AI1072: Machine learning, exercise sheet 8

A general remark: the object w.r.t. which a derivative is taken in TF can, but need not be tf.Variable instances.

1 A scalar-scalar function in TF

Let $f(x) = \sum_{i=1}^{4} x^i$.
a) Use TF to compute $f(0)$, $f(1)$ and $f(2)$
b) Use TF to compute $f'(x)|_{x=-1}$
c) Use TF to compute $(f'(x)|_{x=-1})^2$

2 A vector-scalar function in TF

Let $f(\vec{x}) = \sum_{i=1}^{3} x_i^3$.
a) Implement this function in TF and compute its output for the inputs $\vec{x}_1 = (1, 2, 3)^T$ and $\vec{x}_2 = (2, 0, 2)^T$. Hint: use a tf function to compute the sum!
b) Use TF to compute and display the value of $\vec{\nabla} f$, evaluated for $\vec{x} = \vec{x}_1$
c) Use TF to compute and display the value of $\frac{\partial f}{\partial x_1}$, evaluated for $\vec{x} = \vec{x}_2$

3 Vector-vector chain rule in TF

Suppose we have a matrix $W = \begin{pmatrix} 1 & 2 \\ -1 & 1 \\ 0 & 1 \end{pmatrix}$, a function $f(\vec{x}) = W\vec{x}$ and a function $g(\vec{x}) = \sum_i x_i$.
a) Implement the composite function $h = f(g(\vec{x}))$ in TF and compute its output for the inputs $\vec{x}_1 = (1, 2)^T$ and $\vec{x}_2 = (2, 0)^T$.
b) Use TF to compute the vector $\frac{\partial h}{\partial x_i}$ for $\vec{x} = \vec{x}_1$
c) Use TF to compute the vector $\frac{\partial h}{\partial W_{ij}}$ for $\vec{x} = \vec{x}_1$