



Chemische Digitalcomputer

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Thema:

Berechnung des größten
gemeinsamen Teilers auf
3-Bit-Operanden

Inhalt

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2. Berechnung des größten gemeinsamen Teilers (ggT)
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8. Simulation des Netzwerkverhaltens
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Berechnung des ggT

- Erzeugung der numerischen Tabelle und Berechnung des ggT

x	y	ggT(x,y) = z
0	0	0
0	1	0
...
4	6	2
...
7	7	7

Kodierung der Operanden

- Operanden:
 - zwei Operanden x und y
 - Ergebnis von $\text{ggT}(x,y) = z$
- jede Variable besteht aus **drei** Bits
 - $x, y, z \in [0,7]$
 - Beispiel:
 - $x = 5_{10} = 101_2$
 - $x_2 = 1, x_1 = 0, x_0 = 1$
 - Variablen
 - $x_2, x_1, x_0, y_2, y_1, y_0, z_2, z_1, z_0,$

Schaltbelegungstabelle

Erstellung der Schaltbelegungstabelle durch die numerische Tabelle

x	y	z
0	0	0
0	1	0
...
4	6	2



x2	x1	x0	y2	y1	y0	z2	z1	z0
0	0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0
...								
1	1	0	1	0	0	0	1	0

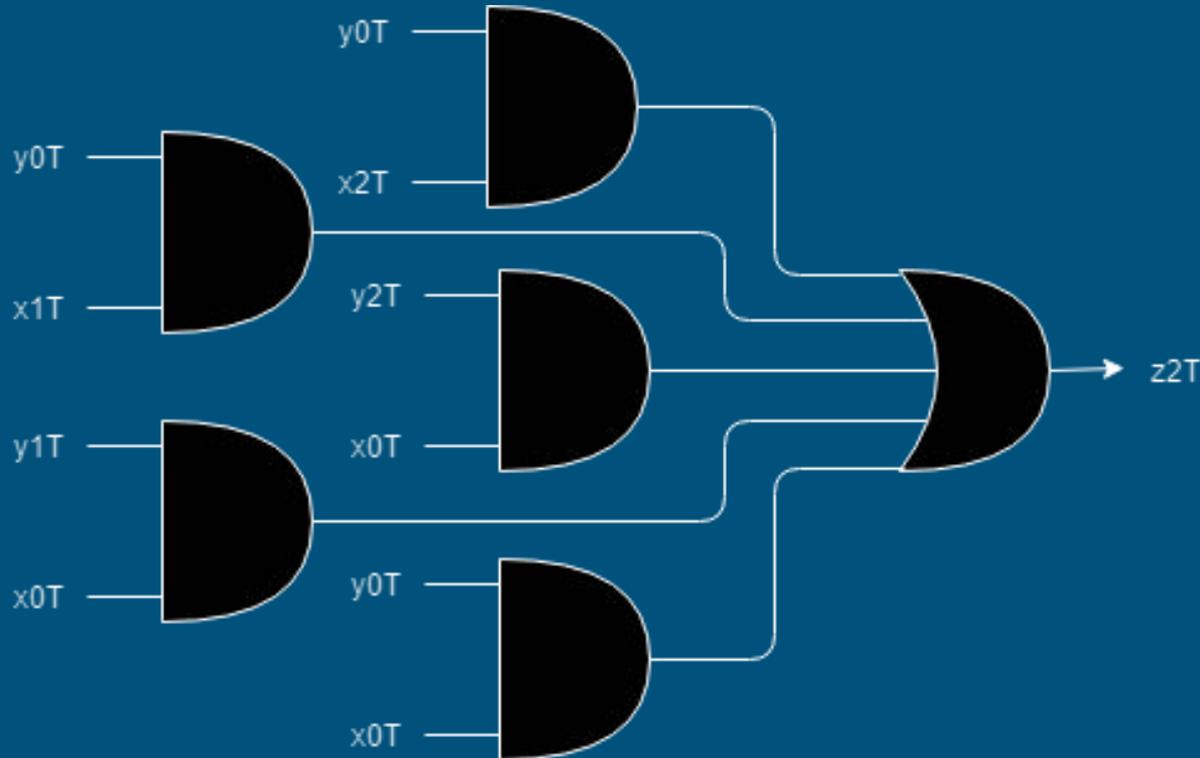
numerische Tabelle

Schaltbelegungstabelle

Minimale Schaltfunktion

- Je **eine** minimale Schaltfunktion für jedes Ausgangsbit (z_2, z_1, z_0)
- Minimalisierung durch **Quine-McCluskey Algorithmus**
- Ergebnis:
 - $f_0 = (x_2 \wedge y_0) \vee (x_1 \wedge y_0) \vee (x_0 \wedge y_2) \vee (x_0 \wedge y_1) \vee (x_0 \wedge y_0)$
 - $f_1 = (x_2 \wedge y_1 \wedge \neg x_0 \wedge \neg y_0) \vee (x_1 \wedge y_2 \wedge \neg x_0 \wedge \neg y_0) \vee (x_1 \wedge y_1 \wedge \neg x_0 \wedge \neg y_0) \vee (x_2 \wedge x_1 \wedge y_1 \wedge \neg x_0 \wedge \neg y_2) \vee (x_1 \wedge y_2 \wedge y_1 \wedge \neg x_2 \wedge \neg y_0) \vee (x_2 \wedge x_1 \wedge x_0 \wedge y_2 \wedge y_1 \wedge y_0) \vee (x_1 \wedge x_0 \wedge y_1 \wedge y_0 \wedge \neg x_2 \wedge \neg y_2)$
 - $f_2 = (x_2 \wedge x_1 \wedge x_0 \wedge y_2 \wedge y_1 \wedge y_0) \vee (x_2 \wedge x_1 \wedge y_2 \wedge y_1 \wedge \neg x_0 \wedge \neg y_0) \vee (x_2 \wedge x_0 \wedge y_2 \wedge y_0 \wedge \neg x_1 \wedge \neg y_1) \vee (x_2 \wedge y_2 \wedge \neg x_1 \wedge \neg x_0 \wedge \neg y_1 \wedge \neg y_0)$

Minimale Schaltfunktion für z2



z2:

- 2 Bit AND
- 5 Bit OR

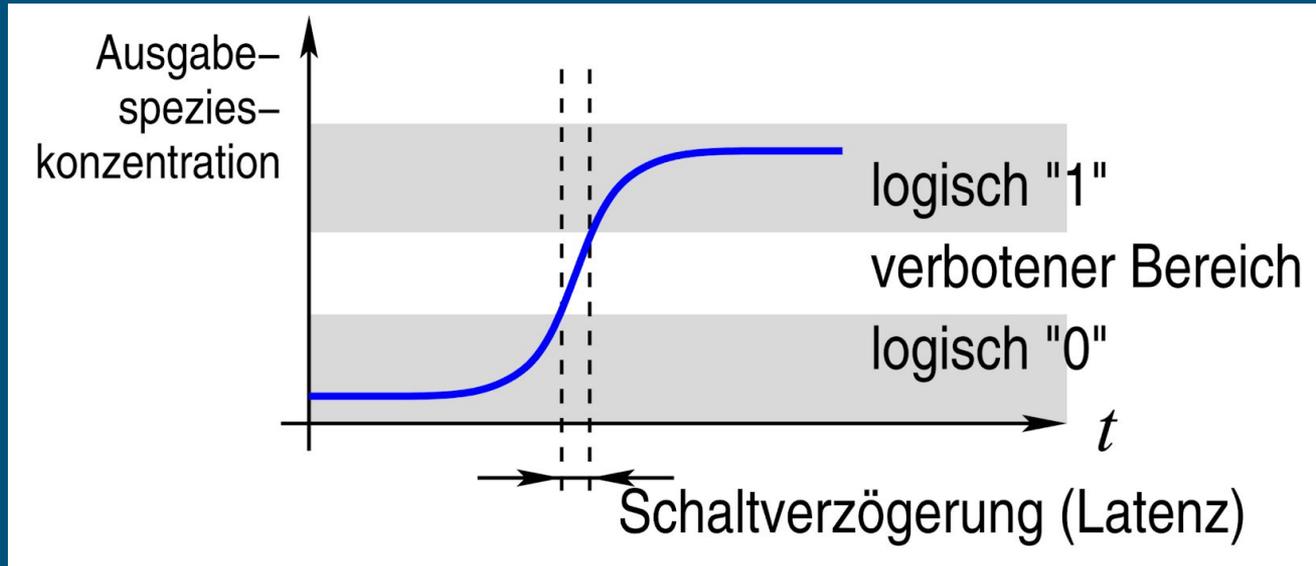
z1:

- 4 Bit AND
- 5 Bit AND
- 6 Bit AND
- 7 Bit OR

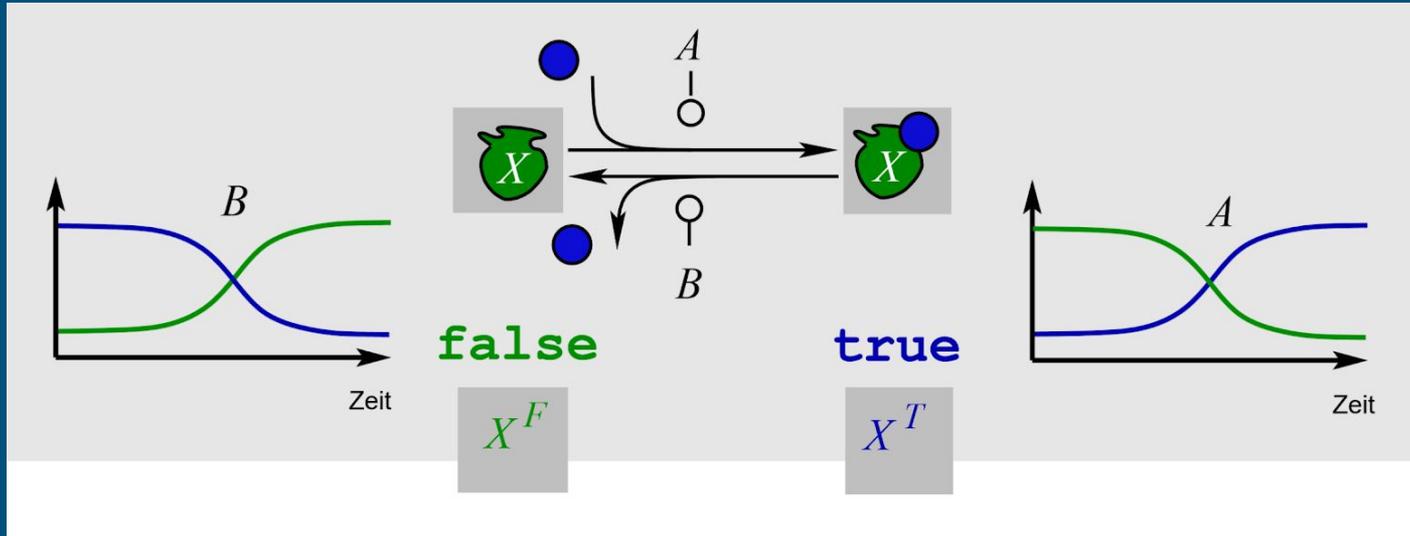
z0:

- 6 Bit AND
- 4 Bit OR

Chemisches Digitalcomputermodell



Aktivierungszustände



Formulierung eines Reaktionsnetzwerk

Bsp:

$$f_0 = \begin{aligned} &(x_2 \wedge y_0) \vee \\ &(x_1 \wedge y_0) \vee \\ &(x_0 \wedge y_2) \vee \\ &(x_0 \wedge y_1) \vee \\ &(x_0 \wedge y_0) \end{aligned}$$

#	Name	Reaction
1	R01	$z_{2F} + x_{2T} + x_{1F} + x_{0F} + y_{2T} + y_{1F} + y_{0F} \rightarrow z_{2T} + x_{2T} + x_{1F} + x_{0F} + y_{2T} + y_{1F} + y_{0F}$
2	R02	$z_{2F} + x_{2T} + x_{1F} + x_{0T} + y_{2T} + y_{1F} + y_{0T} \rightarrow z_{2T} + x_{2T} + x_{1F} + x_{0T} + y_{2T} + y_{1F} + y_{0T}$
3	R03	$z_{2F} + x_{2T} + x_{1T} + x_{0F} + y_{2T} + y_{1T} + y_{0F} \rightarrow z_{2T} + x_{2T} + x_{1T} + x_{0F} + y_{2T} + y_{1T} + y_{0F}$
4	R04	$z_{2F} + x_{2T} + x_{1T} + x_{0T} + y_{2T} + y_{1T} + y_{0T} \rightarrow z_{2T} + x_{1T} + x_{2T} + x_{0T} + y_{1T} + y_{2T} + y_{0T}$
5	R05	$z_{1F} + x_{1T} + x_{0F} + y_{1T} + y_{0F} \rightarrow z_{1T} + x_{1T} + x_{0F} + y_{1T} + y_{0F}$
6	R06	$z_{1F} + x_{1T} + x_{0F} + y_{2T} + y_{0F} \rightarrow z_{1T} + x_{1T} + x_{0F} + y_{2T} + y_{0F}$
7	R07	$z_{1F} + x_{2T} + x_{0F} + y_{1T} + y_{0F} \rightarrow z_{1T} + x_{2T} + x_{0F} + y_{1T} + y_{0F}$
8	R08	$z_{1F} + x_{2F} + x_{1T} + y_{2T} + y_{1T} + y_{0F} \rightarrow z_{1T} + x_{2F} + x_{1T} + y_{2T} + y_{1T} + y_{0F}$
9	R09	$z_{1F} + x_{2T} + x_{1T} + x_{0F} + y_{2F} + y_{1T} \rightarrow z_{1T} + x_{2T} + x_{1T} + x_{0F} + y_{2F} + y_{1T}$
10	R10	$z_{1F} + x_{2F} + x_{1T} + x_{0T} + y_{2F} + y_{1T} + y_{0T} \rightarrow z_{1T} + x_{2F} + x_{1T} + x_{0T} + y_{2F} + y_{1T} + y_{0T}$
11	R11	$z_{1F} + x_{2T} + x_{1T} + x_{0T} + y_{2T} + y_{1T} + y_{0T} \rightarrow z_{1T} + x_{2T} + x_{1T} + x_{0T} + y_{2T} + y_{1T} + y_{0T}$
12	R12	$z_{0F} + x_{0T} + y_{0T} \rightarrow z_{0T} + x_{0T} + y_{0T}$
13	R13	$z_{0F} + x_{0T} + y_{1T} \rightarrow z_{0T} + x_{0T} + y_{1T}$
14	R14	$z_{0F} + x_{0T} + y_{2T} \rightarrow z_{0T} + x_{0T} + y_{2T}$
15	R15	$z_{0F} + x_{1T} + y_{0T} \rightarrow z_{0T} + x_{1T} + y_{0T}$
16	R16	$z_{0F} + x_{2T} + y_{0T} \rightarrow z_{0T} + x_{2T} + y_{0T}$

