

# Bildverarbeitung: Greyscaling & Gammakorrektur von 8bpp PPM Bildern

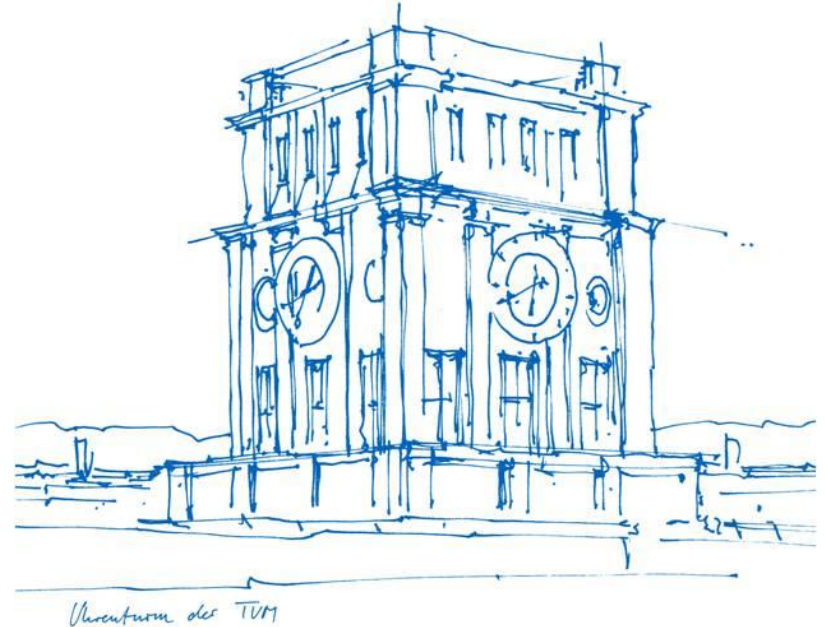
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TUM School Computation, Information and Technology

Lehrstuhl für Rechnerarchitektur und Parallele Systeme

Garching b. München, 24. August 2023



# Problemstellung



# Problemstellung



## Greyscaling

# Problemstellung



**Greyscaling**

**Gammakorrektur**

Greyscaling



**Speichereffizienz**

**Erleichterte  
Weiterverarbeitung**

**Rückwärtskompatibilität**

# Gammakorrektur



# Gammakorrektur





# Gammakorrektur



## Helligkeitsausgleich



# Implementation

## Teilschritte



**Laden**

**Verarbeiten**

**Schreiben**

# Laden



# Laden

## 8 bpp PPM

```
1 P3
2 # Sample comment
3 512 512
4 255
5 193
6 111
7 74
8 198
9 116
10 79
11 195
12 113
13 76
```

...

# Laden

8 bpp PPM

```
1 P3
2 # Sample comment
3 512 512
4 255
5 193
6 111
7 74
8 198
9 116
10 79
11 195
12 113
13 76
```



**HEADER auslesen und validieren**

...

# Laden

8 bpp PPM

```
1 P3
2 # Sample comment
3 512 512
4 255
5 193
6 111
7 74
8 198
9 116
10 79
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12 113
13 76
```

**HEADER auslesen und validieren**

**PIXEL laden**

...

# Laden

8 bpp PPM

```
1 P3
2 # Sample comment
3 512 512
4 255
5 193
6 111
7 74
8 198
9 116
10 79
11 195
12 113
13 76
```

1 Pixel

HEADER auslesen und validieren

PIXEL laden

...



# Laden

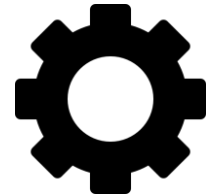
8 bpp PPM

```
1 P3
2 # Sample comment
3 512 512
4 255
5 193
6 111
7 74
8 198
9 116
10 79
11 195
12 113
13 76
```

1 Pixel

HEADER auslesen und validieren

PIXEL laden



...

