
gridlines=true):

display(Palpha,%);
```

$$f(t) = \sum_{j=0}^{1} a_j t^j$$

Approximation of the infection schedule by the solution of the Verhulst equation

$$M := 4273.369418$$

$$N(t) = 4273.369418 - \frac{4273.369418}{e^{0.09650977365\,t - 5.949179454} + 1}$$

$$Chi2 := 1428.078908$$

Next day forecast: 4170

The level of 0.5 M is reached at 48 apr

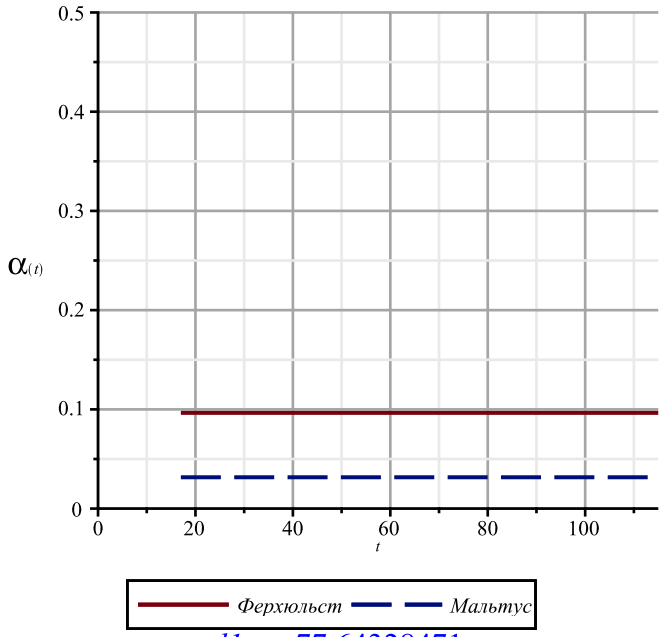
The level of 0.85 M is reached at 66 apr

Approximation of the infection schedule by solving the Malthus equation

$$N(t) = e^{0.03156622675\,t + 5.516743793}$$

$$[0.09650977365]$$

Коэффициент заражения



$d1 := 77.64328471$

$K\_ := 4273.369418$

$alpha\_ := 0.09650977365$

$$f(t) = \sum_{j=0}^{4} a_j t^j$$

Approximation of the infection schedule by the solution of the Verhulst equation

$M := 4273.369418$

$$N(t) = 4273.369418 - \frac{4273.369418}{e^{5.318491734\,10^{-7}\,t^4 - 0.0001022337263\,t^3 + 0.005873980102\,t^2 + 0.01569822774\,t - 6.928438323} + 1}$$

$Chi2 := 63.98818627$

Next day forecast: 4218

The level of 0.5 M is reached at 46 apr

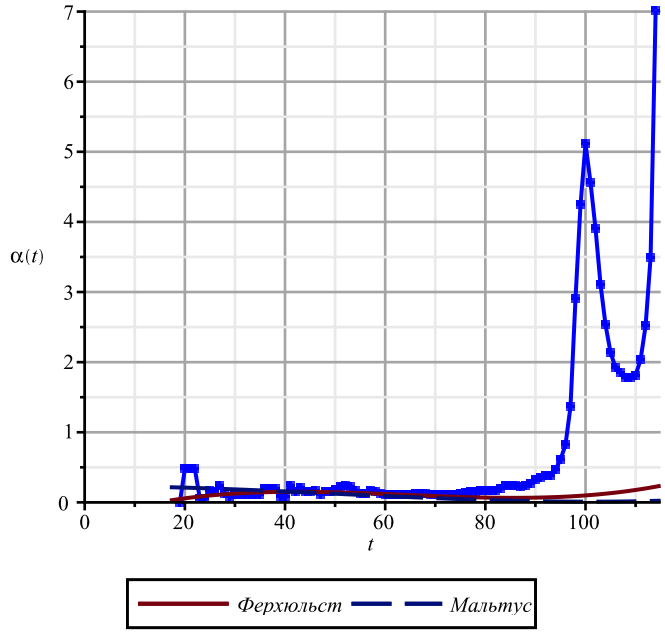
The level of 0.85 M is reached at 70 apr

Approximation of the infection schedule by solving the Malthus equation

$$N(t) = e^{1.079419773\,10^{-7}\,t^4 - 0.00001490350189\,t^3 - 0.0008816760899\,t^2 + 0.2179282127\,t - 0.4422165450}$$

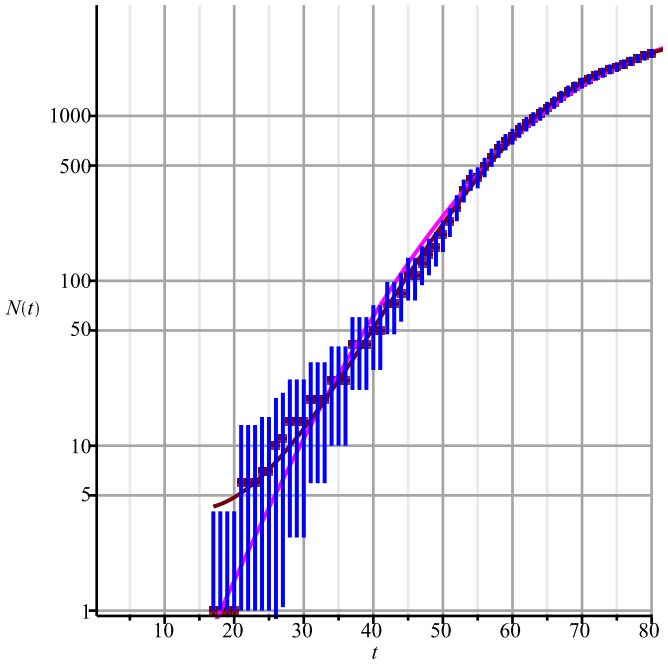
$$[-0.259498454300000,\ 0.0231962385800000,\ -0.000408816220200000,\ 2.127396694\,10^{-6}]$$

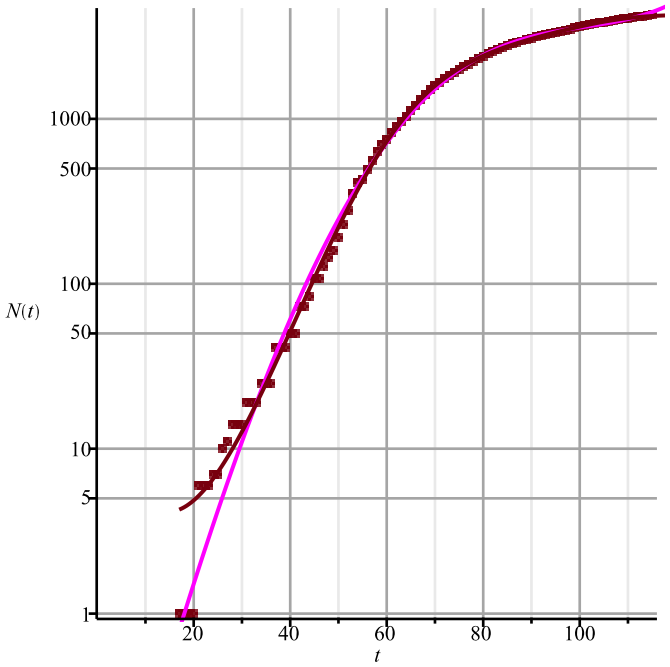
Коэффициент заражения

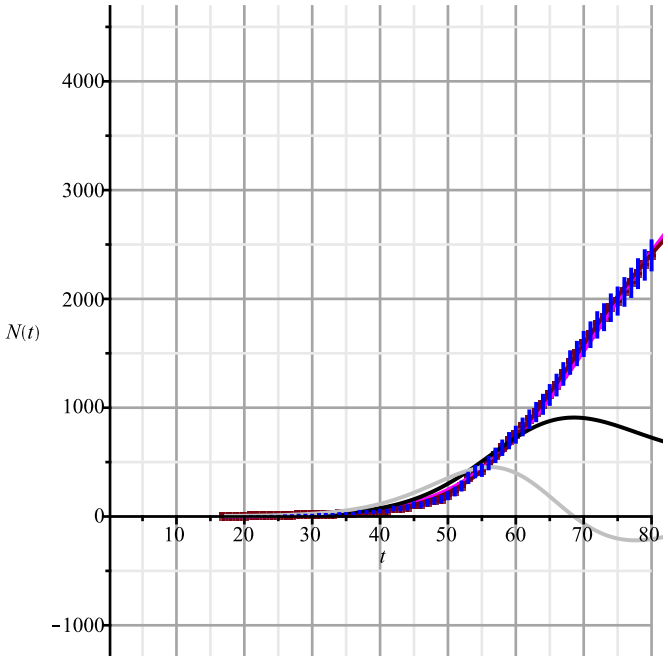


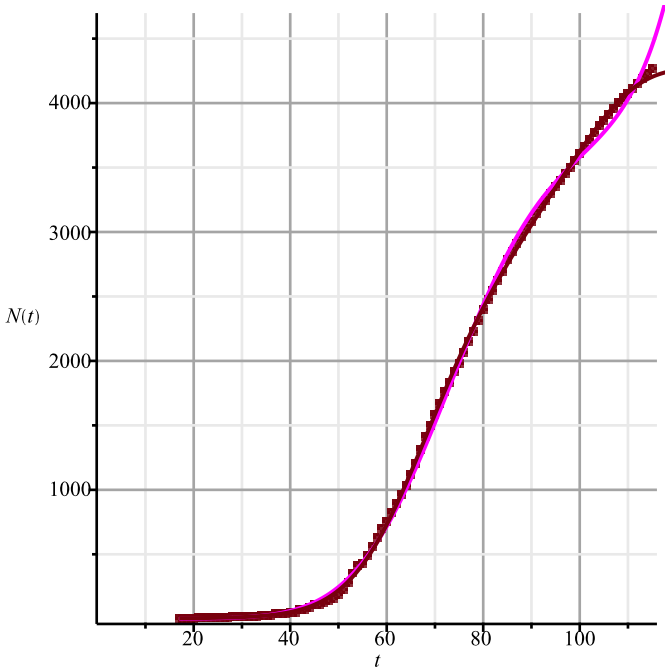