Belegung der Reaktionsparameter

Belegung für $ggT(0,0) = 0$

- $x = 000$
- $y = 000$
- $z = 000$

#	Name	Compartment	Type	Unit	Initial Concentration [Unit]
1	x0T	gcdCalc	reactions	mmol/ml	0
2	x0F	gcdCalc	reactions	mmol/ml	100
3	x1T	gcdCalc	reactions	mmol/ml	0
4	x1F	gcdCalc	reactions	mmol/ml	100
5	x2T	gcdCalc	reactions	mmol/ml	0
6	x2F	gcdCalc	reactions	mmol/ml	100
7	y0T	gcdCalc	reactions	mmol/ml	0
8	y0F	gcdCalc	reactions	mmol/ml	100
9	y1T	gcdCalc	reactions	mmol/ml	0
10	y1F	gcdCalc	reactions	mmol/ml	100
11	y2T	gcdCalc	reactions	mmol/ml	0
12	y2F	gcdCalc	reactions	mmol/ml	100
13	z0T	gcdCalc	reactions	mmol/ml	0
14	z0F	gcdCalc	reactions	mmol/ml	100
15	z1T	gcdCalc	reactions	mmol/ml	0
16	z1F	gcdCalc	reactions	mmol/ml	100
17	z2T	gcdCalc	reactions	mmol/ml	0
18	z2F	gcdCalc	reactions	mmol/ml	100
	New Species	gcdCalc	reactions	mmol/ml	1

Simulation des Netzwerkverhaltens

- Fallstudie 1: $ggT(3,2)$
- Fallstudie 2: $ggT(6,3)$
- Fallstudie 3: $ggT(2,4)$

Fallstudie 1

— $\text{ggT}(3,2)=1$

Belegung für $\text{ggT}(3,2) = 1$

- $x = 011$
- $y = 010$
- $z = 000$

-> Erwartetes Ereignis:

- $z = 001$

#	Name	Compartment	Type	Unit	Initial Concentration [Unit]
1	x0T	gcdCalc	reactions	mmol/ml	100
2	x0F	gcdCalc	reactions	mmol/ml	0
3	x1T	gcdCalc	reactions	mmol/ml	100
4	x1F	gcdCalc	reactions	mmol/ml	0
5	x2T	gcdCalc	reactions	mmol/ml	0
6	x2F	gcdCalc	reactions	mmol/ml	100
7	y0T	gcdCalc	reactions	mmol/ml	0
8	y0F	gcdCalc	reactions	mmol/ml	100
9	y1T	gcdCalc	reactions	mmol/ml	100
10	y1F	gcdCalc	reactions	mmol/ml	0
11	y2T	gcdCalc	reactions	mmol/ml	0
12	y2F	gcdCalc	reactions	mmol/ml	100
13	z0T	gcdCalc	reactions	mmol/ml	0
14	z0F	gcdCalc	reactions	mmol/ml	100
15	z1T	gcdCalc	reactions	mmol/ml	0
16	z1F	gcdCalc	reactions	mmol/ml	100
17	z2T	gcdCalc	reactions	mmol/ml	0
18	z2F	gcdCalc	reactions	mmol/ml	100

Fallstudie 1

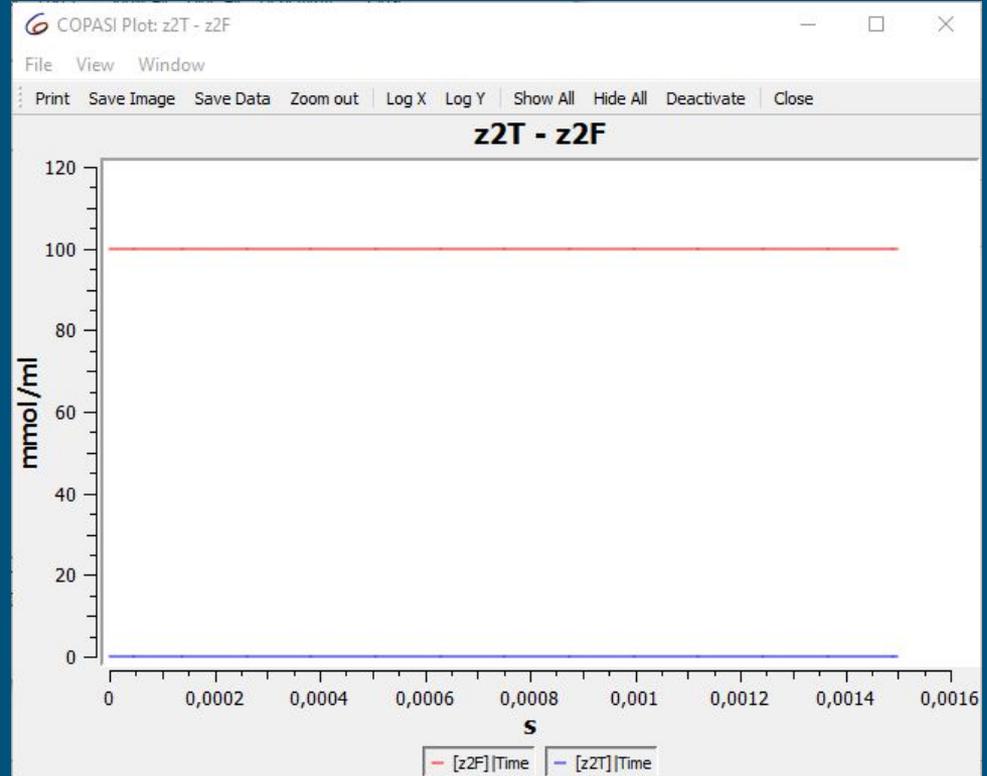
— $\text{ggt}(3,2)=1$

Belegung für $\text{ggT}(3,2) = 1$

- $x = 011$
- $y = 010$
- $z = 000$

-> Erwartetes Ereignis:

