```
> 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, #0.0000945735454255790];

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*
1.1; 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*
1.1; od;
 t:=goldMin(t->ff(t*V0+(1-t)*V2),0..1,0.0001);
 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 := "https://gogov.ru/covid-19/rt#data"

valp := [9.243366066, 4191.259001, 0.05595514027, 0.09579542333, 0.1173616824, 0.181920404, 0.1420450087, 0.1171386628, 0.1250435919, 0.1196220088, 0.01463856287, 0.08754481825, 0.00009459445504]

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

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

$$\pi := 3.141592654 \tag{1}$$

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

$$==================================$$

VERHULST FItAING

$$================================== \tag{2}$$

```
> 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:
```

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

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

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

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

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

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

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

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

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

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

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

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

$$chi2e := (T, f\_) \rightarrow simplify\left(\sum_{k=1}^{nops(T)} \frac{evalf\left(ffe\_(T_k) - f\_(k)\right)^2}{dffe\_(T_k)^2 \, \sigma(T_k)^2}\right) \quad (3$$

```
> 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]]

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]

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]

$T2$ = [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]

$T3$ = [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, 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]

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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, 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] **(4**

```
> 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
  );
```

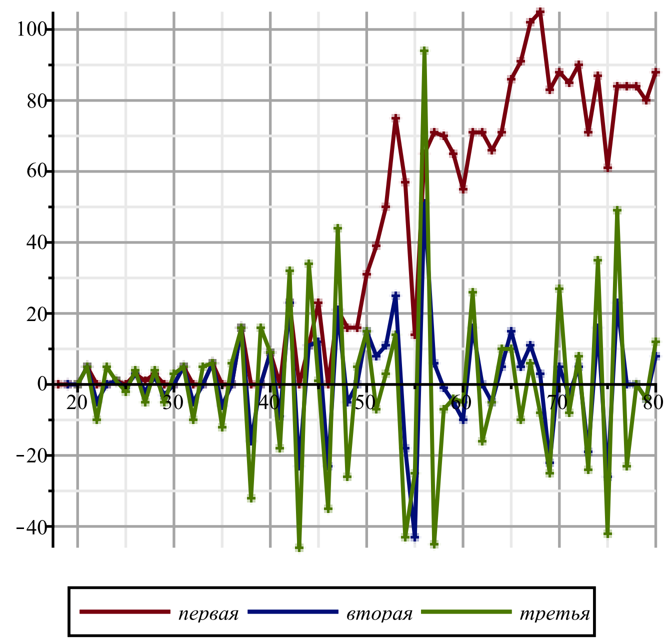
$$h := x \mapsto x$$

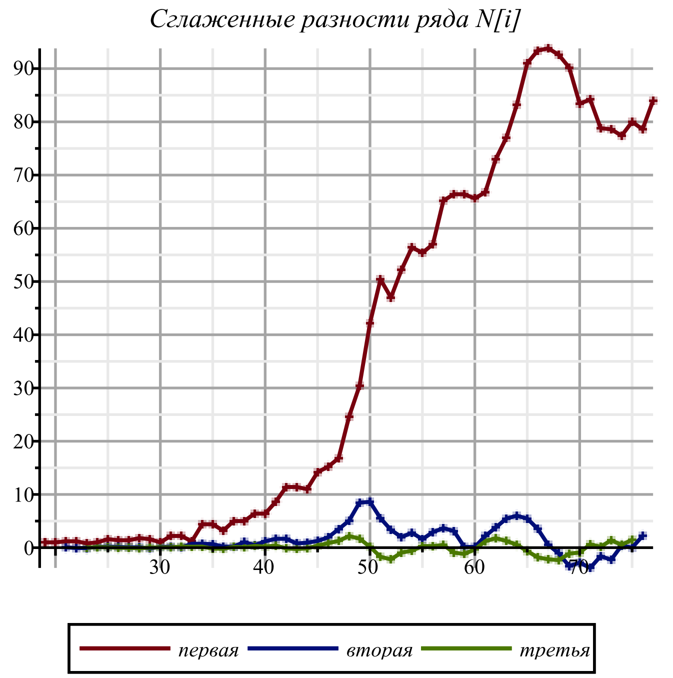
[0, 0, 0, 5, 0, 0, 1, 0, 3, 1, 3, 0, 0, 5, 0, 0, 6, 0, 0, 16, 0, 0, 9, 0, 23, 0, 11, 23, 0, 21, 16, 16, 31, 39, 50, 75, 57, 14, 65, 71, 70, 65, 55, 71, 71, 66, 71, 86, 91, 102, 105, 83, 88, 85, 90, 71, 87, 61, 84, 84, 84, 80, 88]

[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]

[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]

Разности ряда N[i]






```
> h:=x->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=[``,``,``]),
```

