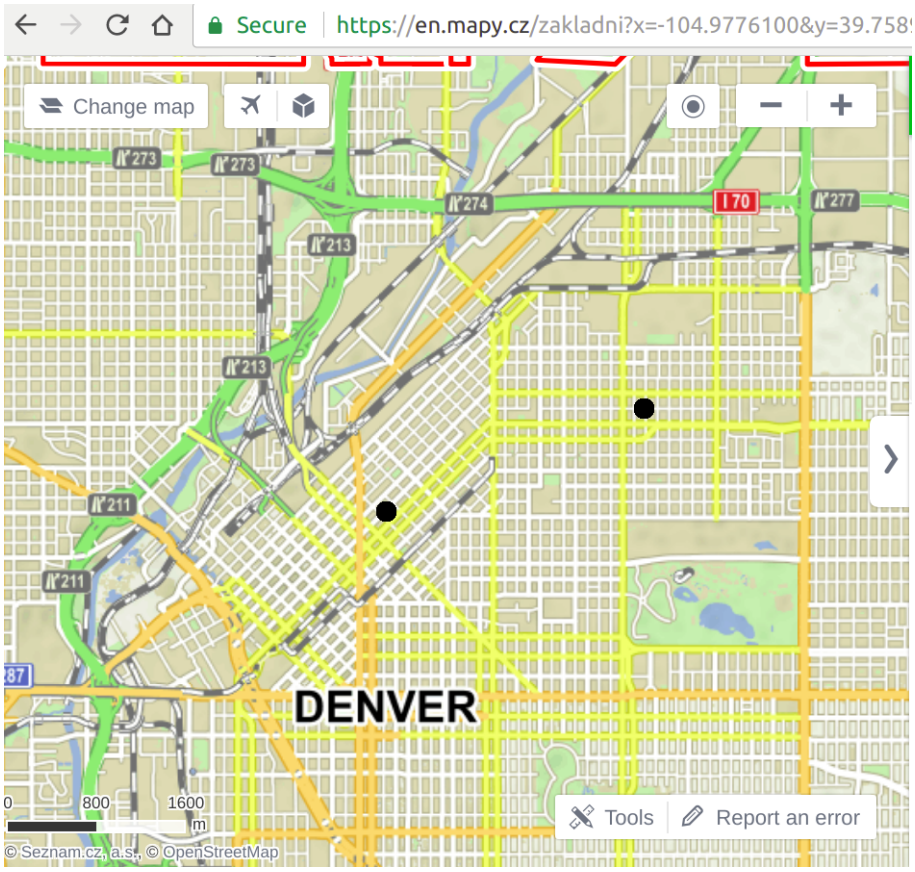
Different metrics in 2D – an example for illustration

The problem:
An owner of two small pizzerias at Denver (the left and the right black dot on the map) charges his customers for delivery of food; the amount depends on customer distance from the pizzeria.

How should he measure the distance?



Assume he uses cartesian coordinates parallel to the edges of the map (North, East).

Consider four different scenarios of delivery of foods (limited to ≈ 800 m):

1. by drone, from the right pizzeria
2. by drone, from the left pizzeria,
3. by bike, from the right pizzeria,
4. by bike, from the left pizzeria.

Answers

Delivery from the point $A = [x_a, y_a]$ to the point $B = [x_b, y_b]$:

- by drone (cases 1. and 2.) – use Euclidean norm

$$||A - B||_2 = \sqrt{(x_a - x_b)^2 + (y_a - y_b)^2}$$

- by bike from the right store (case 3.) – use column norm

$$||A - B||_1 = |x_a - x_b| + |y_a - y_b|$$

- by bike from the left store (case 4.) – use row norm

$$||A - B||_\infty = \max\{|x_a - x_b|, |y_a - y_b|\}$$