- $z = 001$



Fallstudie 1

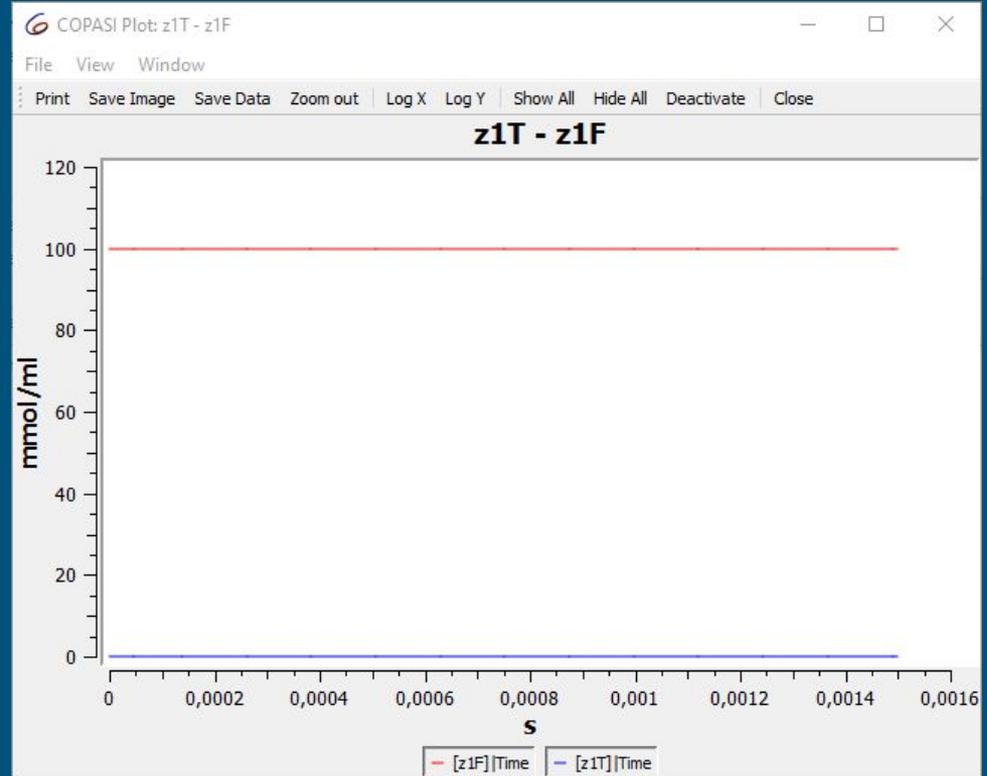
— $ggT(3,2)=1$

Belegung für $ggT(3,2) = 1$

- $x = 011$
- $y = 010$
- $z = 000$

-> Erwartetes Ereignis:

- $z = 001$



Fallstudie 1

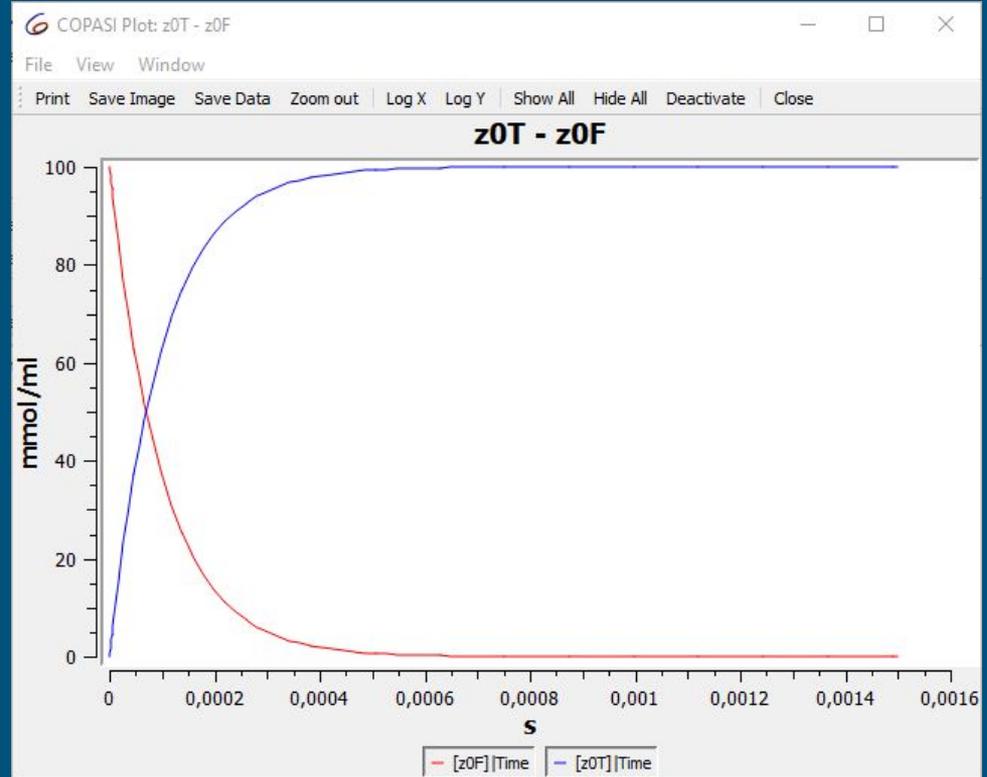
— $ggT(3,2)=1$

Belegung für $ggT(3,2) = 1$

- $x = 011$
- $y = 010$
- $z = 001$

-> Erwartetes Ereignis:

- $z = 001$

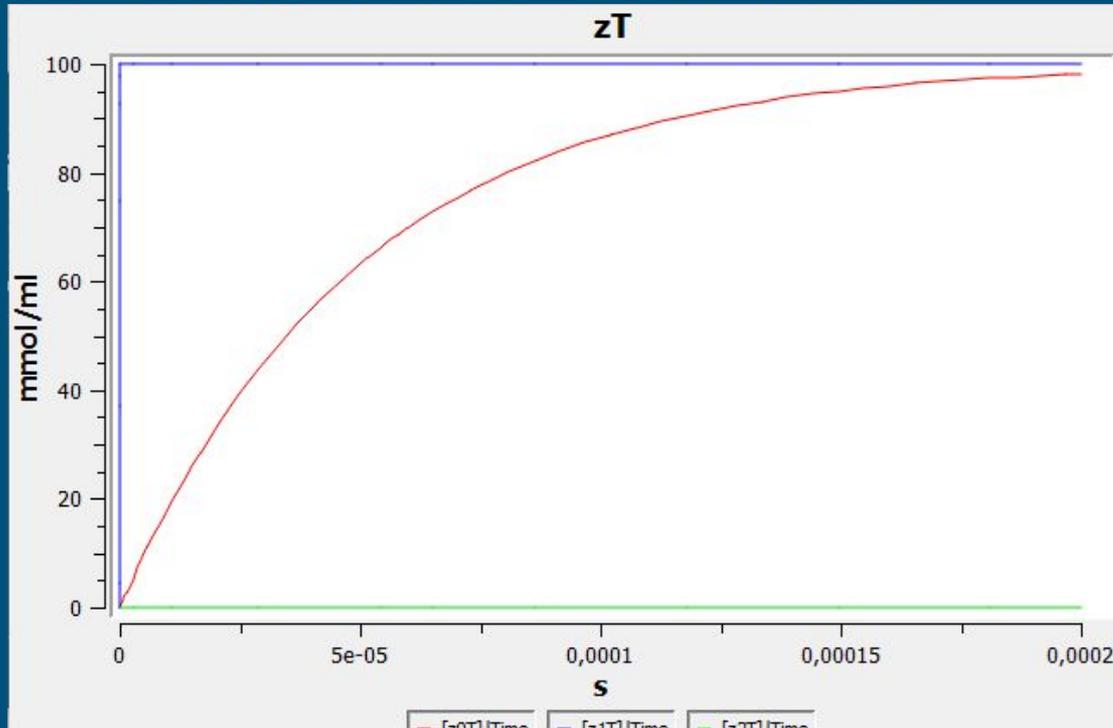


Fallstudie 2

- $ggT(6,3) = 3$
- Belegung:
 - $x = 110$
 - $y = 011$
- Erwartetes Ergebnis:
 - $z = 011$

#	Name	Compartment	Type	Unit	Initial Concentration [Unit]
1	x0T	gcdCalc	reactions	mmol/ml	0
2	x0F	gcdCalc	reactions	mmol/ml	100
3	x1T	gcdCalc	reactions	mmol/ml	100
4	x1F	gcdCalc	reactions	mmol/ml	0
5	x2T	gcdCalc	reactions	mmol/ml	100
6	x2F	gcdCalc	reactions	mmol/ml	0
7	y0T	gcdCalc	reactions	mmol/ml	100
8	y0F	gcdCalc	reactions	mmol/ml	0
9	y1T	gcdCalc	reactions	mmol/ml	100
10	y1F	gcdCalc	reactions	mmol/ml	0
11	y2T	gcdCalc	reactions	mmol/ml	0
12	y2F	gcdCalc	reactions	mmol/ml	100
13	z0T	gcdCalc	reactions	mmol/ml	0
14	z0F	gcdCalc	reactions	mmol/ml	100
15	z1T	gcdCalc	reactions	mmol/ml	0
16	z1F	gcdCalc	reactions	mmol/ml	100
17	z2T	gcdCalc	reactions	mmol/ml	0
18	z2F	gcdCalc	reactions	mmol/ml	100

Fallstudie 2



$z_0T = 100$ mmol/ml
nach ca. 0.00119s

$z_1T = 100$ mmol/ml
nach ca. 0.00000000239 s

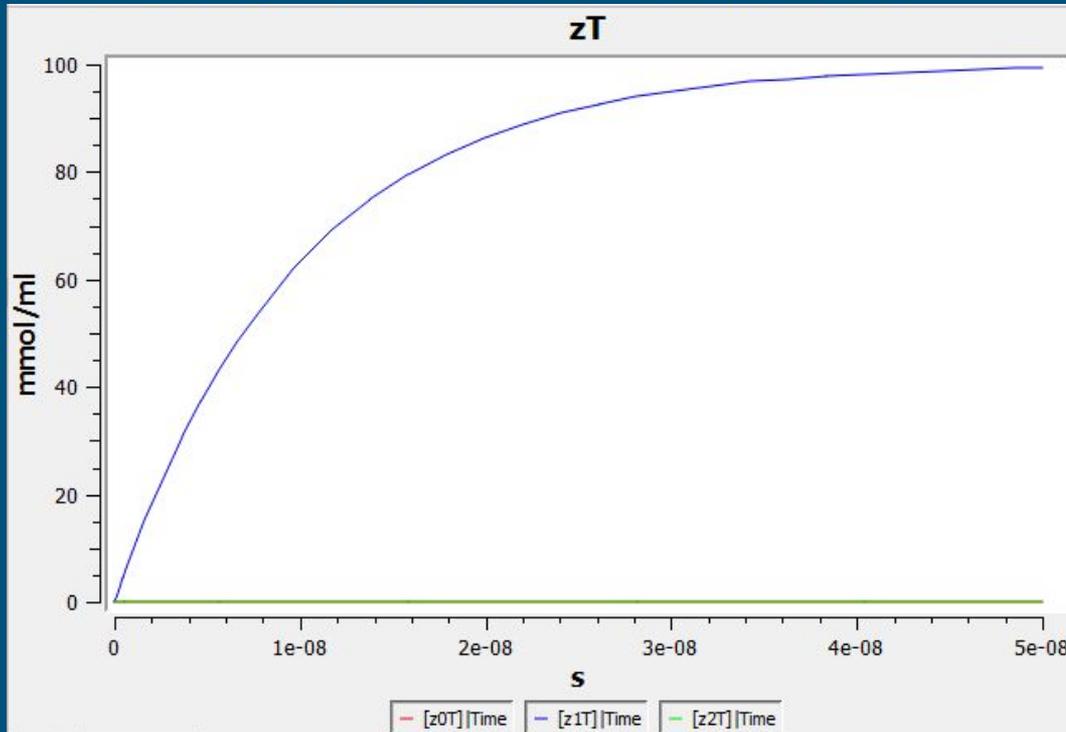
$z_2T = 0$ mmol/ml
verändert sich nicht

Fallstudie 3

- $ggT(4,2) = 2$
- Belegung:
 - $x = 100$
 - $y = 010$
- Erwartetes Ergebnis:
 - $z = 010$

#	Name	Compartment	Type	Unit	Initial Concentration [Unit]
1	x0T	gcdCalc	reactions	mmol/ml	0
2	x0F	gcdCalc	reactions	mmol/ml	100
3	x1T	gcdCalc	reactions	mmol/ml	0
4	x1F	gcdCalc	reactions	mmol/ml	100
5	x2T	gcdCalc	reactions	mmol/ml	100
6	x2F	gcdCalc	reactions	mmol/ml	0
7	y0T	gcdCalc	reactions	mmol/ml	0
8	y0F	gcdCalc	reactions	mmol/ml	100
9	y1T	gcdCalc	reactions	mmol/ml	100
10	y1F	gcdCalc	reactions	mmol/ml	0
11	y2T	gcdCalc	reactions	mmol/ml	0
12	y2F	gcdCalc	reactions	mmol/ml	100
13	z0T	gcdCalc	reactions	mmol/ml	0
14	z0F	gcdCalc	reactions	mmol/ml	100
15	z1T	gcdCalc	reactions	mmol/ml	0
16	z1F	gcdCalc	reactions	mmol/ml	100
17	z2T	gcdCalc	reactions	mmol/ml	0
18	z2F	gcdCalc	reactions	mmol/ml	100

