

UN ALGORITMO PARA

HALLAR TODOS LOS

MATCHING MÁXIMOS DE UN
ÁRBOL

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Molina — Solá — Jaime

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HALLAR TODOS LOS

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Molina — Solá — Jaime

UNSL — San Luis

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ÁRBOL

Molina — Solá — Jaime

UNSL — San Luis

UMA 2016 — UNS — BAHÍA BLANCA

UN ALGORITMO PARA

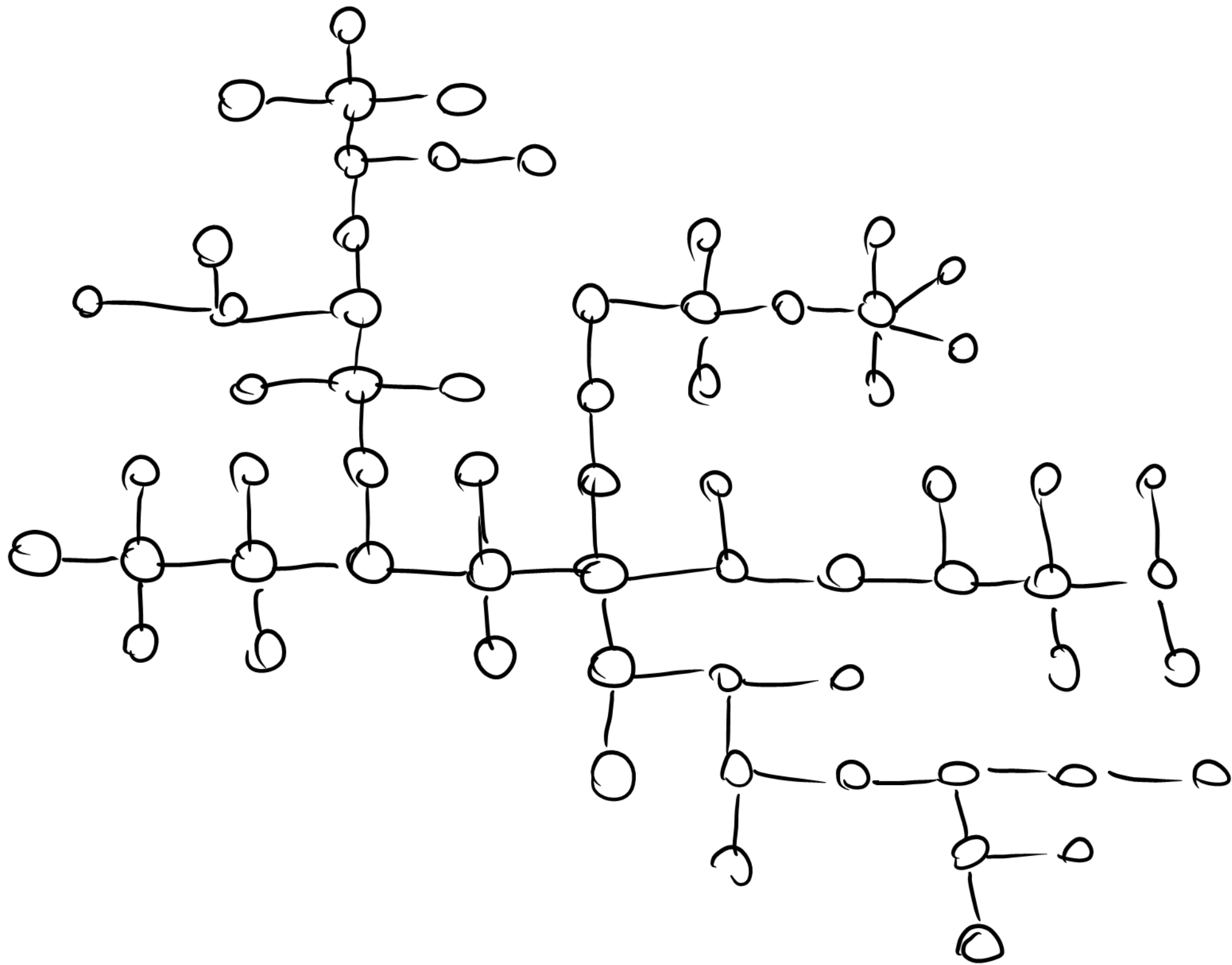
HALLAR TODOS LOS

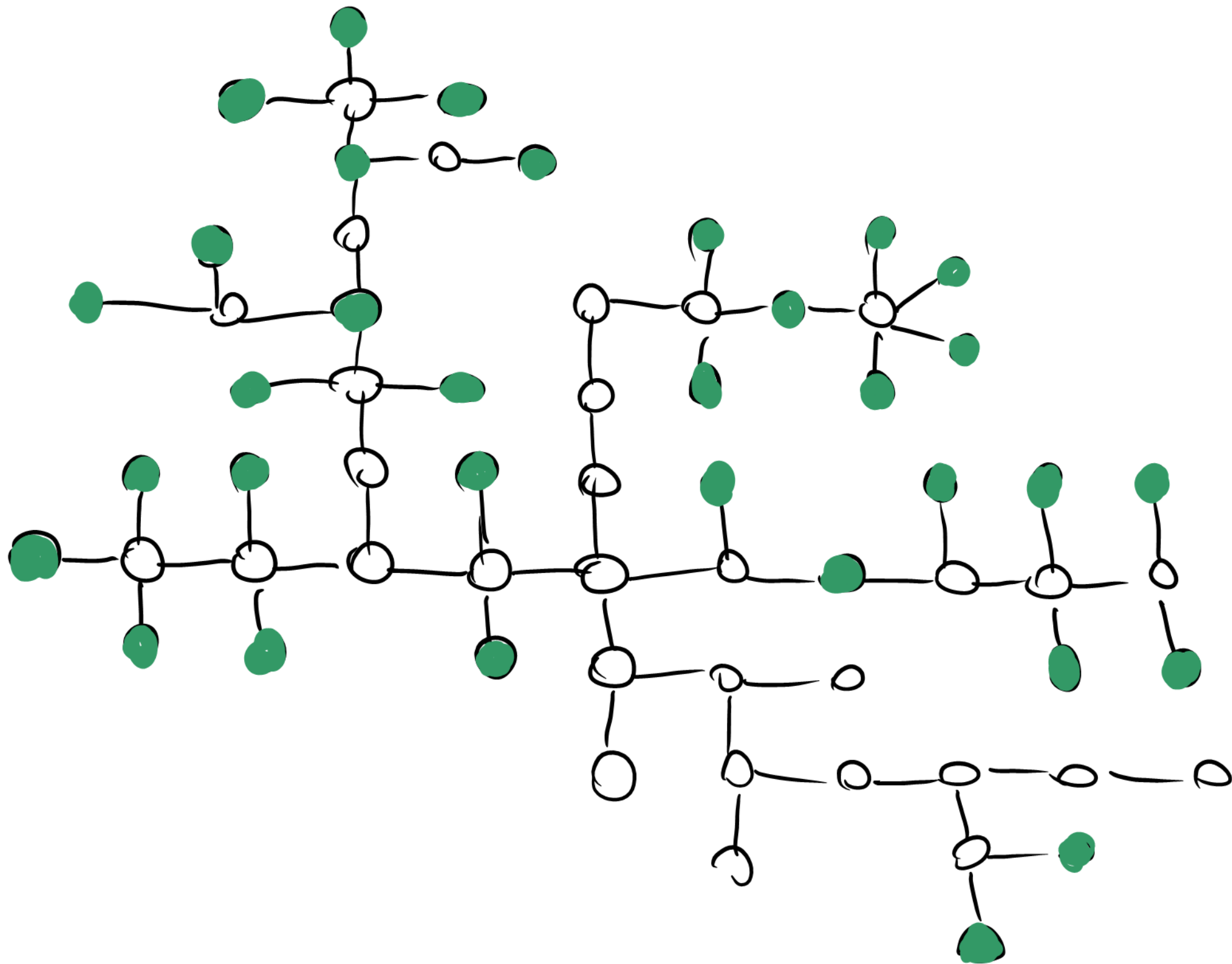
MATCHING MÁXIMOS DE UN