# Verarbeiten



$$P_{alt} = (R, G, B)^T$$

Verarbeiten



$$D = \frac{a \cdot R + b \cdot G + c \cdot B}{a + b + c}$$

$$P_{alt} = (R, G, B)^T$$

# Verarbeiten



$$D = \frac{a \cdot R + b \cdot G + c \cdot B}{a + b + c}$$



$$P_{alt} = (R, G, B)^T$$

$$P_{grau} = (D, D, D)^T$$

# Verarbeiten



$$D = \frac{a \cdot R + b \cdot G + c \cdot B}{a + b + c}$$



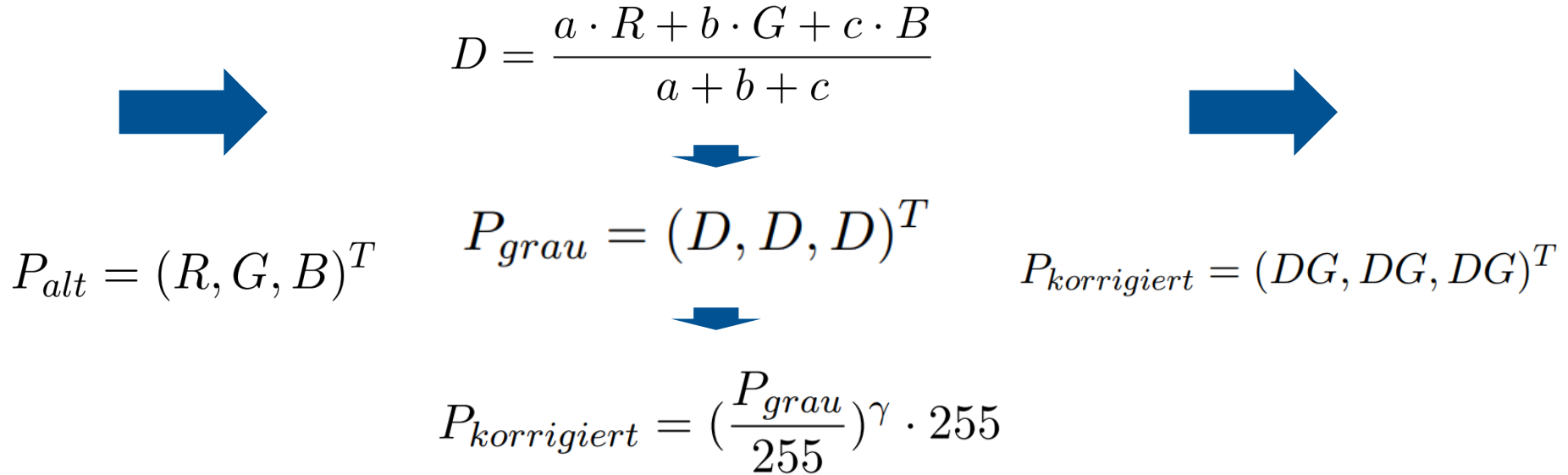
$$P_{grau} = (D, D, D)^T$$



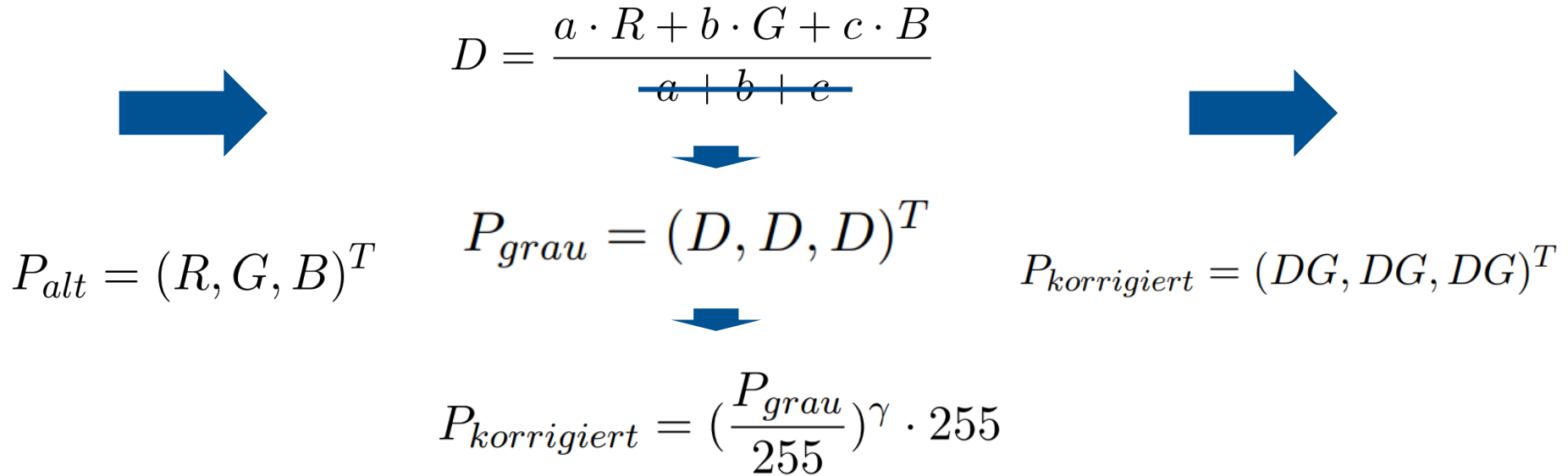
$$P_{korrigiert} = \left(\frac{P_{grau}}{255}\right)^\gamma \cdot 255$$

$$P_{alt} = (R, G, B)^T$$

# Verarbeiten

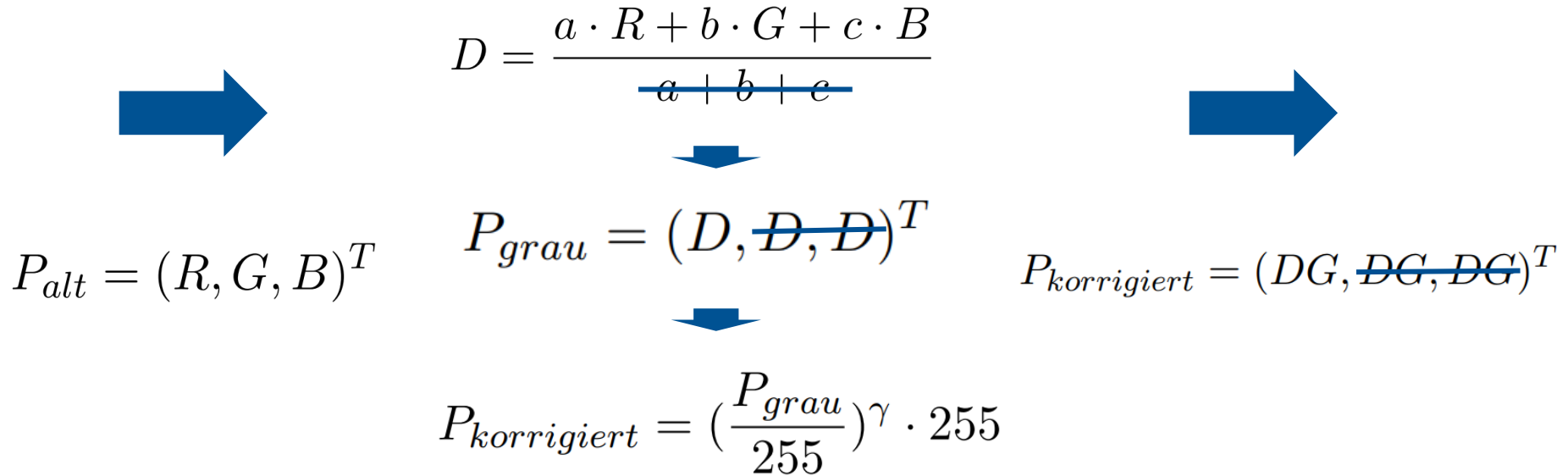


## Verarbeiten





## Verarbeiten



The diagram illustrates the process of converting an RGB image to grayscale and applying gamma correction. It starts with an input vector  $P_{alt} = (R, G, B)^T$ . A large blue arrow points to the calculation of a weighted average  $D$ , where the weights  $a, b, c$  are crossed out in the denominator. A downward blue arrow leads to the grayscale vector  $P_{grau} = (D, D, D)^T$ , where the  $D$  values are crossed out. Another downward blue arrow leads to the final gamma-corrected vector  $P_{korrigiert} = (\frac{P_{grau}}{255})^\gamma \cdot 255$ . A second large blue arrow points from the grayscale vector to the gamma-corrected vector, where the  $DG$  values are crossed out in the input vector.

$$D = \frac{a \cdot R + b \cdot G + c \cdot B}{\cancel{a + b + c}}$$

$$P_{alt} = (R, G, B)^T$$

$$P_{grau} = (D, \cancel{D}, \cancel{D})^T$$

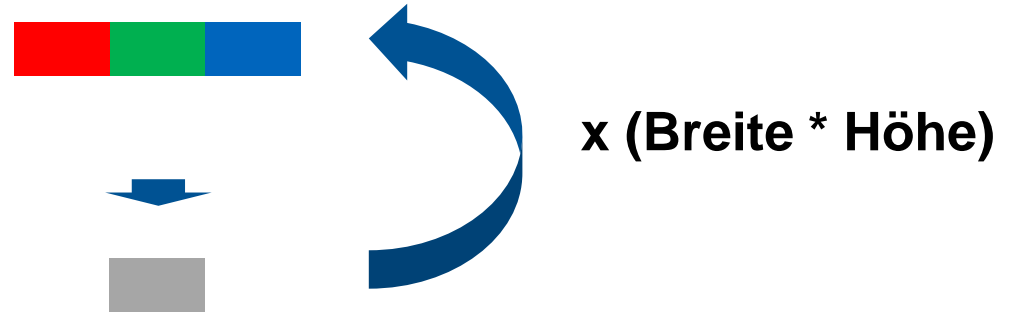
$$P_{korrigiert} = (DG, \cancel{DG}, \cancel{DG})^T$$