Fallstudie 3



$z_{2T} = 0$ mmol/ml
verändert sich nicht

$z_{1T} = 100$ mmol/ml
nach ca. 0.000000239 s

$z_{0T} = 0$ mmol/ml
verändert sich nicht

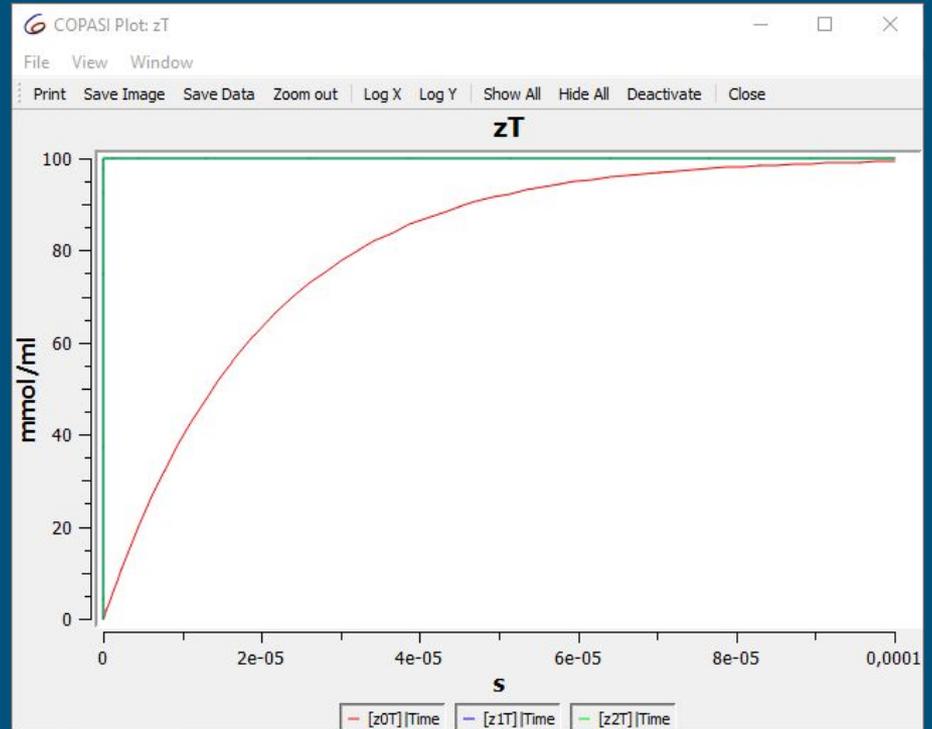
Fragestellung

- Wie lange dauert es (in Abhängigkeit der Reaktionsparameterwerte), bis sich im ungünstigsten Fall die Stoffkonzentrationen aller 3 Ausgabebits mit mindestens 99% Genauigkeit ihrem Zielwert angenähert haben?

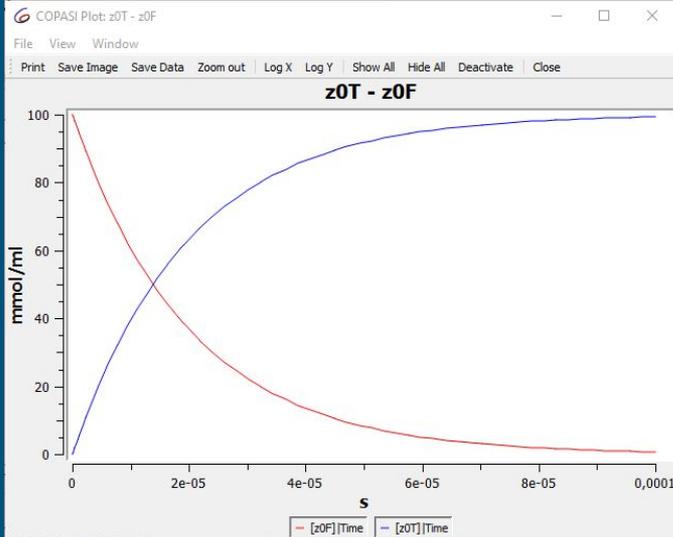
Fragestellung

intuitiv ungünstigster Fall -> $\text{ggt}(7,7)=7$

#	Name	Compartment	Type	Unit	Initial Concentration [Unit]
1	x0T	gcdCalc	reactions	mmol/ml	100
2	x0F	gcdCalc	reactions	mmol/ml	0
3	x1T	gcdCalc	reactions	mmol/ml	100
4	x1F	gcdCalc	reactions	mmol/ml	0
5	x2T	gcdCalc	reactions	mmol/ml	100
6	x2F	gcdCalc	reactions	mmol/ml	0
7	y0T	gcdCalc	reactions	mmol/ml	100
8	y0F	gcdCalc	reactions	mmol/ml	0
9	y1T	gcdCalc	reactions	mmol/ml	100
10	y1F	gcdCalc	reactions	mmol/ml	0
11	y2T	gcdCalc	reactions	mmol/ml	100
12	y2F	gcdCalc	reactions	mmol/ml	0
13	z0T	gcdCalc	reactions	mmol/ml	0
14	z0F	gcdCalc	reactions	mmol/ml	100
15	z1T	gcdCalc	reactions	mmol/ml	0
16	z1F	gcdCalc	reactions	mmol/ml	100
17	z2T	gcdCalc	reactions	mmol/ml	0
18	z2F	gcdCalc	reactions	mmol/ml	100