ÁRBOL

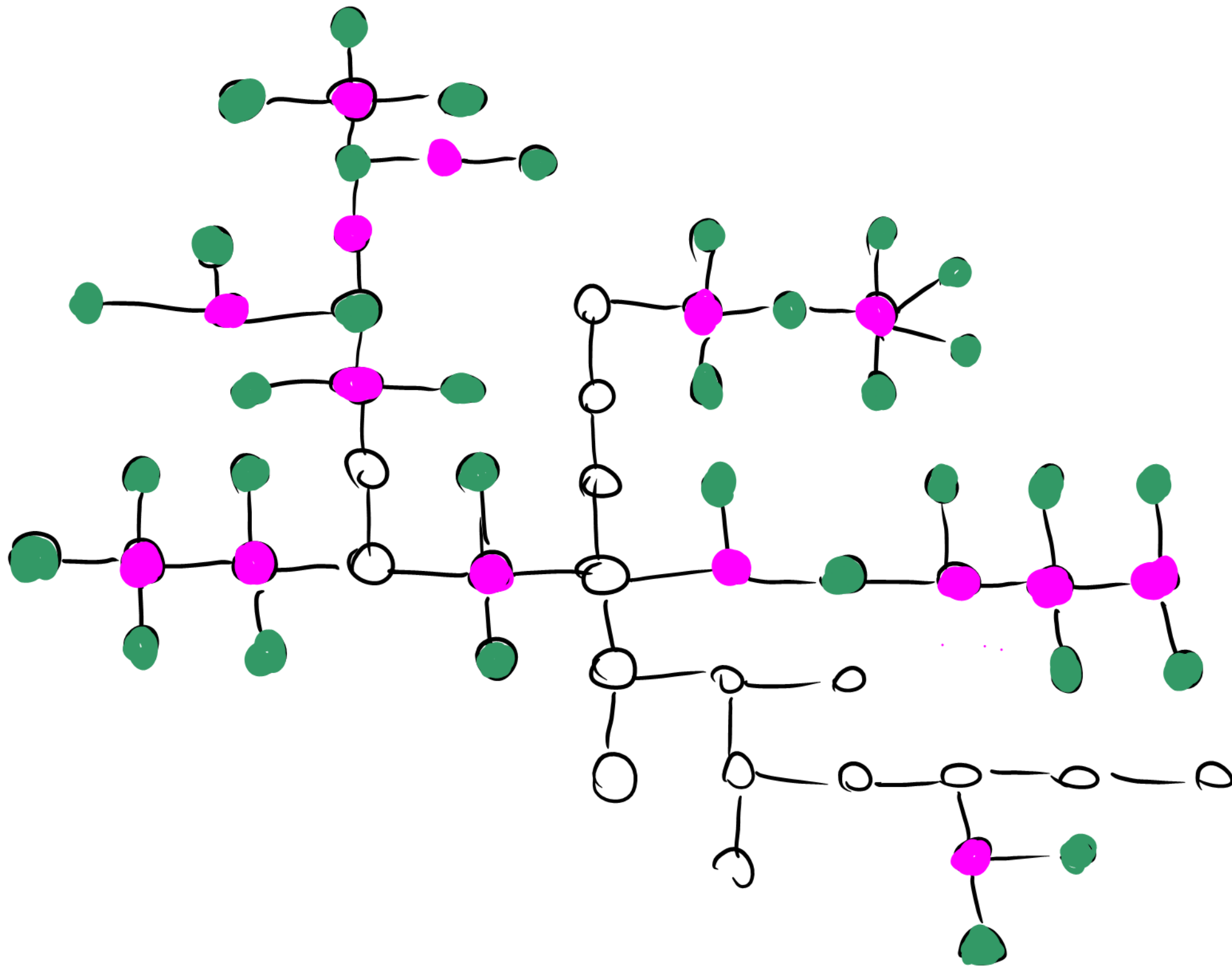
Molina — Solá — Jume

UNSL — San Luis

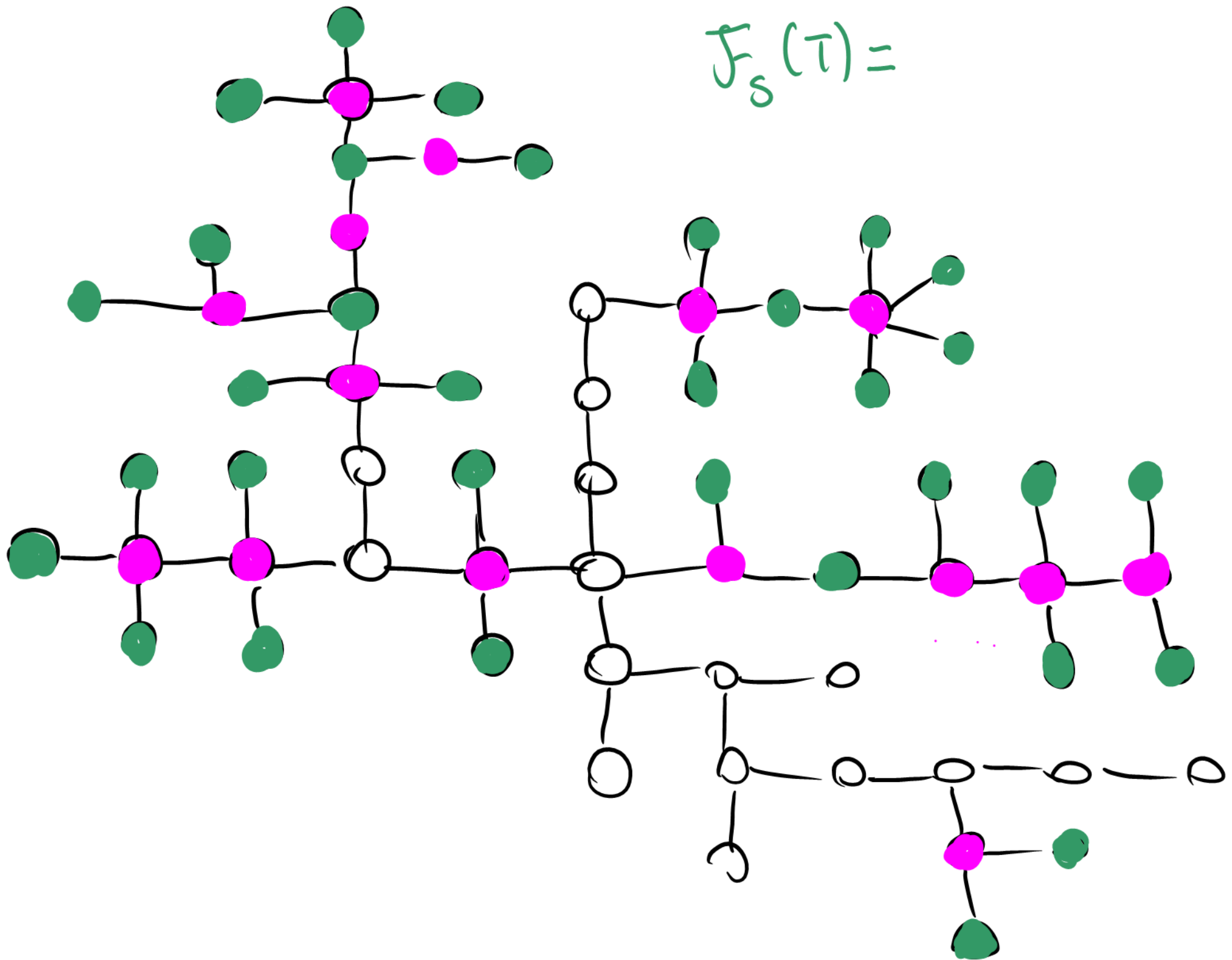
UMA 2016 — UNS — BAHÍA BLANCA



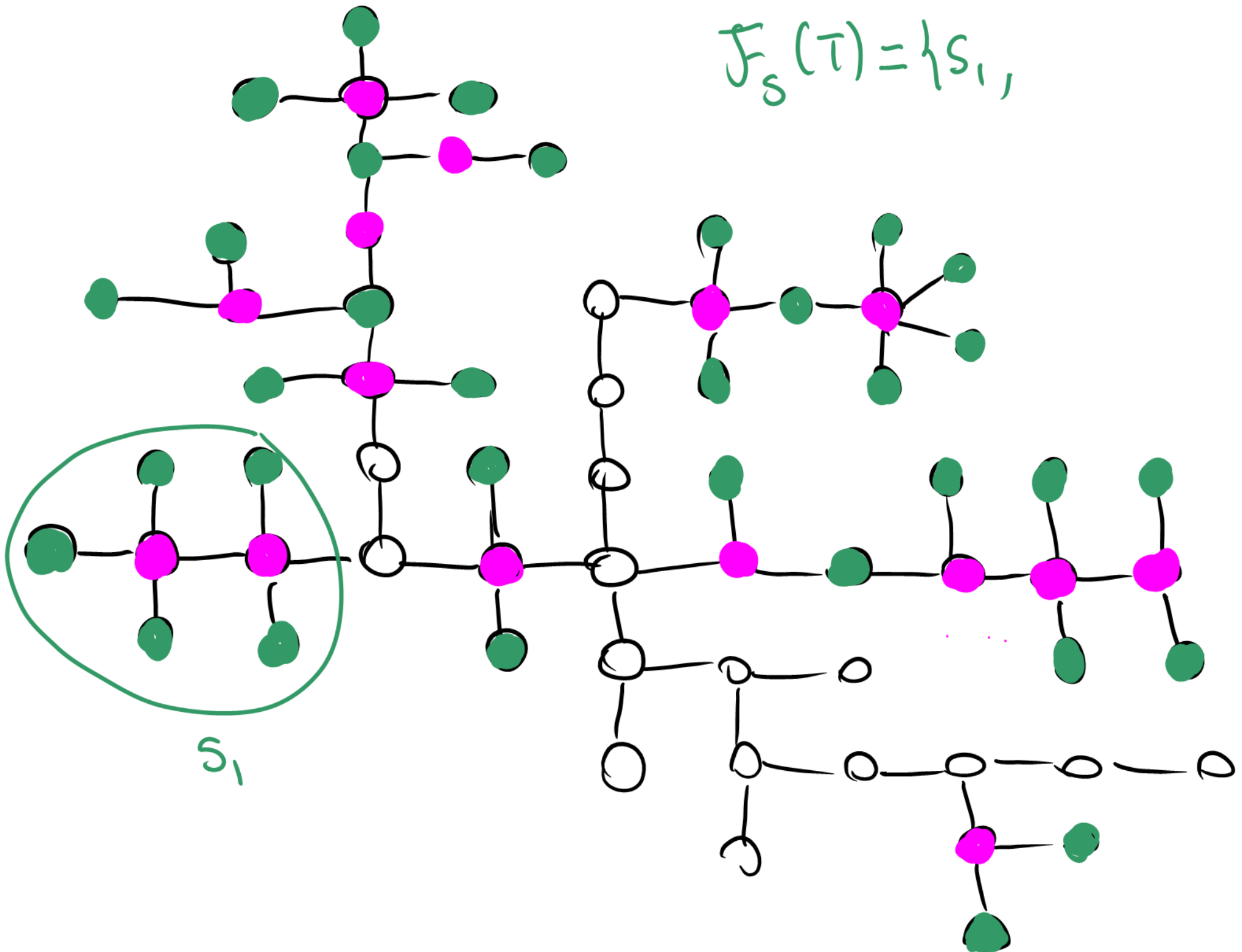




$$\mathcal{F}_S(\tau) =$$

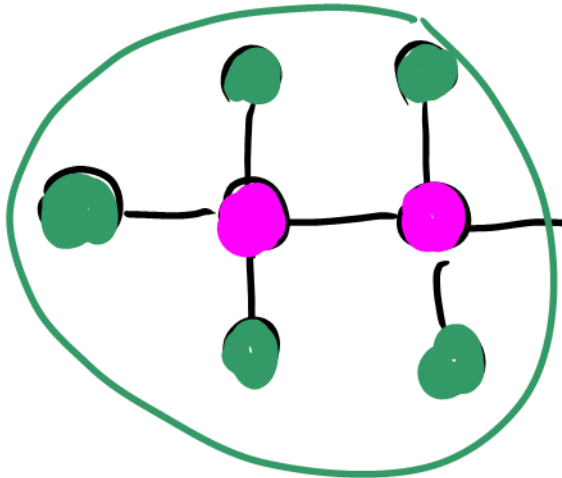


$$F_S(\tau) = \gamma_S,$$

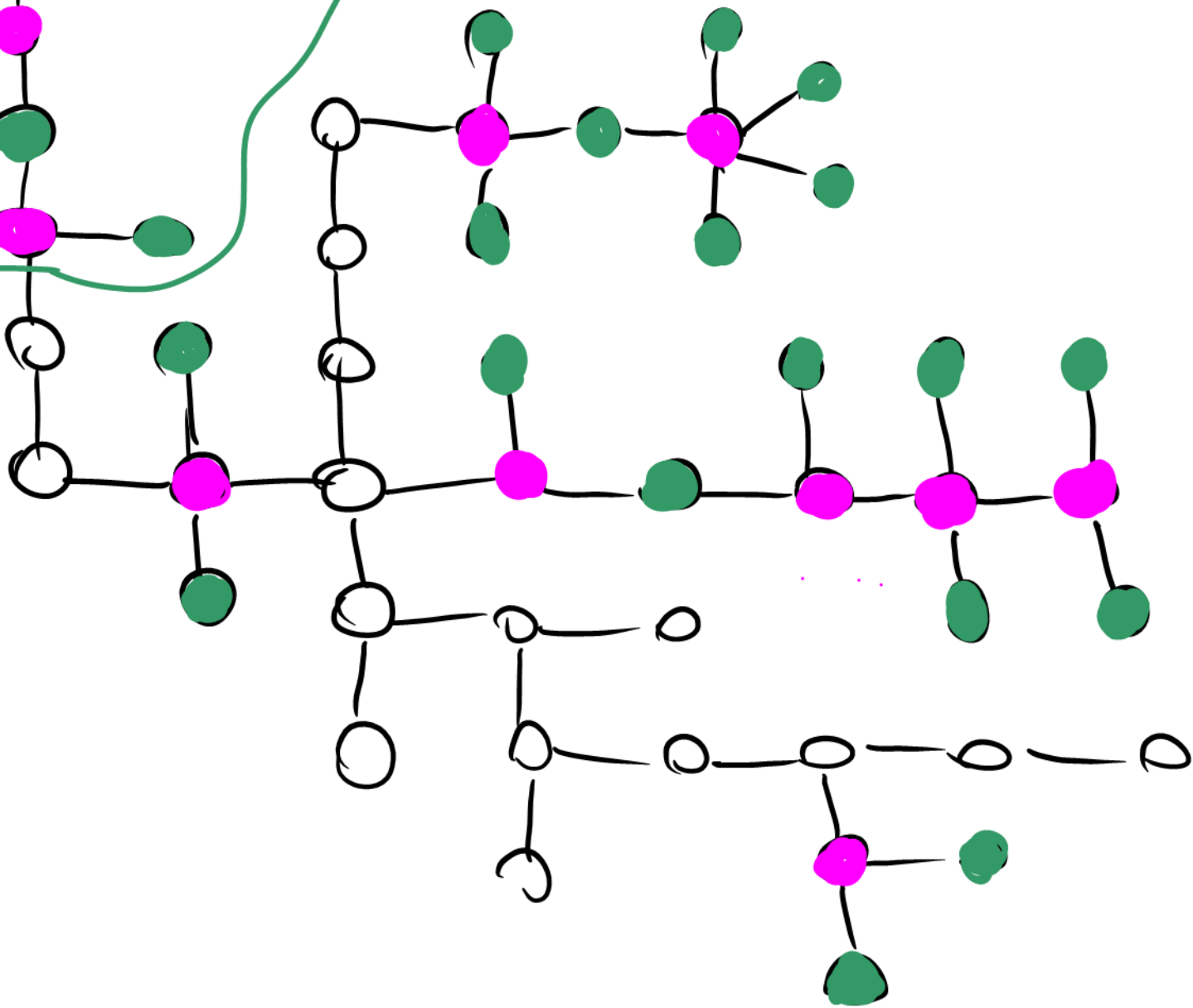


S_2

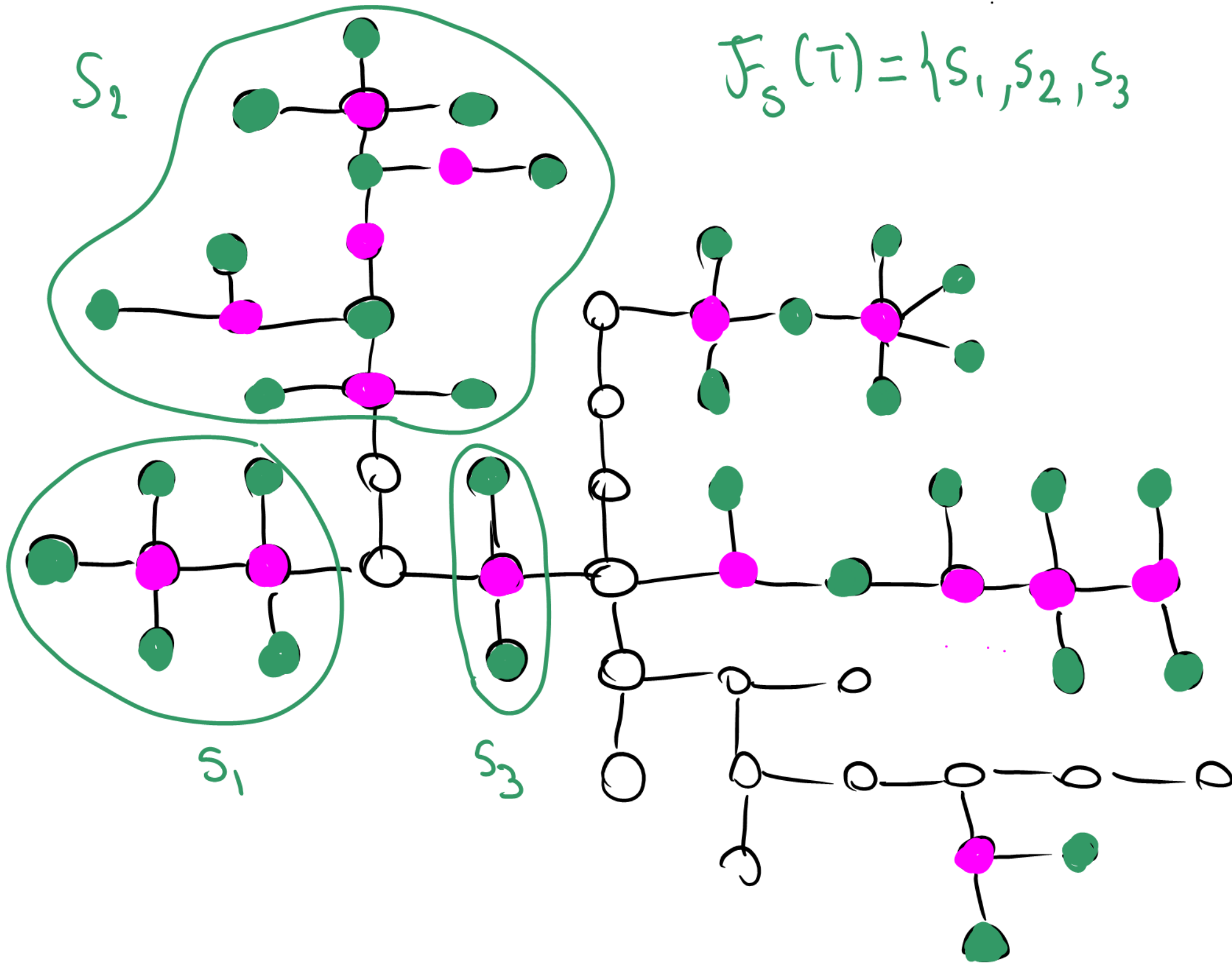
$$\mathcal{F}_S(\tau) = \{S_1, S_2\}$$



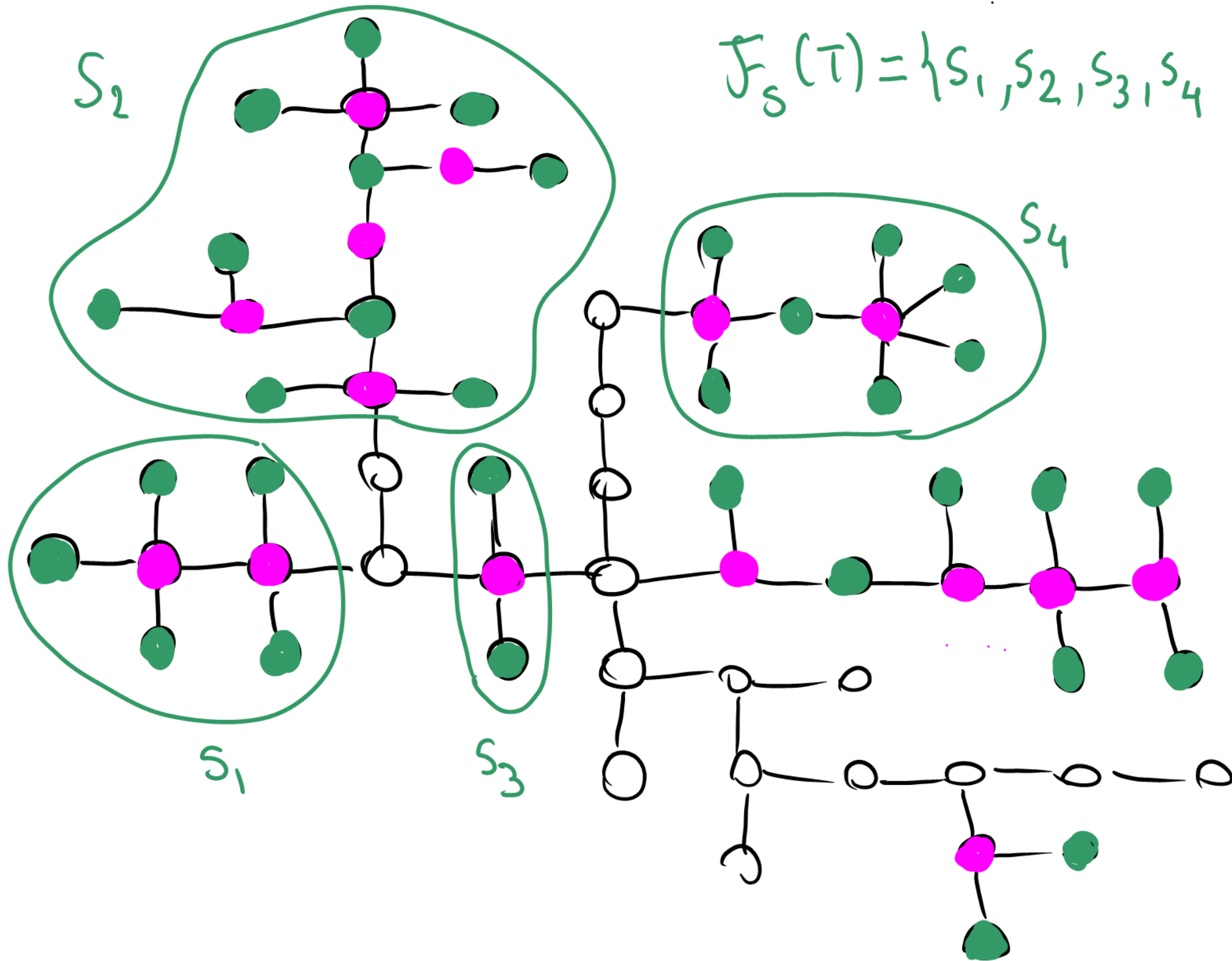
S_1



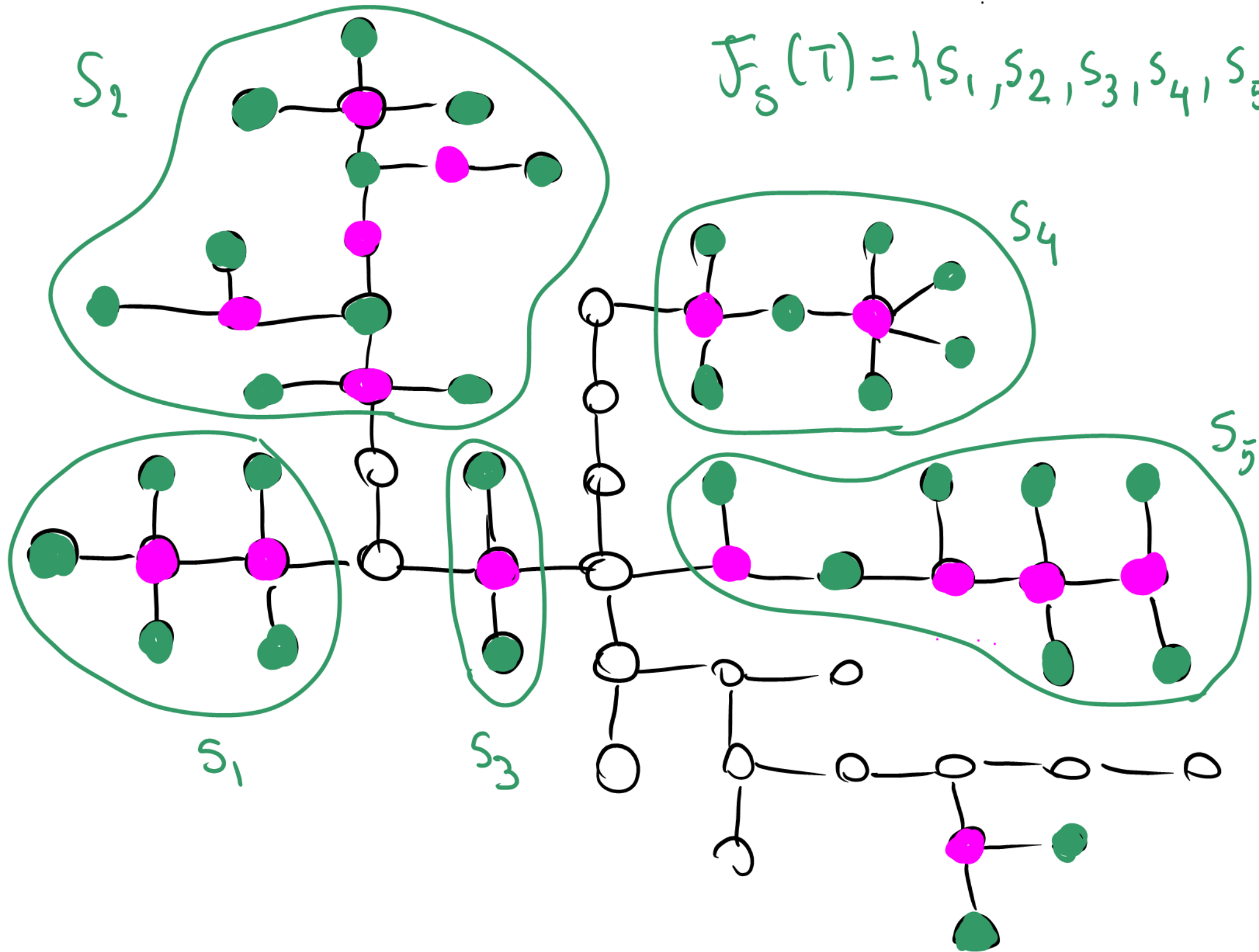
$$\mathcal{F}_S(\tau) = \{s_1, s_2, s_3\}$$