```
> df:=unapply(diff(f(i),i),i): ddf:=unapply(diff(f(i),i,i),i):

  display(
   plot([[i+dd,T[i]] $ i=1..nops(T)],style=point,symbolsize=10,symbol=solidcircle),
   plot(fe(i-dd),i=1+dd..max(90,dd+nops(T)),color=magenta),
   plot(f(i-dd),i=1+dd..max(90,dd+nops(T))),
   seq(plot([[i+dd,T[i]+3*sqrt(T[i])],[i+dd,T[i]-3*sqrt(T[i])]],color=blue),i=1..nops(T)),
   axis[2]=[mode=log],
   view=[1..80,1..M*1.1],labels=[t,N(t)],gridlines=true
```

```
);

display(
 plot([[i+dd,T[i]] $ i=1..nops(T)],style=point,symbolsize=8,symbol=solidcircle),
 plot(fe(i-dd),i=1+dd..max(120,dd+nops(T)),color=magenta),
 plot(f(i-dd),i=1+dd..max(120,dd+nops(T))),
# seq(plot([[i+dd,T[i]+3*sqrt(T[i])],[i+dd,T[i]-3*sqrt(T[i])]],color=blue),i=1..nops(T)),
 axis[2]=[mode=log],
 view=[1..nops(T)+dd+1,1..T[nops(T)]*1.1],labels=[t,N(t)],gridlines=true
);


display(
 plot([[i+dd,T[i]] $ i=1..nops(T)],style=point,symbolsize=10,symbol=solidcircle),
 plot(fe(i-dd),i=1+dd..max(120,dd+nops(T)),color=magenta),
 plot(f(i-dd),i=1+dd..max(dd+nops(T),90)),
 plot(10*df(i-dd),i=1+dd..max(dd+nops(T),120),color=black),
 plot(100*ddf(i-dd),i=1+dd..max(dd+nops(T),120),color=gray),
 seq(plot([[i+dd,T[i]+3*sqrt(T[i])],[i+dd,T[i]-3*sqrt(T[i])]],color=blue),i=1..nops(T)),
 view=[1..80,-M*0.3..M*1.1],labels=[t,N(t)],gridlines=true
);

display(
 plot([[i+dd,T[i]] $ i=1..nops(T)],style=point,symbolsize=8,symbol=solidcircle),
 plot(fe(i-dd),i=1+dd..max(120,dd+nops(T)),color=magenta),
 plot(f(i-dd),i=1+dd..max(dd+nops(T),120)),
# seq(plot([[i+dd,T[i]+3*sqrt(T[i])],[i+dd,T[i]-3*sqrt(T[i])]],color=blue),i=1..nops(T)),
 view=[1..nops(T)+dd+1,1..T[nops(T)]*1.1],labels=[t,N(t)],gridlines=true
);
```


1000
500
100
50
10
5
1
N(t)
10
20
30
40
50
60
70
80
t

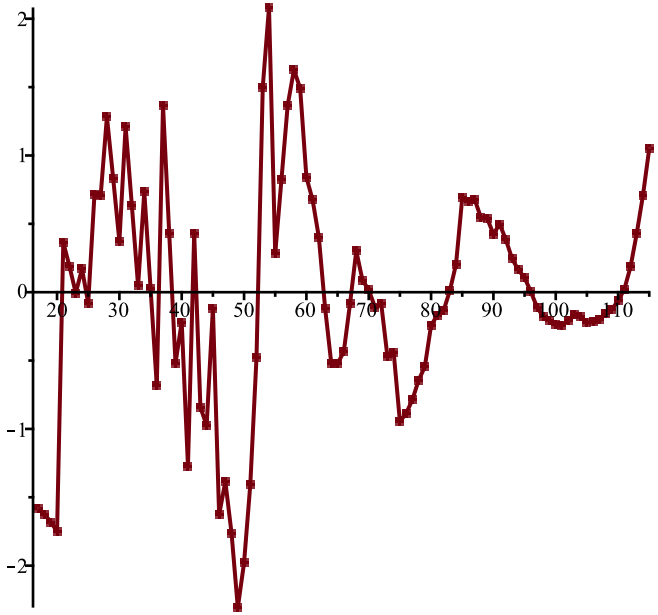

1000
500
100
50
10
5
1
N(t)
20
40
60
80
100
t


4000
3000
2000
N(t)
1000
0
-1000
10
20
30
40
50
60
70
80
t




```
> dT:=[[i,(T[i-dd]-f(i-dd))/sigma(f(i-dd))] $ i=1+dd..dd+nops(T)]:
  display( plot(%), plot(%,style=point,symbolsize=8,symbol=solidcircle),t i t l e = ` `     ,titlefont=
  [roman,20] );
```

Девиация