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

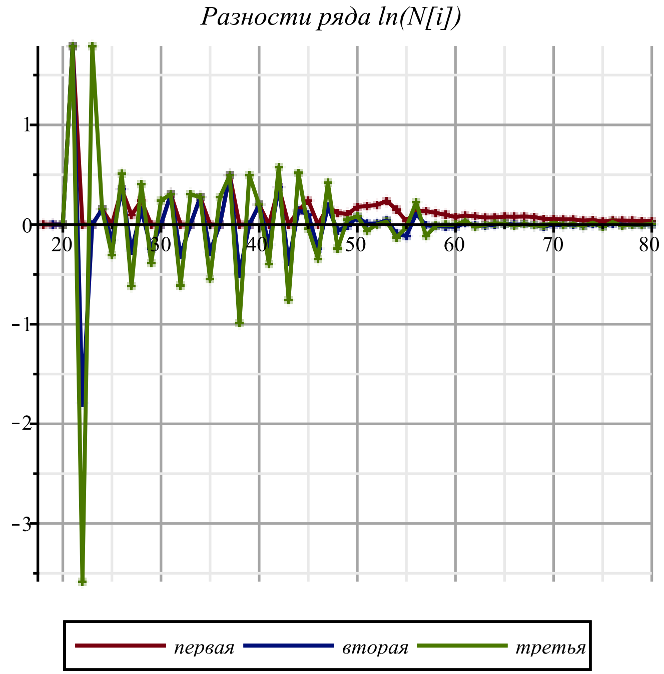
$$h := x \mapsto \ln(x)$$

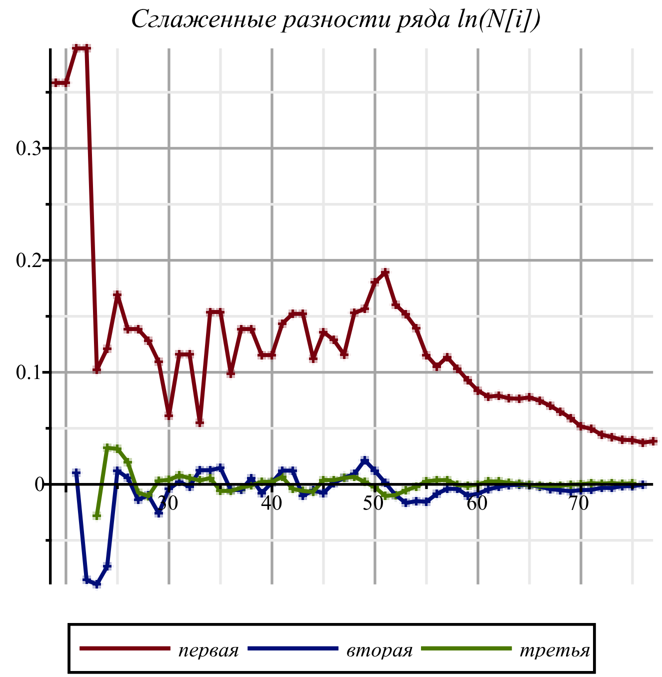
[0, 0, 0, ln(6), 0, 0, ln(7) − ln(6), 0, ln(10) − ln(7), ln(11) − ln(10), ln(14) − ln(11), 0, 0, ln(19) − ln(14), 0, 0, 2 ln(5) − ln(19), 0, 0, ln(41) − 2 ln(5), 0, 0, ln(50) − ln(41), 0, ln(73) − ln(50), 0, ln(84) − ln(73), ln(107) − ln(84), 0, 7 ln(2) − ln(107), 2 ln(12) − 7 ln(2), ln(160) − 2 ln(12), ln(191) − ln(160), ln(230) − ln(191), ln(280) − ln(230), ln(355) − ln(280), ln(412) − ln(355), ln(426) − ln(412), ln(491) − ln(426), ln(562) − ln(491), ln(632) − ln(562), ln(697) − ln(632), ln(752) − ln(697), ln(823) − ln(752), ln(894) − ln(823), ln(960) − ln(894), ln(1031) − ln(960), ln(1117) − ln(1031), ln(1208) − ln(1117), ln(1310) − ln(1208), ln(1415) − ln(1310), ln(1498) − ln(1415), ln(1586) − ln(1498), ln(1671) − ln(1586), ln(1761) − ln(1671), ln(1832) − ln(1761), ln(1919) − ln(1832), ln(1980) − ln(1919), ln(2064) − ln(1980), ln(2148) − ln(2064), ln(2232) − ln(2148), ln(2312) − ln(2232), ln(2400) − ln(2312)]

[0, 0, ln(6), -ln(6), 0, ln(7) − ln(6), -ln(7) + ln(6), ln(10) − ln(7), ln(11) − 2 ln(10) + ln(7), ln(14) − 2 ln(11) + ln(10), -ln(14) + ln(11), 0, ln(19) − ln(14), -ln(19) + ln(14), 0, 2 ln(5) − ln(19), -2 ln(5) + ln(19), 0, ln(41) − 2 ln(5), -ln(41) + 2 ln(5), 0, ln(50) − ln(41), -ln(50) + ln(41), ln(73) − ln(50), -ln(73) + ln(50), ln(84) − ln(73), ln(107) − 2 ln(84) + ln(73), -ln(107) + ln(84), 7 ln(2) − ln(107), 2 ln(12) − 14 ln(2) + ln(107), ln(160) − 4 ln(12) + 7 ln(2), ln(191) − 2 ln(160) + 2 ln(12), ln(230) − 2 ln(191) + ln(160), ln(280) − 2 ln(230) + ln(191), ln(355) − 2 ln(280) + ln(230), ln(412) − 2 ln(355) + ln(280), ln(426) − 2 ln(412) + ln(355), ln(491) − 2 ln(426) + ln(412), ln(562) − 2 ln(491) + ln(426), ln(632) − 2 ln(562) + ln(491), ln(697) − 2 ln(632) + ln(562), ln(752) − 2 ln(697) + ln(632), ln(823) − 2 ln(752) + ln(697), ln(894) − 2 ln(823) + ln(752), ln(960) − 2 ln(894) + ln(823), ln(1031) − 2 ln(960) + ln(894), ln(1117) − 2 ln(1031) + ln(960), ln(1208) − 2 ln(1117) + ln(1031), ln(1310) − 2 ln(1208) + ln(1117), ln(1415) − 2 ln(1310) + ln(1208), ln(1498) − 2 ln(1415) + ln(1310), ln(1586) − 2 ln(1498) + ln(1415), ln(1671) − 2 ln(1586) + ln(1498), ln(1761) − 2 ln(1671) + ln(1586), ln(1832) − 2 ln(1761) + ln(1671), ln(1919) − 2 ln(1832) + ln(1761), ln(1980) − 2 ln(1919) + ln(1832), ln(2064) − 2 ln(1980) + ln(1919), ln(2148) − 2 ln(2064) + ln(1980), ln(2232) − 2 ln(2148) + ln(2064), ln(2312) − 2 ln(2232) + ln(2148), ln(2400) − 2 ln(2312) + ln(2232)]

[0, ln(6), -2 ln(6), ln(6), ln(7) − ln(6), -2 ln(7) + 2 ln(6), ln(10) − ln(6), ln(11) − 3 ln(10) + 2 ln(7), ln(14) − 3 ln(11) + 3 ln(10) − ln(7), -2 ln(14) + 3 ln(11) − ln(10), ln(14) − ln(11), ln(19) − ln(14), -2 ln(19) + 2 ln(14), ln(19) − ln(14), 2 ln(5) − ln(19), -4 ln(5) + 2 ln(19), 2 ln(5) − ln(19), ln(41) − 2 ln(5), -2 ln(41) + 4 ln(5), ln(41) − 2 ln(5), ln(50) − ln(41), -2 ln(50) + 2 ln(41), ln(73) − ln(41), -2 ln(73) + 2 ln(50), ln(84) − ln(50), ln(107) − 3 ln(84) + 2 ln(73), -2 ln(107) + 3 ln(84) − ln(73), 7 ln(2) − ln(84), 2 ln(12) − 21 ln(2) + 2 ln(107), ln(160) − 6 ln(12) + 21 ln(2) − ln(107), ln(191) − 3 ln(160) + 6 ln(12) − 7 ln(2), ln(230) − 3 ln(191) + 3 ln(160) − 2 ln(12), ln(280) − 3 ln(230) + 3 ln(191) − ln(160), ln(355) − 3 ln(280) + 3 ln(230) − ln(191), ln(412) − 3 ln(355) + 3 ln(280) − ln(230), ln(426) − 3 ln(412) + 3 ln(355) − ln(280), ln(491) − 3 ln(426)