$$P_{korrigiert} = \left( \frac{P_{grau}}{255} \right)^\gamma \cdot 255$$

# SISD



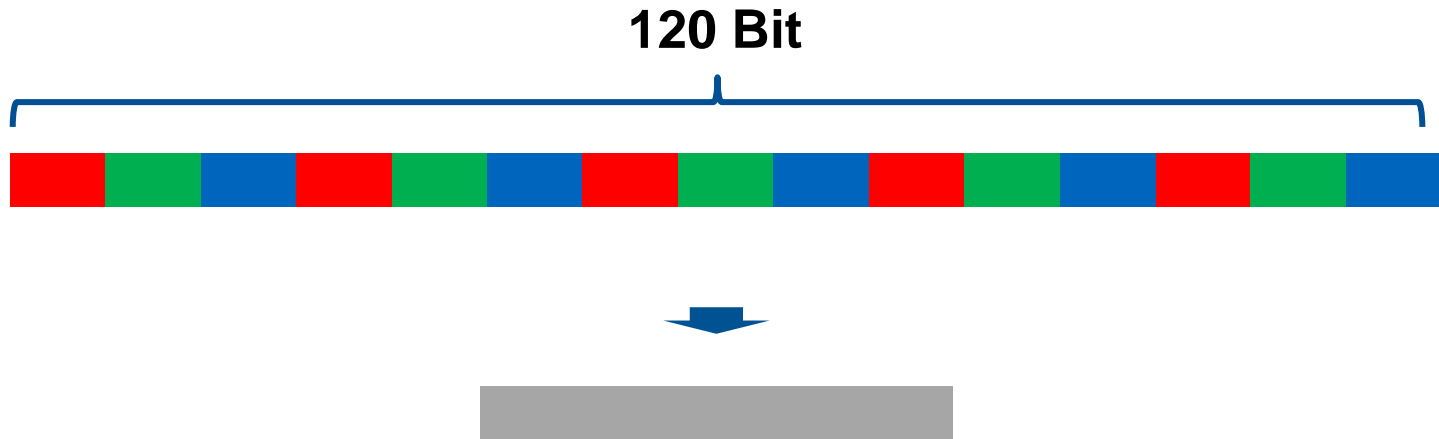
## SISD



# SIMD



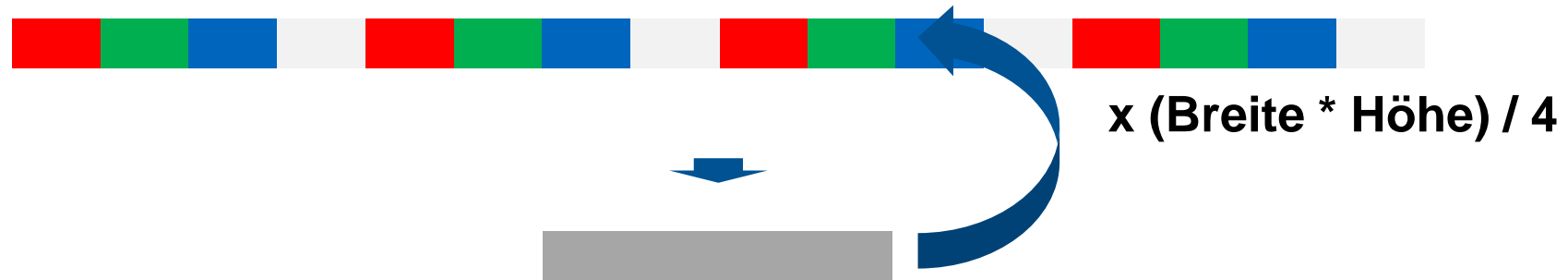
## SIMD



# SIMD



## SIMD





# Verarbeiten



$$D = \frac{a \cdot R + b \cdot G + c \cdot B}{\cancel{a + b + c}}$$



$$P_{grau} = (D, \cancel{D}, \cancel{D})^T$$



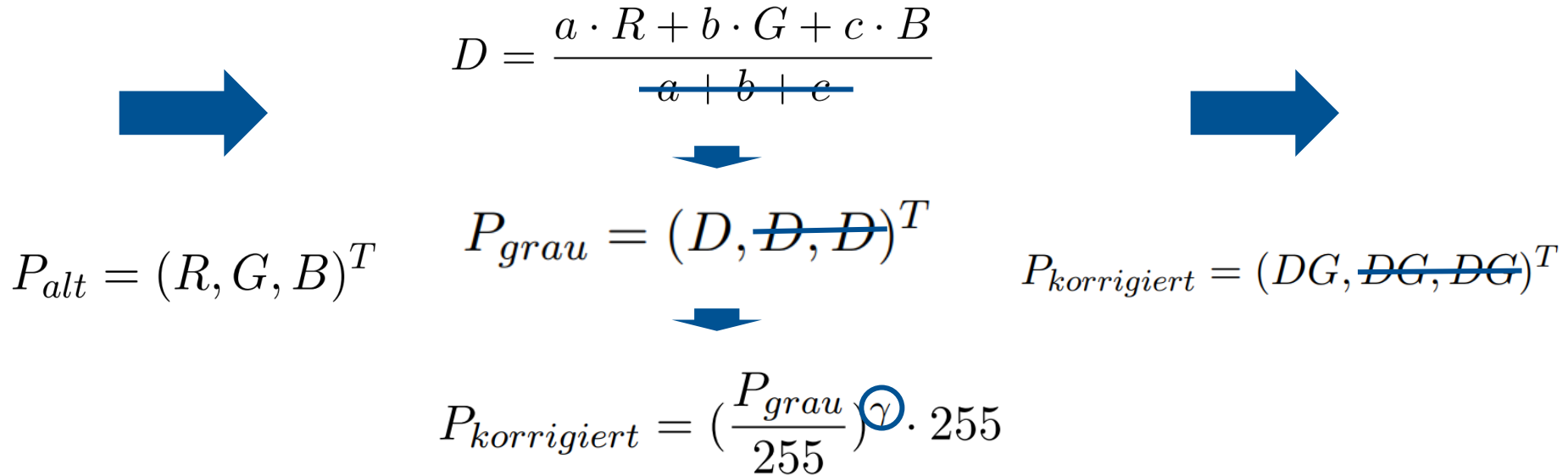
$$P_{korrigiert} = \left( \frac{P_{grau}}{255} \right)^\gamma \cdot 255$$



