

Summary entry-level requirements Data Science

Prospective students should be fluent concerning the following topics in mathematics.

Arithmetic

- Concepts: natural, integer, rational, real numbers (\mathbb{N} , \mathbb{Z} , \mathbb{Q} , \mathbb{R})
- Standard operations (sum, difference, product, quotient, power, square root) and their precedence rules (including brackets)
- Calculations with negative numbers, fractions, percentages
- Simplification of powers and radicals (e.g. $a^b a^c = a^{b+c}$), exponentials and logarithms in natural or arbitrary base (e.g. $\ln(ab) = \ln a + \ln b$)
- Trigonometric values of special angles in radians or degrees
- Computation and estimation by hand, calculation by means of a calculator, scientific notation, rounding and accuracy

Algebra

- Manipulating symbolic variables
- Expanding brackets in products, factoring terms in sums (e.g. $a^2 - b^2 = (a + b)(a - b)$)
- Manipulating trigonometric functions (e.g. $\tan(x) = \frac{\cos(\frac{\pi}{2}-x)}{\cos(x)}$)
- Sequences and series, sum and product notation (i.e. $\sum_n a_n$, $\prod_n a_n$)
- Solving:
 - linear equations with a single unknown
 - linear inequalities with a single unknown
 - quadratic equations with a single unknown
 - trigonometric, exponential or logarithmic equations with a single unknown
 - absolute-value equations with a single unknown
 - pairs of linear equations with two unknowns

Geometry

- Concepts: points, lines, line segments, planes, polygons, circles, perimeter, area, cartesian and polar coordinates, distance, acute/right/obtuse/straight angle, parallel, perpendicular, tangent, similarity, symmetry
- Calculation of angles or side lengths in triangles (Pythagorean identity, sin-/cos-rules)
- Implicit and parametric equations of lines and circles, computing intersections of lines and/or circles
- Geometric and arithmetic representation of vectors in two or three dimensions, vector addition, scalar product, dot product

Function analysis

- Concepts: functions with one argument, zero-root, extremum/minimum/maximum, inflection point, pole, tangent, limit, asymptote, domain and range, periodicity, symmetry, piecewise function, (dis)continuity, inverse

- Special functions: constant, linear, quadratic, higher-order polynomial, rational, power law with rational exponent (including \sqrt{x} and $\frac{1}{x}$), exponential, logarithmic, absolute value, trigonometric functions and their inverses
- Plotting a function of a single variable on cartesian axes
- Deriving equations of functions from their graph for linear, quadratic, sinusoidal, exponential functions
- Calculation of intersections of functions with the axes and with each other
- Function composition (i.e. $f(g(x))$) and function transformations (e.g. translation, scaling)

Calculus

- Concepts: first- and second-order derivatives and anti-derivatives as slope, curvature and area-under-the-curve
- Notation of derivative and anti-derivative, indefinite and definite integrals
- Derivatives and anti-derivatives of special functions
- Sum-/difference-/product-/quotient-rules and chain rule of differentiation
- Sum-/difference-rules and substitution rule of integration
- Solving first-order homogeneous linear differential equations with constant coefficients (i.e. $ay + by' = 0$)

Combinatorics and statistics

- Concepts: factorial, permutation, combination, binomial, discrete probability and probability distribution, average, mean, median, spread, variance, standard deviation, inter-quartile range, outlier, sample and population
- Combining probabilities as products (for independent events) or sums (for mutually exclusive events)
- Special distributions: uniform, normal
- Frequentist statistics, z -transform, p -value, testing, confidence level
- Scatterplots, barplots, histograms, boxplots, semi- or double-logarithmic axes