```
> `====================================`;
  `FORECAST`;
  `====================================`;
```

==========

FORECAST

==========

(5

```
> proc3:=proc(E)
   E[1]*convert(map(X->X^coeff(E[2],X,1),M),`*`);
  end:

  proc2:=proc(X,E)
   proc3(E)*(coeff(E[3],X,1)-coeff(E[2],X,1));
  end:

  proc1:=proc(X)
   convert(map(E->proc2(X,E),L),`+`);
  end:
```

```
> A:='A': B:='B': C:='C': Q:='Q': M:=[A,B,C,Q];

  L:=[
   [(A+C)*P[`01`],0,A],
   [(B/K)*P[`12`],A,B],
   [P[`23`],B,C],
   [P[`10`],A,0], [P[`20`],B,Q], [P[`30`],C,0]
  ]: Matrix(%);

  eqs:=map(X->Diff(X,t)=proc1(X),M); Vector(%);
```

$$M := [A, B, C, Q]$$

$$\begin{bmatrix} (A+C)\,P_{01} & 0 & A \\ \frac{B\,P_{12}}{K} & A & B \\ P_{23} & B & C \\ P_{10} & A & 0 \\ P_{20} & B & Q \\ P_{30} & C & 0 \end{bmatrix}$$

$$eqs := \left[\frac{\partial}{\partial t} A = (A+C)\,P_{01} - \frac{B\,P_{12}\,A}{K} - P_{10}\,A,\ \frac{\partial}{\partial t} B = \frac{B\,P_{12}\,A}{K} - P_{23}\,B - P_{20}\,B,\ \frac{\partial}{\partial t} C = P_{23}\,B - P_{30}\,C,\ \frac{\partial}{\partial t} Q = P_{20}\,B \right]$$

(6

$$\left[\begin{array}{c} \frac{\partial}{\partial t} A = (A + C)\, P_{01} - \frac{B\, P_{12}\, A}{K} - P_{10}\, A \\ \frac{\partial}{\partial t} B = \frac{B\, P_{12}\, A}{K} - P_{23}\, B - P_{20}\, B \\ \frac{\partial}{\partial t} C = P_{23}\, B - P_{30}\, C \\ \frac{\partial}{\partial t} Q = P_{20}\, B \end{array}\right] \quad (6$$

```
> v:=M; alpha:='alpha': K:=k0; tA:=[-7,15,35,50,58,62,78,nops(T)+dd]; kA:=['k1x||i' $ i=1..nops(tA)
  ];

  par:=[d0,k0,op(kA),k2a,k2b,k2c,k3]; kappa:=0; 0.011/365;

  param:=[
    P[`01`]=kappa,  P[`12`]=alpha(t,op(kA)), P[`23`]=beta(t,k2a,k2b,k2c),
    P[`10`]=kappa, P[`20`]=k3,  P[`30`]=kappa
  ];

  init:=[   A(-d0)=K,   B(-d0)=1,   C(-d0)=0,   Q(-d0)=0   ];
```

$$v := [A, B, C, Q]$$

$$K := k0$$

$$tA := [-7, 15, 35, 50, 58, 62, 78, 115]$$

$$kA := [k1x1, k1x2, k1x3, k1x4, k1x5, k1x6, k1x7, k1x8]$$

$$par := [d0, k0, k1x1, k1x2, k1x3, k1x4, k1x5, k1x6, k1x7, k1x8, k2a, k2b, k2c, k3]$$

$$\kappa := 0$$

$$0.00003013698630$$

$$param := \left[P_{01} = 0, P_{12} = \alpha(t, k1x1, k1x2, k1x3, k1x4, k1x5, k1x6, k1x7, k1x8), P_{23} = \beta(t, k2a, k2b, k2c), P_{10} = 0, P_{20} = k3, P_{30} = 0\right]$$

$$init := [A(-d0) = k0, B(-d0) = 1, C(-d0) = 0, Q(-d0) = 0] \quad (7$$

```
> Eqs:=subs(map(q->q=q(t),v),Diff=diff,param,eqs); #dsolve(%);
```

$$Eqs := \left[\frac{d}{dt} A(t) = -\frac{B(t)\ \alpha(t, k1x1, k1x2, k1x3, k1x4, k1x5, k1x6, k1x7, k1x8)\ A(t)}{k0}, \frac{d}{dt} B(t) \right. \tag{8}$$

$$= \frac{B(t)\ \alpha(t, k1x1, k1x2, k1x3, k1x4, k1x5, k1x6, k1x7, k1x8)\ A(t)}{k0} - \beta(t, k2a, k2b, k2c)\ B(t) - k3\ B(t), \frac{d}{dt} C(t) = \beta(t, k2a, k2b,$$

$$\left. k2c)\ B(t), \frac{d}{dt} Q(t) = k3\ B(t) \right]$$

```
> N:='N': A:='A': B:='B': C:='C': Q:='Q': val:=valp:

  #alpha:=unapply(simplify(evalf(piecewise(t<tA[1],kA[1],t<tA[2],Lag(t,tA[1..3],kA[1..3]),
  # seq(op([t<tA[i+1],(Lag(t,tA[i-1..i+1],kA[i-1..i+1])+Lag(t,tA[i..i+2],kA[i..i+2]))/2]),i=2..nops
  (kA)-2),
  #t<tA[nops(tA)],Lag(t,tA[nops(tA)-2..nops(tA)],kA[nops(kA)-2..nops(kA)]),
  #kA[nops(kA)]))),t,op(kA)):

  alpha:=unapply(simplify(evalf(piecewise(t<tA[1],kA[1],t<tA[3],Lag(t,tA[1..4],kA[1..4]),
   seq(op([t<tA[i+1],Lag(t,tA[i-1..i+2],kA[i-1..i+2])]),i=3..nops(kA)-2),
  t<tA[nops(tA)],Lag(t,tA[nops(tA)-2..nops(tA)],kA[nops(kA)-2..nops(kA)]),
  kA[nops(kA)]))),t,op(kA)):

  beta:=(t,k2a,k2b,k2c)->piecewise(t<60,k2a,t<97,Lag(t,[60,80,97],[k2a,k2b,k2c]),k2c):
  beta:=unapply(simplify(evalf(beta(t,k2a,k2b,k2c))),t,k2a,k2b,k2c);

  EQS:=[op(Eqs),op(init)]:

  res:=dsolve(EQS,numeric,map(q->q(t),v),output=listprocedure,parameters=par); assign('v[i]=subs
  (res,v[i](t))' $ i=1..nops(v)):

  chi2a:='chi2a': chi2:=unapply(chi2a(x0,xx,kA,x2a,x2b,x2c,x3),x0,xx,op(kA),x2a,x2b,x2c,x3):

  chi2a:=proc(x0,xx,x1,x2a,x2b,x2c,x3) local i; global K_; K_:=xx;
    res(parameters=[corr(par,[x0,xx,op(x1),x2a,x2b,x2c,x3])]):
    sum((T[i]-(K_-A(i+dd)))^2/(K_-A(i+dd)),i=1..nops(T))+
    sum((T2[i]-B(i+dd))^2/B(i+dd),i=1..nops(T2))+
    sum((T3[i]-Q(i+dd))^2/Q(i+dd),i=1..nops(T2))+
    sum((T1[i]-C(i+dd))^2/C(i+dd),i=1..nops(T1));
  end:
```

```
chi2(op(pr(val))); val:=findMin(chi2,val); chi2(op(%));