$$P_{korrigiert} = (DG, \cancel{DG}, \cancel{DG})^T$$

$$P_{alt} = (R, G, B)^T$$

# Verarbeiten



# Potenzieren



```
#include <math.h>
```

# Potenzieren

**Gamma = 1**  **Keine Potenzierung**

~~`#include <math.h>`~~

# Potenzieren

**Gamma = 1**



**Keine Potenzierung**

**Ganzzahlexponenten**



**Wiederholte Multiplikation**

A large blue 'X' mark is drawn over the code snippet.

```
#include <math.h>
```

# Potenzieren

**Gamma = 1**



**Keine Potenzierung**

**Ganzzahlexponenten**



**Wiederholte Multiplikation**

**Fließkommaexponenten**



$$x^y = \exp(y * \ln(x))$$



```
#include <math.h>
```

# Potenzieren

Gamma = 1



Keine Potenzierung

Ganzzahlexponenten



Wiederholte Multiplikation

Fließkommaexponenten



$$x^y = \exp(y * \ln(x))$$



Approximationen von  $\exp()$   
und  $\ln()$  mittels Taylorreihen

~~`#include <math.h>`~~

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \dots$$



# Potenzieren mit Lookup-Table

# Potenzieren mit Lookup-Table

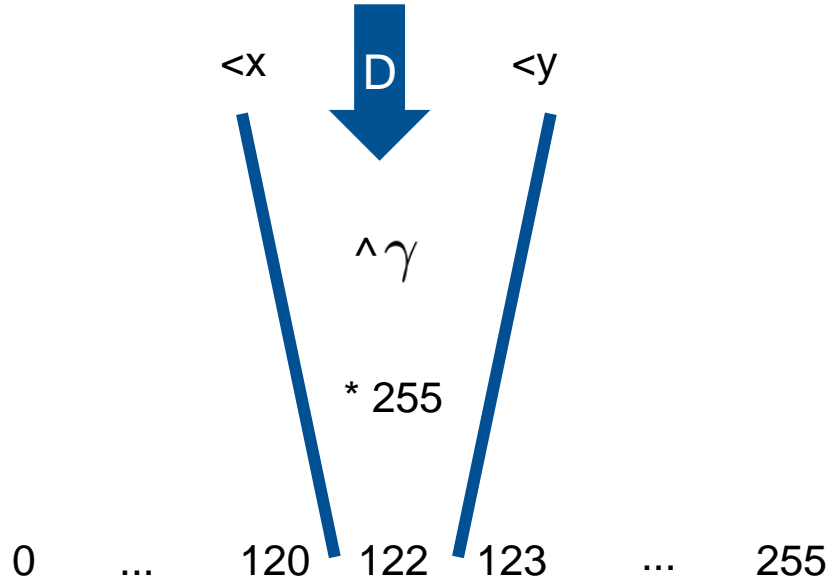
0    ...    120   122   123    ...    255

# Potenzieren mit Lookup-Table

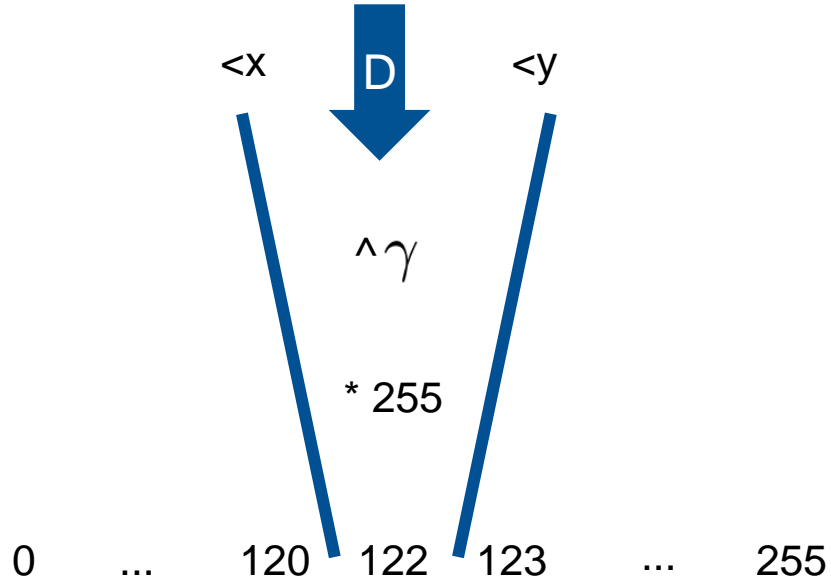
 $^{\gamma}$  $\cdot 255$ 

0    ...    120    122    123    ...    255

# Potenzieren mit Lookup-Table

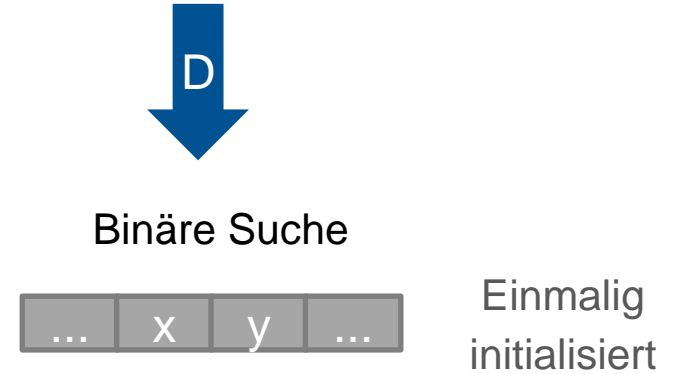
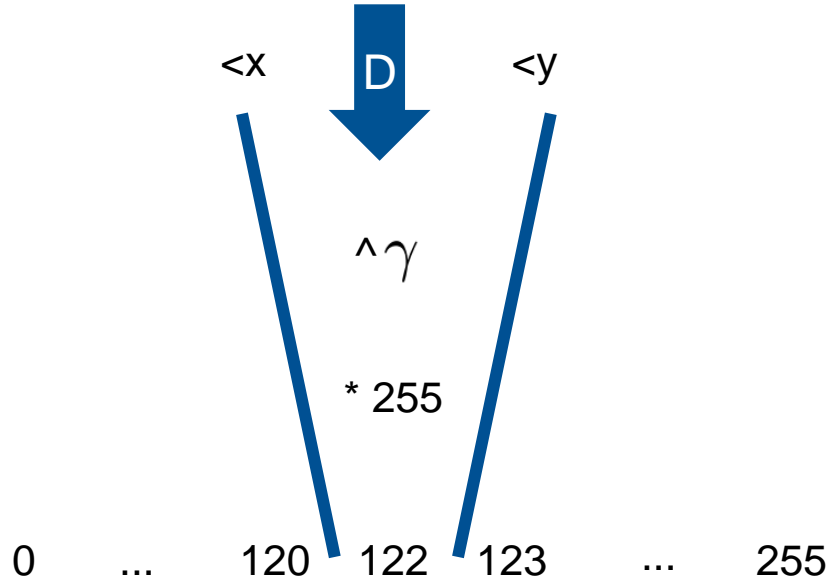