$+ 3\ln(412) - \ln(355), \ln(562) - 3\ln(491) + 3\ln(426) - \ln(412), \ln(632) - 3\ln(562) + 3\ln(491) - \ln(426), \ln(697) - 3\ln(632) + 3\ln(562) - \ln(491), \ln(752) - 3\ln(697) + 3\ln(632) - \ln(562), \ln(823) - 3\ln(752) + 3\ln(697) - \ln(632), \ln(894) - 3\ln(823) + 3\ln(752) - \ln(697), \ln(960) - 3\ln(894) + 3\ln(823) - \ln(752), \ln(1031) - 3\ln(960) + 3\ln(894) - \ln(823), \ln(1117) - 3\ln(1031) + 3\ln(960) - \ln(894), \ln(1208) - 3\ln(1117) + 3\ln(1031) - \ln(960), \ln(1310) - 3\ln(1208) + 3\ln(1117) - \ln(1031), \ln(1415) - 3\ln(1310) + 3\ln(1208) - \ln(1117), \ln(1498) - 3\ln(1415) + 3\ln(1310) - \ln(1208), \ln(1586) - 3\ln(1498) + 3\ln(1415) - \ln(1310), \ln(1671) - 3\ln(1586) + 3\ln(1498) - \ln(1415), \ln(1761) - 3\ln(1671) + 3\ln(1586) - \ln(1498), \ln(1832) - 3\ln(1761) + 3\ln(1671) - \ln(1586), \ln(1919) - 3\ln(1832) + 3\ln(1761) - \ln(1671), \ln(1980) - 3\ln(1919) + 3\ln(1832) - \ln(1761), \ln(2064) - 3\ln(1980) + 3\ln(1919) - \ln(1832), \ln(2148) - 3\ln(2064) + 3\ln(1980) - \ln(1919), \ln(2232) - 3\ln(2148) + 3\ln(2064) - \ln(1980), \ln(2312) - 3\ln(2232) + 3\ln(2148) - \ln(2064), \ln(2400) - 3\ln(2312) + 3\ln(2232) - \ln(2148)]$






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

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

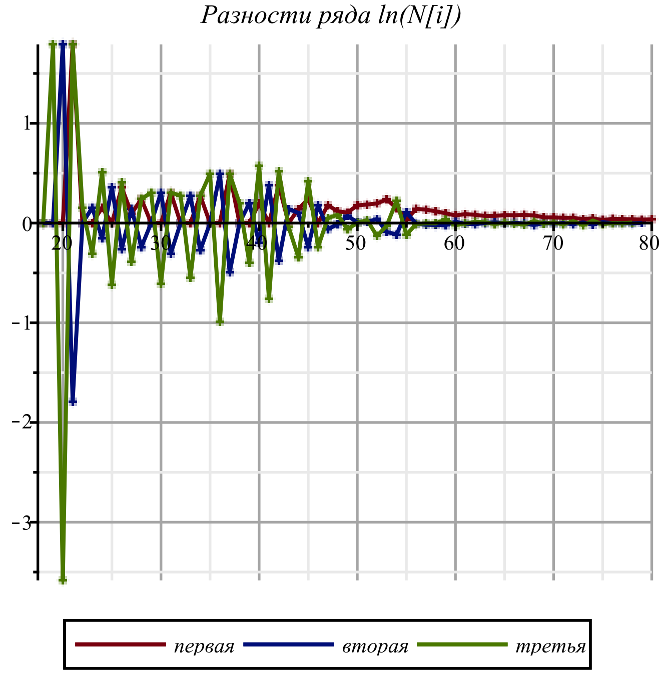
$$[0, 0, 0, \ln(6), 0, 0, \ln(7) - \ln(6), 0, \ln(10) - \ln(7), \ln(11) - \ln(10), \ln(14) - \ln(11), 0, 0, \ln(19) - \ln(14), 0, 0, 2\ln(5) - \ln(19), 0, 0, \ln(41) - 2\ln(5), 0, 0, \ln(50) - \ln(41), 0, \ln(73) - \ln(50), 0, \ln(84) - \ln(73), \ln(107) - \ln(84), 0, 7\ln(2) - \ln(107), 2\ln(12) - 7\ln(2), \ln(160) - 2\ln(12), \ln(191) - \ln(160), \ln(230) - \ln(191), \ln(280) - \ln(230), \ln(355) - \ln(280), \ln(412) - \ln(355), \ln(426) - \ln(412), \ln(491) - \ln(426), \ln(562) - \ln(491), \ln(632) - \ln(562), \ln(697) - \ln(632), \ln(752) - \ln(697), \ln(823)$$

$- \ln(752), \ln(894) - \ln(823), \ln(960) - \ln(894), \ln(1031) - \ln(960), \ln(1117) - \ln(1031), \ln(1208) - \ln(1117), \ln(1310) - \ln(1208), \ln(1415) - \ln(1310), \ln(1498) - \ln(1415), \ln(1586) - \ln(1498), \ln(1671) - \ln(1586), \ln(1761) - \ln(1671), \ln(1832) - \ln(1761), \ln(1919) - \ln(1832), \ln(1980) - \ln(1919), \ln(2064) - \ln(1980), \ln(2148) - \ln(2064), \ln(2232) - \ln(2148), \ln(2312) - \ln(2232), \ln(2400) - \ln(2312)]$

$[0, 0, \ln(6), -\ln(6), 0, \ln(7) - \ln(6), -\ln(7) + \ln(6), \ln(10) - \ln(7), \ln(11) - 2\ln(10) + \ln(7), \ln(14) - 2\ln(11) + \ln(10), -\ln(14) + \ln(11), 0, \ln(19) - \ln(14), -\ln(19) + \ln(14), 0, 2\ln(5) - \ln(19), -2\ln(5) + \ln(19), 0, \ln(41) - 2\ln(5), -\ln(41) + 2\ln(5), 0, \ln(50) - \ln(41), -\ln(50) + \ln(41), \ln(73) - \ln(50), -\ln(73) + \ln(50), \ln(84) - \ln(73), \ln(107) - 2\ln(84) + \ln(73), -\ln(107) + \ln(84), 7\ln(2) - \ln(107), 2\ln(12) - 14\ln(2) + \ln(107), \ln(160) - 4\ln(12) + 7\ln(2), \ln(191) - 2\ln(160) + 2\ln(12), \ln(230) - 2\ln(191) + \ln(160), \ln(280) - 2\ln(230) + \ln(191), \ln(355) - 2\ln(280) + \ln(230), \ln(412) - 2\ln(355) + \ln(280), \ln(426) - 2\ln(412) + \ln(355), \ln(491) - 2\ln(426) + \ln(412), \ln(562) - 2\ln(491) + \ln(426), \ln(632) - 2\ln(562) + \ln(491), \ln(697) - 2\ln(632) + \ln(562), \ln(752) - 2\ln(697) + \ln(632), \ln(823) - 2\ln(752) + \ln(697), \ln(894) - 2\ln(823) + \ln(752), \ln(960) - 2\ln(894) + \ln(823), \ln(1031) - 2\ln(960) + \ln(894), \ln(1117) - 2\ln(1031) + \ln(960), \ln(1208) - 2\ln(1117) + \ln(1031), \ln(1310) - 2\ln(1208) + \ln(1117), \ln(1415) - 2\ln(1310) + \ln(1208), \ln(1498) - 2\ln(1415) + \ln(1310), \ln(1586) - 2\ln(1498) + \ln(1415), \ln(1671) - 2\ln(1586) + \ln(1498), \ln(1761) - 2\ln(1671) + \ln(1586), \ln(1832) - 2\ln(1761) + \ln(1671), \ln(1919) - 2\ln(1832) + \ln(1761), \ln(1980) - 2\ln(1919) + \ln(1832), \ln(2064) - 2\ln(1980) + \ln(1919), \ln(2148) - 2\ln(2064) + \ln(1980), \ln(2232) - 2\ln(2148) + \ln(2064), \ln(2312) - 2\ln(2232) + \ln(2148), \ln(2400) - 2\ln(2312) + \ln(2232)]$