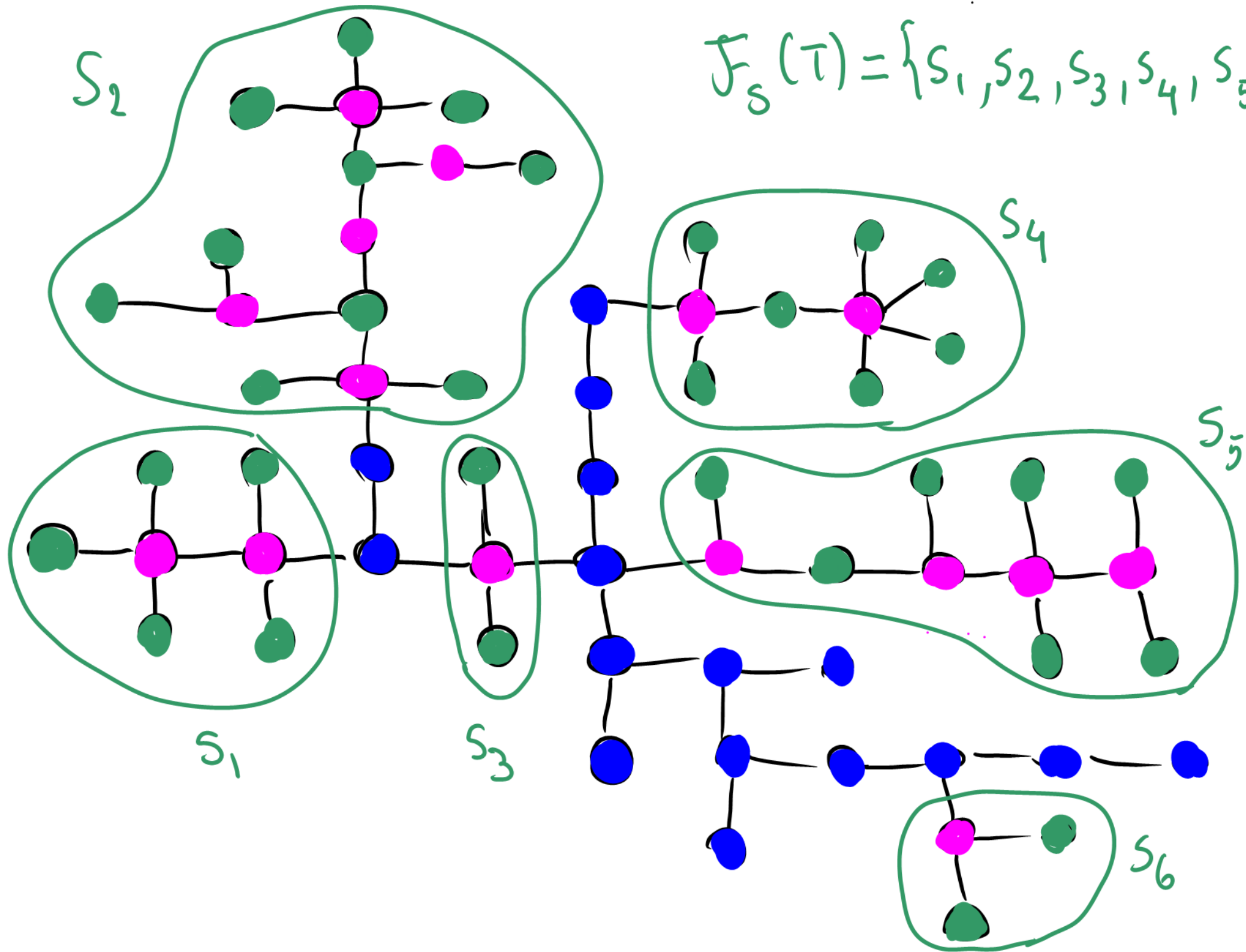
$$\mathcal{F}_S(\mathcal{T}) = \{S_1, S_2, S_3, S_4\}$$



$$\mathcal{F}_S(\mathcal{T}) = \{S_1, S_2, S_3, S_4, S_5\}$$

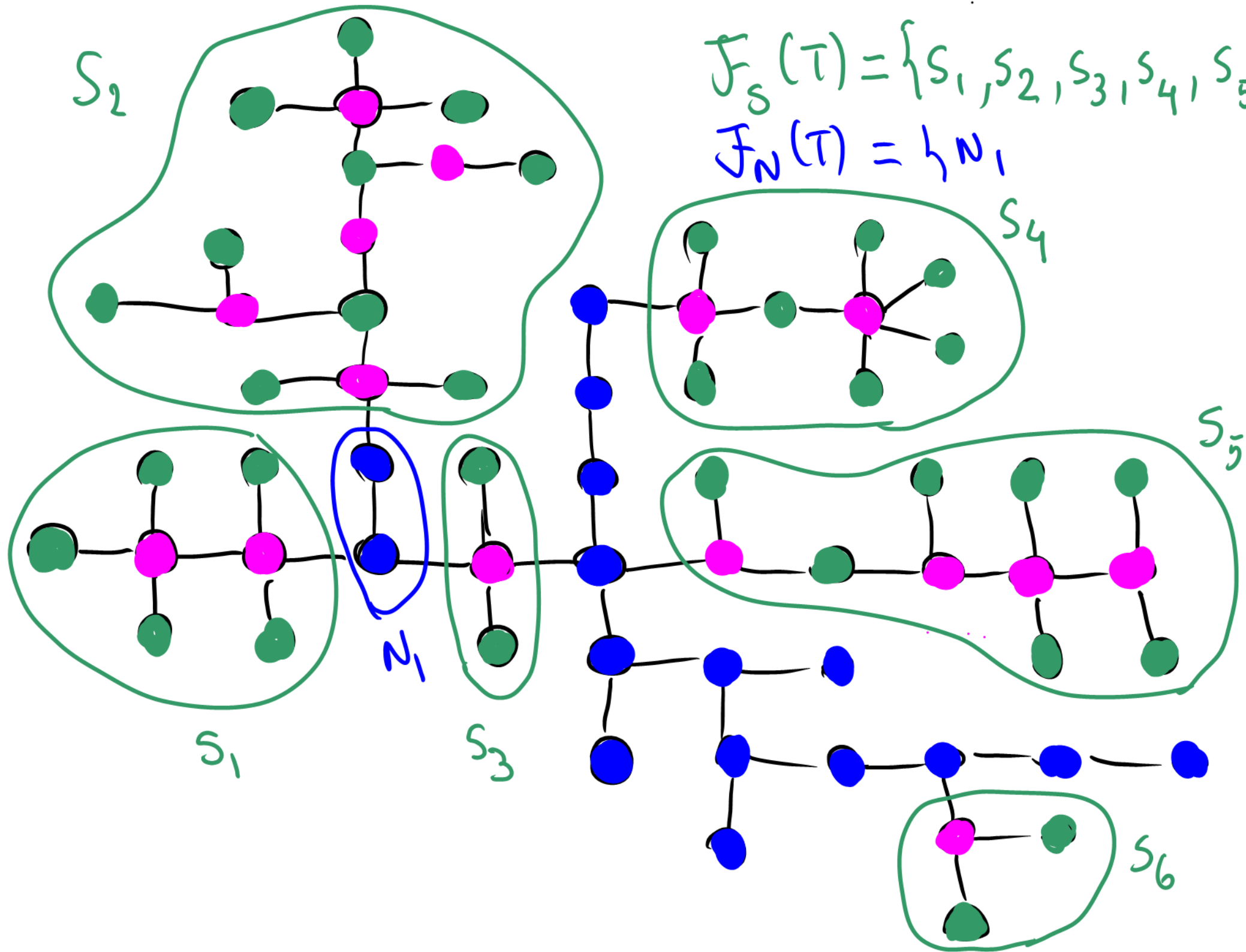


$$\mathcal{F}_S(\mathcal{T}) = \{S_1, S_2, S_3, S_4, S_5, S_6\}$$



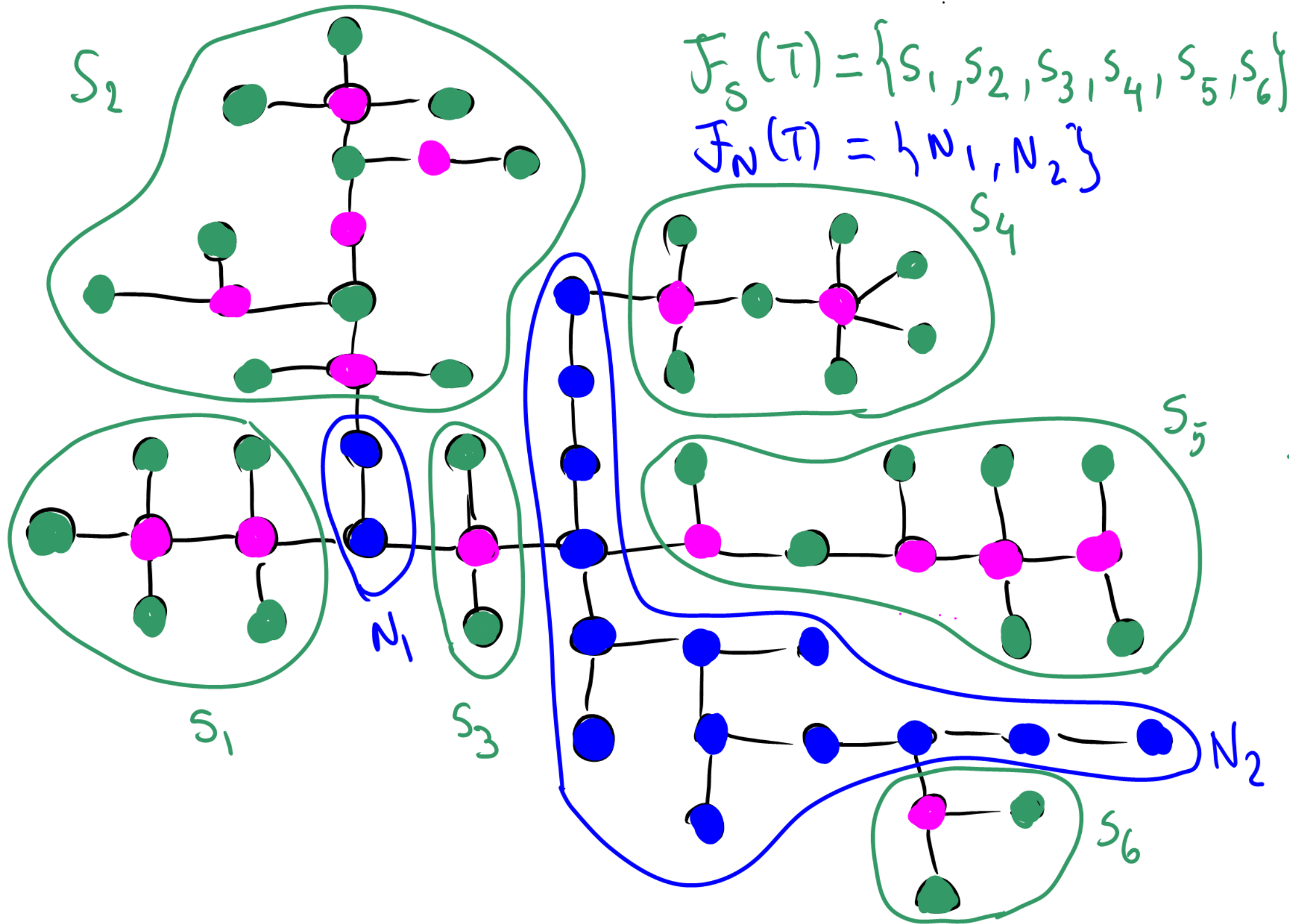
$$\mathcal{F}_S(T) = \{S_1, S_2, S_3, S_4, S_5, S_6\}$$

$$\mathcal{F}_N(T) = \{N_1\}$$



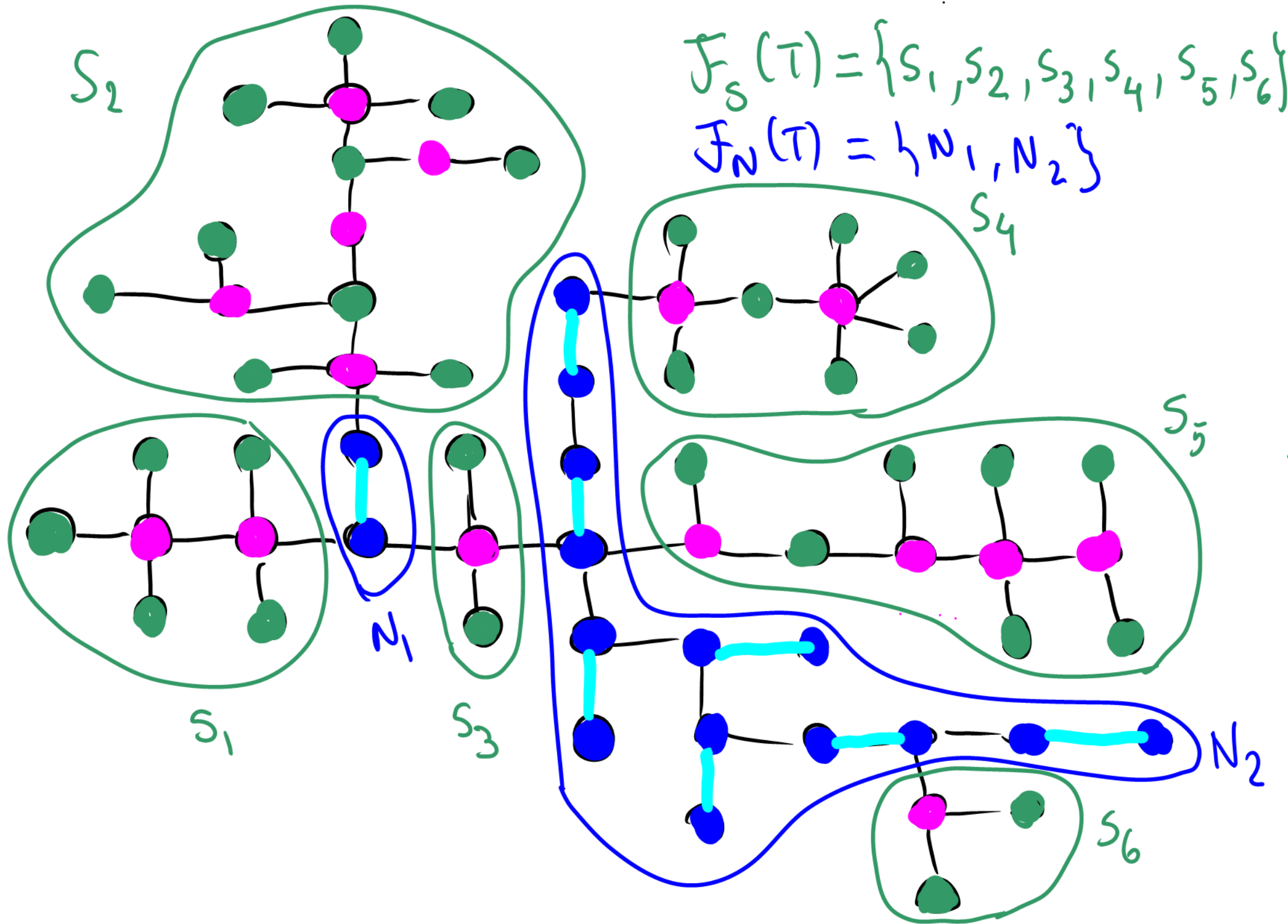
$$\mathcal{F}_S(T) = \{S_1, S_2, S_3, S_4, S_5, S_6\}$$

$$\mathcal{F}_N(T) = \{N_1, N_2\}$$

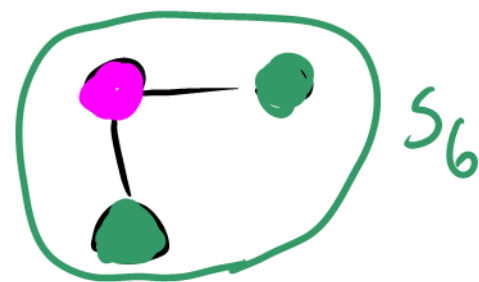
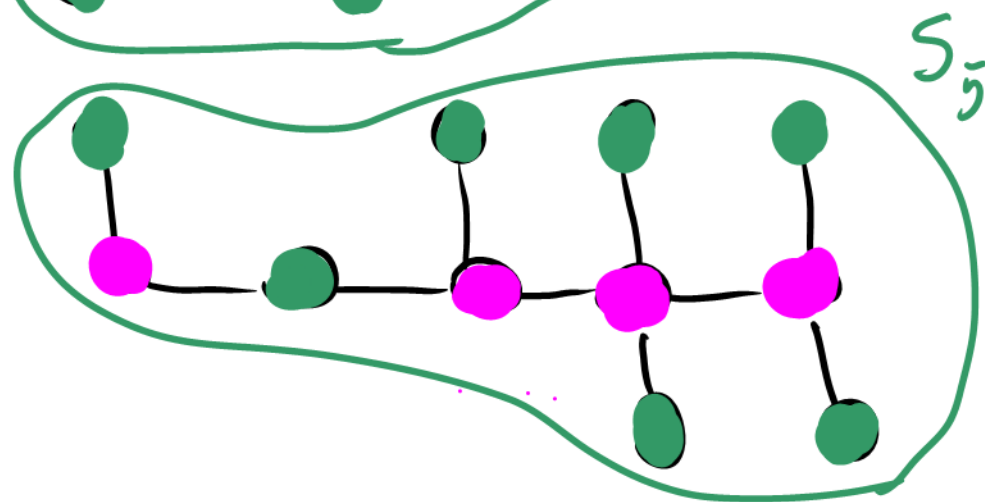
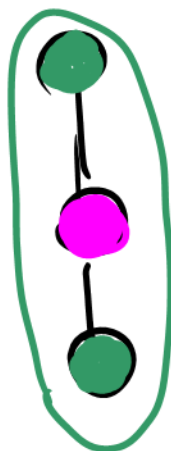
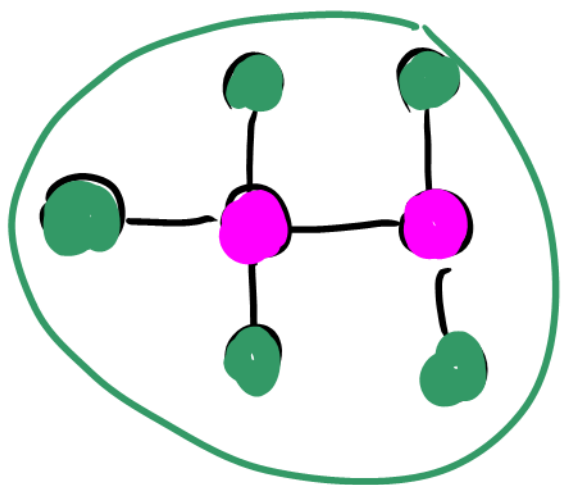
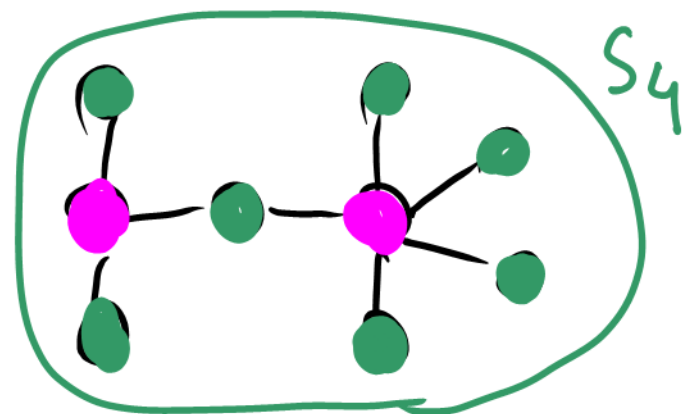
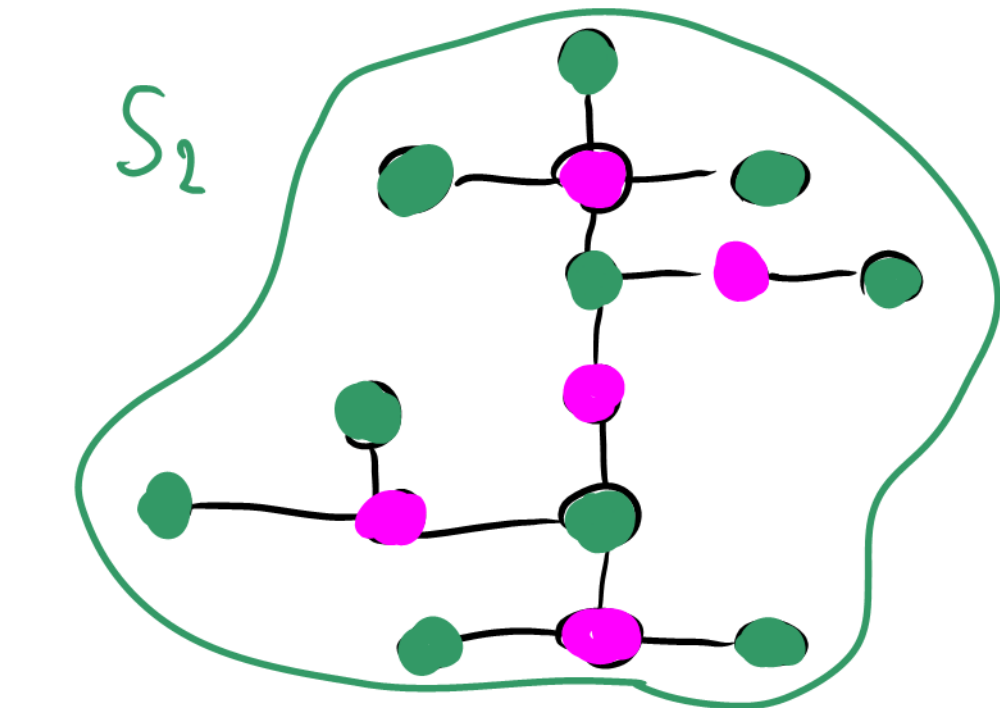


