1 Categories

Definiton 1.1 (Category)**.** A category, $\mathcal{A}$ is defined to have each of the following,

(i) A collection of objects, denoted by ob($\mathcal{A}$) and written A,B,C $\in \mathcal{A}$.
Such that each object has an 'identity', $1_A \in \mathcal{A}(A, A), 1_B \in \mathcal{A}(B, B), 1_C \in \mathcal{A}(C, C)$

(ii) For each pair of objects, a collection of 'links'/morphisms between them, denoted by $\mathcal{A}(A, B)$ and written as f $\in \mathcal{A}(A, B)$ $g \in \mathcal{A}(B, C)$. Such that,

  (a) morphisms with matching domain,co-domain can be 'chained'/composed $(g, f) = g \circ f$

  (b) with this composition being associative, $(h \circ g) \circ f = h \circ (g \circ f)$

  (c) and they are 'fixed' by the identity $f \circ 1_A = f = 1_B \circ f$

Example 1.1 (Non-trivial Identity)**.** Consider the objects to be groups, and morphisms to be direct product between them:

i ob $(\mathcal{A}) = \{G|$ G is a group$\}$

ii $\mathcal{A}(A, B) := A \times B$

iii $\mathcal{A}(A, B)\ \circ \mathcal{A}(B, C) \mapsto \mathcal{A}(A, C)$

So, there's a unique morphism between any two objects i.e groups. And the identity morphism,

$$\forall A, B \in \mathcal{A}\ ,\ \text{if f} \in \mathcal{A}(A, B),\ \text{then}\ 1_A \circ f \in \mathcal{A}(A, A) \times \mathcal{A}(A, B) \mapsto \mathcal{A}(A, B)$$

Thus, $ob(\mathcal{A})$ along with $\circ$ is actually a group. And hence has a unique inverse. asd

2 Functors

Example 2.1.

3 Natural Isomorphisms

Example 3.1.