$[0, \ln(6), -2\ln(6), \ln(6), \ln(7) - \ln(6), -2\ln(7) + 2\ln(6), \ln(10) - \ln(6), \ln(11) - 3\ln(10) + 2\ln(7), \ln(14) - 3\ln(11) + 3\ln(10) - \ln(7), -2\ln(14) + 3\ln(11) - \ln(10), \ln(14) - \ln(11), \ln(19) - \ln(14), -2\ln(19) + 2\ln(14), \ln(19) - \ln(14), 2\ln(5) - \ln(19), -4\ln(5) + 2\ln(19), 2\ln(5) - \ln(19), \ln(41) - 2\ln(5), -2\ln(41) + 4\ln(5), \ln(41) - 2\ln(5), \ln(50) - \ln(41), -2\ln(50) + 2\ln(41), \ln(73) - \ln(41), -2\ln(73) + 2\ln(50), \ln(84) - \ln(50), \ln(107) - 3\ln(84) + 2\ln(73), -2\ln(107) + 3\ln(84) - \ln(73), 7\ln(2) - \ln(84), 2\ln(12) - 21\ln(2) + 2\ln(107), \ln(160) - 6\ln(12) + 21\ln(2) - \ln(107), \ln(191) - 3\ln(160) + 6\ln(12) - 7\ln(2), \ln(230) - 3\ln(191) + 3\ln(160) - 2\ln(12), \ln(280) - 3\ln(230) + 3\ln(191) - \ln(160), \ln(355) - 3\ln(280) + 3\ln(230) - \ln(191), \ln(412) - 3\ln(355) + 3\ln(280) - \ln(230), \ln(426) - 3\ln(412) + 3\ln(355) - \ln(280), \ln(491) - 3\ln(426) + 3\ln(412) - \ln(355), \ln(562) - 3\ln(491) + 3\ln(426) - \ln(412), \ln(632) - 3\ln(562) + 3\ln(491) - \ln(426), \ln(697) - 3\ln(632) + 3\ln(562) - \ln(491), \ln(752) - 3\ln(697) + 3\ln(632) - \ln(562), \ln(823) - 3\ln(752) + 3\ln(697) - \ln(632), \ln(894) - 3\ln(823) + 3\ln(752) - \ln(697), \ln(960) - 3\ln(894) + 3\ln(823) - \ln(752), \ln(1031) - 3\ln(960) + 3\ln(894) - \ln(823), \ln(1117) - 3\ln(1031) + 3\ln(960) - \ln(894), \ln(1208) - 3\ln(1117) + 3\ln(1031) - \ln(960), \ln(1310) - 3\ln(1208) + 3\ln(1117) - \ln(1031), \ln(1415) - 3\ln(1310) + 3\ln(1208) - \ln(1117), \ln(1498) - 3\ln(1415) + 3\ln(1310) - \ln(1208), \ln(1586) - 3\ln(1498) + 3\ln(1415) - \ln(1310), \ln(1671) - 3\ln(1586) + 3\ln(1498) - \ln(1415), \ln(1761) - 3\ln(1671) + 3\ln(1586) - \ln(1498), \ln(1832) - 3\ln(1761) + 3\ln(1671) - \ln(1586), \ln(1919) - 3\ln(1832) + 3\ln(1761) - \ln(1671), \ln(1980)$