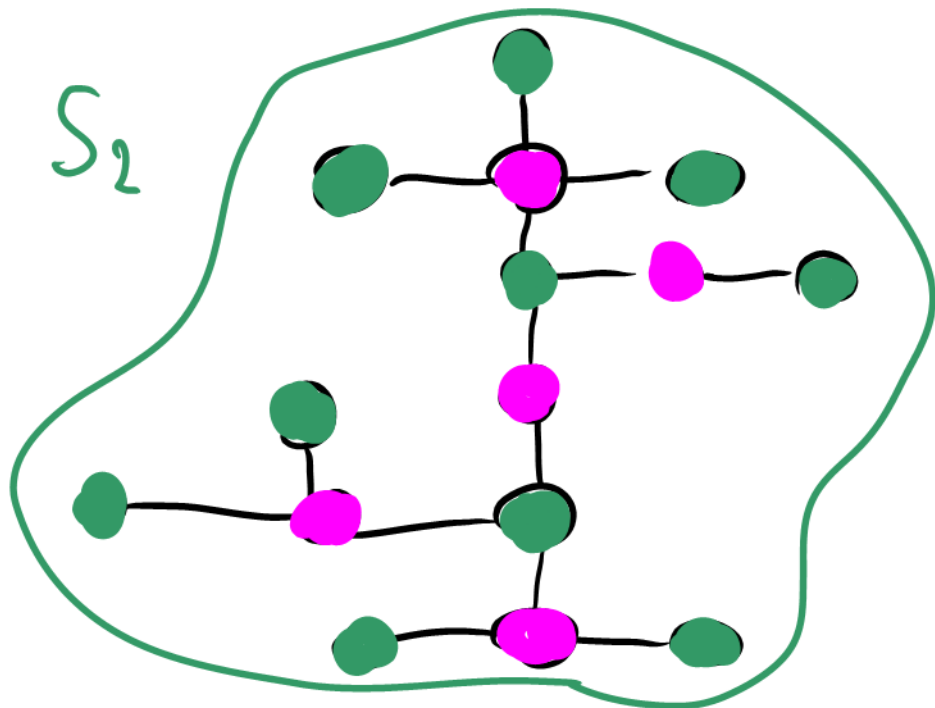
$$\mathcal{F}_S(T) = \{S_1, S_2, S_3, S_4, S_5, S_6\}$$

$$\mathcal{F}_N(T) = \{N_1, N_2\}$$

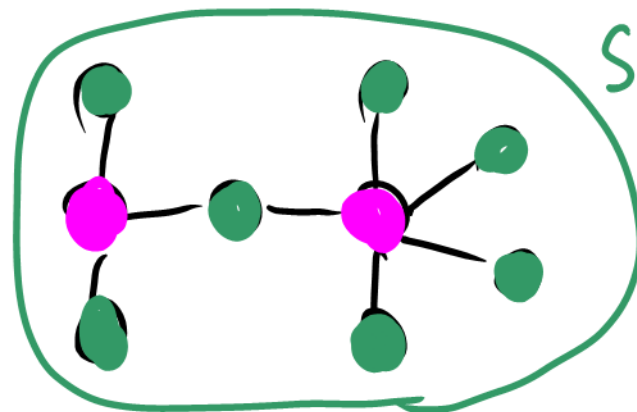
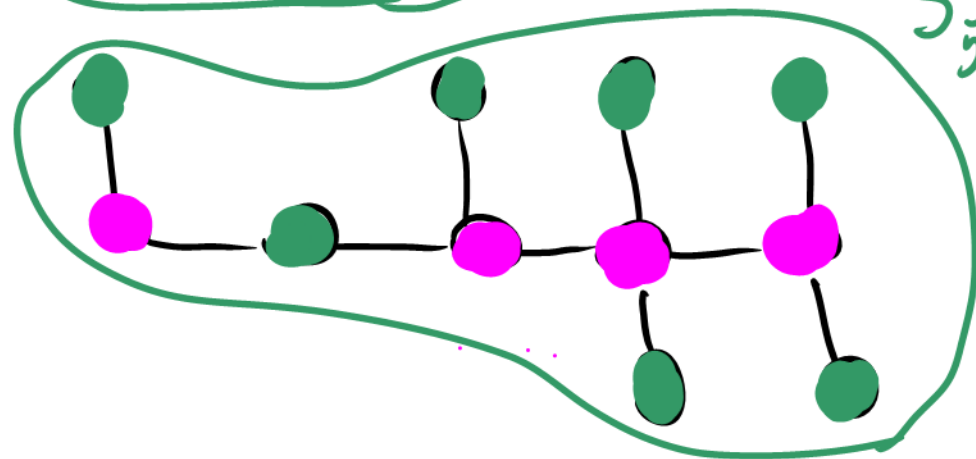
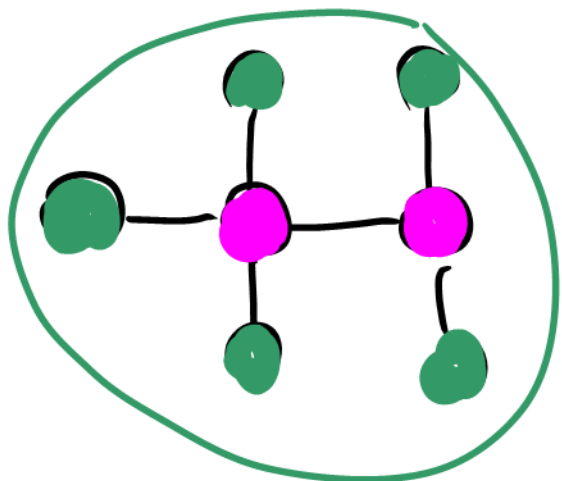
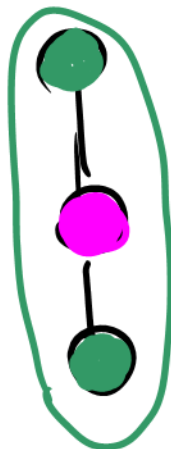
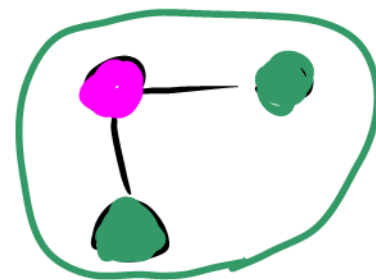


$$\mathcal{F}_S(\mathcal{T}) = \{S_1, S_2, S_3, S_4, S_5, S_6\}$$

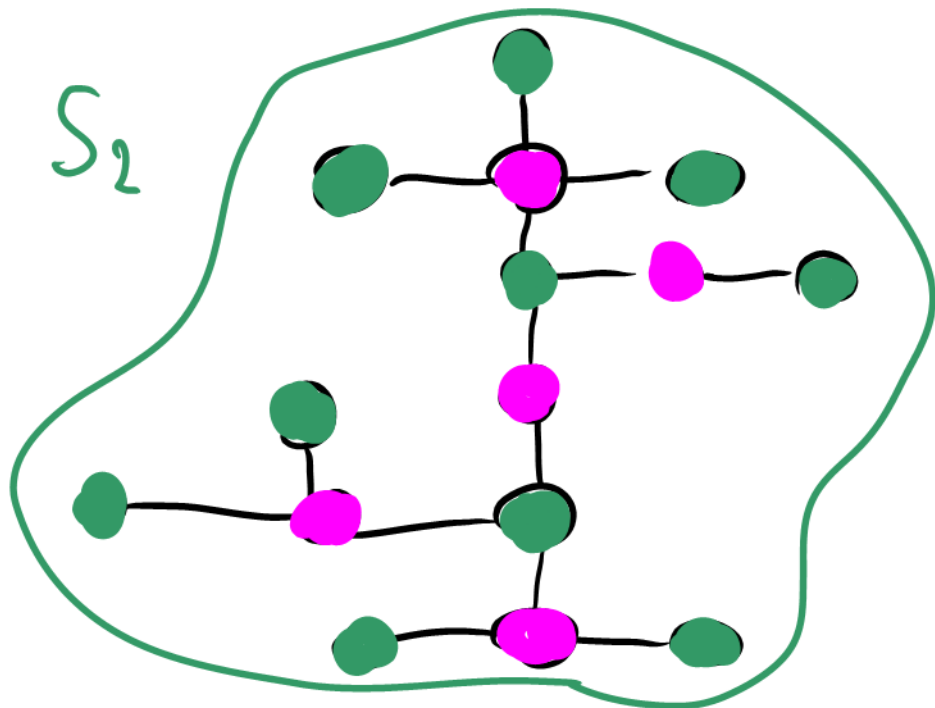


S_2 

$$m(T) = \prod_{S \in \mathcal{F}_S(T)} m(S)$$

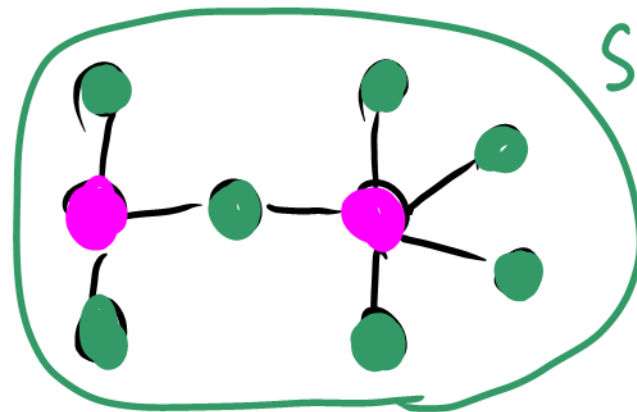
 S_4  S_5  S_1  S_3  S_6 

S_2

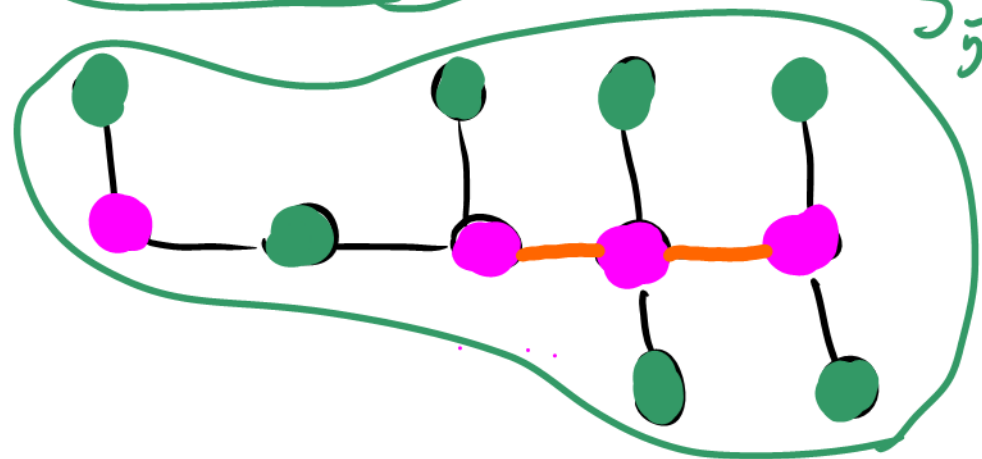


$$m(T) = \prod_{S \in \mathcal{F}_S(T)} m(S)$$

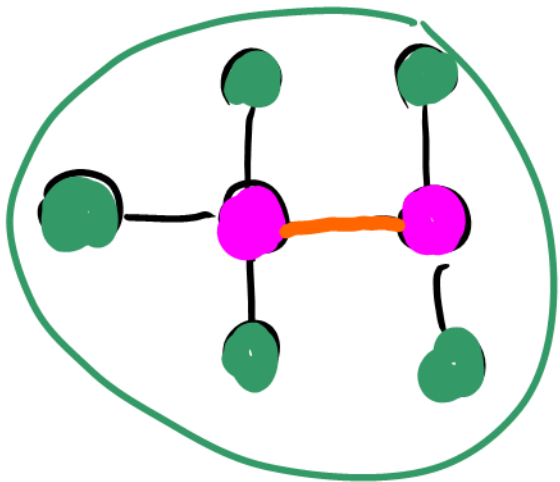
S_4



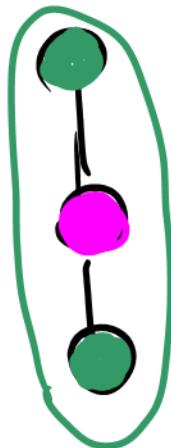
S_5



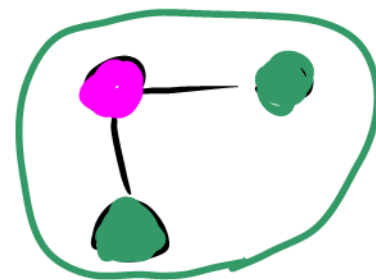
S_1



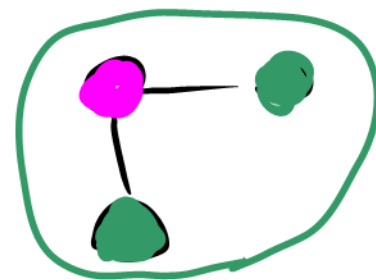
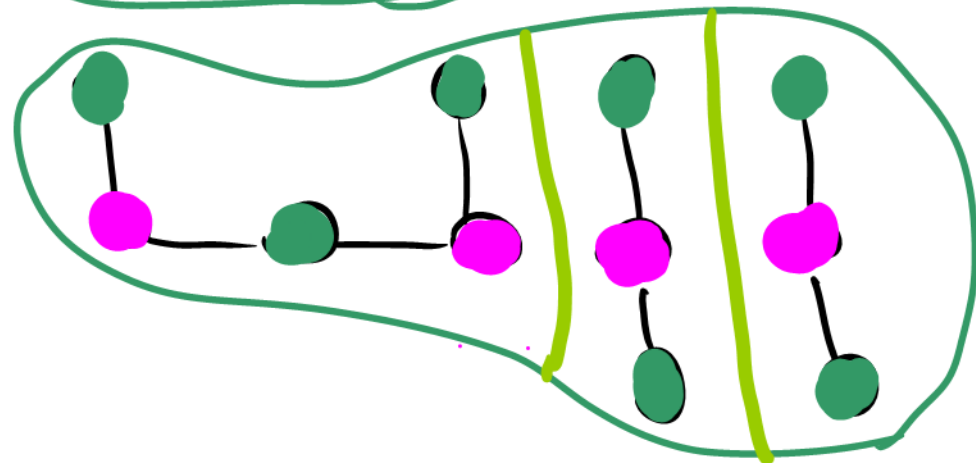
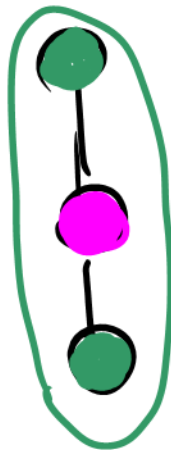
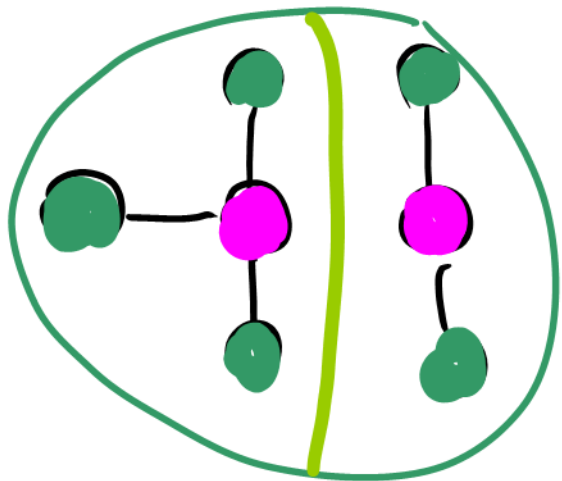
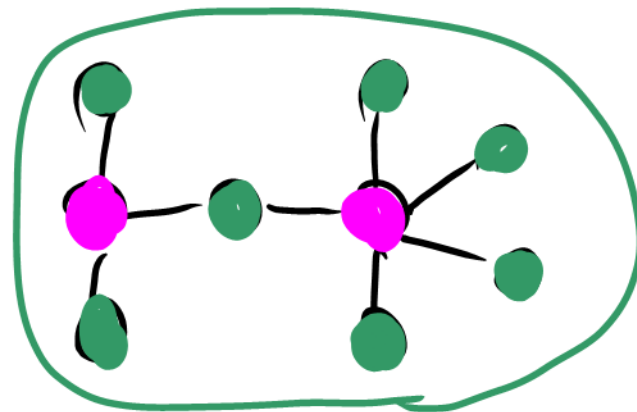
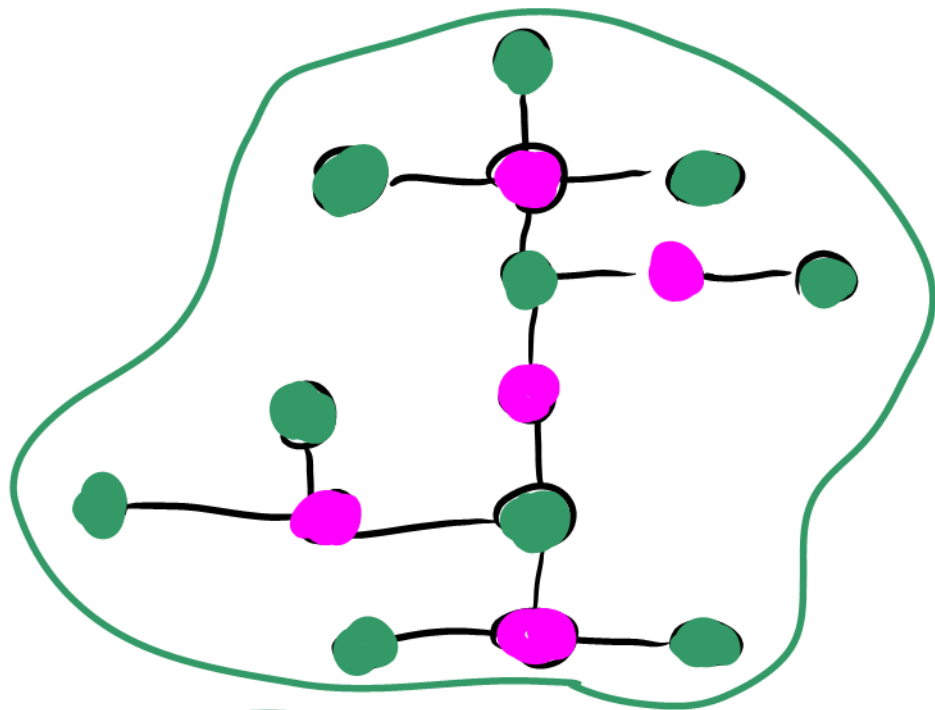
S_3



