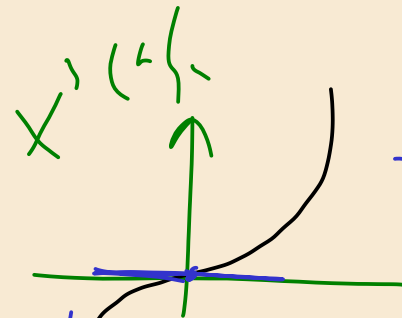


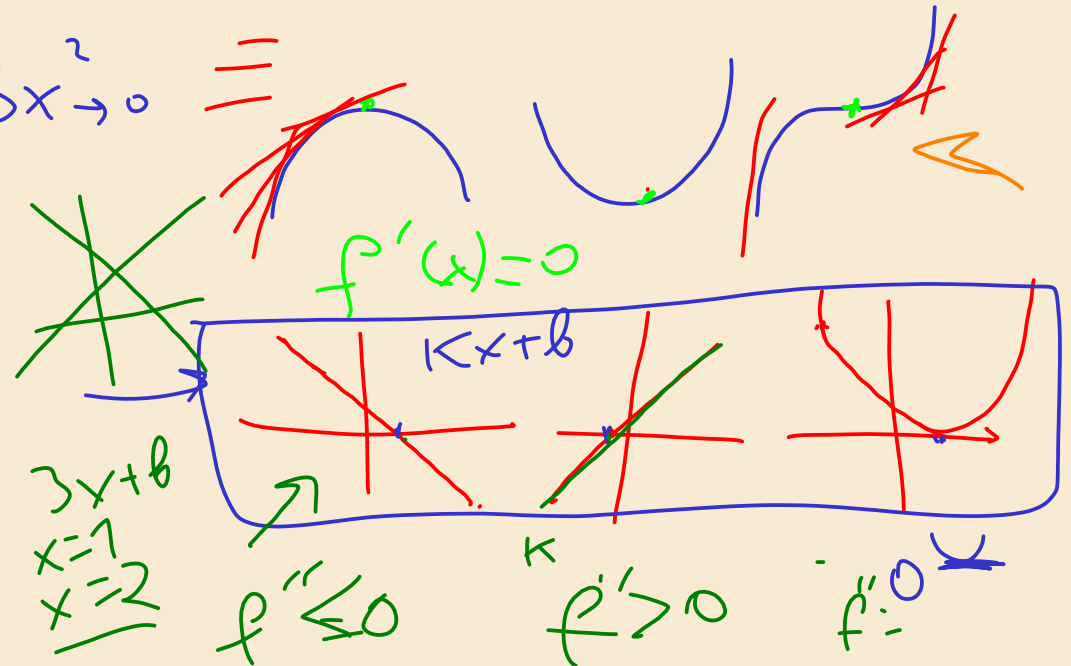
$\exists \delta > 0$ s.t. $|x - x_0| < \delta \Rightarrow$
 $f(x) \geq f(x_0)$