#plot(map(q->q(t),v), t=0..3.0e4, legend=[``,``,``],
#linestyle=[solid,dash,dashdot],gridlines=true);

writedata(cat(Region,`3c.txt`),val);

display(
 plot(map(q->q(t),v[1..3]), t=0..300, legend=[``,``,``],
  linestyle=[solid,dash,dashdot],gridlines=true),
 plot([[seq([i+dd,K_-T[i]],i=1..nops(T))]],style=point,symbolsize=7,symbol=asterisk),
 plot([[seq([i+dd,T1[i]],i=1..nops(T1))]],style=point,symbolsize=7,symbol=circle),
 plot([[seq([i+dd,T2[i]],i=1..nops(T2))]],style=point,symbolsize=7,symbol=diamond,color=black),
 size=[1000,400],legendstyle=[font=[roman,15]]
): fdisplay(cat(Region,`3c`),%);
```

$$\beta := (t, k2a, k2b, k2c) \mapsto \begin{cases} k2a \\ (-0.2391891892 \cdot t + 0.001351351352 \cdot t^2 + 10.48648649) \cdot k2a + (-17.11764706 + 0.4617647058 \cdot t - 0.00294117647 \\ k2c \end{cases}$$

res := [*t* = **proc**(*t*) ... **end proc**, *A*(*t*) = **proc**(*t*) ... **end proc**, *B*(*t*) = **proc**(*t*) ... **end proc**, *C*(*t*) = **proc**(*t*) ... **end proc**, *Q*(*t*) = **proc**(*t*)
...
end proc]

[9.027883628, 11843.41478, 0.05118252549, 0.08768869384, 0.1219317768, 0.1656771227, 0.1287578269, 0.1090075711, 0.08241319677, 0.3761057629, 0.01199523996, 0.1086118749, 0.2274905321, 0.0002732039562]

10872.1606133571

10872.1606133571

7551.74437593237

5834.01777657904

4894.49347302921
4328.72078261343
3972.40929033921
3742.19902976995
3578.38305200649
3461.36389836751
3373.66756069492
3308.17216421439
3252.46749149908
3209.23462001351
3169.57656973269
3138.51428321800
3109.78174622437
3086.68871850301
3066.01106213860
3049.09345040577
3032.52101463438
3018.24086181784
3004.26841455072
2992.81933277276
2976.80133296253
2963.92810331168
2949.86868578238
2938.48329500879
2924.78395782129
2913.01451362374
2889.36621973267
2871.31594494162
2797.93549245188
2779.56038500471

2772.26228017085
2769.68188892357
2736.64907345667
2734.52349400282
2732.73721075222
2730.75325641776
2729.14693674958
2727.35120864736
2725.93126104101
2723.51190802225
2721.69998430062
2720.38995867076
2719.30465172186
2718.06045296415
2717.04142312877
2715.24127330503
2713.69447654457
2705.06004708067
2700.40316525403
2695.14502414509
2694.00104861491
2693.04355808238
2692.58282247785
2692.03413372638
2691.63797319429
2691.21791748518
2690.88467037930
2690.52197912210
2690.21865884191
2689.85639227305

2689.57497038410
2688.26451624129
2687.16117130984
2680.30239825666
2674.58406930313
2671.39854758006
2670.59238433451
2670.11098668886
2669.56867147283
2669.25985638589
2668.76843908993
2668.42113131228
2668.02412818297
2667.68694231610
2667.14444013638
2666.72152403930
2666.31937784936
2665.98695199460
2660.11898878064
2654.77907719529
2646.88531524702
2643.13281172765
2640.37225672826
2639.73600258535
2632.13441438392
2629.69561861517
2628.45309918324
2627.44013737369
2626.90619091041
2626.38347835418

2626.07933515379

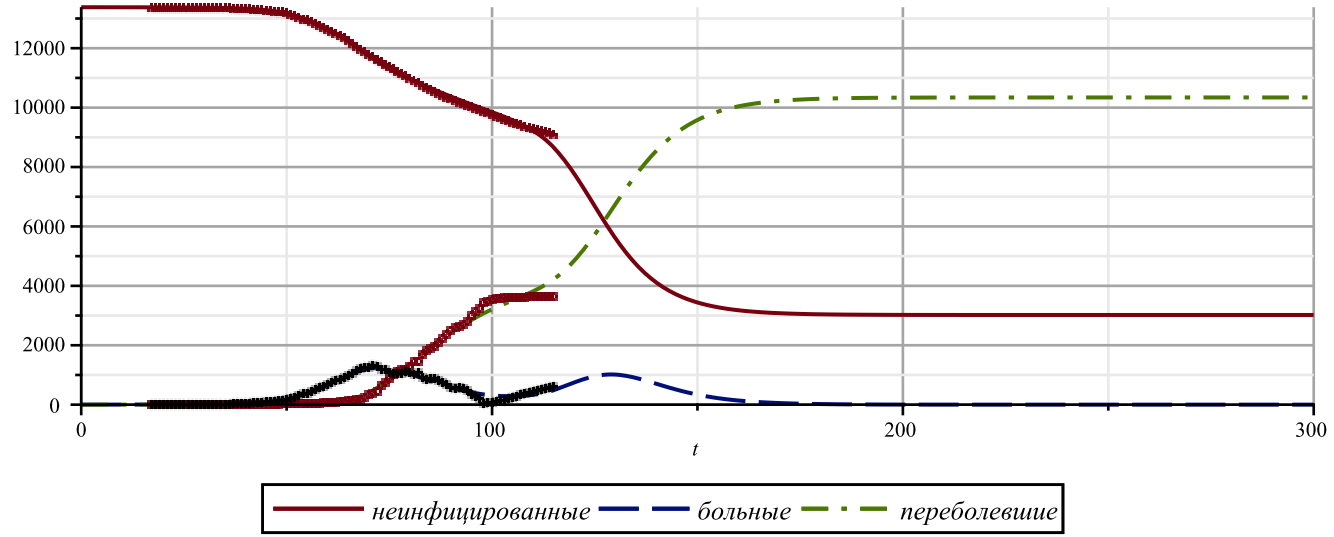
2625.70609872549

2625.47158283574

val := [9.04975926871991, 13380.7013637885, 0.0511516341122043, 0.0876110760233198, 0.121324016958117, 0.165054303003467, 0.123380281215598, 0.113569079033557, 0.0700190187615531, 0.468851923809304, 0.0117865640917915, 0.106139398901217, 0.203563558116982, 0.000270413162241497]

2625.47158283574

RT3c.jpg

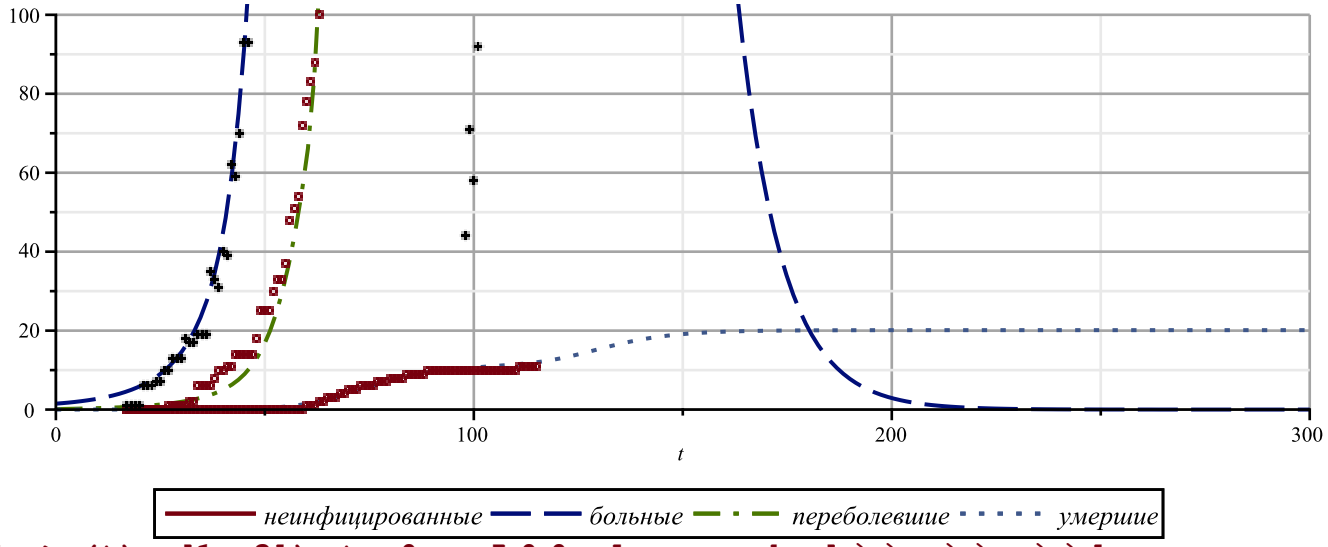