Fragestellung

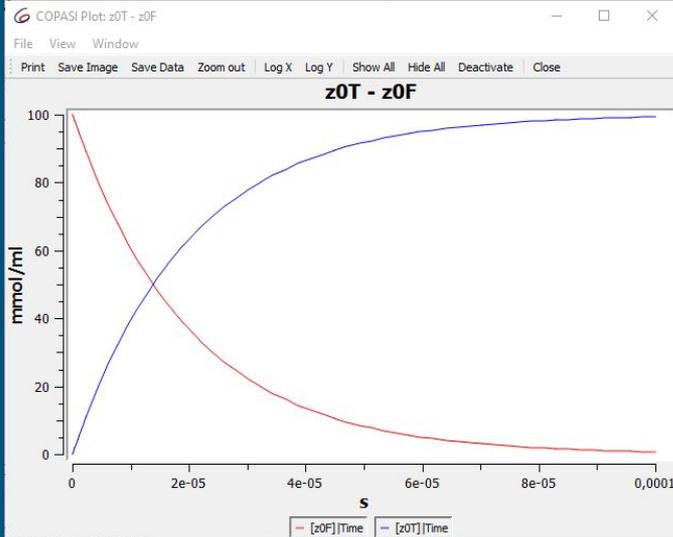


$$zOT(0.99) \approx 0.0000935 \text{ s}$$

Time Course Result

	Time	z1T	z0F	z2T	z1F	z2F	z0T
222	4.925676626e-5	100	8.519321928	100	-4.403642157e-40	-4.403642157e-40	91.48067807
223	5.136533601e-5	100	7.66687044	100	-1.499154182e-39	-1.499154182e-39	92.33312956
224	5.347390576e-5	100	6.89971613	100	1.632414069e-39	1.632414069e-39	93.10028387
225	5.558247551e-5	100	6.209323858	100	3.475202433e-39	3.475202433e-39	93.79067614
226	5.769104525e-5	100	5.588012815	100	-5.408176798e-39	-5.408176798e-39	94.41198718
227	5.9799615e-5	100	5.028870814	100	-7.553805453e-39	-7.553805453e-39	94.97112919
228	6.190818475e-5	100	4.525677286	100	-7.040231826e-46	-7.040231826e-46	95.47432271
229	6.40167545e-5	100	4.07283391	100	7.457296828e-45	7.457296828e-45	95.92716609
230	6.612532424e-5	100	3.665302464	100	-8.405711998e-45	-8.405711998e-45	96.33469754
231	6.823389399e-5	100	3.298548938	100	3.965024516e-45	3.965024516e-45	96.70145106
232	7.034246374e-5	100	2.968493091	100	-7.164438673e-46	-7.164438673e-46	97.03150691
233	7.245103349e-5	100	2.671462955	100	-2.887739998e-50	-2.887739998e-50	97.32853704
234	7.455960324e-5	100	2.404153943	100	1.365731041e-50	1.365731041e-50	97.59584606
235	7.666817298e-5	100	2.163592111	100	-4.280316961e-51	-4.280316961e-51	97.83640789
236	7.877674273e-5	100	1.947101105	100	8.007190483e-52	8.007190483e-52	98.0528989
237	8.088531248e-5	100	1.752272384	100	-6.790460314e-53	-6.790460314e-53	98.24772762
238	8.299388223e-5	100	1.576938407	100	-1.966166928e-56	-1.966166928e-56	98.42306159
239	8.510245197e-5	100	1.419148512	100	5.259647922e-57	5.259647922e-57	98.58085149
240	8.721102172e-5	100	1.277147216	100	-9.879606934e-58	-9.879606934e-58	98.72285278
241	8.931959147e-5	100	1.149354698	100	1.16158131e-58	1.16158131e-58	98.8506453
242	9.142816122e-5	100	1.034349216	100	-6.41822544e-60	-6.41822544e-60	98.96565078
243	9.353673097e-5	100	0.9308512883	100	-6.835427749e-63	-6.835427749e-63	99.06914871
244	9.564530071e-5	100	0.8377094584	100	1.283395174e-63	1.283395174e-63	99.16229054
245	9.775387046e-5	100	0.7538874848	100	-1.726966368e-64	-1.726966368e-64	99.24611252
246	9.986244021e-5	100	0.678452814	100	1.480828859e-65	1.480828859e-65	99.32154719
247	0.0001	100	0.6228024235	100	1.050248420e-65	1.050248420e-65	99.32610757