$\forall x$ $f(x) \geq f(x_0)$

$5 - 4(1+1) = 1$
 $2 - 1(1) = 1$
 $8.5 - 4(1+1) = 0.5$



$3x^2 \rightarrow 0 =$



$f'(x)=0$

$f''(x) < 0 \Rightarrow x$ local max
 $f''(x) > 0 \Rightarrow x$ local min

$$x^4 - 4x^3 + 4x^2$$

$$f'(x) = 4x^3 - 12x^2 + 8x$$

$$f'(x) = 0 \quad \text{f}$$

$$x=0 \quad 4(x^3 - 3x^2 + 2x)$$

$$4x(x^2 - 3x + 2) = 0$$

$$x^2 + 4x$$

$$x(x+4)$$

$$4x(x-1)(x-2) = 0$$

$$0$$

$$x = 1$$

$$2$$

$$A \neq C = 0$$

$$A = 0$$

$$4, 1$$

$$x_1 x_2 = 2$$

$$x_1 + x_2 = 3$$

$$2, 1$$

$$1. x^2 - 3x + 2 = 0$$

$$D = 9 - 4 \cdot 2 = 1$$

$$ax^2 + bx + c = 0$$

$$D = b^2 - 4ac$$

$$(x-1)(x-2) =$$

$$x_1 = \frac{-b + \sqrt{D}}{2a}$$

$$x_2 = \frac{-b - \sqrt{D}}{2a}$$

$$x_1 = \frac{3+1}{2 \cdot 1} = \frac{4}{2} = 2$$

$$x_2 = \frac{3-1}{2} = 1$$

$$x^2 - 2x - x + 2 =$$

$$x^2 - 3x + 2 =$$

$$1^2 - 3 \cdot 1 + 2 = 0$$

$$2^2 - 3 \cdot 2 + 2 = 0$$

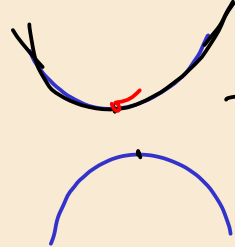
$$a=1$$

$$x_1 x_2 = c$$

$$x_1 + x_2 = -b$$

$$f'' > 0$$

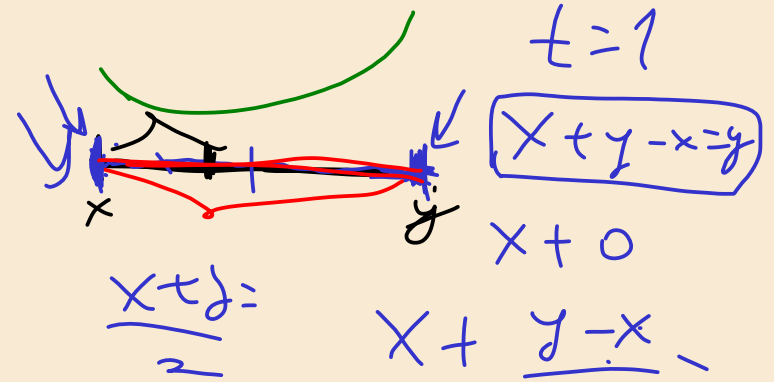
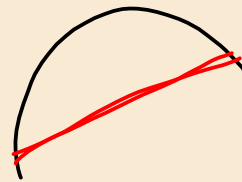
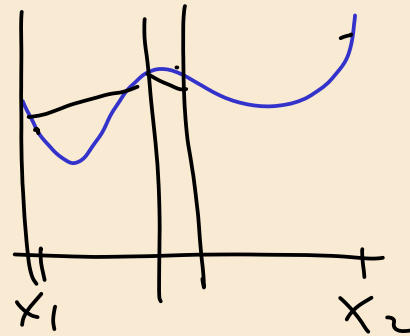
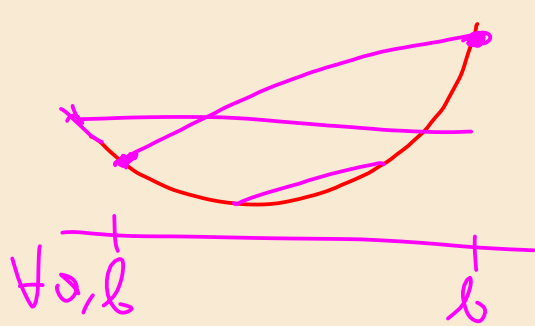
$$f'' < 0$$