```
> chi2(op(pr(val)));
  display(
   plot(map(q->q(t),v), t = 0 . . 3 0 0 , l e g e n d = [ ` ` , ` ` , ` ` , ` `                                    ],
    linestyle=[solid,dash,dashdot,dot],gridlines=true),
   plot([[seq([i+dd,K_-T[i]],i=1..nops(T))]],style=point,symbolsize=7,symbol=asterisk),
   plot([[seq([i+dd,T1[i]],i=1..nops(T1))]],style=point,symbolsize=7,symbol=circle),
   plot([[seq([i+dd,T3[i]],i=1..nops(T1))]],style=point,symbolsize=7,symbol=circle),
   plot([[seq([i+dd,T2[i]],i=1..nops(T2))]],style=point,symbolsize=7,symbol=diamond,color=black),
   size=[1000,400],legendstyle=[font=[roman,15]],view=[0..300,0..100]
  );
```

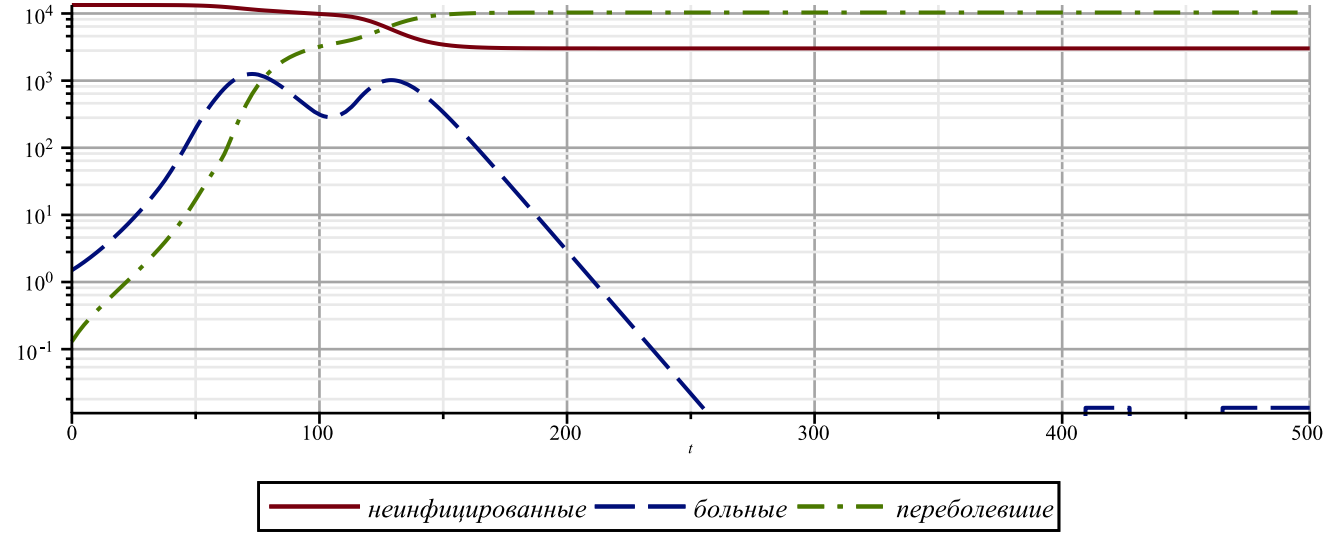
[9.04975926871991, 13380.7013637885, 0.0511516341122043, 0.0876110760233198, 0.121324016958117, 0.165054303003467, 0.123380281215598, 0.113569079033557, 0.0700190187615531, 0.468851923809304, 0.0117865640917915, 0.106139398901217,

0.203563558116982, 0.000270413162241497]

2625.47158283574



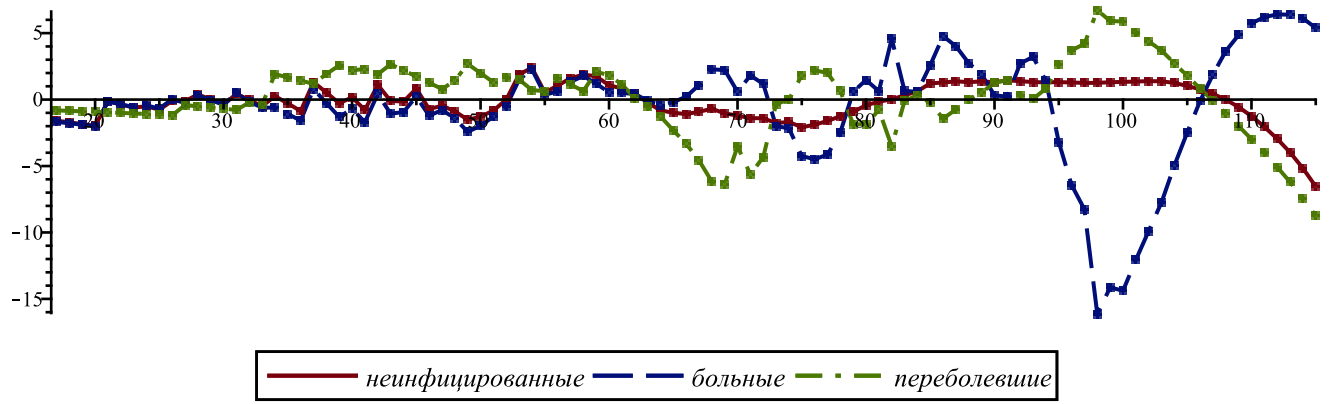

```
> logplot(map(q->q(t),v[1..3]), t=0..500, legend=[``,``,``],
  linestyle=[solid,dash,dashdot],gridlines=true,size=[1000,400],legendstyle=[font=[roman,15]]);
```




