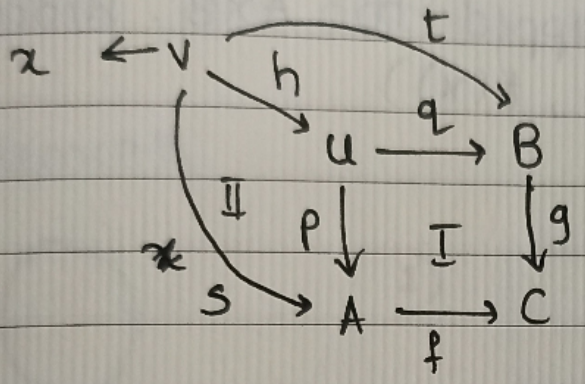
1) Pullbacks:

For given objects A & B

$u = A \times B$

(where p & q are projection maps/morphisms)




If the squares I and II commute for the other object C, then there exists a pullback h from $v \to u$ such that it is unique

[Note product is a special case of pullback where f & g are identity maps & c is terminal object]

For sets (Intuitive & concrete understanding):

$a \in A$ and $b \in B$, $u = A \times B$

→ then set = $\{ (a,b) \in A \times B \text{ iff } f(a) = g(b) \}$
∴ has to commute

→ $x \in v$

→ To show: $h(x) = (s(x), t(x))$

JUL 2023

# 11 tuesday

(192-173) Week 28

| | | | | | | |
|---|---|---|---|---|---|---|
| J | Monday | 31 | 3 | 10 | 17 | 24 |
| U | Tuesday | | 4 | 11 | 18 | 25 |
| L | Wednesday | | 5 | 12 | 19 | 26 |
| | Thursday | | 6 | 13 | 20 | 27 |
| 2 | Friday | | 7 | 14 | 21 | 28 |
| 0 | Saturday | 1 | 8 | 15 | 22 | 29 |
| 2 | Sunday | 2 | 9 | 16 | 23 | 30 |
| 3 | Week | 26/31 | 27 | 28 | 29 | 30 |

→ Proof: $s(x) \in A$ & $t(x) \in B$

$f(s(x)) = g(t(x))$ (∵ has to commute)

So, $(s(x), g\,t(x)) \in A \times B$ from square II

& $x$ is an element in $V$.

This is uniquely mapped to $A \times B$. Hence,

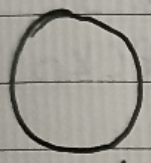
$h(x) = (s(x), t(x))$

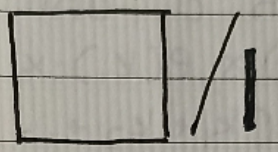
9.00
9.30
10.00
10.30
11.00
11.30
12.00
12.30
1.00
1.30
2.00
2.30
3.00
3.30

## 2) Petri - Nets

(& Formal method for multitasking and synchronization
- One of the mathematical modelling languages for the description of distributed systems.
- A class of discrete event dynamic systems.)

Elements:

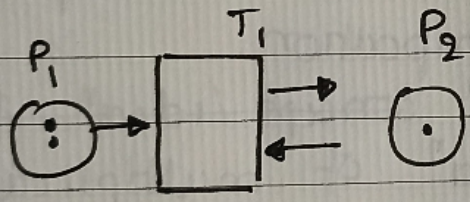
1) 
Places/ species

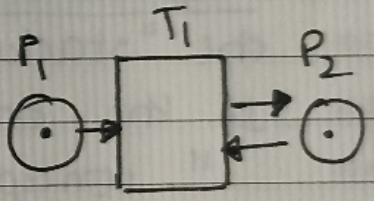
2) 
Transitions

3) 
input/output arcs

4) •
mark/ tokens

5)

Ex: 




Properties / Characteristics & Syntax
i) Transitions "fire" (produce an output arc's token) iff all the input arcs have token.
ii) All transitions are synchronized
iii) Multiple transitions are enapled simultaneously.

3) Operads: Algebraic to structures, used in topology & category theory etc. to understand composition or to simply compose.

