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Visual Category Theory Brick by Brick, Part 0: Using LEGO® to Teach Abstract Mathematics
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## Preface

This free to download and distribute Part 0 was added to Visual Category Theory Brick by Brick series to explain mathematical notation and other foundational aspects used in brick construction annotations. Some readers expressed concern that the notation used is unfamiliar to them, and I realized that not everyone is continuously reading books on mathematical logic and set theory or studied proper foundations of mathematical analysis where they encountered logical quantifiers. Readers who already bought the visual Category Theory bundle from other sources other than directly from me can download this part if necessary. The cover subtitle alludes to an initial object in category theory introduced in part 2.

The choice of object notation for sets in this part matches the notation in subsequent parts.

The short Handbook of Logic and Proof Techniques for computer Science by Steven G. Krantz is recommended for further studying or filling the gaps. In addition to topics from the book title, it covers many others, including elementary and axiomatic set theories, recursive functions, lambda calculus, groups, Boolean algebra, and complexity theory. It also has a short chapter on category theory.

Information about further parts, including sample pages and index, can be found on the Software Diagnostics Institute page:
https://www.dumpanalysis.org/visual-category-theory

## Contents of Parts 0-7

0 . Universe and sets, set-builder notation, set membership, set inclusion, subsets as members, membership vs. subset, powerset, relations, functions, domain, codomain, range, injection, surjection, bijection, product, union, intersection, set difference, symmetric set difference, sets of functions, function composition, inverse functions.

1. The definition of categories and arrows, the composition and associativity of arrows, retracts, equivalence, covariant and contravariant functors, natural transformations, and 2-categories.
2. Duality, products, coproducts, biproducts, initial and terminal objects, pointed categories, matrix representation of morphisms, and monoids.
3. Adjoint functors, diagram shapes and categories, cones and cocones, limits and colimits, pullbacks and pushouts.
4. Non-concrete categories, group objects, monoid, group, opposite, arrow, slice, and coslice categories, forgetful functors, monomorphisms, epimorphisms, and isomorphisms.
5. Exponentials, evaluation in sets and categories, subobjects, equalizers, equivalence classes and quotients, coequalizers, congruence categories, morphism functors, and presheaves.
6. Vertical and whisker compositions of natural transformations, identity and isomorphism of functors, equivalence, isomorphism, and adjoint equivalence of categories, functor and morphism categories, natural transformations as functors, representable functors, category of presheaves, Yoneda embedding and lemma.
7. Exponentials, disjoint unions, endofunctors and natural transformations, partial and total functions, monads.
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