

WEEK 1

IMPERIAL COLLEGE LONDON

DEPARTMENT OF COMPUTING

multivariate

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Moving to multivariate

1.1 Differentiate with respect to anything

- limitation

$$f(x, y, z) = \sin(x) e^{yz^2}$$

$$x = t - 1; \quad y = t^2; \quad z = \frac{1}{t}$$

$$\frac{df(x, y, z)}{dt} = \frac{\partial f}{\partial x} \frac{dx}{dt} + \frac{\partial f}{\partial y} \frac{dy}{dt} + \frac{\partial f}{\partial z} \frac{dz}{dt}$$

Figure 1: This is l1

$$f(x, y, z) = \sin(x) e^{yz^2}$$

$$\frac{\partial f}{\partial x} = \cos(x) e^{yz^2} \quad \frac{\partial f}{\partial y} = z^2 \sin(x) e^{yz^2} \quad \frac{\partial f}{\partial z} = 2yz \sin(x) e^{yz^2}$$

$$\frac{dx}{dt} = 1 \quad \frac{dy}{dt} = 2t \quad \frac{dz}{dt} = -t^{-2}$$

$$\frac{df(x, y, z)}{dt} = \frac{\partial f}{\partial x} \frac{dx}{dt} + \frac{\partial f}{\partial y} \frac{dy}{dt} + \frac{\partial f}{\partial z} \frac{dz}{dt}$$

$$\frac{df(x, y, z)}{dt} = \cos(x) e^{yz^2} \times 1 + z^2 \sin(x) e^{yz^2} \times 2t + 2yz \sin(x) e^{yz^2} \times (-t^{-2})$$

Figure 2: This is l1

$$\begin{aligned}f(x, y, z) &= \sin(x) e^{yz^2} \\ \frac{df(x, y, z)}{dt} &= \cos(x) e^{yz^2} \times 1 + z^2 \sin(x) e^{yz^2} \times 2t + 2yz \sin(x) e^{yz^2} \times (-t^{-2}) \\ x &= t - 1; \quad y = t^2; \quad z = \frac{1}{t} \\ \frac{df(x, y, z)}{dt} &= \cos(t - 1) e + t^{-2} \sin(t - 1) e \times 2t + 2t \sin(t - 1) e \times (-t^{-2}) \\ \frac{df(x, y, z)}{dt} &= \cos(t - 1) e + 2t^{-1} \sin(t - 1) e - 2t^{-1} \sin(t - 1) e \\ \frac{df(x, y, z)}{dt} &= \cos(t - 1) e\end{aligned}$$

Figure 3: This is l1

2 Jacobian

2.1

$$\begin{aligned}f(x_1, x_2, x_3, \dots) \\ J = \left[\frac{\partial f}{\partial x_1}, \frac{\partial f}{\partial x_2}, \frac{\partial f}{\partial x_3}, \dots \right]\end{aligned}$$

Figure 4: This is Jacobian

2.2 Jacobian applied

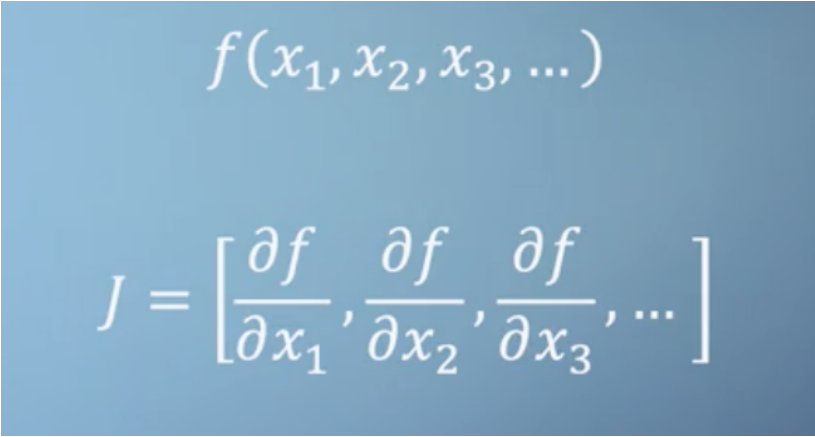

$$f(x_1, x_2, x_3, \dots)$$
$$J = \left[\frac{\partial f}{\partial x_1}, \frac{\partial f}{\partial x_2}, \frac{\partial f}{\partial x_3}, \dots \right]$$

Figure 5: This is Jacobian