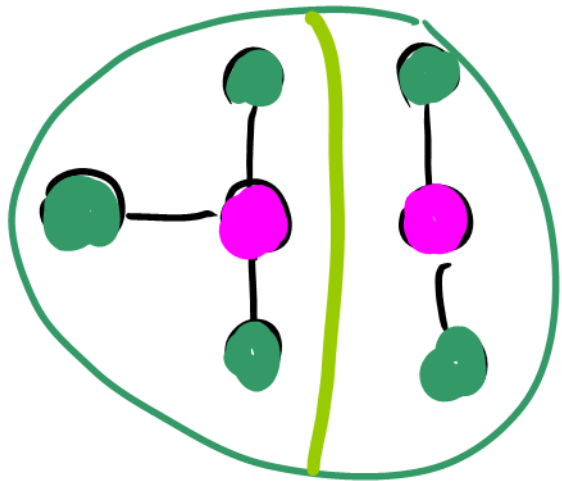
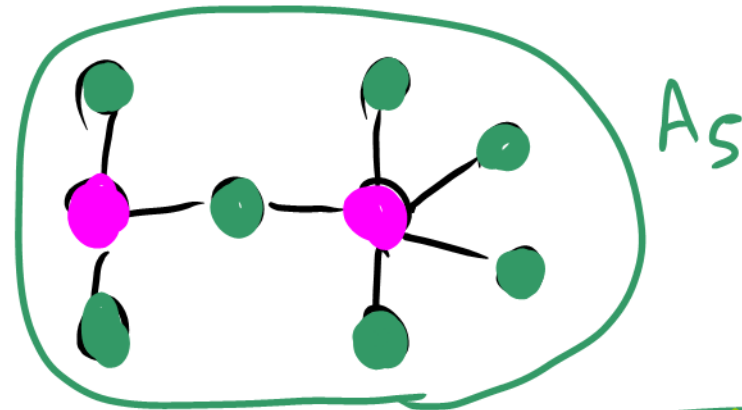
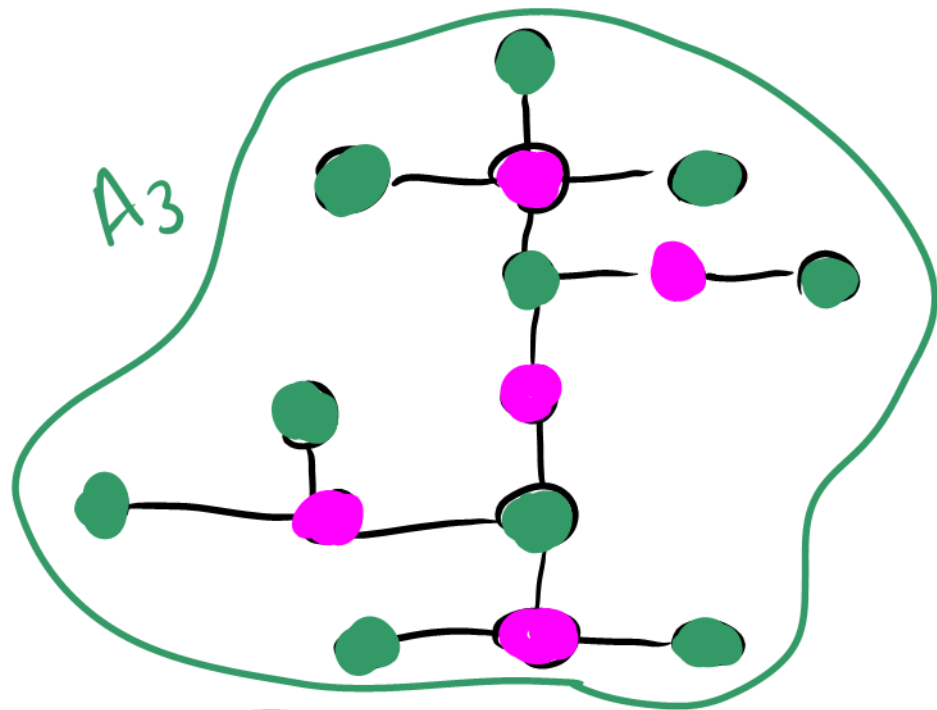
S_6



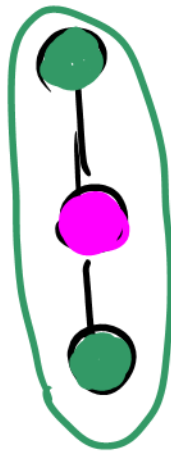
$$m(T) = \prod_{S \in \mathcal{F}_S(T)} m(S)$$



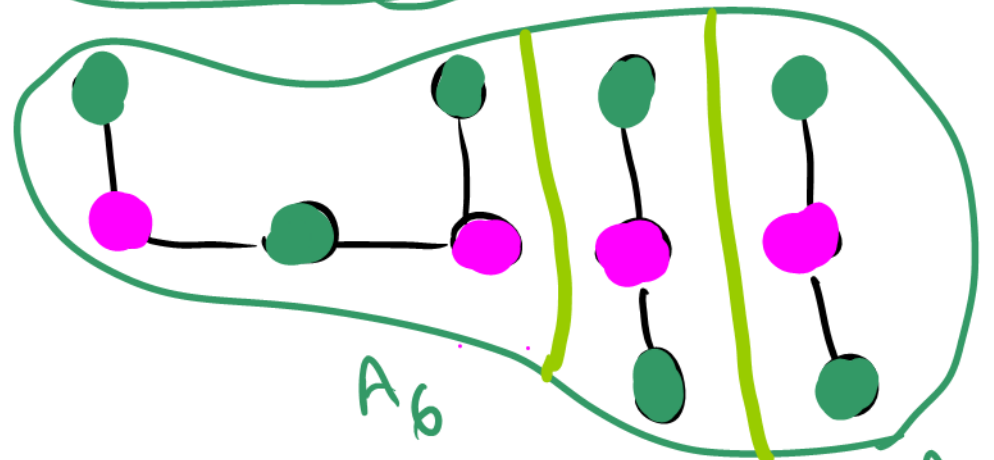
$$m(T) = \prod_{e \in F(T)} m(e)$$



A2



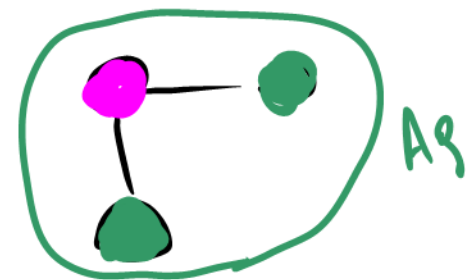
A4

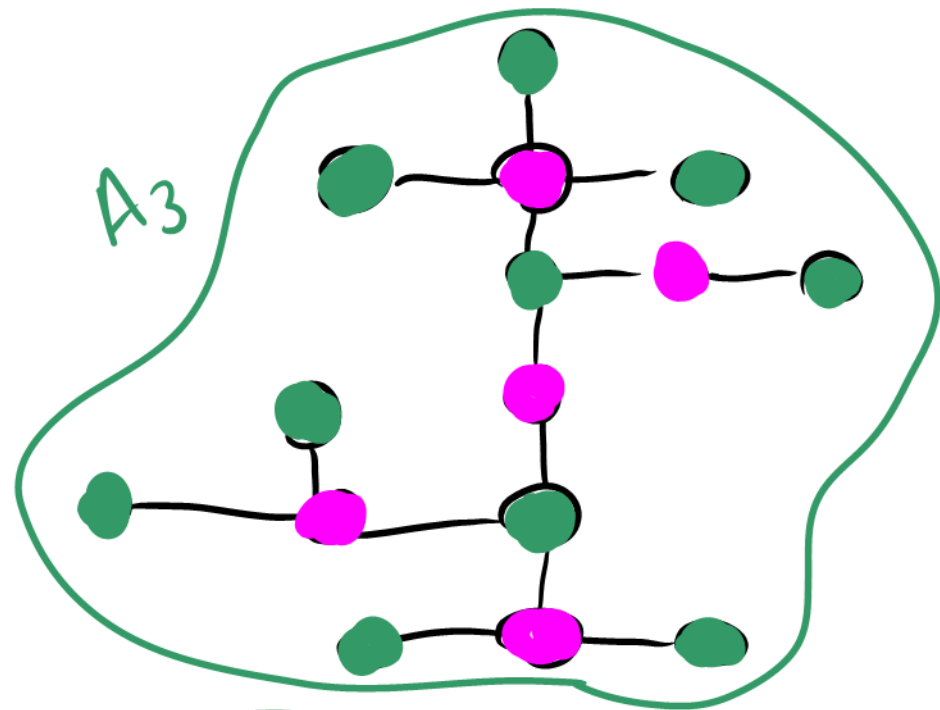


A6

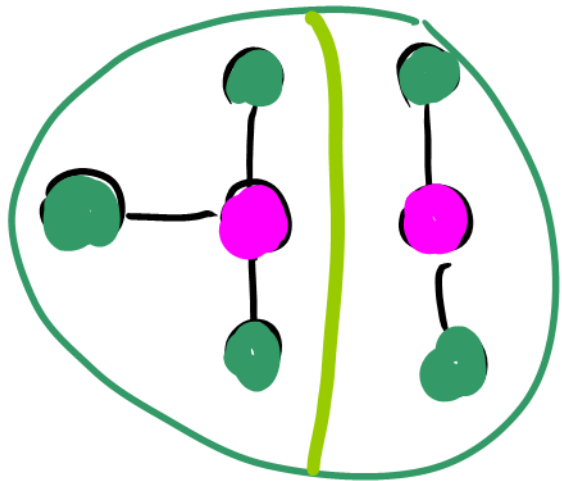
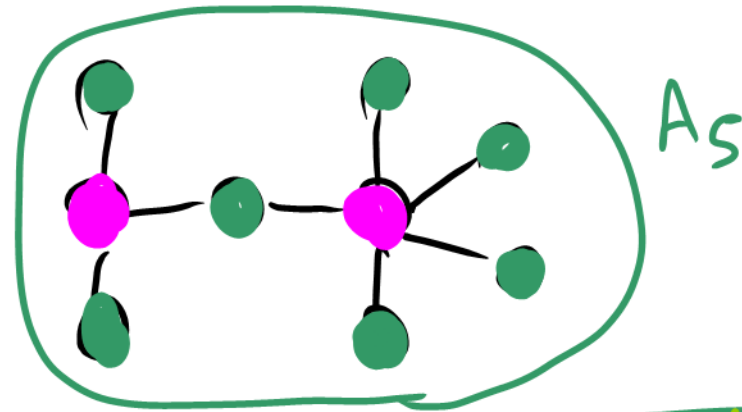
A7

A8

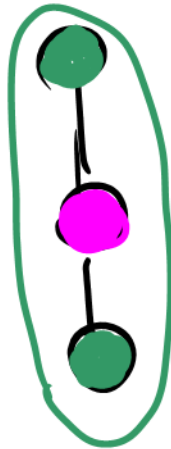




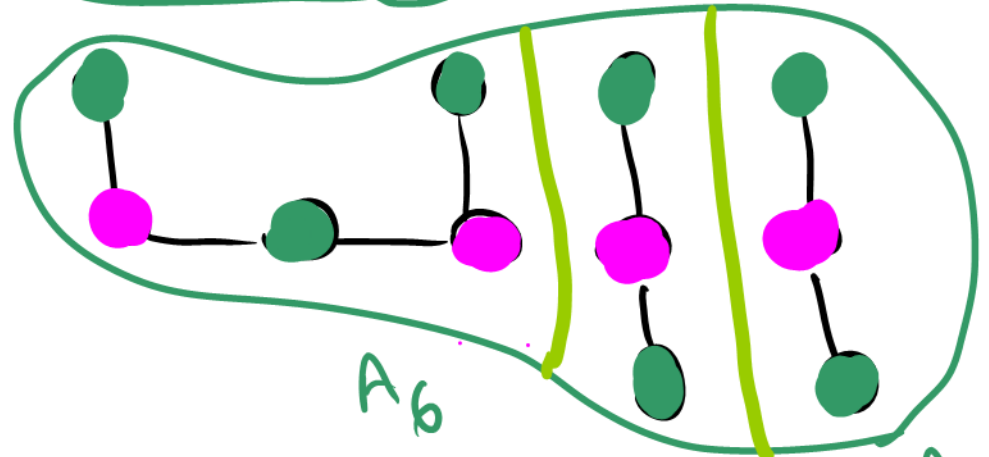
$$m(T) = \prod_{e \in F(T)} m(e)$$



A_2



A_4

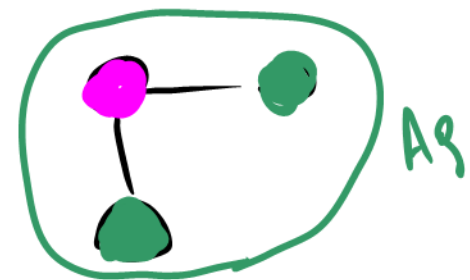


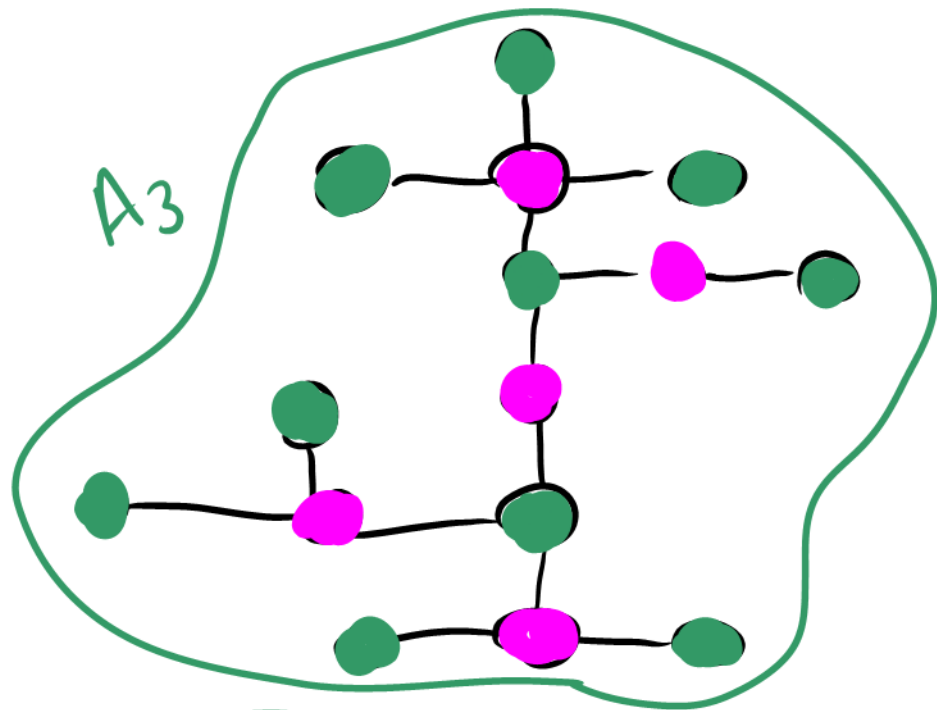
A_6

A_7

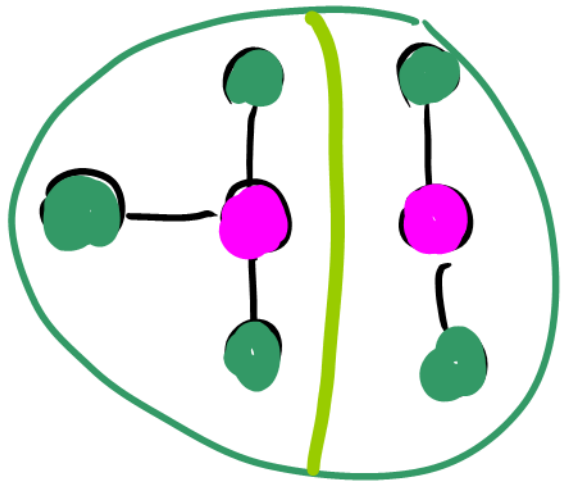
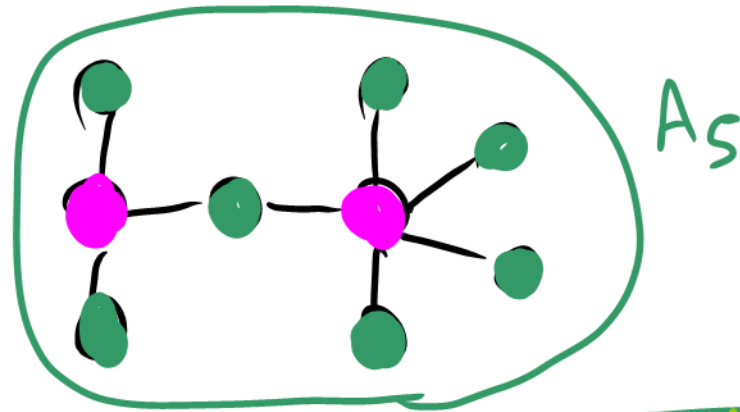
A_8

$$F_{cs}(T) = \{A_1, \dots, A_9\}$$

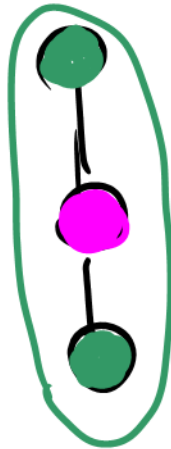




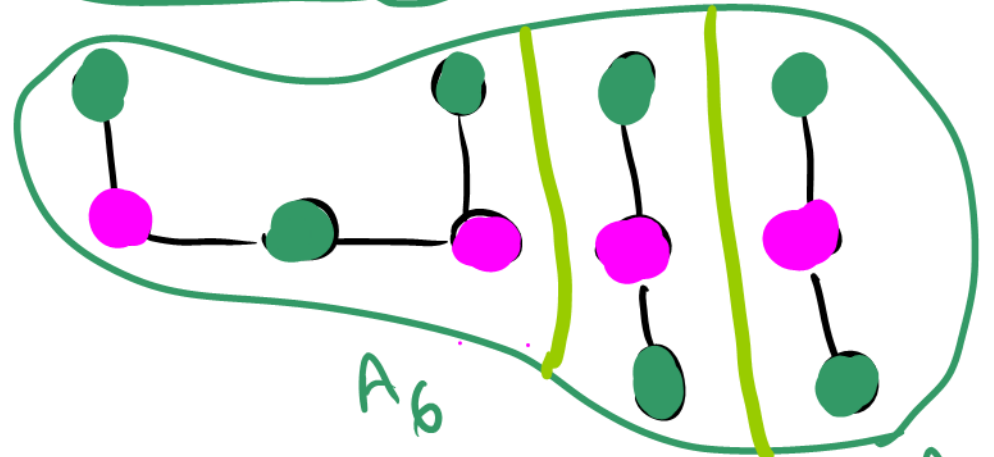
$$m(T) = \prod_{A \in \mathcal{F}(T)} m(A)$$