(Intuitively; "Abstracting the idea of "algebra" through visual representation)

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9.30
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12.30
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1.30
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3.00
3.30
4.00
4.30
5.00
5.30
6.00

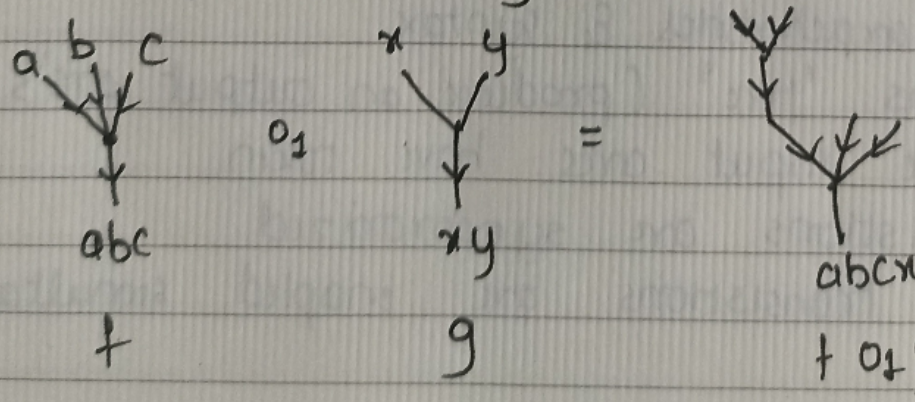
Definition: An operad is a sequence of sets $(P(i))_{i \in \mathbb{N}}$ with a unit $1 \in P(1)$ and operations

$$P(n) \times P(k_1) \times P(k_2) \times \dots \times P(k_n) \longrightarrow P(k_1 + k_2 + \dots + k_n)$$

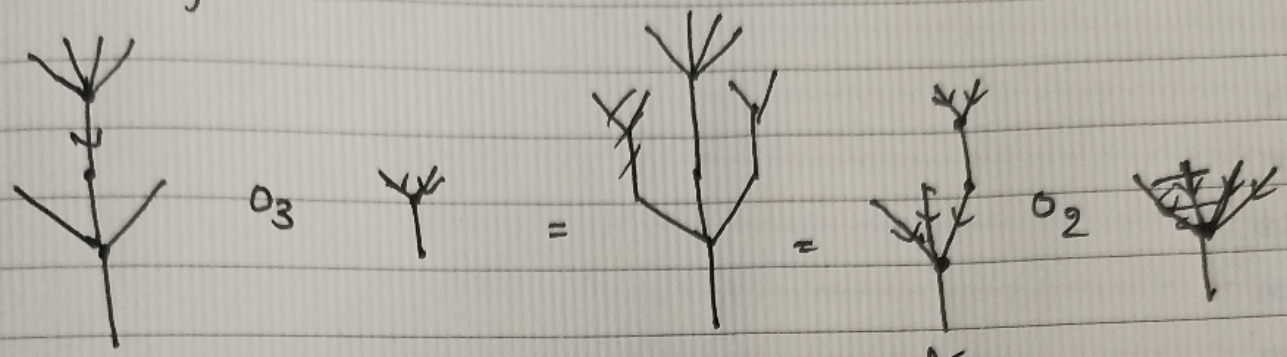
such that associativity & identity hold true.
Here $P(i)$ are inputs.

Illustration: Consider "trees" as the inputs and the "stacking" as the composition.

If the tree represents "~~concept/idea" of multi~~ "concept/ideal algebra" of multiplication then

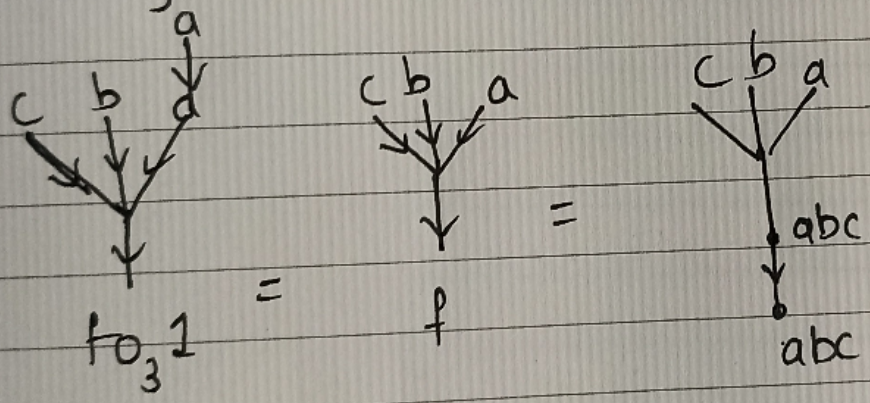


## Associativity:




$(f o_3 g)\ o_3\ h$ ~~$f o_2$~~ $(g\ o_3\ h)$

## Identity:




$f o_3 1$ $f$