```
> display(
   plot([
```

```
  [[i,(T[i-dd]-(K_-A(i)))/sigma(K_-A(i))] $ i=1+dd..dd+nops(T)],
  [[i,(T2[i-dd]-(B(i)))/sigma(B(i))] $ i=1+dd..dd+nops(T)],
  [[i,(T1[i-dd]-(C(i)))/sigma(C(i))] $ i=1+dd..dd+nops(T)]
 ],linestyle=[solid,dash,dashdot],l e g e n d = [ ` ` , ` ` , ` ` ]                    ),
 plot([
  [[i,(T[i-dd]-(K_-A(i)))/sigma(K_-A(i))] $ i=1+dd..dd+nops(T)],
  [[i,(T2[i-dd]-(B(i)))/sigma(B(i))] $ i=1+dd..dd+nops(T)],
  [[i,(T1[i-dd]-(C(i)))/sigma(C(i))] $ i=1+dd..dd+nops(T)]
 ],style=point,symbolsize=8,symbol=solidcircle),
 size=[1000,300],legendstyle=[font=[roman,15]]
): fdisplay(cat(Region,`3c-dev`),%);
```

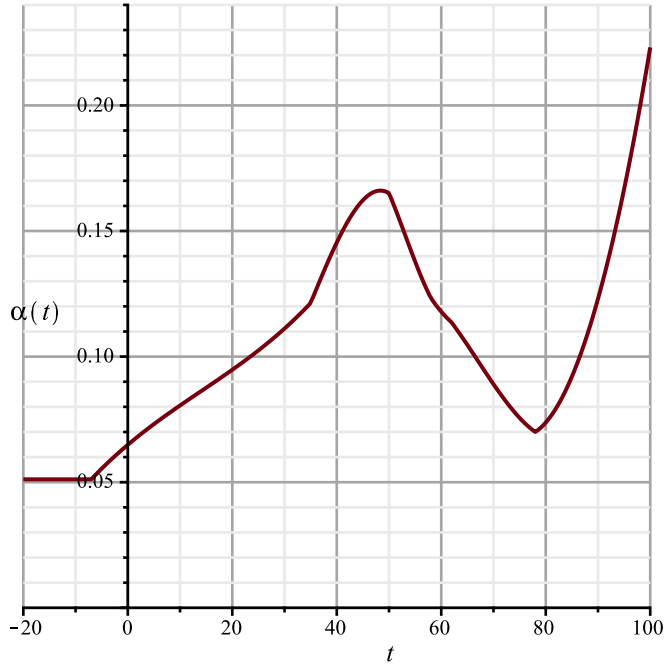
RT3c-dev.jpg



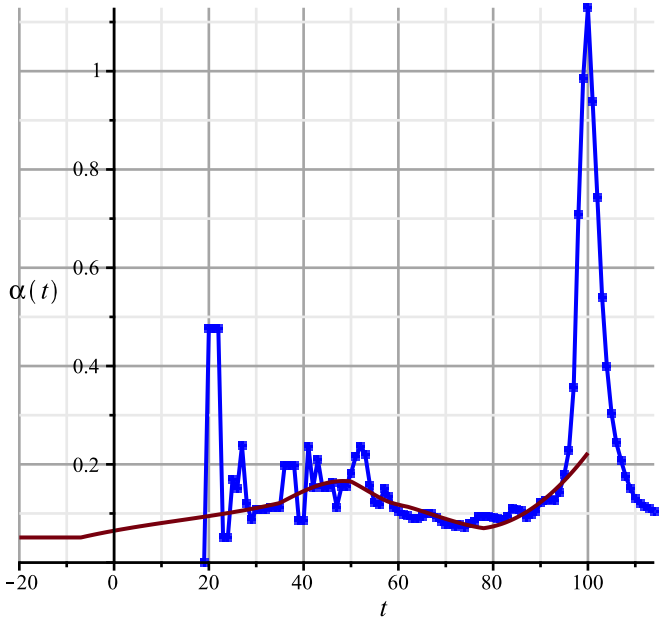

```
> [seq([i,(
  (T[i-dd]-T[i-dd-1]) /(T2[i-dd]+T2[i-dd-1]) /((1-T[i-dd]/K_)+(1-T[i-dd-1]/K_))
 )*4],i=1+dd+1..nops(T)+dd)]: [seq([%[i][1],(%[i-1][2]+%[i][2]+%[i+1][2])/3],i=2..nops(%)-1)]:
 Palpha:=display(plot([%],color=blue),plot([%],style=point,symbolsize=8,symbol=solidcircle,color=
 blue)):
 #display(%,gridlines=true,labels=['t','alpha(t)'],labelfont=[roman,15],view=[0..nops(T)+dd,0.
 .0.9]);

 subs(corr(par,val),alpha(t, op(kA)));
 plot(%,t=-20..100,gridlines=true,labels=['t',''alpha(t)''],labelfont=[roman,15],view=[-20..100,0.
 .0.24]):
 fdisplay(cat(Region,`3c-zar`),%); display([Palpha,%],t i t l e = `   `                ,titlefont=
 [roman,20]);
```

$$\begin{cases} 0.0511516341122043 & t < -7. \\ 6.04530802773049\ 10^{-7}\ t^3 - 0.000025318641671893 8\ t^2 + 0.00175763078808757\ t + 0.0649030171283571 & t < 35. \\ -9.03204975892332\ 10^{-6}\ t^3 + 0.000938339415512518\ t^2 - 0.0273930254385119\ t + 0.317863257179106 & t < 50. \\ 0.000021590668508694 1\ t^3 - 0.00344070930944677\ t^2 + 0.177166733029866\ t - 2.79034264888937 & t < 58. \\ -8.68422351596605\ 10^{-6}\ t^3 + 0.00170602235274439\ t^2 - 0.113351131958020\ t + 2.65308294416811 & t < 62. \\ 4.70513200205594\ 10^{-6}\ t^3 - 0.000945070046235592\ t^2 + 0.0601213589315806\ t - 1.10247062461386 & t < 78. \\ 0.000254738612732159\ t^2 - 0.0383852845501610\ t + 1.51424149384334 & t < 115. \\ 0.468851923809304 & 115. \le t \end{cases}$$

RT3c-zar.jpg



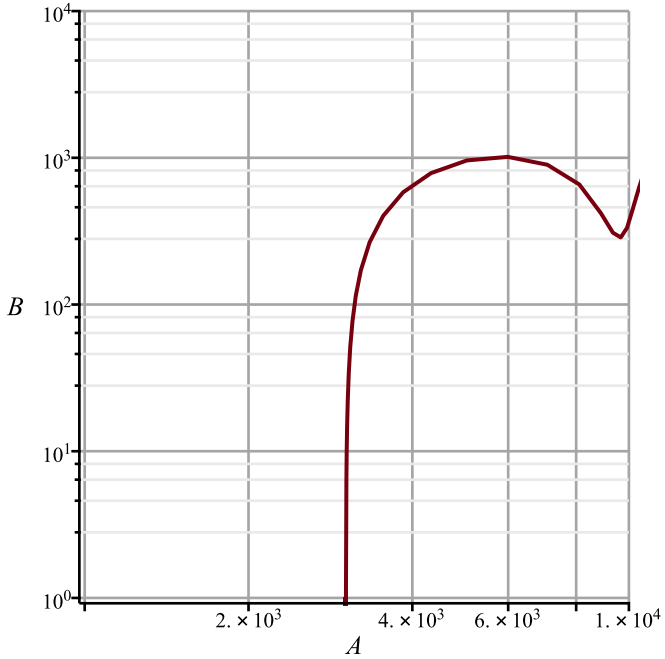
Коэффициент заражения