# Potenzieren mit Lookup-Table

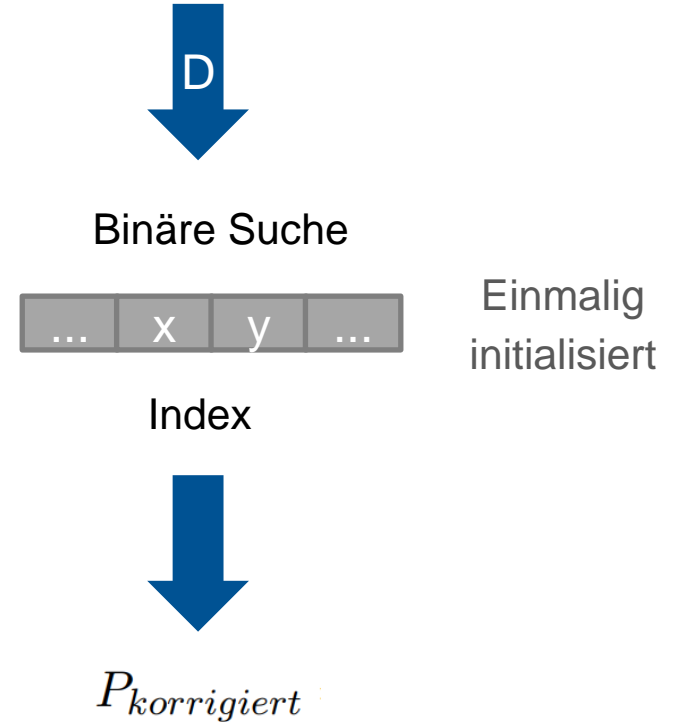
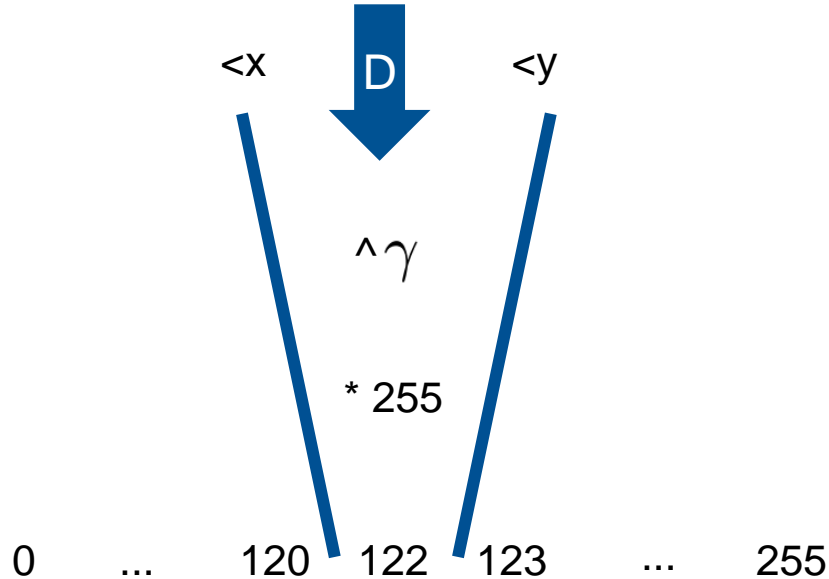


Einmalig  
initialisiert

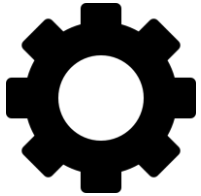
# Potenzieren mit Lookup-Table



# Potenzieren mit Lookup-Table



# Schreiben



...

DG<sub>15</sub>

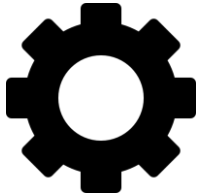
DG<sub>16</sub>

DG<sub>17</sub>

...



# Schreiben



**1 Pixel**



...

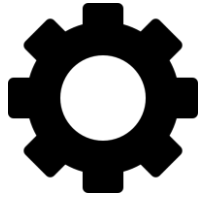
DG<sub>15</sub>

DG<sub>16</sub>

DG<sub>17</sub>

...

# Schreiben



**1 Pixel**



...  
DG<sub>15</sub>  
DG<sub>16</sub>  
DG<sub>17</sub>  
...

...

DG<sub>15</sub>

DG<sub>15</sub>

DG<sub>15</sub>

DG<sub>16</sub>

DG<sub>16</sub>

DG<sub>16</sub>

DG<sub>17</sub>

DG<sub>17</sub>

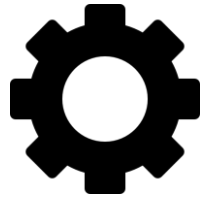
DG<sub>17</sub>

...



**1 Pixel**

# Schreiben



1 Pixel



...  
DG<sub>15</sub>  
DG<sub>16</sub>  
DG<sub>17</sub>  
...



...

DG<sub>15</sub>

DG<sub>15</sub>

DG<sub>15</sub>

DG<sub>16</sub>

DG<sub>16</sub>

DG<sub>16</sub>

DG<sub>17</sub>

DG<sub>17</sub>

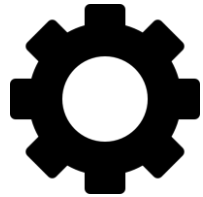
DG<sub>17</sub>

...



1 Pixel

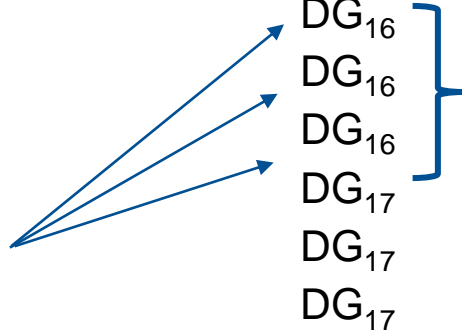
# Schreiben



1 Pixel



...  
 $DG_{15}$   
 $DG_{16}$   
 $DG_{17}$   
 ...



...  
 $DG_{15}$   
 $DG_{15}$   
 $DG_{15}$   
 $DG_{16}$   
 $DG_{16}$   
 $DG_{16}$   
 $DG_{17}$   
 $DG_{17}$   
 $DG_{17}$   
 ...

1 Pixel



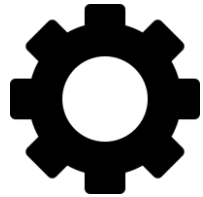
```

1 P6
2 512 512
3 255
4 XXX]]ZZZXXX^^^]] [[[^^^Z
  [X][X][X][X][X][X][X][X][X][X]
  ###[X][X][X][X][X][X][X][X][X][X]!!!!!"
  000222555888333;;7778887
  999:::>>>@@@<<<BBB===@@@=
  888;;>>>;==>>>>>>>>>
  999==>>>>999666999<<<<<<
  999:::;;:::999:::999777<
  888<<<AAABBBAAA999:::;;5
  $,,--666888>>>GGGPPPNNN
  \SSSWWWXXX000RRRVVVSSSUUU
  NNNNNKKKMMMQQQUUUjjj|||
  %%%,,+,+((111000,,000,
  11122255544400044444222/
  \YYYZZZ```YYYVVV^^^aaa_
  
```

...

...

