

invertierbar = regulär
 $\det(A) = 0$

Schnelles Orthogonalisierungsschema

Basis b_1, b_2, b_3 gegeben
 $\rightarrow$ Gram-Schmidt
 $a_1 = b_1$
 $a_2 = b_2 - \frac{\langle b_2, a_1 \rangle}{\langle a_1, a_1 \rangle} a_1$
 $a_3 = b_3 - \frac{\langle b_3, a_1 \rangle}{\langle a_1, a_1 \rangle} a_1 - \frac{\langle b_3, a_2 \rangle}{\langle a_2, a_2 \rangle} a_2$

Affine Abbildungen

$A(x) = A \cdot x + t$
 A : lineare Abbildung
 t : Translationsvektor
 Affine Abbildung ist bijektiv
 Affine Abbildung ist umkehrbar
 $\det(A) \neq 0$
 $A^{-1}(x) = A^{-1}(x - t)$

2x2-Matrizen

Wegorthog $\rightarrow$ Drehung
 $\begin{pmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{pmatrix}$
 Spiegelung
 $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$
 Streckung
 $\begin{pmatrix} s & 0 \\ 0 & s \end{pmatrix}$
 Scherung
 $\begin{pmatrix} 1 & s \\ 0 & 1 \end{pmatrix}$

Koordinatentransformation

Koordinatenvektor $p = g \circ f^{-1}(x)$
 $f: \mathbb{R}^n \rightarrow \mathbb{R}^n$
 $g: \mathbb{R}^n \rightarrow \mathbb{R}^n$
 $f(x) = T \cdot x + p$
 $g(x) = T^{-1} \cdot (x - p)$
 $E = (e_1, \dots, e_n)$
 $E' = (e'_1, \dots, e'_n)$
 $E' = E \cdot T^{-1}$

Eigenwerttheorie

Eigenwert $\lambda \in \mathbb{C}$, $A \in \mathbb{C}^{n \times n}$
 $(A - \lambda I) \cdot v = 0$
 $\det(A - \lambda I) = 0$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Eigenraum

Eigenraum $E_\lambda = \{v \in \mathbb{C}^n \mid A \cdot v = \lambda \cdot v\}$
 $\dim(E_\lambda) = \text{Rang}(A - \lambda I)$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Eigenraum

Eigenraum $E_\lambda = \{v \in \mathbb{C}^n \mid A \cdot v = \lambda \cdot v\}$
 $\dim(E_\lambda) = \text{Rang}(A - \lambda I)$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Wegorthog

Wegorthog $\rightarrow$ Drehung
 $\begin{pmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{pmatrix}$
 Spiegelung
 $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$
 Streckung
 $\begin{pmatrix} s & 0 \\ 0 & s \end{pmatrix}$
 Scherung
 $\begin{pmatrix} 1 & s \\ 0 & 1 \end{pmatrix}$

Koordinate

Koordinate $p = g \circ f^{-1}(x)$
 $f: \mathbb{R}^n \rightarrow \mathbb{R}^n$
 $g: \mathbb{R}^n \rightarrow \mathbb{R}^n$
 $f(x) = T \cdot x + p$
 $g(x) = T^{-1} \cdot (x - p)$
 $E = (e_1, \dots, e_n)$
 $E' = (e'_1, \dots, e'_n)$
 $E' = E \cdot T^{-1}$

Eigenwert

Eigenwert $\lambda \in \mathbb{C}$, $A \in \mathbb{C}^{n \times n}$
 $(A - \lambda I) \cdot v = 0$
 $\det(A - \lambda I) = 0$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Eigenraum

Eigenraum $E_\lambda = \{v \in \mathbb{C}^n \mid A \cdot v = \lambda \cdot v\}$
 $\dim(E_\lambda) = \text{Rang}(A - \lambda I)$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Eigenraum

Eigenraum $E_\lambda = \{v \in \mathbb{C}^n \mid A \cdot v = \lambda \cdot v\}$
 $\dim(E_\lambda) = \text{Rang}(A - \lambda I)$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Eigenraum

Eigenraum $E_\lambda = \{v \in \mathbb{C}^n \mid A \cdot v = \lambda \cdot v\}$
 $\dim(E_\lambda) = \text{Rang}(A - \lambda I)$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Eigenraum

Eigenraum $E_\lambda = \{v \in \mathbb{C}^n \mid A \cdot v = \lambda \cdot v\}$
 $\dim(E_\lambda) = \text{Rang}(A - \lambda I)$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Hauptdiagonalisierung

Diagonalisierung
 $A = P \cdot D \cdot P^{-1}$
 $P = (v_1, \dots, v_n)$
 $D = \text{diag}(\lambda_1, \dots, \lambda_n)$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Koordinate

Koordinate $p = g \circ f^{-1}(x)$
 $f: \mathbb{R}^n \rightarrow \mathbb{R}^n$
 $g: \mathbb{R}^n \rightarrow \mathbb{R}^n$
 $f(x) = T \cdot x + p$
 $g(x) = T^{-1} \cdot (x - p)$
 $E = (e_1, \dots, e_n)$
 $E' = (e'_1, \dots, e'_n)$
 $E' = E \cdot T^{-1}$