$-3\ln(1919)+3\ln(1832)-\ln(1761), \ln(2064)-3\ln(1980)+3\ln(1919)-\ln(1832), \ln(2148)-3\ln(2064)+3\ln(1980)-\ln(1919), \ln(2232)-3\ln(2148)+3\ln(2064)-\ln(1980), \ln(2312)-3\ln(2232)+3\ln(2148)-\ln(2064), \ln(2400)-3\ln(2312)+3\ln(2232)-\ln(2148)]$




```
> 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

\` \`

$$M := 2604.083755$$

$$N(t) = 2604.083755 - \frac{2604.083755}{e^{0.1441490672\,t - 7.297048445} + 1}$$

$$Chi2 := 77.04062949$$

Next day forecast: 2313

The level of 0.5 M is reached at 37 apr

The level of 0.85 M is reached at 49 apr

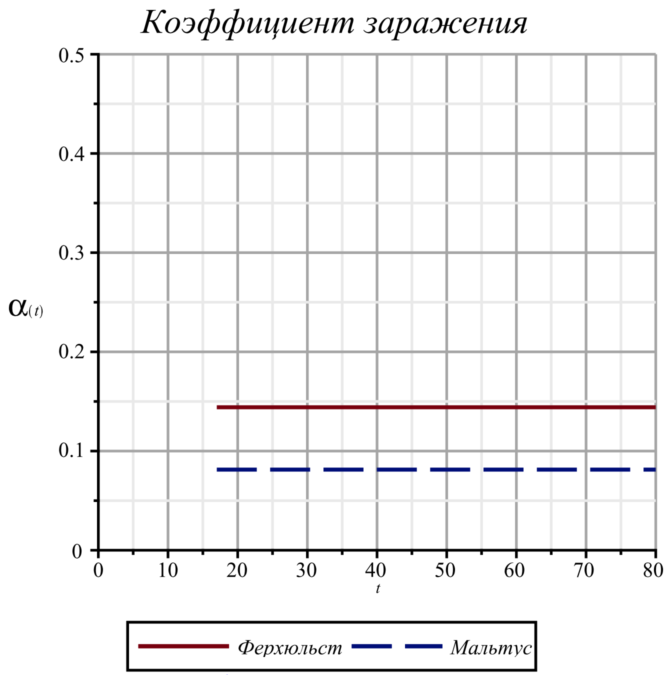
\` \`

Approximation of the infection schedule by solving the Malthus equation

\` \`

$$N(t) = e^{0.08127516567\,t + 2.842345802}$$

$$[0.1441490672]$$



$$d1 := 66.62154468$$

$$K\_ := 2604.083755$$

$$alpha\_ := 0.1441490672$$

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

\` \`

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

\` \`

$$M := 3578.529922$$

$$N(t) = 3578.529922 - \frac{3578.529922}{e^{6.743817110\,10^{-7}\,t^4 - 0.0001254516645\,t^3 + 0.007340319817\,t^2 - 0.02127336435\,t - 6.464809287} + 1}$$

$$Chi2 := 54.73506131$$

Next day forecast: 2431

The level of 0.5 M is reached at   42 apr

The level of 0.85 M is reached at   62 apr

\` \`

Approximation of the infection schedule by solving the Malthus equation

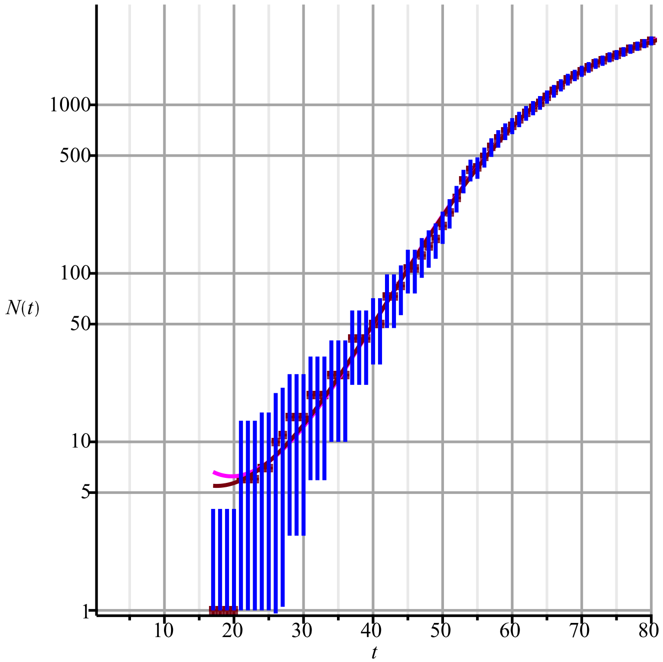
\` \`

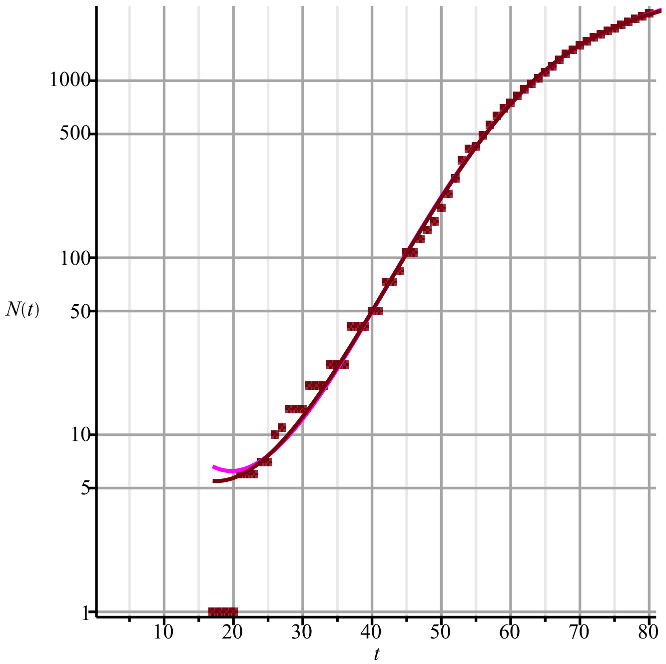
$$N(t) = e^{9.787984771\,10^{-7}\,t^4 - 0.0001779322754\,t^3 + 0.009819078032\,t^2 - 0.06513968177\,t + 1.947047925}$$

$$[-0.363559546700000, 0.0287957000400000, -0.000505836282000000, 2.697526844\,10^{-6}]$$

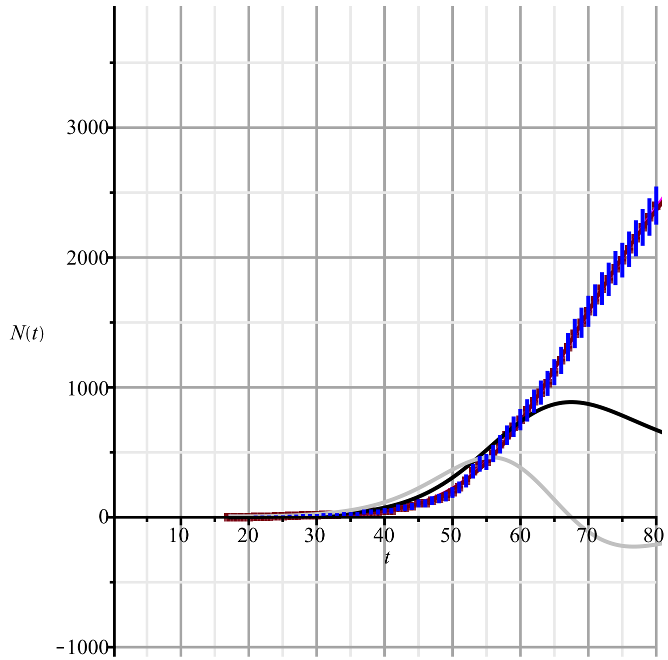

```
> df:=unapply(diff(f(i),i),i): ddf:=unapply(diff(f(i),i,i),i):

