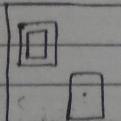


Membrane Computing.

inspiration from nature (like neural netw., plant inspired).
DNA and peptide - molecular computing → implement on
membrane - takes inspiration of computing at cellular level

again ↴
implementation also called p-system.

on silicon why?
made up of - membrane structures
- objects
- rules.



(exchange of materials can happen (transp).
transform from one form to another.
transportation

can try to dissolve the membrane

will only consider string objects.

rules will be applied

↓

$a \rightarrow v'$

set of all objects
 $v = \{ \quad ? \}$

where a is one of the objects.

v' is a string over a here, a_{out} or a_{inj} .

a is one of the elements in v .

here - a remains in the same membrane.

a_{out} - a will come out of membrane to the next

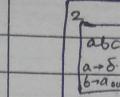
a_{inj} - membranes are numbered. j is the membrane number. so move a inside membrane j .

$\delta \rightarrow$ special symbol not in v .

denotes dissolving the membrane

so whatever object was there in the membrane they move out into the next

nesting
means
1 [2 [3 [4 [5]]]]
membrane structure



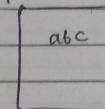
$$M = [[[]_2]_2]$$

opening closing

$$R = a \rightarrow \delta$$

rules can have priority ($R_1 > R_2$).

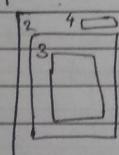
all rules are applied parallelly. All computation stops when no more rules can be applied. so when $a \rightarrow \delta$, dissolves membrane 2.



rules are lost.

e.g. outermost membrane - skin membrane

↓
never dissolve it.



$\Pi \rightarrow$ name of system

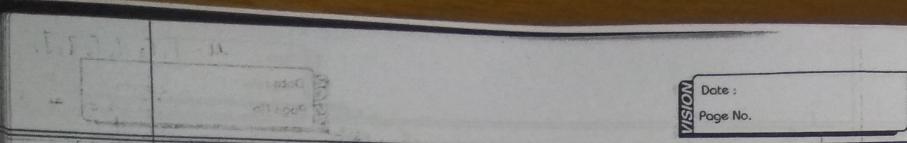
degree of system = number of membranes

where degree is 4.

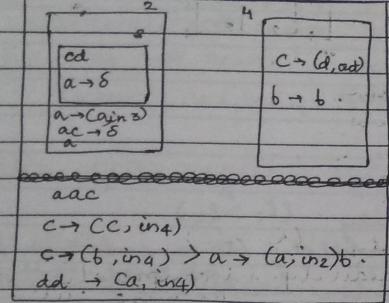
each membrane has regions enclosed inside it.

111

(next page)



eg:



and 2

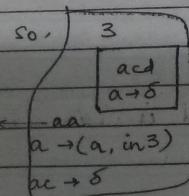
Step 1: membrane 1, mein we can apply.
1 mein you can apply either of the c rules.

but we see that the second c rule will give an off.
So let's apply the first one.

(also, if you apply first circle, you can apply a rule:
had you applied second c rule, you wouldn't have been
able to apply a rule).

In 2,

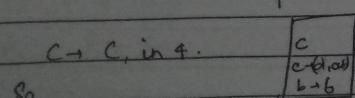
$a \rightarrow a, in 3$



objects consumed
when rule applied.

In 1,

$c -> C, in 4$

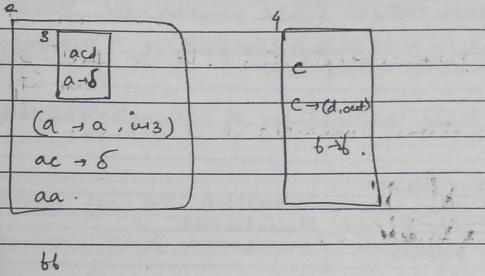


$a \rightarrow (a, in 2)b$

both a's go inside a.

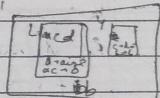
and a 'b' gets produced

so after Step 1,



bb

after step 2:



acd comes out. when 3 gets dissolved.

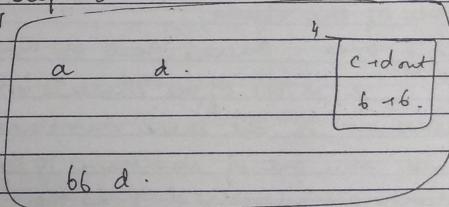
$a \rightarrow a, in 3$ now makes no sense. in 2.

cd.

aa cd.