```
> [seq([i,(
   (T1[i-dd]-T1[i-dd-1]) /(T2[i-dd]+T2[i-dd-1])
  )*2],i=1+dd+1..nops(T1)+dd)]: [seq([%[i][1],(%[i-1][2]+%[i][2]+%[i+1][2])/3],i=2..nops(%)-1)]:
  Pbeta:=display(plot([%],color=blue),plot([%],style=point,symbolsize=8,symbol=solidcircle,color=
  blue)):

  subs(corr(par,val),beta(t,k2a,k2b,k2c));
  plot(%,t=-20..100,gridlines=true,labels=['t',''beta(t)''],labelfont=[roman,15]):
  display([Pbeta,%],t i t l e = `   `                    ,titlefont=[roman,20],view=[-20..100,0..1]);
```

$$\begin{cases} 0.0117865640917915 & t < 60. \\ 0.000883945449305763\, t + 0.0000273835447400681\, t^2 - 0.139830925434023 & t < 97. \\ 0.203563558116982 & 97. \le t \end{cases}$$


```
> plot([v[1](t),v[2](t),t=0..3.0e4],axis[1]=[mode=log],axis[2]=[mode=log],labels=[v[1],v[2]],
  labelfont=[roman,15],gridlines=true,view=[10^3..10^4,10^0..10^4]);
```




```
> res:=solve(map(rhs,eqs[1..2]),v[1..2]); res:=res[2]; evalf(subs(param,t=100,res));

  J:=Matrix(subs(res,map(q->grad(rhs(q),v[1..2]),eqs[1..2]))); J:=evalf(subs(param,corr(par,val),t=
  100,J));
  evalm(%-lambda): collect(Determinant(%),lambda);

  #evalf(subs(param,corr(par,val),t=100,%));
  solve(%,{lambda});
```

$$res := \left[\left[A = \frac{C\,P_{01}}{P_{10} - P_{01}}, B = 0\right], \left[A = \frac{k0\left(P_{23} + P_{20}\right)}{P_{12}}, B = \frac{C\,P_{01}\,P_{12} + k0\,P_{01}\,P_{20} + k0\,P_{01}\,P_{23} - k0\,P_{10}\,P_{20} - k0\,P_{10}\,P_{23}}{P_{12}\left(P_{23} + P_{20}\right)}\right]\right]$$

$$res := \left[A = \frac{k0\left(P_{23} + P_{20}\right)}{P_{12}}, B = \frac{C\,P_{01}\,P_{12} + k0\,P_{01}\,P_{20} + k0\,P_{01}\,P_{23} - k0\,P_{10}\,P_{20} - k0\,P_{10}\,P_{23}}{P_{12}\left(P_{23} + P_{20}\right)}\right]$$

$$\left[A = \frac{k0\,(k2c + k3)}{-0.38915095\,k1x6 + 0.96283784\,k1x7 + 0.426313107\,k1x8}, B = 0.\right]$$

$$J := \begin{bmatrix} P_{01} - \dfrac{C\,P_{01}\,P_{12} + k0\,P_{01}\,P_{20} + k0\,P_{01}\,P_{23} - k0\,P_{10}\,P_{20} - k0\,P_{10}\,P_{23}}{(P_{23} + P_{20})\,k0} - P_{10} & -P_{23} - P_{20} \\ \dfrac{C\,P_{01}\,P_{12} + k0\,P_{01}\,P_{20} + k0\,P_{01}\,P_{23} - k0\,P_{10}\,P_{20} - k0\,P_{10}\,P_{23}}{(P_{23} + P_{20})\,k0} & 0 \end{bmatrix}$$

$$J := \begin{bmatrix} 0. & -0.203833971279223 \\ 0. & 0. \end{bmatrix}$$

$$\lambda^2$$

$$\{\lambda = 0\},\ \{\lambda = 0\}$$

(9

```
> N:='N': A:='A': B:='B': C:='C': Q:='Q':

  param:=[
    P[`01`]=kappa,  P[`12`]=k1, P[`23`]=k2,
    P[`10`]=kappa, P[`20`]=k3, P[`30`]=k4
  ];
  corr(par,val);
  subs(param,eqs); R:=solve(%,[k1,k2,k3,k4])[1];

  X:='X': X1:='X1': subs(R,Diff(A,t)=-X1[1][i][2],Diff(B,t)=X1[2][i][2],Diff(C,t)=X1[3][i][2],Diff
  (Q,t)=X1[4][i][2],A=k0-X[1][i][2],B=X[2][i][2],C=X[3][i][2],Q=X[4][i][2],[k1,k2,k3,k4]): XX:=
  unapply(subs(k0=K_,%),i):
```

$$param := [P_{01} = 0, P_{12} = k1, P_{23} = k2, P_{10} = 0, P_{20} = k3, P_{30} = k4]$$

$$d0 = 9.04975926871991,\ k0 = 13380.7013637885,\ k1x1 = 0.0511516341122043,\ k1x2 = 0.0876110760233198,\ k1x3 = 0.121324016958117,$$
$$k1x4 = 0.165054303003467,\ k1x5 = 0.123380281215598,\ k1x6 = 0.113569079033557,\ k1x7 = 0.0700190187615531,\ k1x8$$
$$= 0.468851923809304,\ k2a = 0.0117865640917915,\ k2b = 0.106139398901217,\ k2c = 0.203563558116982,\ k3 = 0.000270413162241497$$

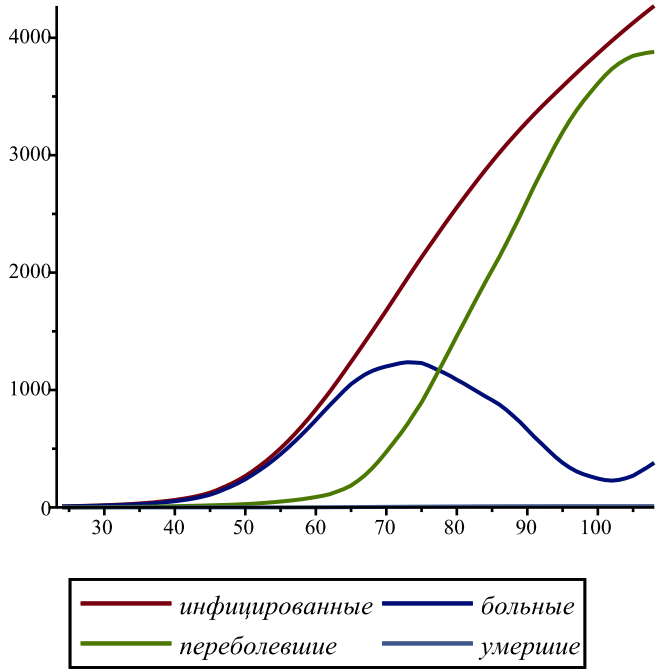
$$\left[\frac{\partial}{\partial t}\ A = -\frac{B\,k1\,A}{k0},\ \frac{\partial}{\partial t}\ B = \frac{B\,k1\,A}{k0} - k2\,B - k3\,B,\ \frac{\partial}{\partial t}\ C = k2\,B - C\,k4,\ \frac{\partial}{\partial t}\ Q = k3\,B\right]$$

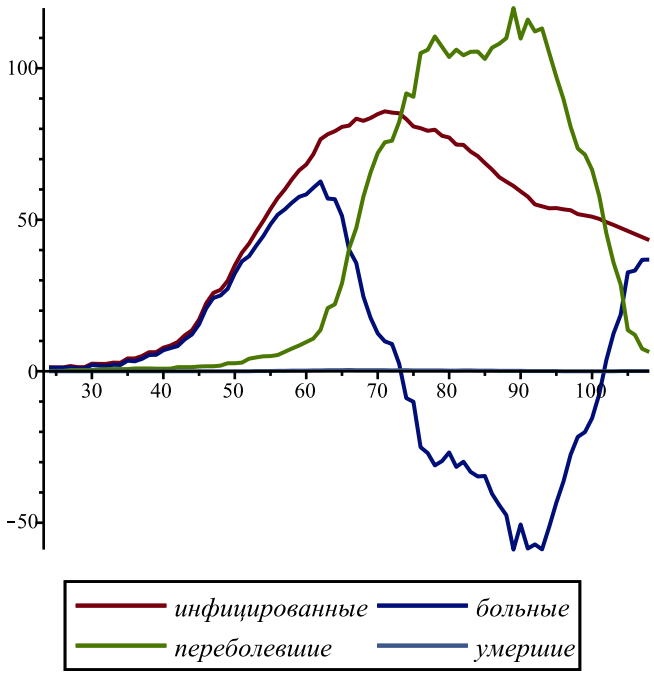
(10

$$R := \left[k1 = -\frac{\frac{\partial}{\partial t} A\,k0}{A\,B},\ k2 = -\frac{\frac{\partial}{\partial t} B + \frac{\partial}{\partial t} Q + \frac{\partial}{\partial t} A}{B},\ k3 = \frac{\frac{\partial}{\partial t} Q}{B},\ k4 = -\frac{\frac{\partial}{\partial t} B + \frac{\partial}{\partial t} Q + \frac{\partial}{\partial t} A + \frac{\partial}{\partial t} C}{C} \right] \quad \text{(10}$$