A_2



A_4

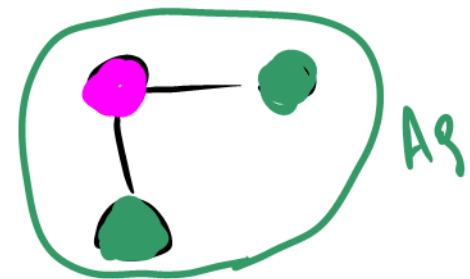


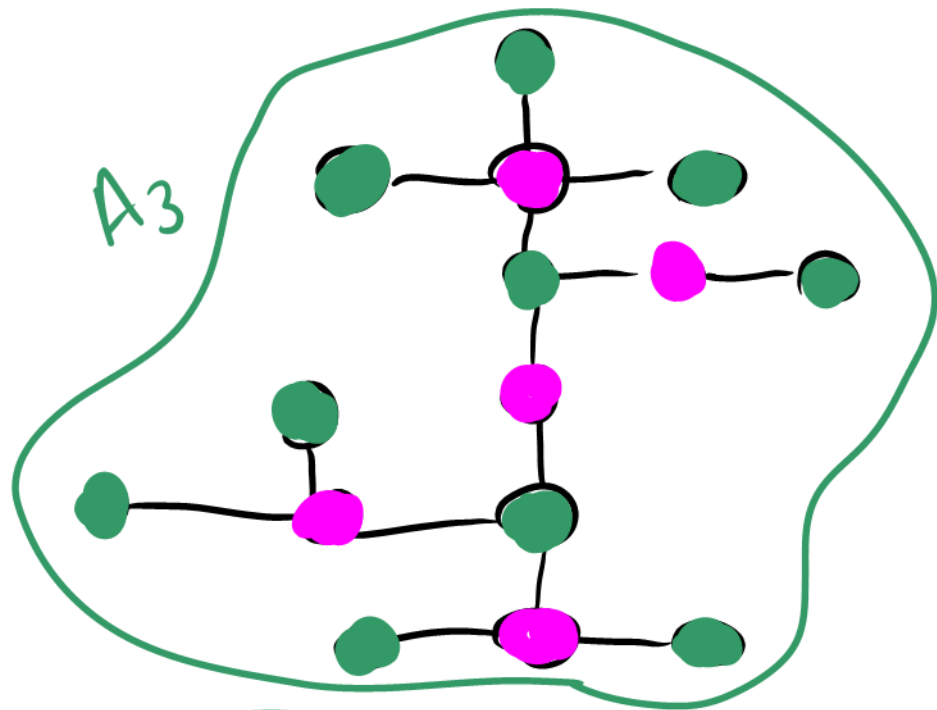
A_6

A_7

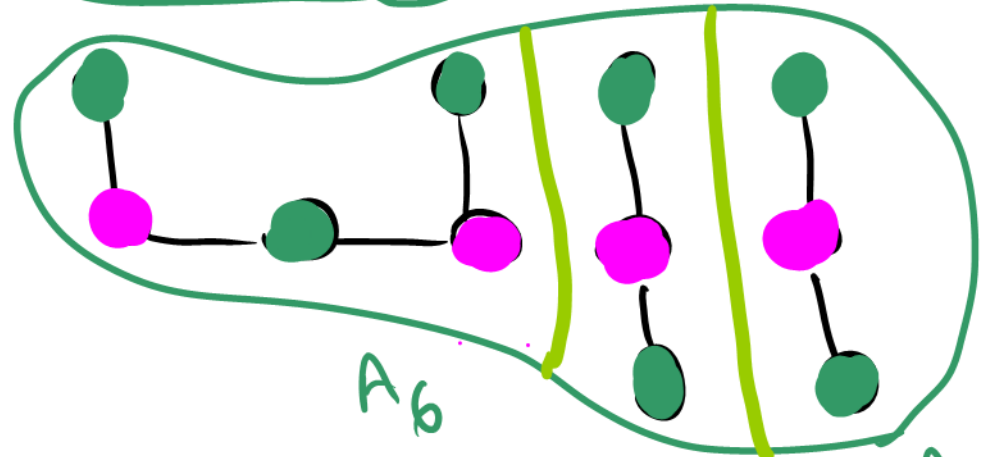
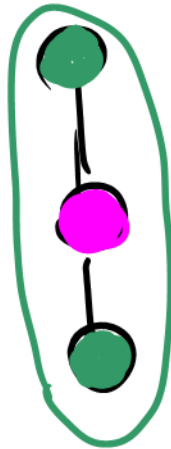
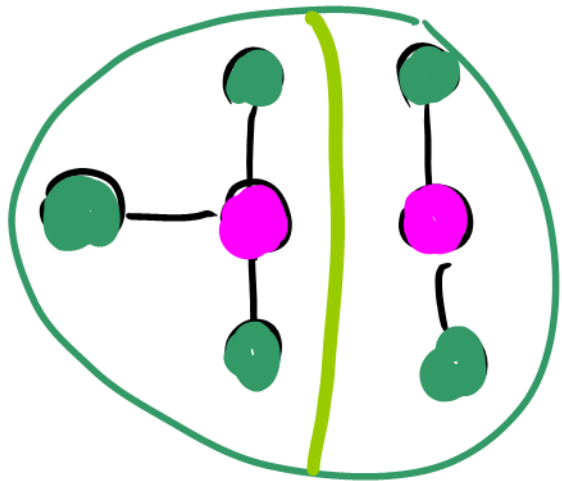
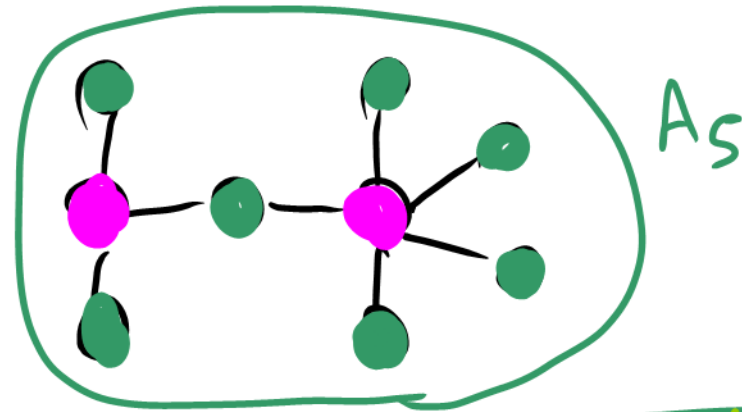
A_8

$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_9\}$$





$$m(T) = \prod_{A \in \mathcal{F}(T)} m(A)$$



A_1

A_2

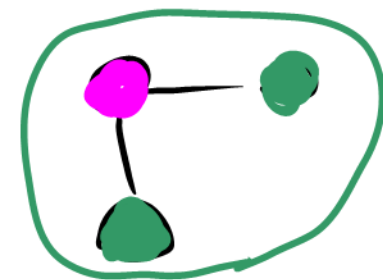
A_4

A_6

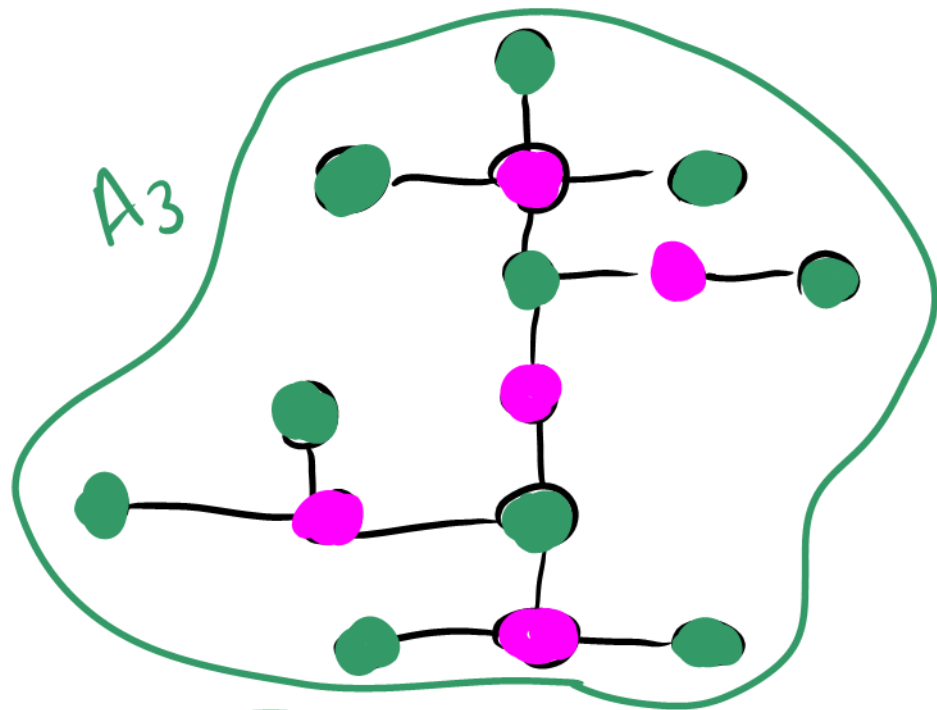
A_7

A_8

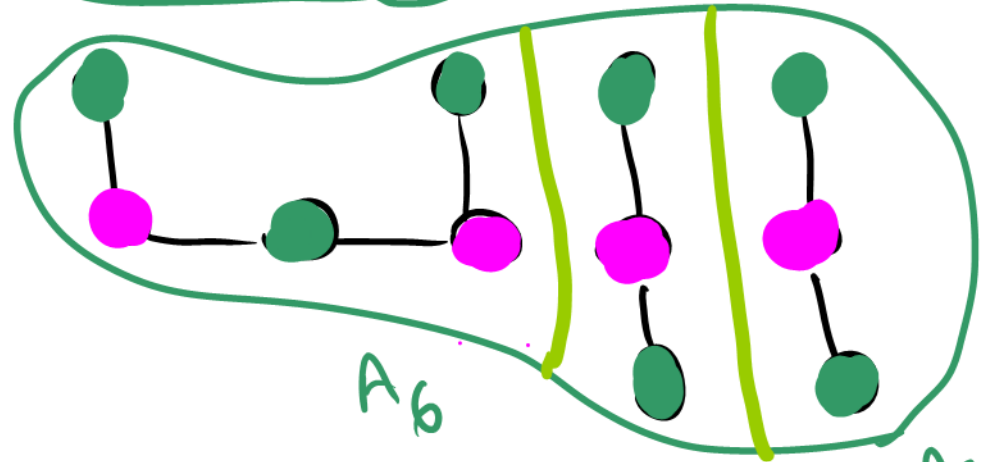
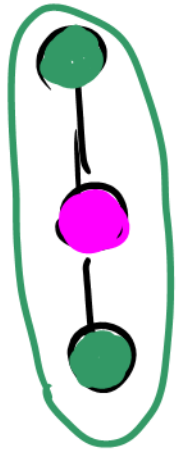
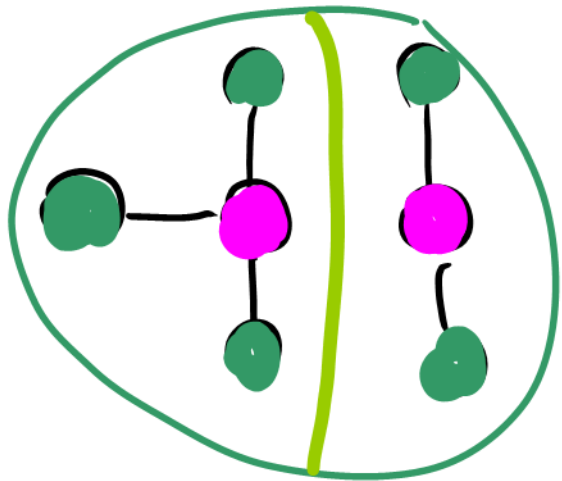
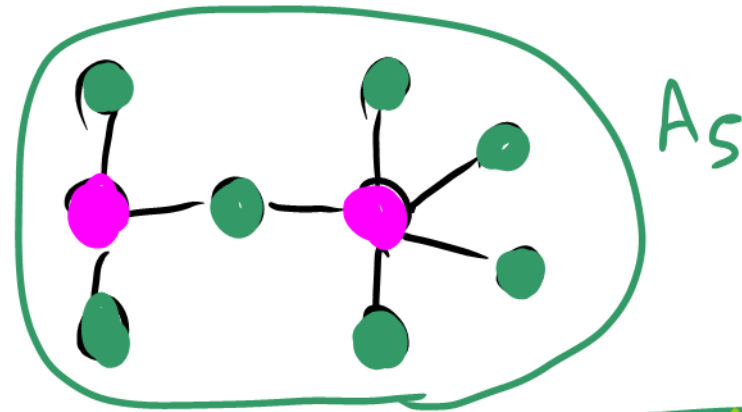
$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_9\}$$



$$m(A_9) = 2$$



$$m(T) = \prod_{A \in \mathcal{F}(T)} m(A)$$



A_1

A_2

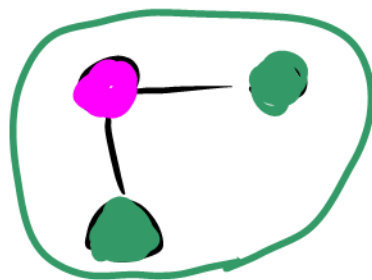
A_4

A_6

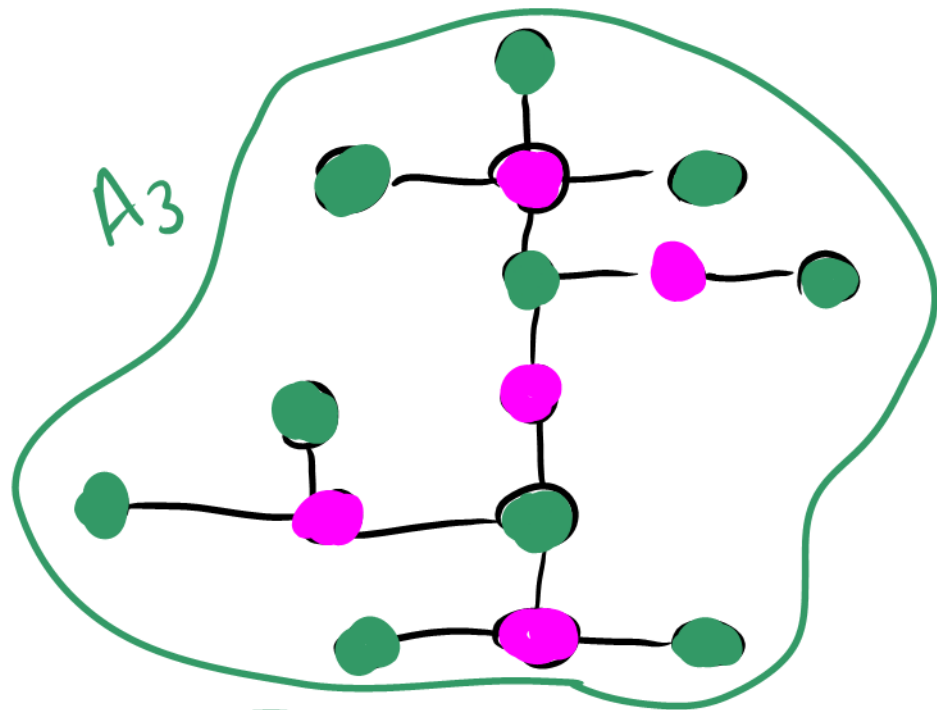
A_8

$$m(A_2) = 2$$

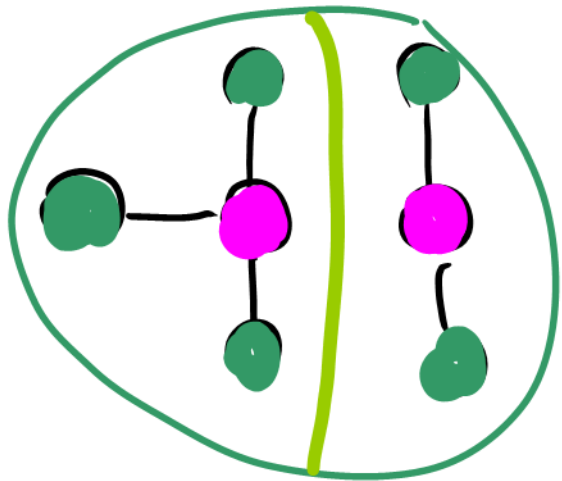
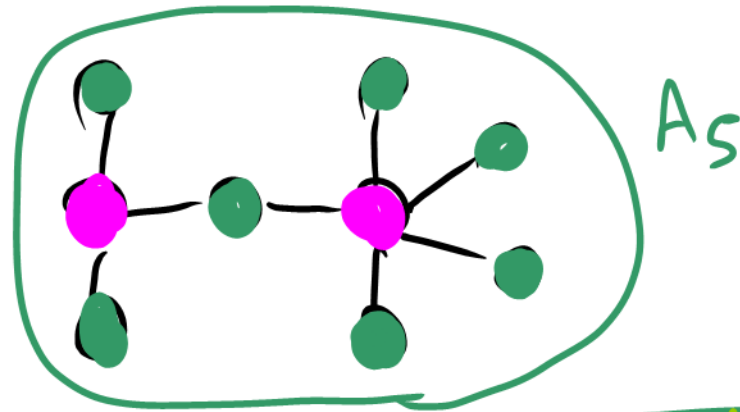
$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_9\}$$