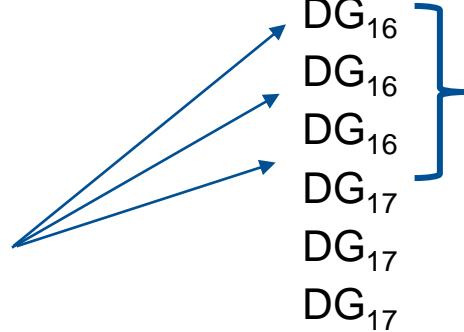
# Schreiben



1 Pixel



...  
 $DG_{15}$   
 $DG_{16}$   
 $DG_{17}$   
 ...



1 Pixel



```

1 P6
2 512 512
3 255
4 XXX]]ZZZXXX^^^]] [[[^^^Z
  [X][X][X][X][X][X][X][X][X][X]
  ### [X][X][X][X][X][X][X][X][X][X]!!!!!"
  000222555888333;;;7778887
  999::;>>@@@<<<BBB===@@@=
  888;;;>>;;>==>>>>>>>>
  999==>>>999666999<<<<<<
  999::;;;;::999::999777<
  888<<<AAABBBAAA999::;;;5
  $,,--666888>>>GGGPPPNNN
  \SSSWWWXXX000RRRVVVSSSUUU
  NNNNNKKKMMMQQQUUUjjj||| [X]
  %%%,,+,+((111000,,000,
  111222555444000444444222/
  \YYYZZZ```YYYVVV^^^aaa___
  
```

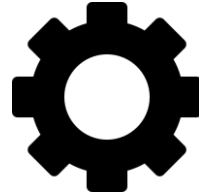
...

...

Genauigkeit

Fließkommazahlen

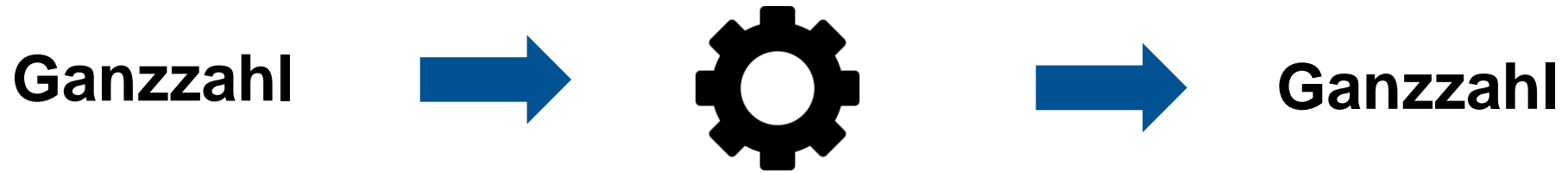
**Ganzzahl**



**Ganzzahl**

**Fließkommazahl**

Fließkommazahlen



**Fließkommazahl**





Fließkommazahlen



+/-	Exponent	Mantisse
-----	----------	----------

Potenzierung

**Performanz**



**Genauigkeit**

Potenzierung

**Performanz**



**Genauigkeit**

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \frac{x^5}{5!} + \dots$$

# Potenzierung

**Performanz**



**Genauigkeit**


$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \frac{x^5}{5!} + \frac{x^6}{6!} + \frac{x^7}{7!} + \frac{x^8}{8!} + \frac{x^9}{9!} + \frac{x^{10}}{10!} + \frac{x^{11}}{11!} + \frac{x^{12}}{12!} + \dots$$