```
> k:=7;
  X:=map(q->[seq([i+dd,(ssum(q[i+j],j=-k..k))/(2*k)],i=1+k..nops(q)-k)],[T,T2,T1,T3]):
  plot(%,legend=[` `, ` `, ` `, ` `]                                    ,legendstyle=[font=[roman,15]]
  );
  X1:=map(q->[seq([i+dd,(q[i+k]-q[i-k])/(2*k)],i=1+k..nops(q)-k)],[T,T2,T1,T3]):
  plot(%,legend=[` `, ` `, ` `, ` `]                                    ,legendstyle=[font=[roman,15]]
  );
```

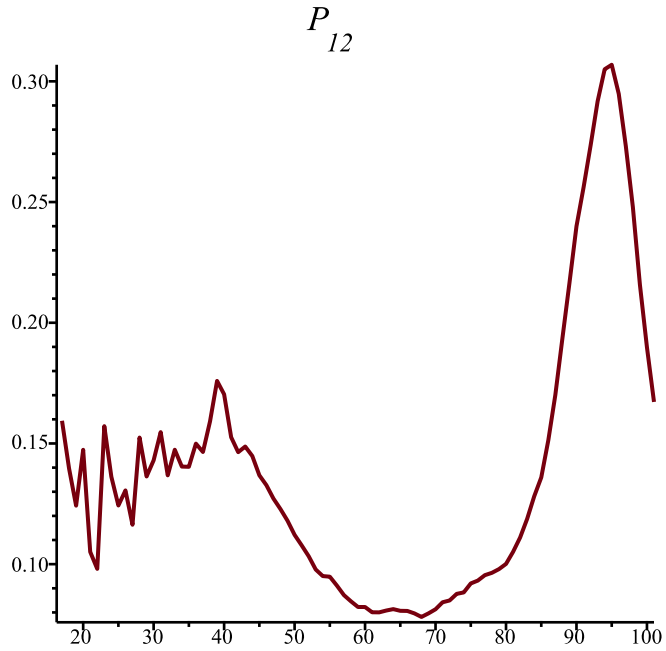
$k := 7$

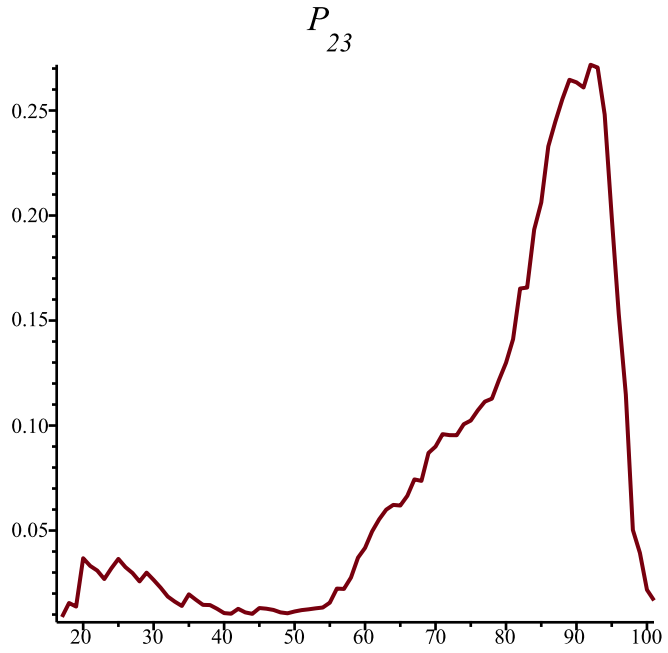


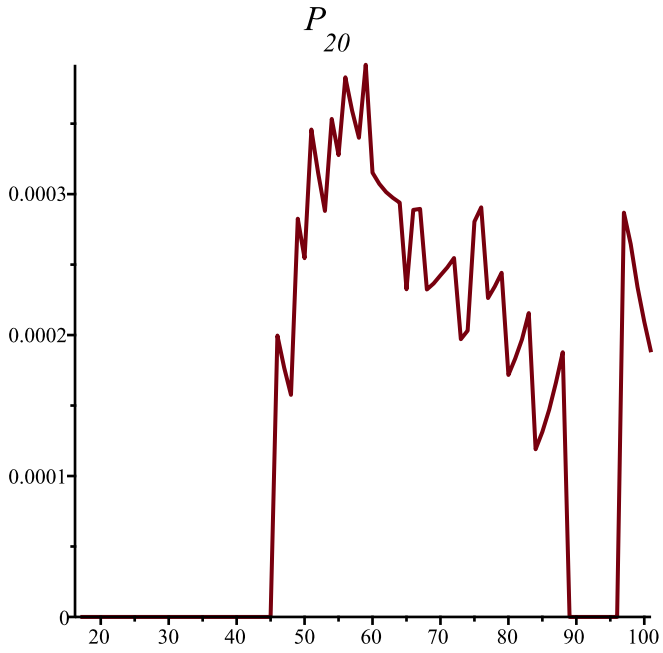



```
> k:=0;

  [seq([i+dd+k,XX(i)[1]],i=1..nops(X[1]))]: [seq([%[i][1],(ssum(%[i+j][2],j=-k..k))/(2*k+1)],i=1+k.
  .nops(%)-k)]:
  plot([%],title=P[`12`],titlefont=[roman,20]);

  [seq([i+dd+k,XX(i)[2]],i=1..nops(X[1]))]: [seq([%[i][1],(ssum(%[i+j][2],j=-k..k))/(2*k+1)],i=1+k.
  .nops(%)-k)]:
  plot([%],title=P[`23`],titlefont=[roman,20]);

  [seq([i+dd+k,XX(i)[3]],i=1..nops(X[1]))]: [seq([%[i][1],(ssum(%[i+j][2],j=-k..k))/(2*k+1)],i=1+k.
  .nops(%)-k)]:
  plot([%],title=P[`20`],titlefont=[roman,20]);
```

$$k := 0$$


P_{12}
0.30
0.25
0.20
0.15
0.10
20
30
40
50
60
70
80
90
100


P_{23}
0.25
0.20
0.15
0.10
0.05
20
30
40
50
60
70
80
90
100


P_{20}
0.0003
0.0002
0.0001
0
20
30
40
50
60
70
80
90
100