$$m(A_9) = 2$$

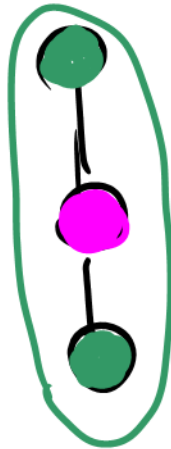


$$m(T) = \prod_{A \in \mathcal{F}(T)} m(A)$$

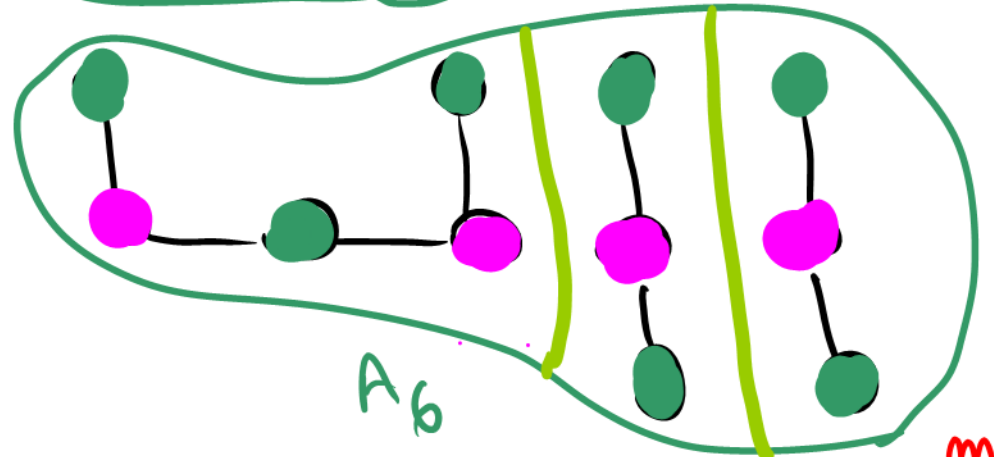


A_1

A_2



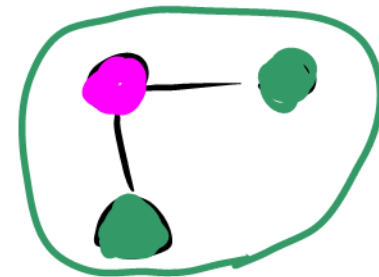
A_4



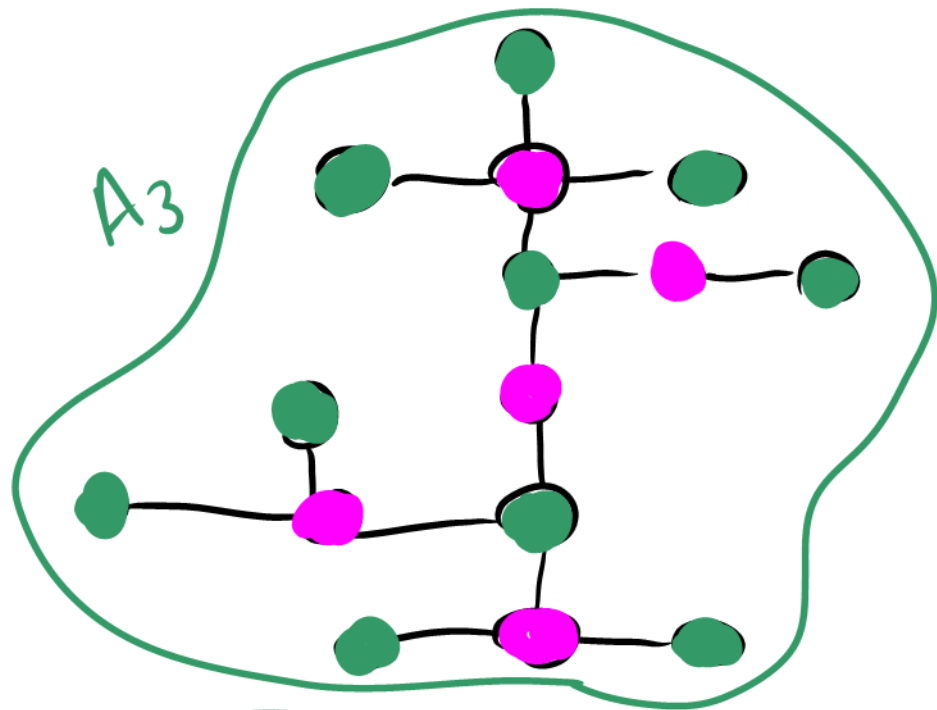
$$m(A_2) = 2$$

$$m(A_6) = 2$$

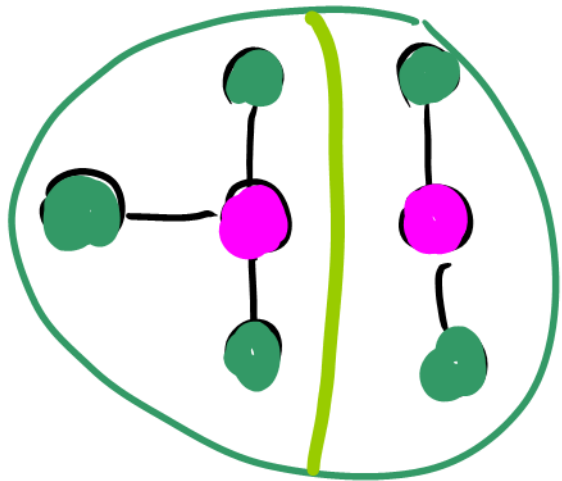
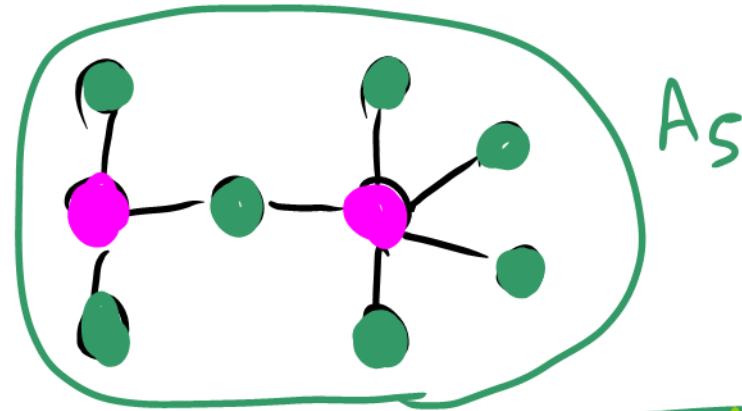
$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_q\}$$



$$m(A_4) = 2$$

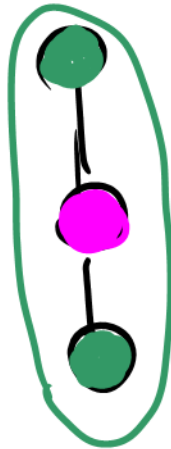


$$m(T) = \prod_{A \in \mathcal{F}(T)} m(A)$$

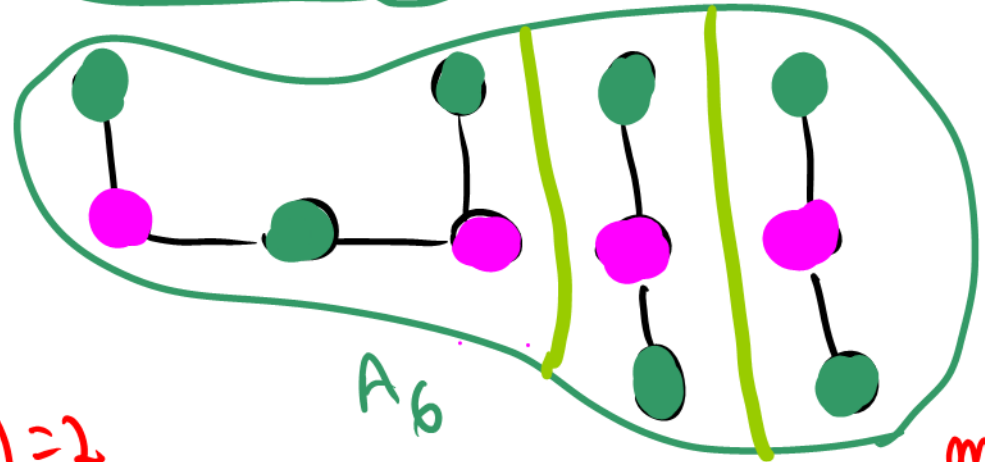


A_1

A_2



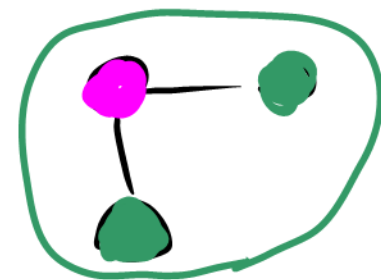
$$m(A_4) = 2$$



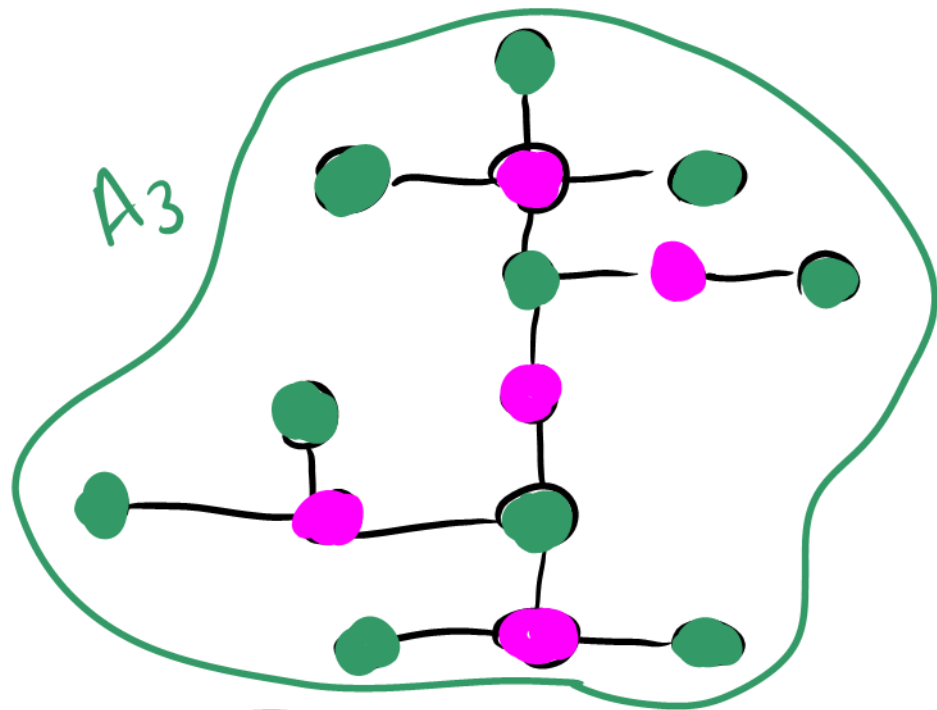
$$m(A_2) = 2$$

$$m(A_8) = 2$$

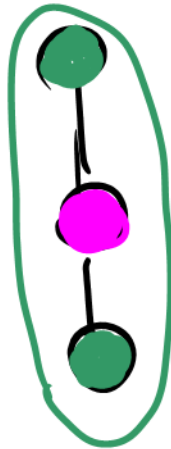
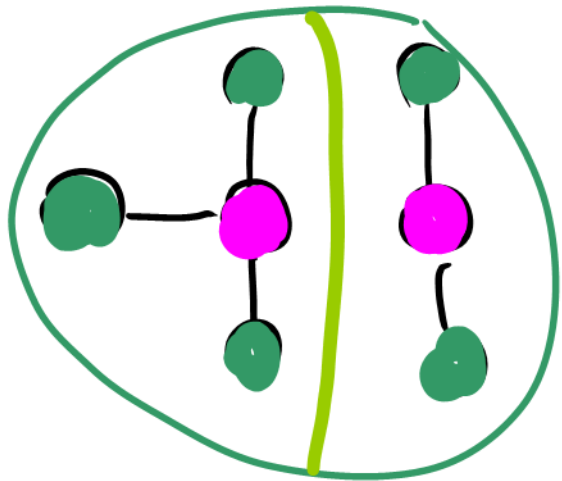
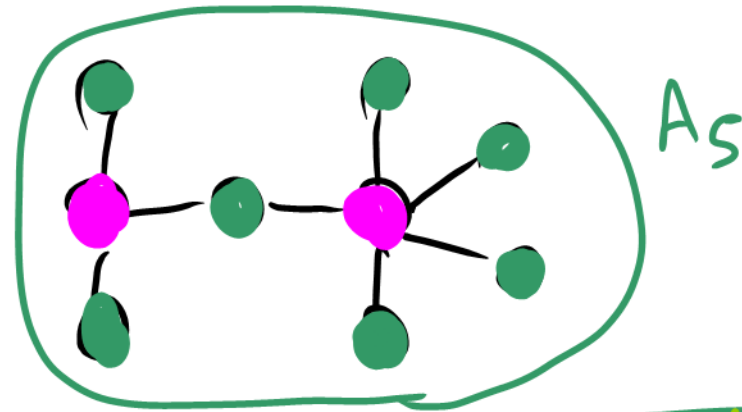
$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_q\}$$



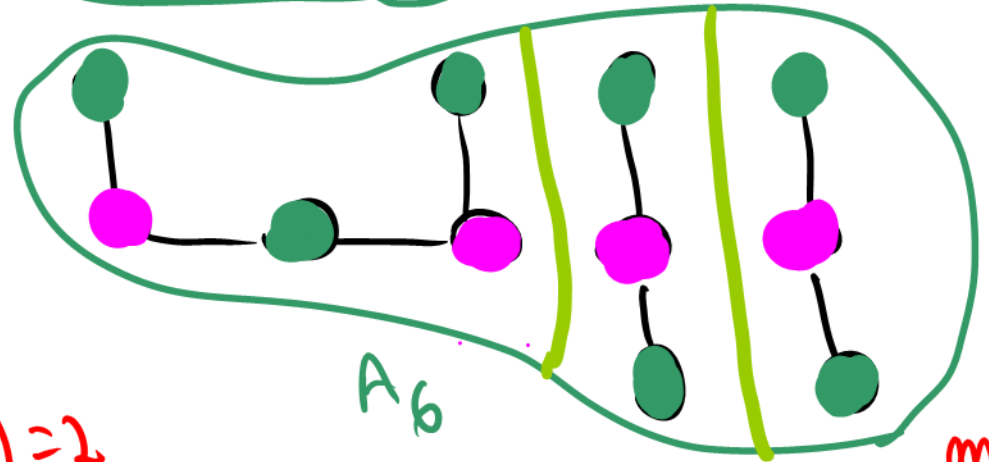
$$m(A_9) = 2$$



$$m(T) = \prod_{A \in \mathcal{F}(T)} m(A)$$



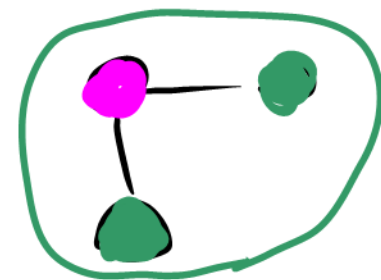
$$m(A_4) = 2$$



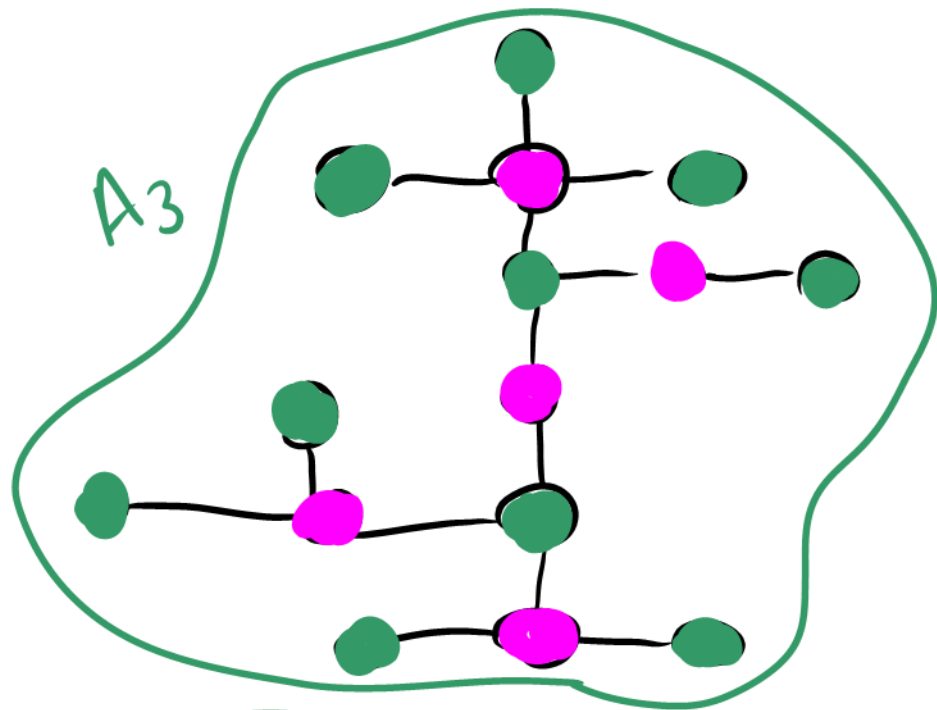
$$m(A_8) = 2$$

$$m(A_7) = 2$$

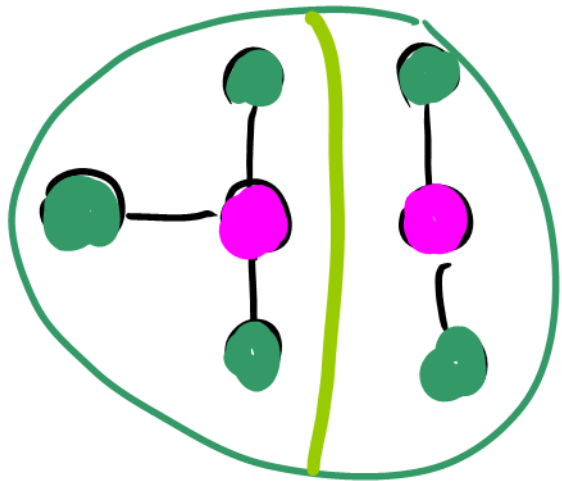
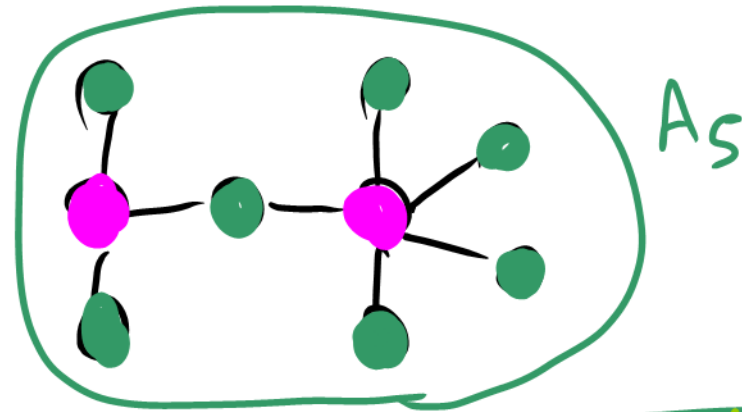
$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_q\}$$