# Potenzierung

**Performanz**

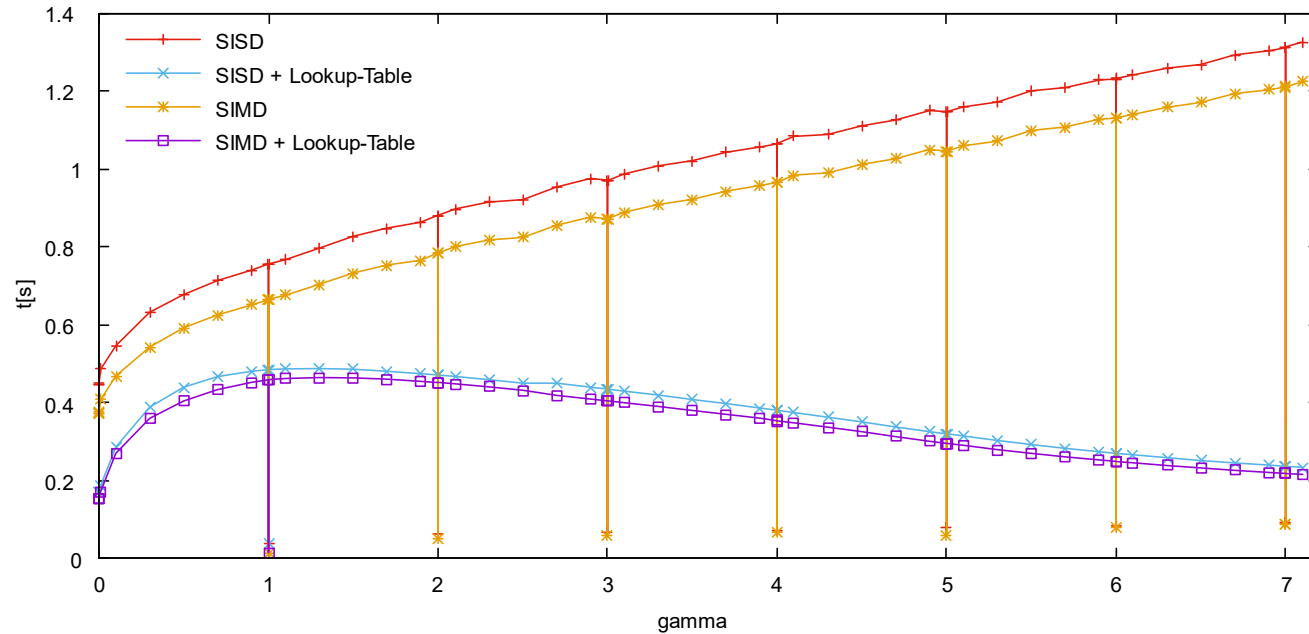


**Genauigkeit**

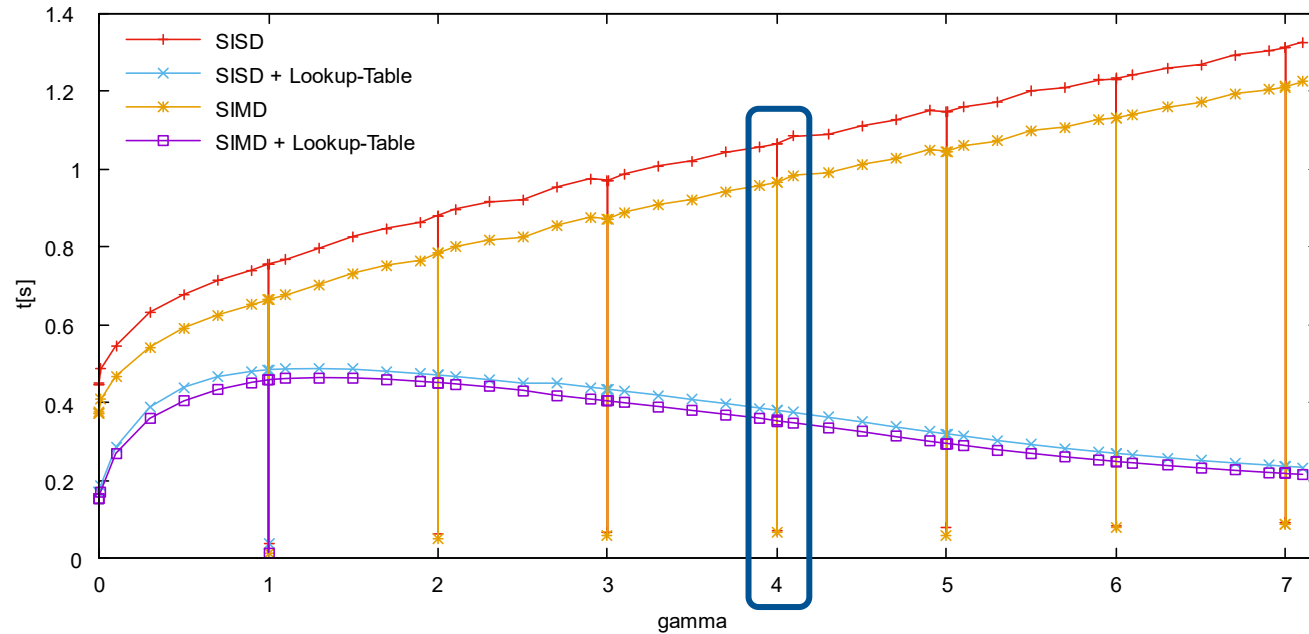
$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \frac{x^5}{5!} + \frac{x^6}{6!} + \frac{x^7}{7!} + \boxed{\frac{x^8}{8!}} + \frac{x^9}{9!} + \frac{x^{10}}{10!} + \frac{x^{11}}{11!} + \frac{x^{12}}{12!} + \dots$$


