**CMSC207 Glossary**

**An alphabetical list of terms related to this course, and their descriptions.**

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|  | **Title** | **Description** |
|  | **Cartesian Products** | “In [mathematics](https://en.wikipedia.org/wiki/Mathematics), a **Cartesian product** is a [mathematical operation](https://en.wikipedia.org/wiki/Mathematical_operation) which returns a [set](https://en.wikipedia.org/wiki/Set_(mathematics)) (or **product set** or simply **product**) from multiple sets. That is, for sets *A* and *B*, the Cartesian product *A* × *B* is the set of all [ordered pairs](https://en.wikipedia.org/wiki/Ordered_pair) (*a*, *b*) where *a* ∈ *A* and *b* ∈ *B*. Products can be specified using [set-builder notation](https://en.wikipedia.org/wiki/Set-builder_notation), e.g.  A\times B = \{\,(a,b)\mid a\in A \ \mbox{ and } \ b\in B\,\}.[[1]](https://en.wikipedia.org/wiki/Cartesian_product#cite_note-1)  A table can be created by taking the Cartesian product of a set of rows and a set of columns. If the Cartesian product *rows* × *columns* is taken, the cells of the table contain ordered pairs of the form (row value, column value).  More generally, a Cartesian product of *n* sets, also known as a ***n*-fold Cartesian product**, can be represented by an array of *n*dimensions, where each element is an *n*-[tuple](https://en.wikipedia.org/wiki/Tuple). An ordered pair is a [2-tuple or **couple**](https://en.wikipedia.org/wiki/Tuple#Names_for_tuples_of_specific_lengths).  The Cartesian product is named after [René Descartes](https://en.wikipedia.org/wiki/Ren%C3%A9_Descartes), whose formulation of [analytic geometry](https://en.wikipedia.org/wiki/Analytic_geometry) gave rise to the concept, which is further generalized in terms of [direct product](https://en.wikipedia.org/wiki/Direct_product).”  *Reference:* <https://en.wikipedia.org/wiki/Cartesian_product>  By Bill K |
|  | **Cartesian Products: Ordered Pairs** | **“Most common implementation (set theory)** *Main article:*[*Implementation of mathematics in set theory*](https://en.wikipedia.org/wiki/Implementation_of_mathematics_in_set_theory)  A formal definition of the Cartesian product from [set-theoretical](https://en.wikipedia.org/wiki/Set_theory) principles follows from a definition of [ordered pair](https://en.wikipedia.org/wiki/Ordered_pair). The most common definition of ordered pairs, the [Kuratowski definition](https://en.wikipedia.org/wiki/Ordered_pair" \l "Kuratowski_definition" \o "Ordered pair), is (x, y) = \{\{x\},\{x, y\}\}. Note that, under this definition,X\times Y \subseteq \mathcal{P}(\mathcal{P}(X \cup Y)), where \mathcal{P} represents the [power set](https://en.wikipedia.org/wiki/Power_set). Therefore, the existence of the Cartesian product of any two sets in [ZFC](https://en.wikipedia.org/wiki/ZFC) follows from the axioms of [pairing](https://en.wikipedia.org/wiki/Axiom_of_pairing), [union](https://en.wikipedia.org/wiki/Axiom_of_union), [power set](https://en.wikipedia.org/wiki/Axiom_of_power_set), and [specification](https://en.wikipedia.org/wiki/Axiom_schema_of_specification). Since [functions](https://en.wikipedia.org/wiki/Function_(mathematics)) are usually defined as a special case of [relations](https://en.wikipedia.org/wiki/Relation_(mathematics)), and relations are usually defined as subsets of the Cartesian product, the definition of the two-set Cartesian product is necessarily prior to most other definitions. Non-commutativity and non-associativity Let *A*, *B*, *C*, and *D* be sets.  The Cartesian product *A* × *B* is not [commutative](https://en.wikipedia.org/wiki/Commutative),  A \times B \neq B \times A,  because the [ordered pairs](https://en.wikipedia.org/wiki/Ordered_pair) are reversed except if at least one of the following conditions is satisfied:[[3]](https://en.wikipedia.org/wiki/Cartesian_product#cite_note-cnx-3)   * *A* is equal to *B*, or * *A* or *B* is the [empty set](https://en.wikipedia.org/wiki/Empty_set).   For example:  *A* = {1,2}; *B* = {3,4}  *A* × *B* = {1,2} × {3,4} = {(1,3), (1,4), (2,3), (2,4)}  *B* × *A* = {3,4} × {1,2} = {(3,1), (3,2), (4,1), (4,2)}  *A* = *B* = {1,2}  *A* × *B* = *B* × *A* = {1,2} × {1,2} = {(1,1), (1,2), (2,1), (2,2)}  *A* = {1,2}; *B* = ∅  *A* × *B* = {1,2} × ∅ = ∅  *B* × *A* = ∅ × {1,2} = ∅  Strictly speaking, the Cartesian product is not [associative](https://en.wikipedia.org/wiki/Associative) (unless one of the involved sets is empty).  (A\times B)\times C \neq A \times (B \times C)  If for example *A* = {1}, then (*A* × *A*) × *A* = { ((1,1),1) } ≠ { (1,(1,1)) } = *A* × (*A* × *A*). “    *Reference:* <https://en.wikipedia.org/wiki/Cartesian_product>  By Alla W. |
|  | Cartesian Plan | “A two-dimensional coordinate system [https://upload.wikimedia.org/wikipedia/commons/thumb/0/0e/Cartesian-coordinate-system.svg/220px-Cartesian-coordinate-system.svg.png](https://en.wikipedia.org/wiki/File:Cartesian-coordinate-system.svg)  Cartesian coordinates of example points  The main historical example is the [Cartesian plane](https://en.wikipedia.org/wiki/Cartesian_plane) in [analytic geometry](https://en.wikipedia.org/wiki/Analytic_geometry). In order to represent geometrical shapes in a numerical way and extract numerical information from shapes' numerical representations, [René Descartes](https://en.wikipedia.org/wiki/Ren%C3%A9_Descartes) assigned to each point in the plane a pair of [real numbers](https://en.wikipedia.org/wiki/Real_number), called its coordinates. Usually, such a pair's first and second component is called its *x* and *y* coordinate, respectively, cf. picture. The set of all such pairs, i.e. the Cartesian product ℝ×ℝ with ℝ denoting the real numbers, is thus assigned to the set of all points in the plane.”  *Reference:* <https://en.wikipedia.org/wiki/Cartesian_product>  By Alla W. |
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