Fragestellung

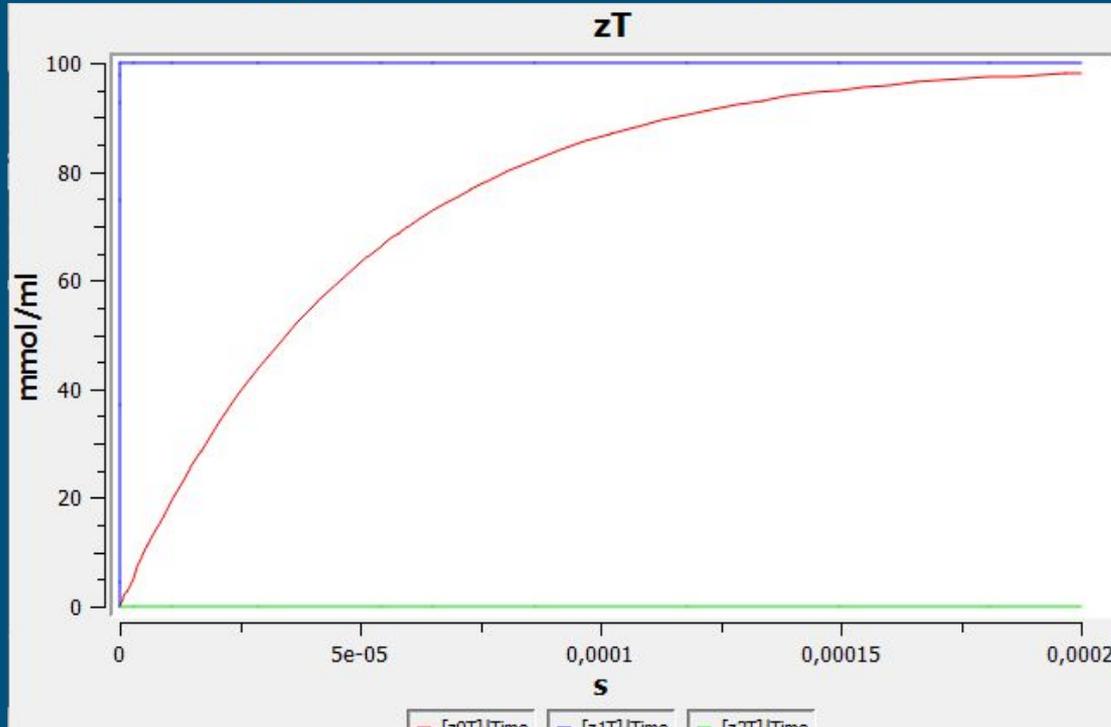


$$zOT(0.99) \approx 0.0000935 \text{ s}$$

Time Course Result

	Time	z1T	z0F	z2T	z1F	z2F	z0T
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223	5.136533601e-5	100	7.66687044	100	-1.499154182e-39	-1.499154182e-39	92.33312956
224	5.347390576e-5	100	6.89971613	100	1.632414069e-39	1.632414069e-39	93.10028387
225	5.558247551e-5	100	6.209323858	100	3.475202433e-39	3.475202433e-39	93.79067614
226	5.769104525e-5	100	5.588012815	100	-5.408176798e-39	-5.408176798e-39	94.41198718
227	5.9799615e-5	100	5.028870814	100	-7.553805453e-39	-7.553805453e-39	94.97112919
228	6.190818475e-5	100	4.525677286	100	-7.040231826e-46	-7.040231826e-46	95.47432271
229	6.40167545e-5	100	4.07283391	100	7.457296828e-45	7.457296828e-45	95.92716609
230	6.612532424e-5	100	3.665302464	100	-8.405711998e-45	-8.405711998e-45	96.33469754
231	6.823389399e-5	100	3.298548938	100	3.965024516e-45	3.965024516e-45	96.70145106
232	7.034246374e-5	100	2.968493091	100	-7.164438673e-46	-7.164438673e-46	97.03150691
233	7.245103349e-5	100	2.671462955	100	-2.887739998e-50	-2.887739998e-50	97.32853704
234	7.455960324e-5	100	2.404153943	100	1.365731041e-50	1.365731041e-50	97.59584606
235	7.666817298e-5	100	2.163592111	100	-4.280316961e-51	-4.280316961e-51	97.83640789
236	7.877674273e-5	100	1.947101105	100	8.007190483e-52	8.007190483e-52	98.0528989
237	8.088531248e-5	100	1.752272384	100	-6.790460314e-53	-6.790460314e-53	98.24772762
238	8.299388223e-5	100	1.576938407	100	-1.966166928e-56	-1.966166928e-56	98.42306159
239	8.510245197e-5	100	1.419148512	100	5.259647922e-57	5.259647922e-57	98.58085149
240	8.721102172e-5	100	1.277147216	100	-9.879606934e-58	-9.879606934e-58	98.72285278
241	8.931959147e-5	100	1.149354698	100	1.16158131e-58	1.16158131e-58	98.8506453
242	9.142816122e-5	100	1.034349216	100	-6.41822544e-60	-6.41822544e-60	98.96565078
243	9.353673097e-5	100	0.9308512883	100	-6.835427749e-63	-6.835427749e-63	99.06914871
244	9.564530071e-5	100	0.8377094584	100	1.283395174e-63	1.283395174e-63	99.16229054
245	9.775387046e-5	100	0.7538874848	100	-1.726966368e-64	-1.726966368e-64	99.24611252
246	9.986244021e-5	100	0.678452814	100	1.480828859e-65	1.480828859e-65	99.32154719
247	0.0001	100	0.6228024225	100	1.050248420e-65	1.050248420e-65	99.32610757

Erinnerung: Fallstudie 2



$z_0T = 100$ mmol/ml
nach ca. **0.00119s**

$z_1T = 100$ mmol/ml
nach ca. 0.00000000239 s

$z_2T = 0$ mmol/ml
verändert sich nicht

$z_0T(0.99) \approx 0.00023$ s

Fragestellung

- Wie lange dauert es (in Abhängigkeit der Reaktionsparameterwerte), bis sich im ungünstigsten Fall die Stoffkonzentrationen aller 3 Ausgabebits mit mindestens 99% Genauigkeit ihrem Zielwert angenähert haben?

tatsächlich Ungünstigster Fall: $ggT(x) = 001$

- für 99% Genauigkeit 0.00011 s - 0.00046 s

Fragestellung

ggT(3,7) = 1

x = 001
y = 111
z = 001

$$f_0 = (x_2 \wedge y_0) \vee (x_1 \wedge y_0) \vee (x_0 \wedge y_2) \vee (x_0 \wedge y_1) \vee (x_0 \wedge y_0)$$

ggT(1,1) = 1

x = 001
y = 001
z = 001

$$f_0 = (x_2 \wedge y_0) \vee (x_1 \wedge y_0) \vee (x_0 \wedge y_2) \vee (x_0 \wedge y_1) \vee (x_0 \wedge y_0)$$

ggT(7,7) = 7

x = 111
y = 111
z = 111

$$f_0 = (x_2 \wedge y_0) \vee (x_1 \wedge y_0) \vee (x_0 \wedge y_2) \vee (x_0 \wedge y_1) \vee (x_0 \wedge y_0)$$

$$f_1 = (x_2 \wedge y_1 \wedge \neg x_0 \wedge \neg y_0) \vee (x_1 \wedge y_2 \wedge \neg x_0 \wedge \neg y_0) \vee (x_1 \wedge y_1 \wedge \neg x_0 \wedge \neg y_0) \vee (x_2 \wedge x_1 \wedge y_1 \wedge \neg x_0 \wedge \neg y_2) \vee$$

$$(x_1 \wedge y_2 \wedge y_1 \wedge \neg x_2 \wedge \neg y_0) \vee (x_2 \wedge x_1 \wedge x_0 \wedge y_2 \wedge y_1 \wedge y_0) \vee (x_1 \wedge x_0 \wedge y_1 \wedge y_0 \wedge \neg x_2 \wedge \neg y_2)$$

$$f_2 = (x_2 \wedge x_1 \wedge x_0 \wedge y_2 \wedge y_1 \wedge y_0) \vee (x_2 \wedge x_1 \wedge y_2 \wedge y_1 \wedge \neg x_0 \wedge \neg y_0) \vee (x_2 \wedge x_0 \wedge y_2 \wedge y_0 \wedge \neg x_1 \wedge \neg y_1) \vee (x_2 \wedge y_2 \wedge \neg x_1 \wedge \neg x_0 \wedge \neg y_1 \wedge \neg y_0)$$

Fragestellung

$$ggT(1,1) = 1$$

$$x = 001$$

$$y = 001$$

$$z = 001$$

$$f_0 = (x2 \wedge y0) \vee$$

$$(x1 \wedge y0) \vee$$

$$(x0 \wedge y2) \vee$$

$$(x0 \wedge y1) \vee$$

$$(x0 \wedge y0)$$

$$z0T(0.99) \approx 0.0004 \text{ s}$$

Time Course Result

	Time	z1T	z0F	z2T	z1F	z2F	z0T
33	5.654433e-5	0	56.81082451	0	100	100	43.18917549
34	6.654433e-5	0	51.40455969	0	100	100	48.59544031
35	7.654433e-5	0	46.512769	0	100	100	53.487231
36	9.702097585e-5	0	37.90034698	0	100	100	62.09965302
37	0.0001174976217	0	30.88261949	0	100	100	69.11738051
38	0.0001379742675	0	25.16431471	0	100	100	74.83568529
39	0.0001584509134	0	20.50482593	0	100	100	79.49517407
40	0.0001789275592	0	16.70810012	0	100	100	83.29189988
41	0.0001994042051	0	13.61438594	0	100	100	86.38561406
42	0.0002198808509	0	11.0935115	0	100	100	88.9064885
43	0.0002403574968	0	9.039408687	0	100	100	90.96059131
44	0.0002608341426	0	7.365648779	0	100	100	92.63435122
45	0.0002813107884	0	6.001806484	0	100	100	93.99819352
46	0.0003017874343	0	4.890496733	0	100	100	95.10950327
47	0.0003222640801	0	3.984959906	0	100	100	96.01504009
48	0.000342740726	0	3.247094585	0	100	100	96.75290541
49	0.0003632173718	0	2.64585429	0	100	100	97.35414571
50	0.0003836940177	0	2.155941173	0	100	100	97.84405883
51	0.0004041706635	0	1.756741619	0	100	100	98.24325838
52	0.0004246473093	0	1.431458869	0	100	100	98.56854113
53	0.0004451239552	0	1.166406301	0	100	100	98.8335937
54	0.000465600601	0	0.9504315421	0	100	100	99.04956846
55	0.0004860772469	0	0.7744472185	0	100	100	99.22555278
56	0.0005065538927	0	0.6310486003	0	100	100	99.3689514
57	0.0005270305386	0	0.5142020354	0	100	100	99.48579796

Viele Dank für eure
Aufmerksamkeit!