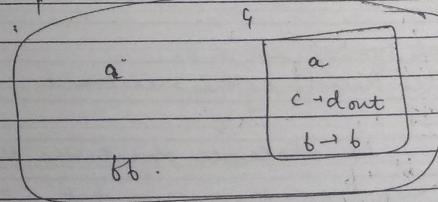
grouped

after step 2 or 3:



bb d.

Step 4:



bb.

elementary membrane - which doesn't have any nested membranes inside it.

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membrane computing can be used to generate languages.
to solve decidability problems.

see slides for formal definitions. Computing stuff given an LPP (LAL)

see how to construct membrane structure.

Ex 3.1 in slides.

$M \rightarrow$ membrane structure.

$w \rightarrow$ strings

$\delta \rightarrow$ priorities for rules

$R \rightarrow$ rules.

$R_1 = \emptyset$ means no rules have δ_1 main.

if $r_1 > r_2$, only unmain priorities have.

LPP should be generated in membrane 4 and Cs should be checked coz $T = \{C\}$.

(if many rules, apply all & check \leq)

number of Cs generated \rightarrow is LPP in 4th membrane.

how n^2 ?

design a membrane sys. which generates n^2
which shows $K \in n$.

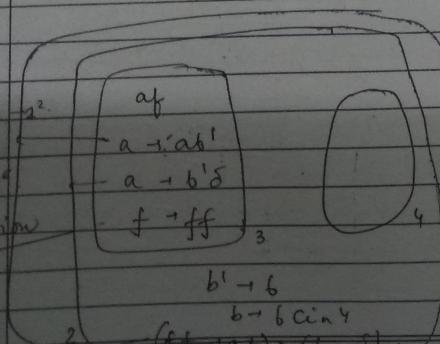
ex:

is this one
 $2 \rightarrow 3^2$??

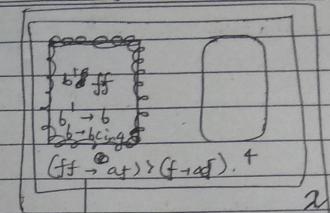
once $\rightarrow 1^2$

multiplication

by 2

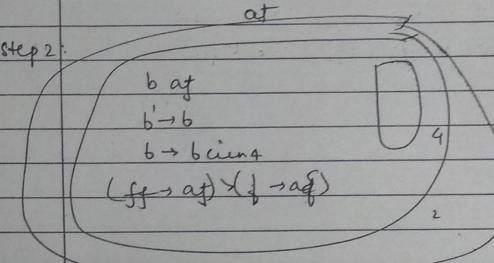


Step 1:

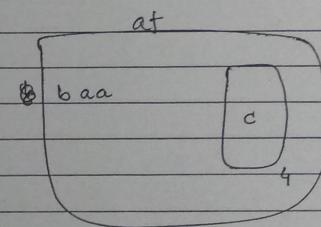


use till ff. if single f, then use lower priority rule.

Step 2:



Step 3:



1 C generated. So, $1^2 \rightarrow 1$.

how to generate $2^2 = 4$?

generalization:

you've to generate b^4 . So 2^2 ke liye $b^2 b^2$ has to be multiplied twice.

for 3^2 , $(b'b'b')(b'b'b')(b'b'b') \rightarrow$ 3 times b^6

5^2 $(b'b'b'b'b') \dots \dots$ 5 times

agar $b'b'b'$
hai, $b' \rightarrow b$
waale se
all b' will get
converted to b .

ex) P-system to decide k divides n.

Subtracting c from a for every occurrence of c.
wanna make sure that
aaaaacc.

$ac \rightarrow c'$ is subtracting cs from a. so it'll give $ac'c$ or
then $ac' \rightarrow c'$.

Opp: a in 3 (chunne se tha) \rightarrow divides
aa in 3 (eknaya aya, cha before) \rightarrow doesn't divide.

consider

a^3c^2d .

$G a c' c' d$.

$G c c' d$

~~now after d - d δ~~ —
rules lost.

bahar hoga \rightarrow try.

Consider

a^2c^2d

$c c d$.

try.

why can't we eliminate δ? doubt. see.

$a \rightarrow a$. kinda redundant; you just don't wanna stop there.