konvex, wachst
 konkave, sinkt

$-f$

$$f(x + (y-x)t) ; t \in [0,1]$$



$$f \text{ ist } \gamma\text{-Hölder, } \forall x, y \quad \forall t \in [0,1]$$

$$f(\lambda x + (1-\lambda)y) \leq \lambda f(x) + (1-\lambda)f(y)$$



$$t=1$$

$$X + (y-x)t = y$$

$$X + 0$$

$$X + \frac{y-x}{2}$$

$$\frac{2X + y - X}{2} = \frac{X+y}{2}$$

$$f(x + (y-x)t) \leq f(x) + (f(y) - f(x))t$$

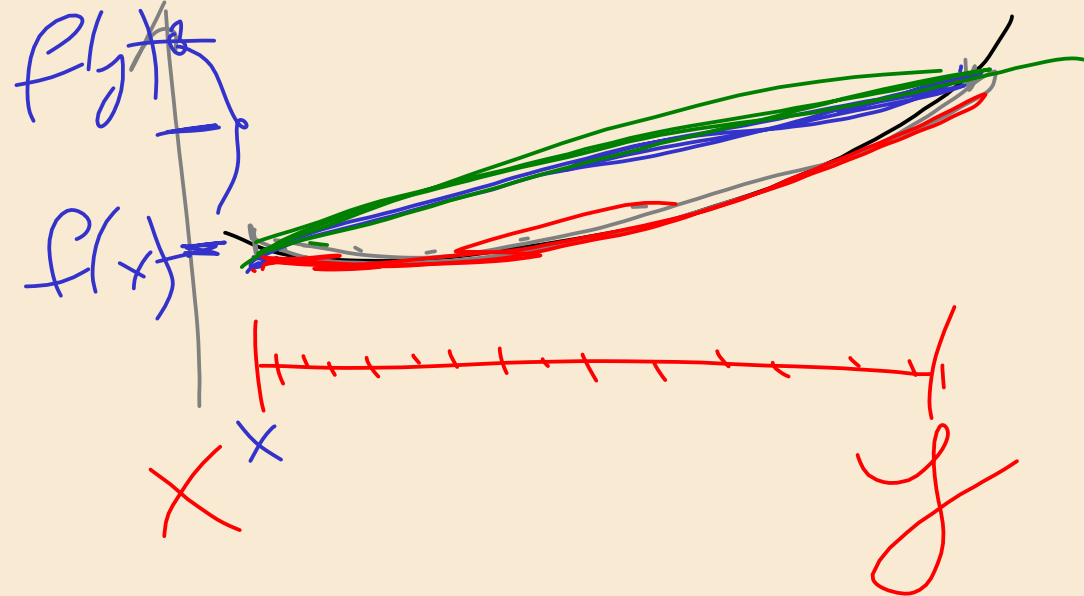
$$x + t(y-x) = x(1-t) + yt \quad | \quad \lambda = 1-t \quad (1-\lambda)y$$

$$t=1 \rightarrow$$

$$\lambda = 0$$

$$\lambda = 1$$





$$x + (y - x)t$$

$$f(x) + (f(y) - f(x))t$$

$$f(x + (y - x)t) \leq f(x) + (f(y) - f(x))t$$

\leq
 \leq
 \leq

~~$f(x) + (f(y) - f(x))t$~~

$f(y) - f(x)$

$$\underline{4x^3 - 12x^2 + 8x}$$

f''

$$12x^2 - 24x + 8$$

0, 1, 2

$$0 \rightarrow 8$$

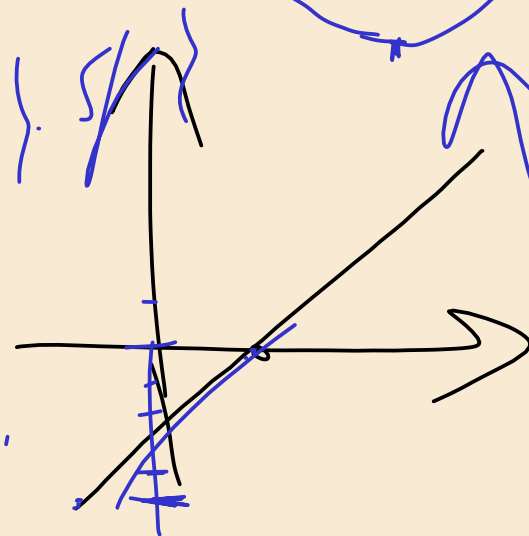
$$x = 0 - 2$$

$$1 \rightarrow -4$$

$$x \rightarrow 1$$

$$2 \rightarrow 8$$

$$x \rightarrow 2$$



1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 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. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100.

2. 4. 6. 8. 10. 12. 14. 16. 18. 20. 22. 24. 26. 28. 30. 32. 34. 36. 38. 40. 42. 44. 46. 48. 50. 52. 54. 56. 58. 60. 62. 64. 66. 68. 70. 72. 74. 76. 78. 80. 82. 84. 86. 88. 90. 92. 94. 96. 98. 100.

3. 2. 1. 0. -1. -2. -3. -4. -5. -6. -7. -8. -9. -10. -11. -12. -13. -14. -15. -16. -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. -81. -82. -83. -84. -85. -86. -87. -88. -89. -90. -91. -92. -93. -94. -95. -96. -97. -98. -99. -100.

