

Klausur zur Analysis II (Lösungen)

Bearbeitungszeit: 9:30 - 10:30

Aufgabe 1 (10 Punkte)

Man untersuche die Funktion $f: \mathbb{R}^2 \rightarrow \mathbb{R}$, $f(x, y) := (x^2 - 4)^2 + (y + 1)^2$ auf lokale und globale Extrema.

Wegen $f(x, y) \rightarrow \infty$ für $\|x\| \rightarrow \infty$ gibt es kein globales Maximum, jedoch ein globales Minimum, natürlich bei $(\pm 2, -1)$ mit dem Funktionswert 0. Alle lokalen Extremstellen sind unter den Nullstellen des Gradienten von f zu finden.

$$(0, 0) = \nabla f(x, y) = (f_x(x, y), f_y(x, y)) = (4x(x^2 - 4), 2(y + 1)) \iff (x, y) \in \{(0, -1), (2, -1), (-2, -1)\}.$$

Diese kritischen Stellen untersuchen wir weiter mit der Hesse-Matrix

$$H_f(x, y) = \begin{pmatrix} f_{xx} & f_{xy} \\ f_{xy} & f_{yy} \end{pmatrix} = \begin{pmatrix} 4(x^2 - 4) + 6x^2 & 0 \\ 0 & 2 \end{pmatrix}.$$

(i) $(x, y) = (0, -1)$: $H_f(0, -1) = \begin{pmatrix} -16 & 0 \\ 0 & 2 \end{pmatrix}$. Diese Matrix ist indefinit. Also liegt kein lokaler Extremwert vor.

(ii) $(x, y) = (2, -1)$: $H_f(2, -1) = \begin{pmatrix} 32 & 0 \\ 0 & 2 \end{pmatrix}$. Diese Matrix ist positiv definit. Also liegt ein lokales Minimum vor.

(iii) $(x, y) = (-2, -1)$: Da $f(x, y) = f(-x, y)$, liegt hier ebenfalls ein lokales Minimum (mit dem gleichen Funktionswert) vor.

Auf (ii) und (iii) kann man hier nat. verzichten (siehe oben).

Aufgabe 2 (je 5 Punkte)

a) Man bestimme das Minimum der Funktion $f_1: \mathbb{R}_{>0}^n \rightarrow \mathbb{R}$, $f_1(x_1, \dots, x_n) := \sum_{k=1}^n x_k^2$ unter der Nebenbedingung $g_1(x) := x_1 \cdots x_n - 1 = 0$.

Zunächst suchen wir mit Lagrange Kandidaten für Extremwerte. Die Lagrangebedingung lautet:

$$\begin{aligned} \nabla f_1(x) = 2x &= \lambda \nabla g_1(x) = (\lambda x_2 \cdots x_n, \lambda x_1 x_3 \cdots x_n, \dots, \lambda x_1 \cdots x_{n-1}) \iff \\ 2x_k^2 &= \lambda x_1 \cdots x_n = \lambda \text{ für } k = 1, \dots, n. \end{aligned}$$

Alle x_k sind also gleich, was auf Grund der Nebenbedingung zu $x_k = 1$ für alle k führt. $(1, \dots, 1)$ ist also der einzige Kandidat und $f_1(1, \dots, 1) = n$. Es handelt sich um das (globale) Minimum von f_1 unter der NB $g_1 = 0$. Gels nämlich ein x_k gegen 0, so muss auf Grund der Nebenbedingung wenigstens ein x_j und damit auch $f_1(x)$ gegen unendlich gehen. Präziser: (auch als vollständige Lösung brauchbar)

Die Ungleichung zwischen den arithmetischen und geometrischen Mitteln liefert:

$$1 = x_1 \cdots x_n \leq \left(\frac{\sum_{k=1}^n x_k^2}{n} \right)^n \Rightarrow \sum_{k=1}^n x_k^2 \geq n; \text{ für unser } (1, \dots, 1) \text{ gilt hier die Gleichheit } \square.$$

Analysis Ii

AN Whitehead



Analysis II:

The Enigmatic Realm of **Analysis Ii**: Unleashing the Language is Inner Magic

In a fast-paced digital era where connections and knowledge intertwine, the enigmatic realm of language reveals its inherent magic. Its capacity to stir emotions, ignite contemplation, and catalyze profound transformations is nothing in short supply of extraordinary. Within the captivating pages of **Analysis Ii** a literary masterpiece penned with a renowned author, readers attempt a transformative journey, unlocking the secrets and untapped potential embedded within each word. In this evaluation, we shall explore the book's core themes, assess its distinct writing style, and delve into its lasting affect on the hearts and minds of those who partake in its reading experience.

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
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