  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
  );
```

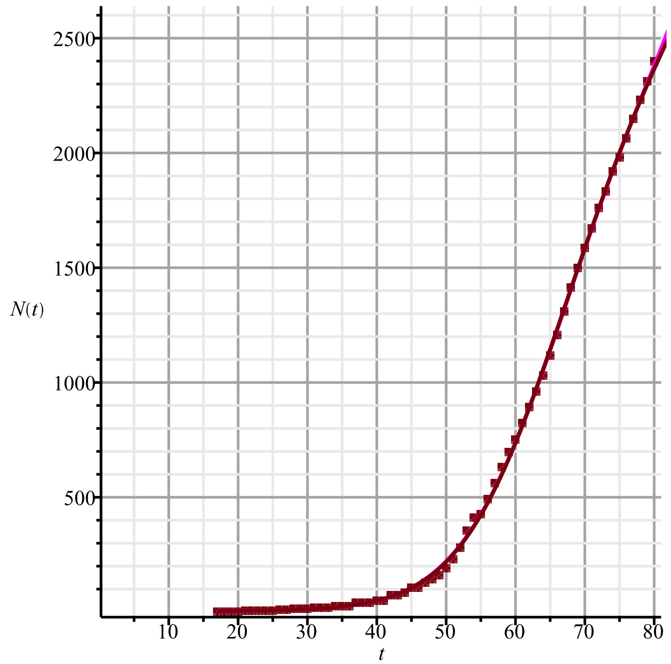
```
display(
 plot([[i+dd,T[i]] $ i=1..nops(T)],style=point,symbolsize=10,symbol=solidcircle),
 plot(fe(i-dd),i=1+dd..max(120,dd+nops(T)),color=magenta),
 plot(f(i-dd),i=1+dd..max(dd+nops(T),90)),
 plot(10*df(i-dd),i=1+dd..max(dd+nops(T),120),color=black),
 plot(100*ddf(i-dd),i=1+dd..max(dd+nops(T),120),color=gray),
 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
);
```



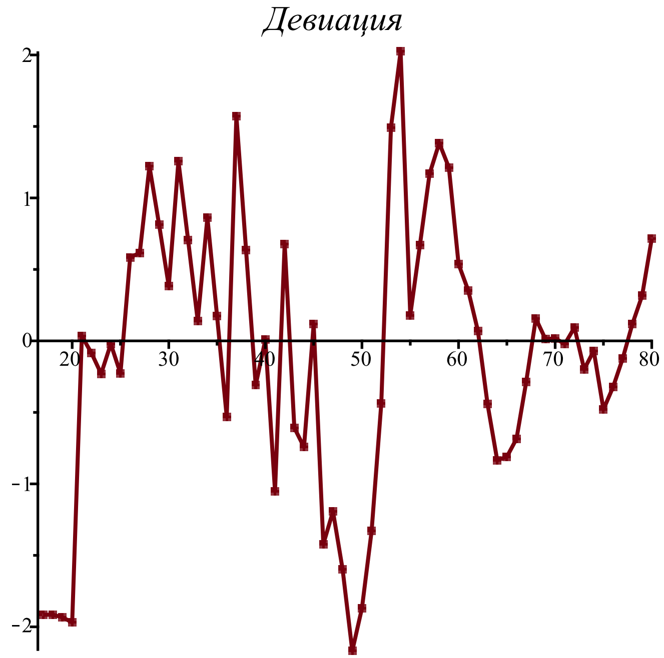


1000
500
100
50
10
5
1
N(t)
10
20
30
40
50
60
70
80
t


3000
2000
1000
0
-1000
N(t)
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] );
```




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

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

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

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

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

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

$$\begin{bmatrix} \frac{\partial}{\partial t}\,A = P_{01} - \frac{B\,P_{12}\,A}{K} - P_{10}\,A \\ \frac{\partial}{\partial t}\,B = \frac{B\,P_{12}\,A}{K} - P_{23}\,B - P_{20}\,B \\ \frac{\partial}{\partial t}\,C = P_{23}\,B - P_{30}\,C \end{bmatrix} \quad \textbf{(6}$$

```
> v:=M; alpha:='alpha': K:=k0; tA:=[1,15,35,50,58,62,73,nops(T)+dd]; kA:=['k1x||i' $ i=1..nops(tA)]
  ;

  par:=[d0,k0,op(kA),k2a,k2b,k3];

  param:=[
    P[`01`]=0,  P[`12`]=alpha(t,op(kA)), P[`23`]=beta(t,k2a,k2b),
    P[`10`]=0, P[`20`]=k3
  ];

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

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

$$K := k0$$

$$tA := [1, 15, 35, 50, 58, 62, 73, 80]$$

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

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

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

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

```
> res:=solve(map(rhs,eqs[1..2]),v[1..2]); res:=res[2]: subs(P[`30`]=P[`10`],param,res);

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

  subs(P[`30`]=P[`10`],pr(param),%); solve(%,{lambda});
```

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

$$\left[A = \frac{k0\left(\beta(t, k2a, k2b) + k3\right)}{\alpha(t, k1x1, k1x2, k1x3, k1x4, k1x5, k1x6, k1x7, k1x8)}, B = 0\right]$$

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

$$\frac{(k0\,P_{20} + k0\,P_{23})\,\lambda^2}{(P_{23}+P_{20})\,k0} + \frac{P_{01}\,P_{12}\,\lambda}{(P_{23}+P_{20})\,k0} + \frac{-k0\,P_{10}\,P_{20}^2 - 2\,k0\,P_{10}\,P_{20}\,P_{23} - k0\,P_{10}\,P_{23}^2 + P_{01}\,P_{12}\,P_{20} + P_{01}\,P_{12}\,P_{23}}{(P_{23}+P_{20})\,k0}$$

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

$$\frac{(k0\,k3 + k0\,\beta(t, k2a, k2b))\,\lambda^2}{(\beta(t, k2a, k2b) + k3)\,k0}$$

$$\{\lambda=0\}, \{\lambda=0\} \quad \textbf{(8}$$

```
> Eqs:=subs(map(q->q=q(t),v),Diff=diff,P[`30`]=P[`10`],param,eqs); #dsolve(%);
```

$$Eqs := \left[\frac{d}{dt} A(t) = -\frac{B(t)\,\alpha(t, k1x1, k1x2, k1x3, k1x4, k1x5, k1x6, k1x7, k1x8)\,A(t)}{k0}, \frac{d}{dt} B(t) = \frac{B(t)\,\alpha(t, k1x1, k1x2, k1x3, k1x4, k1x5, k1x6, k1x7, k1x8)\,A(t)}{k0} - \beta(t, k2a, k2b)\,B(t) - k3\,B(t), \frac{d}{dt} C(t) = \beta(t, k2a, k2b)\,B(t)\right] \quad \textbf{(9}$$