Eigenwert

Eigenwert $\lambda \in \mathbb{C}$, $A \in \mathbb{C}^{n \times n}$
 $(A - \lambda I) \cdot v = 0$
 $\det(A - \lambda I) = 0$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Eigenraum

Eigenraum $E_\lambda = \{v \in \mathbb{C}^n \mid A \cdot v = \lambda \cdot v\}$
 $\dim(E_\lambda) = \text{Rang}(A - \lambda I)$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Eigenraum

Eigenraum $E_\lambda = \{v \in \mathbb{C}^n \mid A \cdot v = \lambda \cdot v\}$
 $\dim(E_\lambda) = \text{Rang}(A - \lambda I)$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Eigenraum

Eigenraum $E_\lambda = \{v \in \mathbb{C}^n \mid A \cdot v = \lambda \cdot v\}$
 $\dim(E_\lambda) = \text{Rang}(A - \lambda I)$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Eigenraum

Eigenraum $E_\lambda = \{v \in \mathbb{C}^n \mid A \cdot v = \lambda \cdot v\}$
 $\dim(E_\lambda) = \text{Rang}(A - \lambda I)$
 $\lambda_1, \lambda_2, \dots, \lambda_n$
 $v_1, v_2, \dots, v_n$
 $A \cdot v_i = \lambda_i \cdot v_i$
 $A = \frac{1}{n} \sum_{i=1}^n \lambda_i \cdot I$

Folgen

Bsp 1: $a_n = 3n$
 $a_1 = 3, a_2 = 6, a_3 = 9, \dots$
 $a_n = 3n$
 $a_n = 3n$
 $a_n = 3n$

Bsp 2

Bsp 2: $a_n = 2 + 3(n-1)$
 $a_1 = 2, a_2 = 5, a_3 = 8, \dots$
 $a_n = 2 + 3(n-1)$
 $a_n = 2 + 3(n-1)$
 $a_n = 2 + 3(n-1)$

Bsp 3

Bsp 3: $a_n = (3-4n)^n$
 $a_1 = 3, a_2 = -4, a_3 = 16, \dots$
 $a_n = (3-4n)^n$
 $a_n = (3-4n)^n$
 $a_n = (3-4n)^n$

Bsp 4

Bsp 4: $a_n = 1/n$
 $a_1 = 1, a_2 = 1/2, a_3 = 1/3, \dots$
 $a_n = 1/n$
 $a_n = 1/n$
 $a_n = 1/n$

Bsp 5

Bsp 5: $a_n = 1/n^2$
 $a_1 = 1, a_2 = 1/4, a_3 = 1/9, \dots$
 $a_n = 1/n^2$
 $a_n = 1/n^2$
 $a_n = 1/n^2$

Bsp 6

Bsp 6: $a_n = 1/n^3$
 $a_1 = 1, a_2 = 1/8, a_3 = 1/27, \dots$
 $a_n = 1/n^3$
 $a_n = 1/n^3$
 $a_n = 1/n^3$

Bsp 7

Bsp 7: $a_n = 1/n^4$
 $a_1 = 1, a_2 = 1/16, a_3 = 1/81, \dots$
 $a_n = 1/n^4$
 $a_n = 1/n^4$
 $a_n = 1/n^4$

Differentialrechnung mehrerer Veränderlicher

Wiederholung:
 $f(x,y) \in D1, f(x,y) \in \mathbb{R}$
 $f(x,y) = 0 \rightarrow$ nach x auflösen
 $\rightarrow$ in $f(x,y) = 0$ einsetzen
 $\rightarrow$ in $f(x,y) = 0$ einsetzen
 $\rightarrow$ in $f(x,y) = 0$ einsetzen

Die Kettenregel:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Partielle Ableitung:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Lineare Approximation:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Satz von Taylor:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Extrema:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Weglängen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Flächen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Volumen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Massen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Weglängen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Weglängen & Flächen

Weglängen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Flächen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Volumen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Massen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Weglängen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Flächen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Volumen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Massen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Weglängen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Flächen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Volumen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Kurvenintegral

reguläre Parametrisierung:
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$

zusammengesetzte Kurven:
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$

Umlaufintegral:
 $\oint_C f(x,y) dx$
 $\oint_C f(x,y) dx$
 $\oint_C f(x,y) dx$
 $\oint_C f(x,y) dx$

Kurvenintegral & Potential:
 $\int_C f(x,y) dx$
 $\int_C f(x,y) dx$
 $\int_C f(x,y) dx$
 $\int_C f(x,y) dx$

Parametrisierung:
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$

Länge der Kurve/Gradient:
 $L(C) = \int_a^b \sqrt{x'(t)^2 + y'(t)^2} dt$
 $L(C) = \int_a^b \sqrt{x'(t)^2 + y'(t)^2} dt$
 $L(C) = \int_a^b \sqrt{x'(t)^2 + y'(t)^2} dt$
 $L(C) = \int_a^b \sqrt{x'(t)^2 + y'(t)^2} dt$

Skalierung:
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$

Weglängen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Flächen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Volumen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Massen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Wichtig

Skalierung:
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$
 $C(t) = (x(t), y(t))$

Weglängen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Flächen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Volumen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Massen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Weglängen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Flächen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Volumen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Massen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Weglängen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$

Flächen:
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$
 $f(x,y) = f(x,y)$