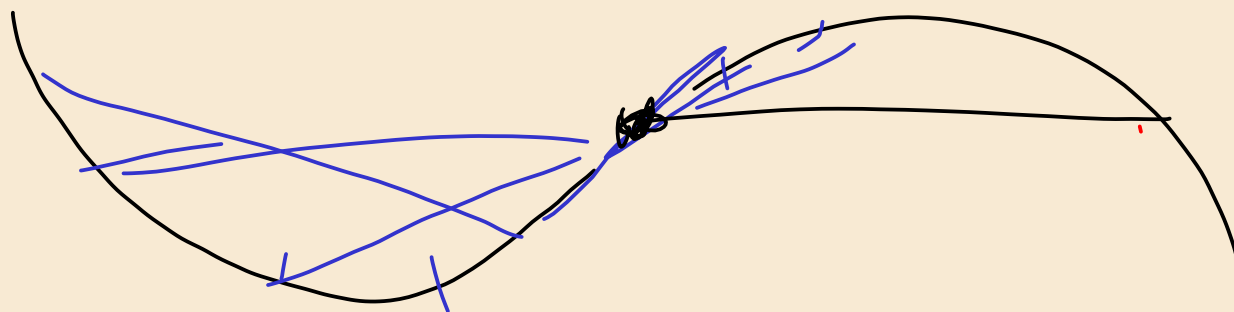
4. 2. 1. 0. -1. -2. -3. -4. -5. -6. -7. -8. -9. -10. -11. -12. -13. -14. -15. -16. -17. -18. -19. -20. -21. -22. -23. -24. -25. -26. -27. -28. -29. -30. -31. -32. -33. -34. -35. -36. -37. -38. -39. -40. -41. -42. -43. -44. -45. -46. -47. -48. -49. -50. -51. -52. -53. -54. -55. -56. -57. -58. -59. -60. -61. -62. -63. -64. -65. -66. -67. -68. -69. -70. -71. -72. -73. -74. -75. -76. -77. -78. -79. -80. -81. -82. -83. -84. -85. -86. -87. -88. -89. -90. -91. -92. -93. -94. -95. -96. -97. -98. -99. -100.

f -max \Rightarrow f has a max
 g -min

$$w_1 f + w_2 g$$

$$w_1, w_2 > 0$$

$$g \text{ is concave} \quad g \circ f \quad g(f(x))$$



inflection point

$$f'' > 0$$

$$f'' < 0$$

$$x^3 - 3x + 1$$

$$ax^2 + bx + c$$

$$1) f'(x) = 3x^2 - 3$$

$$a=3$$

$$b=0$$

$$c=-3$$

$$2) x=1, x=-1 \quad 3x^2 - 3 = 0 \quad (x \geq 1)$$

$$3) \boxed{6x}$$

$$\uparrow \quad x^2 - 1 = 0$$

$$4) 6 \cdot 1 > 0 \Rightarrow x=1 \cup \quad x=-1 \quad (-1, 1)$$

$$6 \cdot -1 < 0 \Rightarrow \cap$$

$$5) \quad 0 \rightarrow 0$$

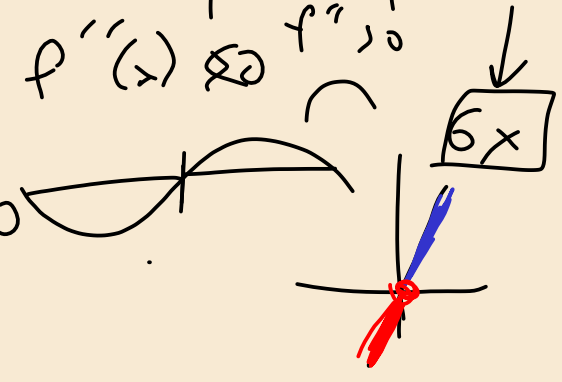
$$1 \rightarrow 6$$

$$-1 \rightarrow -6$$

$$f''(x) \geq 0 \quad f''(x) > 0$$

$$x_0 < x \quad f(x_0) < 0$$

$$x < x_0 \quad f(x_0) > 0$$



domain

image range

$\hookrightarrow \dots$