```
> N:='N': A:='A': B:='B': C:='C': 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)-3),
  t<tA[nops(tA)],Lag(t,tA[nops(tA)-3..nops(tA)],kA[nops(kA)-3..nops(kA)]),
  kA[nops(kA)]))),t,op(kA));

  beta:=(t,k2a,k2b)->piecewise(t<69,k2a,k2b);
```

```
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,x3),x0,xx,op(kA),x2a,x2b,x3):

chi2a:=proc(x0,xx,x1,x2a,x2b,x3) local i; global K_; K_:=xx;
  res(parameters=[corr(par,[x0,xx,op(x1),x2a,x2b,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((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),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`),%);
```

$$\alpha := (t, k1x1, k1x2, k1x3, k1x4, k1x5, k1x6, k1x7, k1x8) \mapsto \begin{cases} (-0.00004287429258 \cdot k1x1 + 0.0001020408163 \cdot k1x2 - 0.00009803921574 \cdot k1x3 + 0.0 \\ (-0.00003322259134 \cdot k1x2 + 0.0001449275363 \cdot k1x3 - 0.0002380952381 \cdot k1x \\ (-0.0001073537306 \cdot k1x3 + 0.0006944444445 \cdot k1x4 - 0.001358695652 \cdot \\ (-0.0004528985509 \cdot k1x4 + 0.002083333333 \cdot k1x5 - 0.001893939394 \cdot k \\ (-0.0007575757577 \cdot k1x5 + 0.001262626263 \cdot k1x6 - 0.0008658008661 \cdot \end{cases}$$

$$\beta := (t, k2a, k2b) \mapsto \begin{cases} k2a & t < 69 \\ k2b & otherwise \end{cases}$$

$res := [t = \mathbf{proc}(t)\ \ldots\ \mathbf{end\ proc}, A(t) = \mathbf{proc}(t)\ \ldots\ \mathbf{end\ proc}, B(t) = \mathbf{proc}(t)\ \ldots\ \mathbf{end\ proc}, C(t) = \mathbf{proc}(t)\ \ldots\ \mathbf{end\ proc}]$

[9.243366066, 4191.259001, 0.05595514027, 0.09579542333, 0.1173616824, 0.181920404, 0.1420450087, 0.1171386628, 0.1250435919, 0.1196220088, 0.01463856287, 0.08754481825, 0.00009459445504]

207.395460244247

207.395460244247

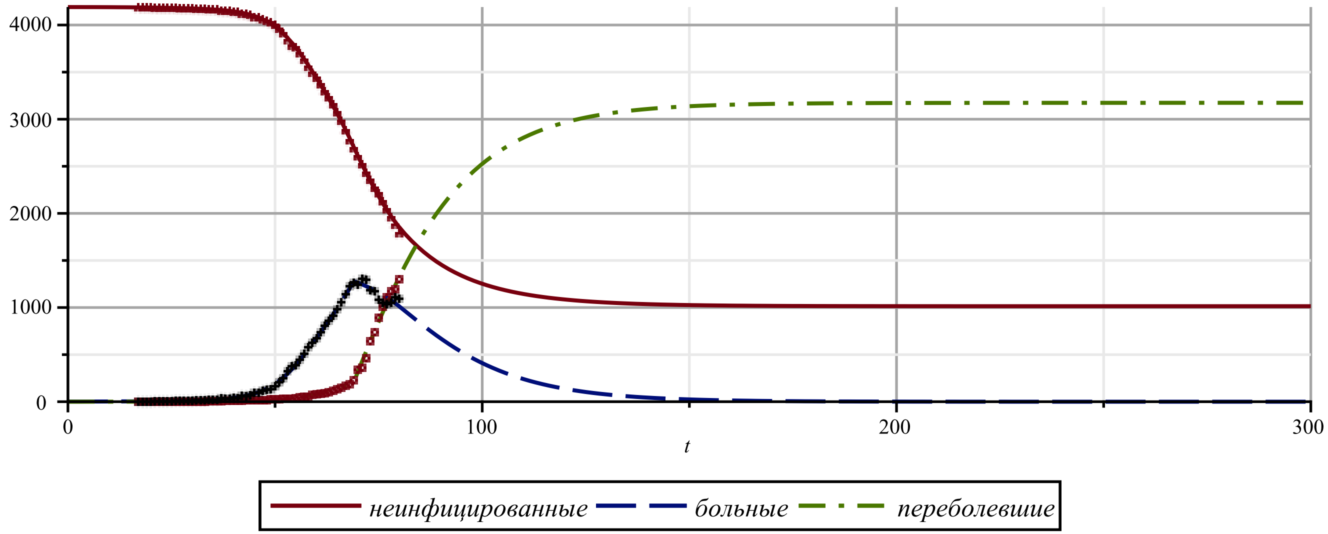
207.386442170899

$val := [9.24345626097916, 4191.57050376304, 0.0559545589114660, 0.0957977651848770, 0.117365035727687, 0.181914906851819,$

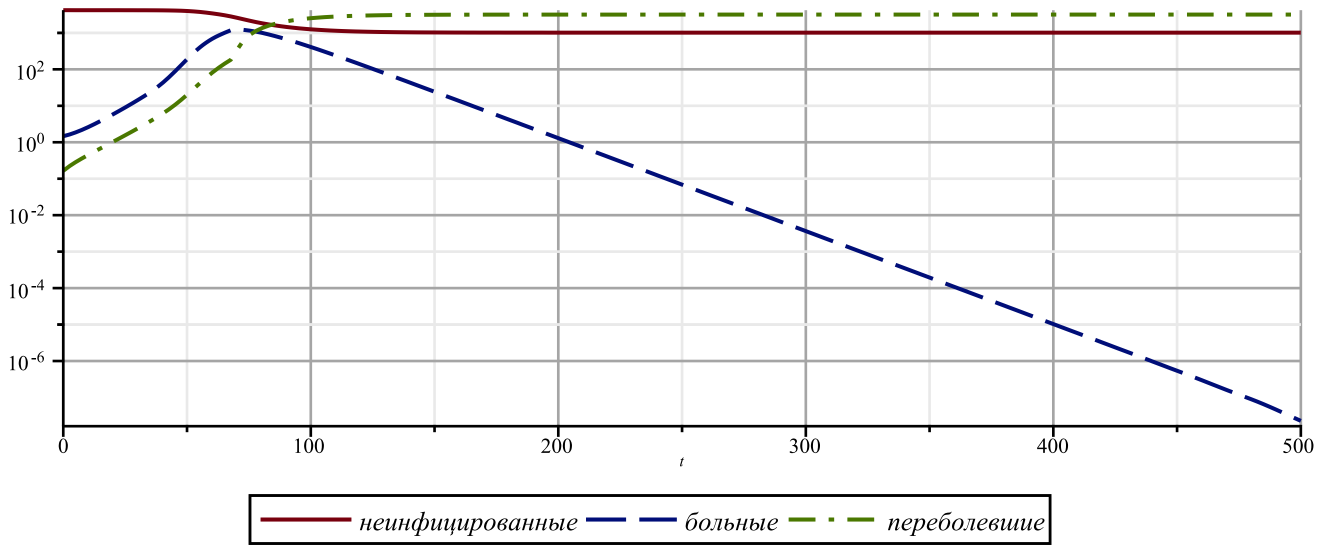
0.142049129005947, 0.117130954383324, 0.125043793890114, 0.119629411762846, 0.0146384879942093, 0.0875460920282156, 0.0000945947103892052]

207.386442170899

RT3c.jpg

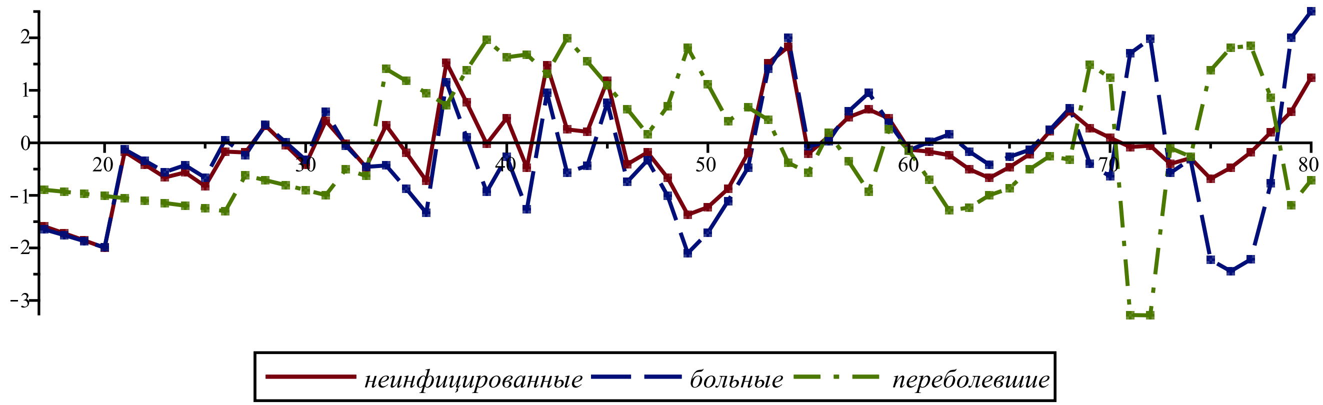