# Performanz

# Performanzmessung

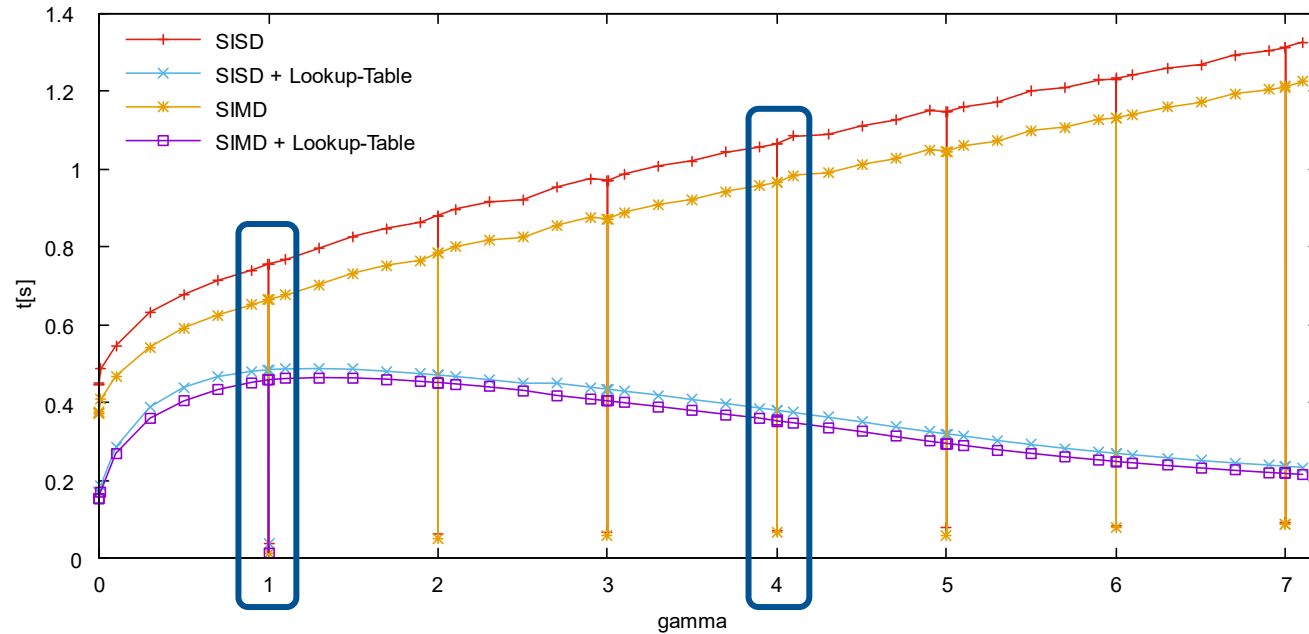


# Performanzmessung

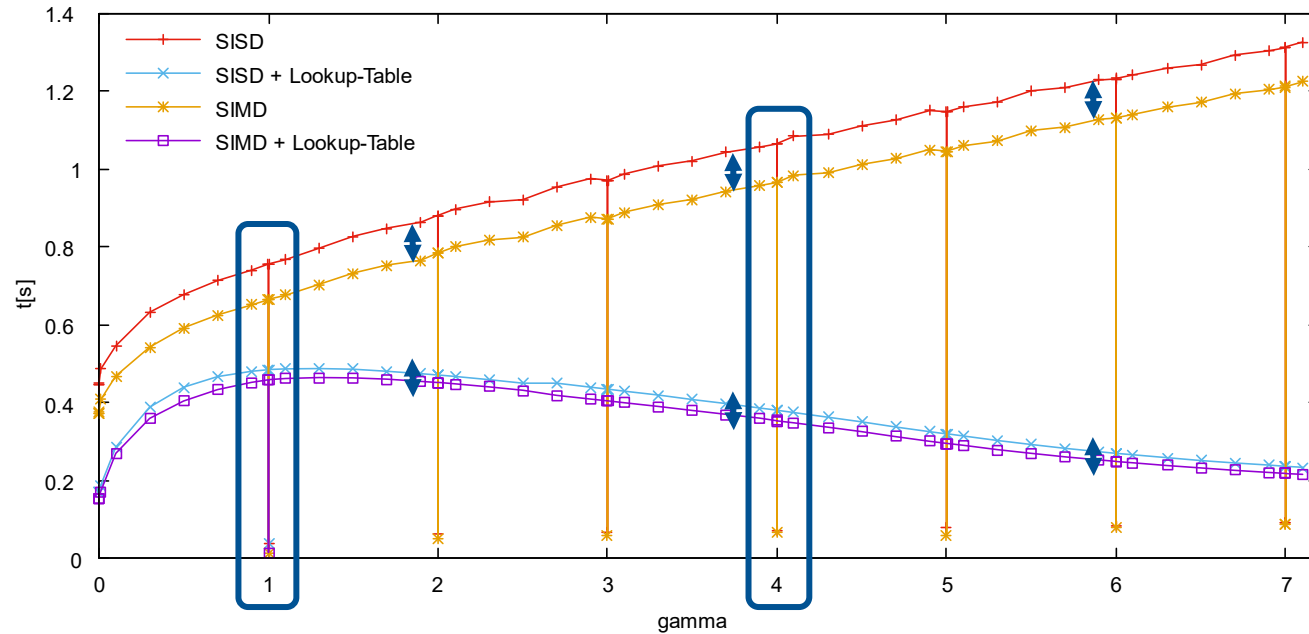




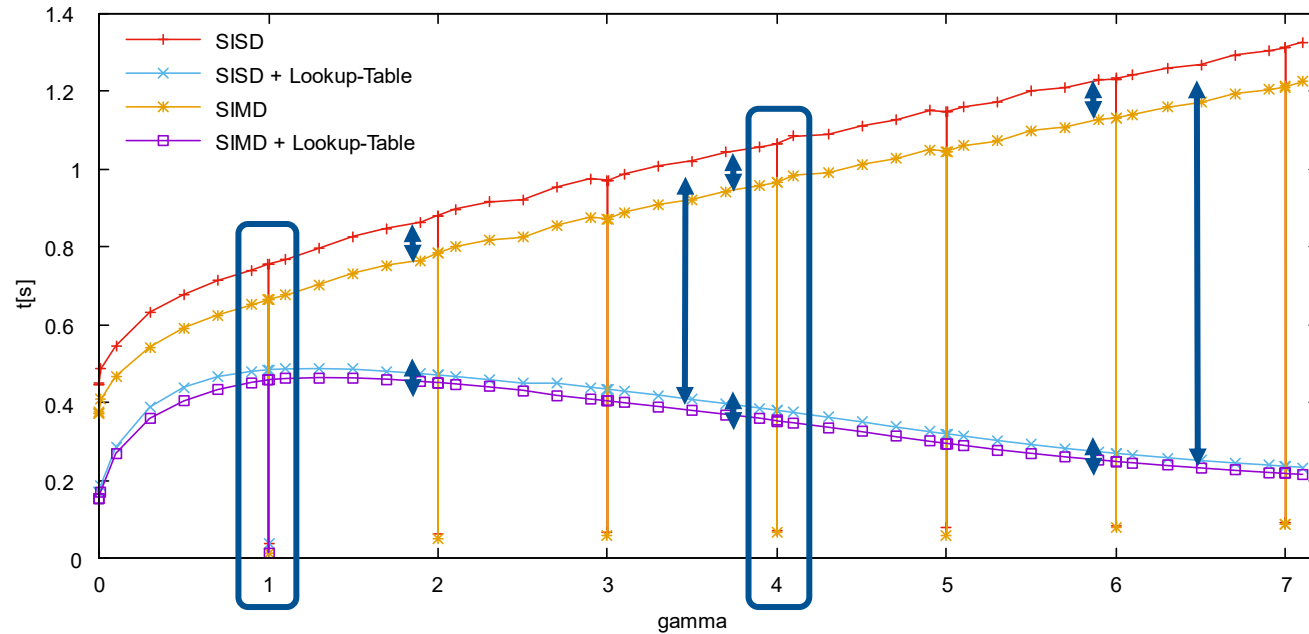
# Performanzmessung



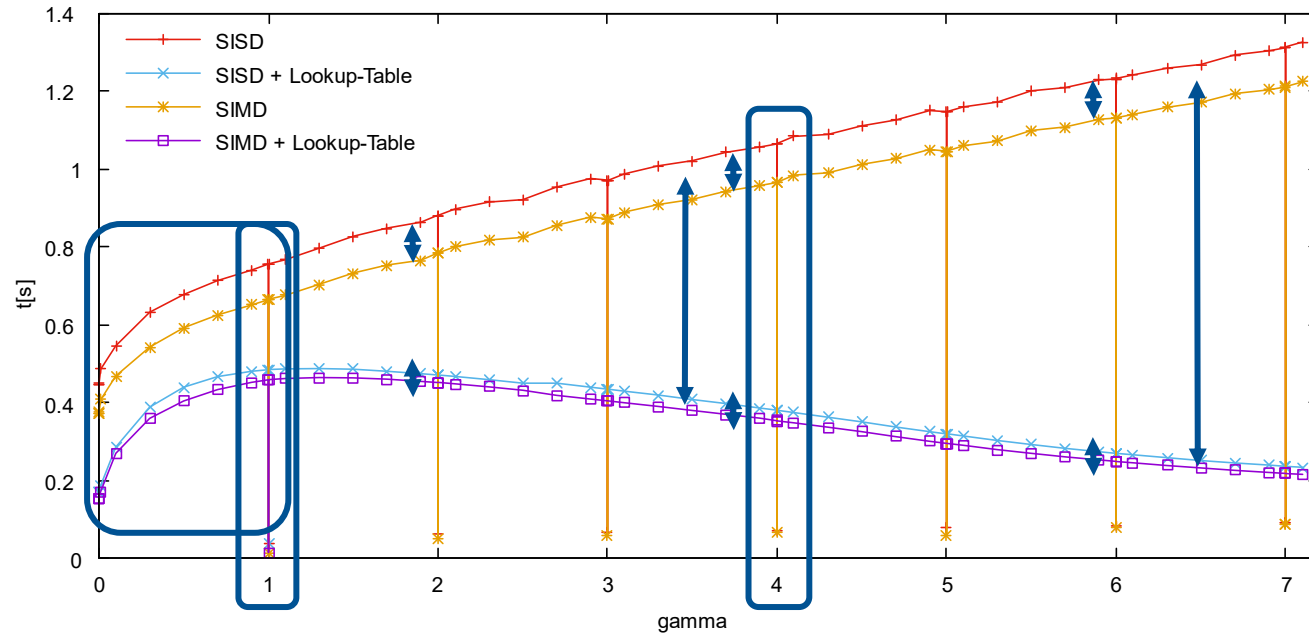
# Performanzmessung



# Performanzmessung



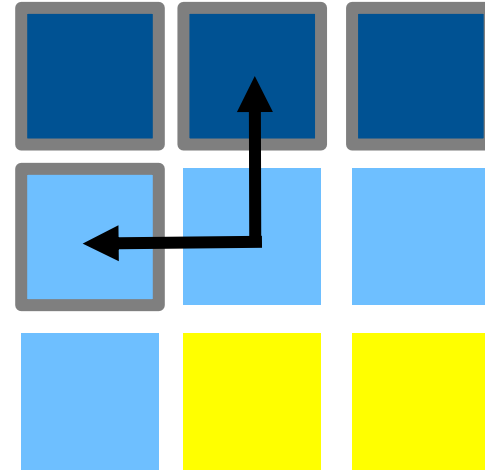
# Performanzmessung



# Ausblick

# Festkommazahlen

# Festkommazahlen



Danke für's Zuhören!