```
> logplot(map(q->q(t),v), t = 0 . . 5 0 0 , l e g e n d = [ ` ` , ` ` , ` ` ] ,
  linestyle=[solid,dash,dashdot],gridlines=true,size=[1000,400],legendstyle=[font=[roman,15]]);
```

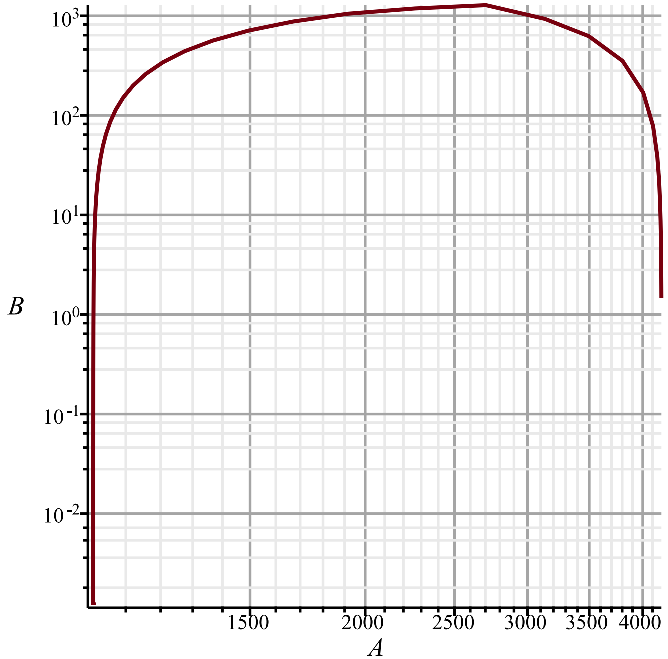



```
> display(
   plot([
    [[i,(T[i-dd]-(K_-A(i)))/sigma(K_-A(i))] $ i=1+dd..dd+nops(T)],
    [[i,(T2[i-dd]-(B(i)))/sigma(B(i))] $ i=1+dd..dd+nops(T)],
    [[i,(T1[i-dd]-(C(i)))/sigma(C(i))] $ i=1+dd..dd+nops(T)]
   ],linestyle=[solid,dash,dashdot],legend=[` `,` `,` `]                        ),
   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




```
> 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);
```

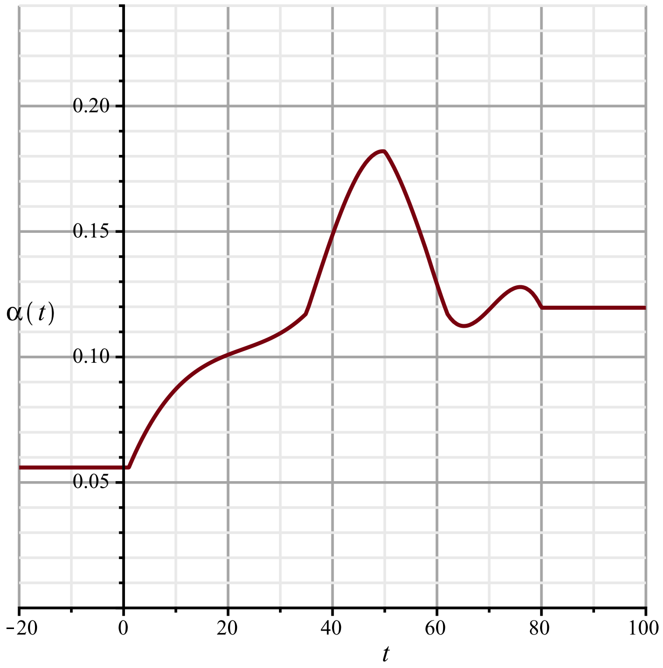



```
> [seq([i,(
   (T[i-dd]-T[i-dd-1]) /(T2[i-dd]+T2[i-dd-1]) /((1-T[i-dd]/K_)+(1-T[i-dd-1]/K_))
  )*4],i=1+dd+1..nops(T)+dd)]: [seq([%[i][1],(%[i-1][2]+%[i][2]+%[i+1][2])/3],i=2..nops(%)-1)]:
```

```
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]);
```

$$
\begin{cases}
0.0559545589114660 & t < 1. \\
2.94141610453063\ 10^{-6}\ t^3 - 0.000201999862444963\ t^2 + 0.00536905983367309\ t + 0.0507845574749940 & t < 35. \\
-0.0000115326665252043\ t^3 + 0.00124540840224490\ t^2 - 0.0384150401830107\ t + 0.430729227112135 & t < 50. \\
0.0000111075108750963\ t^3 - 0.00199213697951050\ t^2 + 0.112821345319634\ t - 1.86724878101372 & t < 58. \\
0.0000246573752350100\ t^3 - 0.00429561392187637\ t^2 + 0.242845843558085\ t - 4.30351440696038 & t < 62. \\
-0.0000248270289174172\ t^3 + 0.00525487610131329\ t^2 - 0.368583454883197\ t + 8.68653759128555 & t < 80. \\
0.119629411762846 & 80. \le t
\end{cases}
$$

RT3c-zar.jpg



α(t)
0.20
0.15
0.10
0.05
-20
0
20
40
60
80
100
t

Коэффициент заражения