$$m(A_4) = 2$$

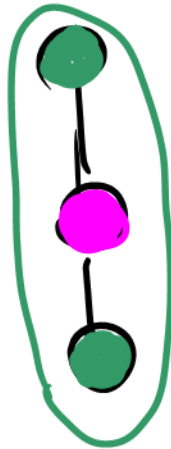


$$m(T) = \prod_{A \in \mathcal{F}(T)} m(A)$$

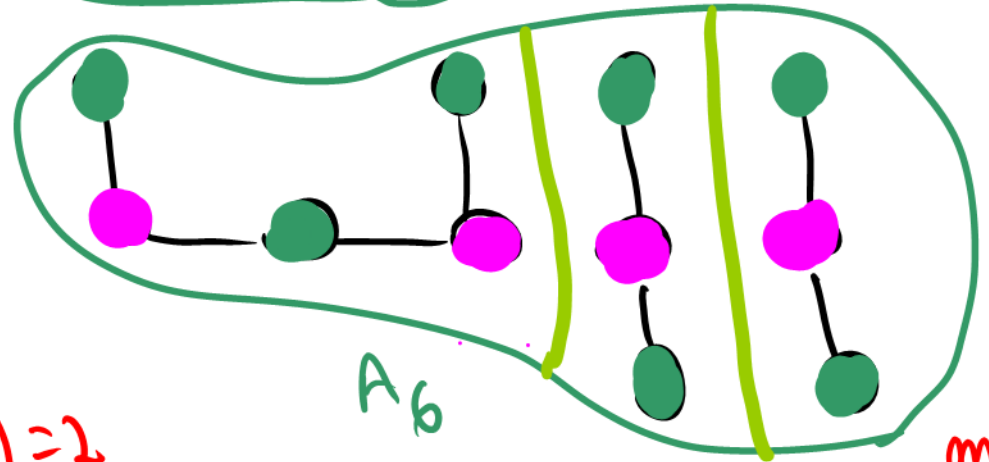


$$m(A_1) = 3$$

$$m(A_2) = 2$$



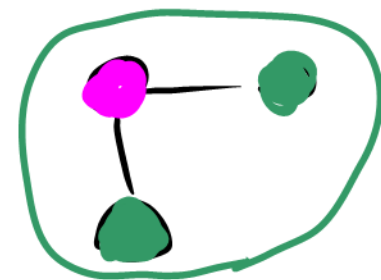
$$m(A_4) = 2$$



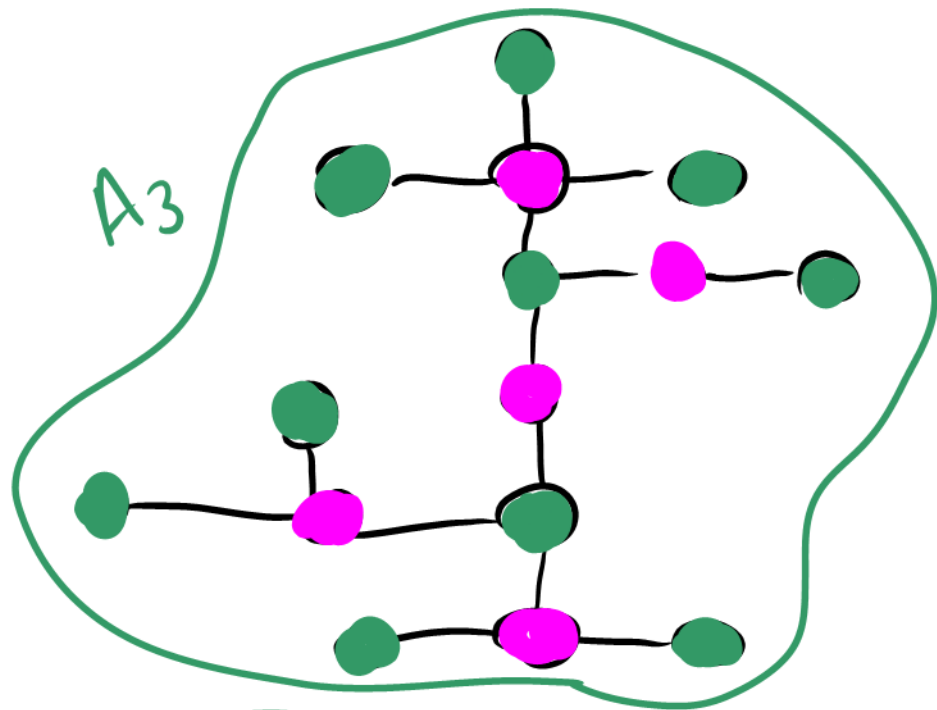
$$m(A_7) = 2$$

$$m(A_8) = 2$$

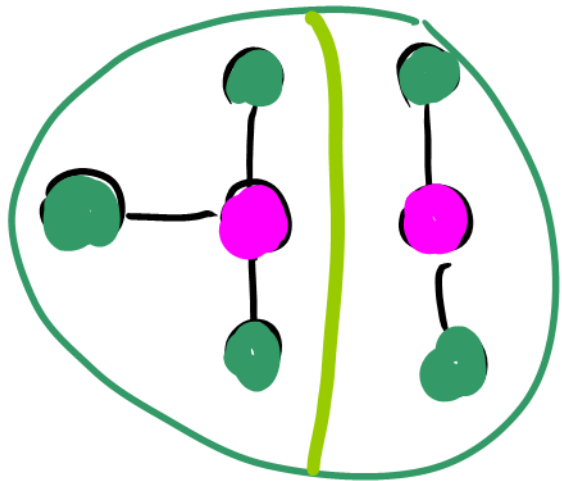
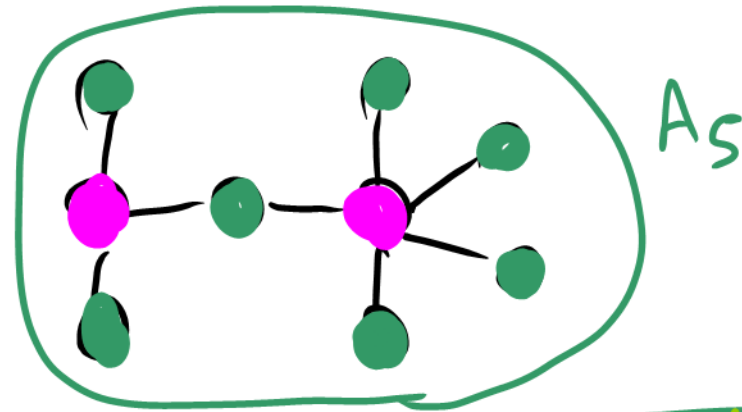
$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_q\}$$



$$m(A_9) = 2$$

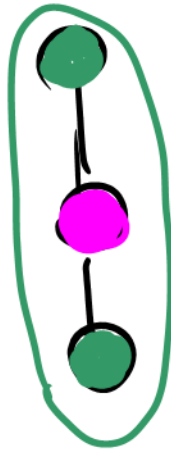


$$m(T) = \prod_{A \in \mathcal{F}(T)} m(A)$$



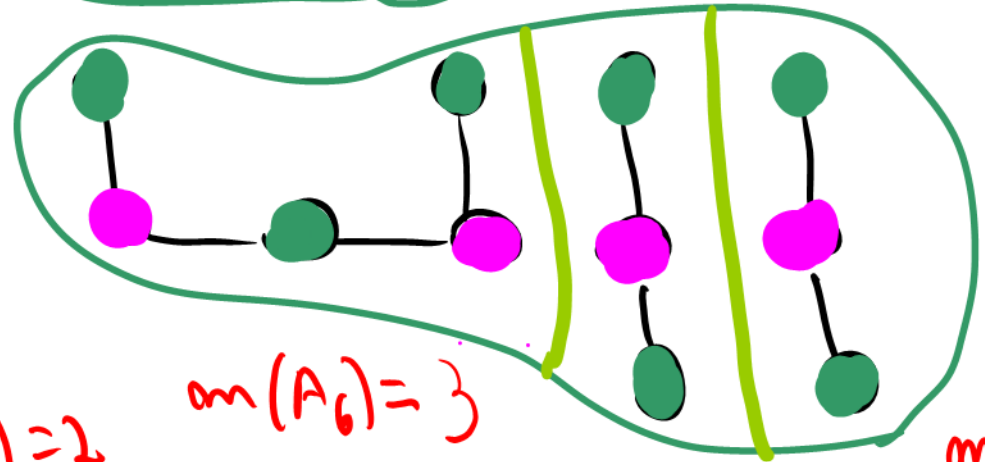
$$m(A_1) = 3$$

$$m(A_2) = 2$$



$$m(A_4) = 2$$

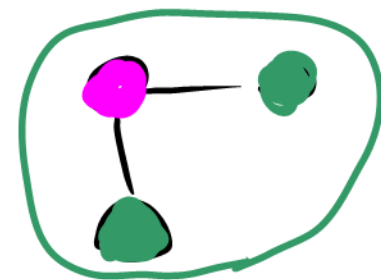
$$m(A_6) = 3$$



$$m(A_7) = 2$$

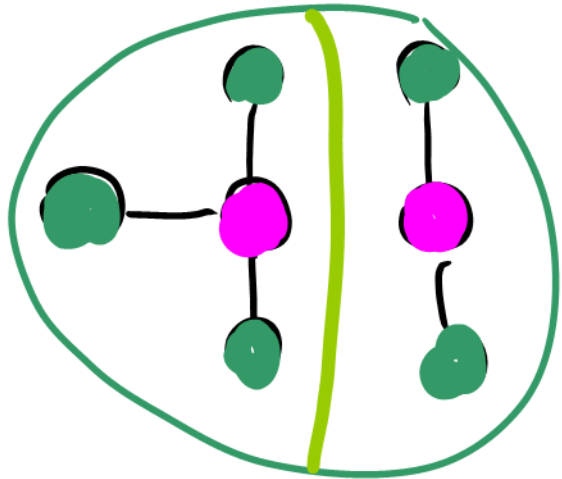
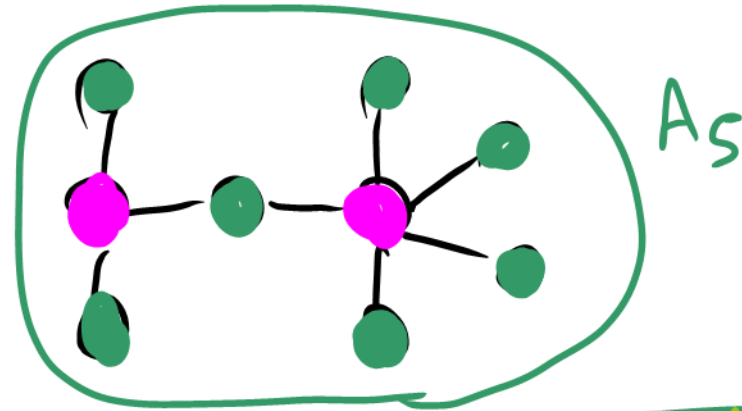
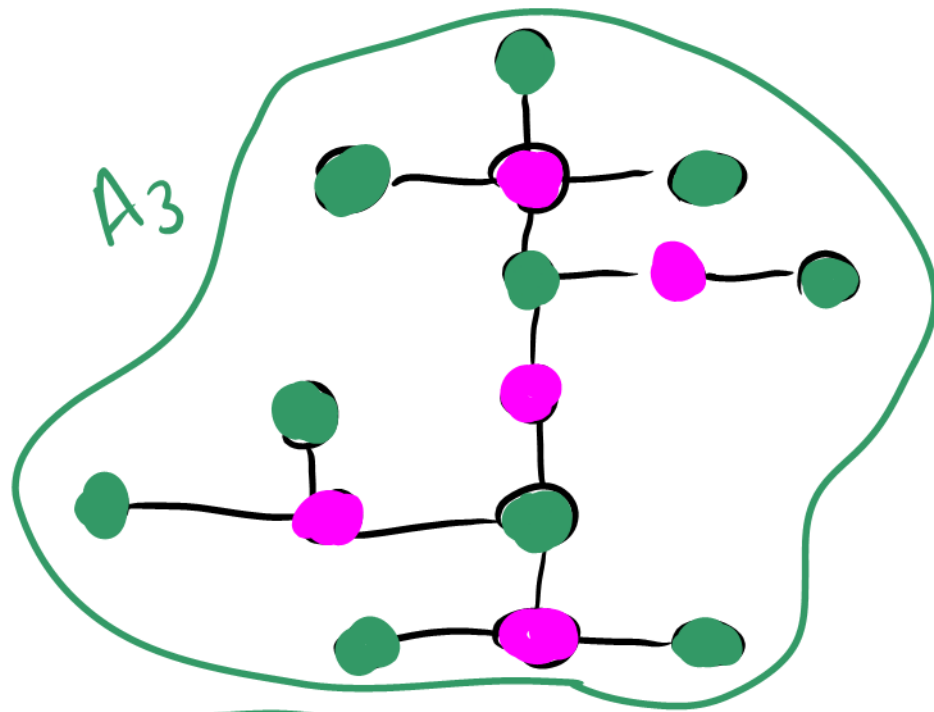
$$m(A_8) = 2$$

$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_q\}$$



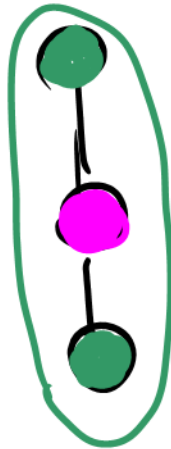
$$m(A_4) = 2$$

$$3 \cdot 2 \cdot m(A_3) + 2 \cdot m(A_5) + 3 \cdot 2 \cdot 2 \cdot 2$$



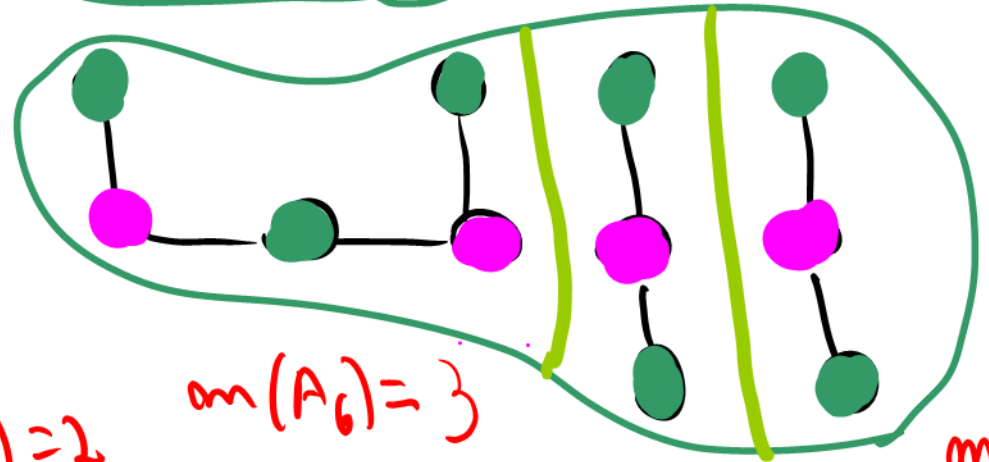
$$m(A_1) = 3$$

$$m(A_2) = 2$$



$$m(A_4) = 2$$

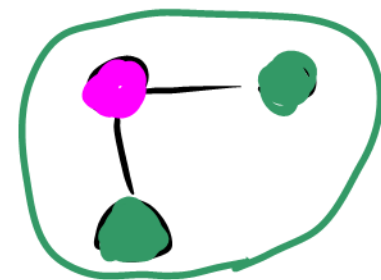
$$m(A_6) = 3$$



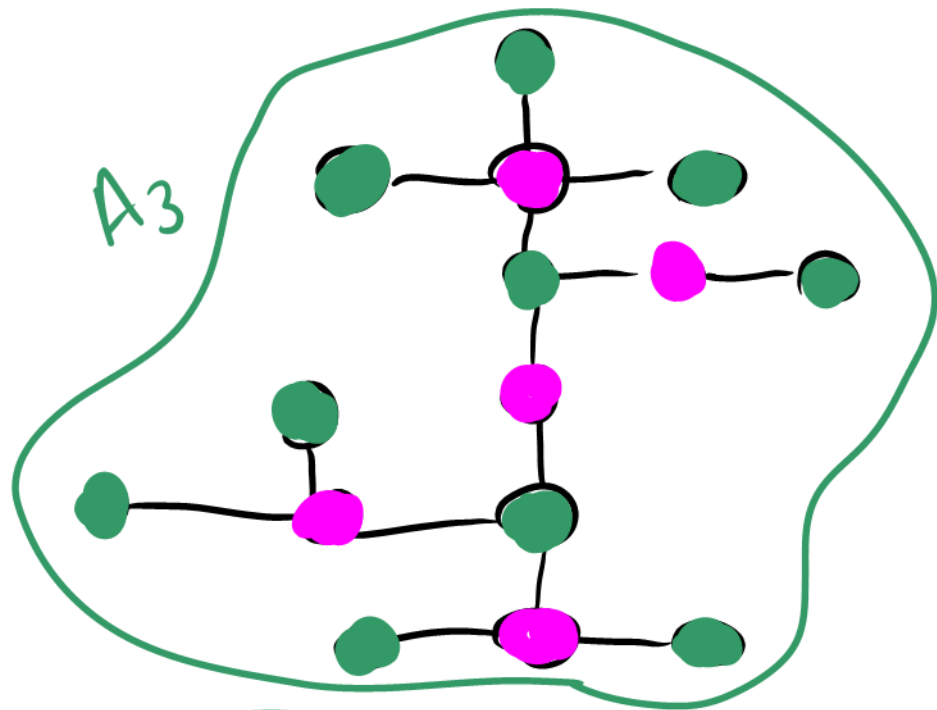
$$m(A_2) = 2$$

$$m(A_8) = 2$$

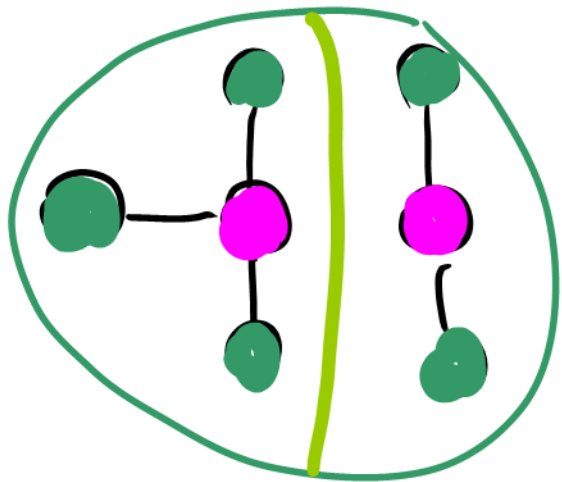
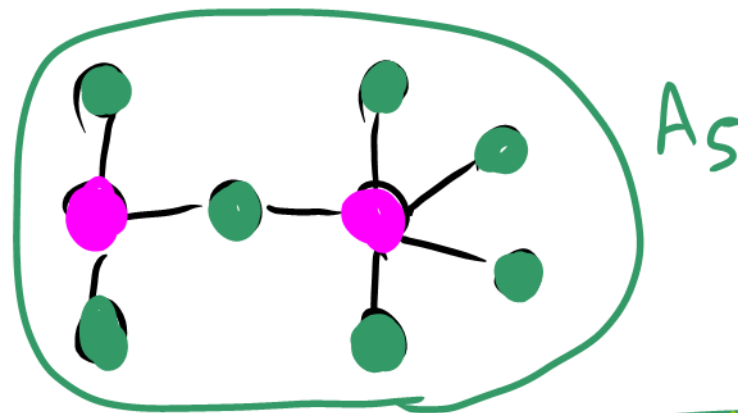
$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_9\}$$



$$m(A_9) = 2$$

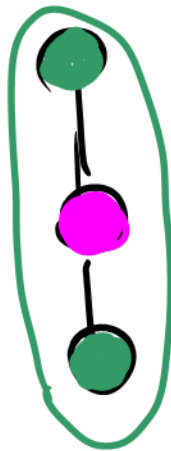


$m(A_3)$



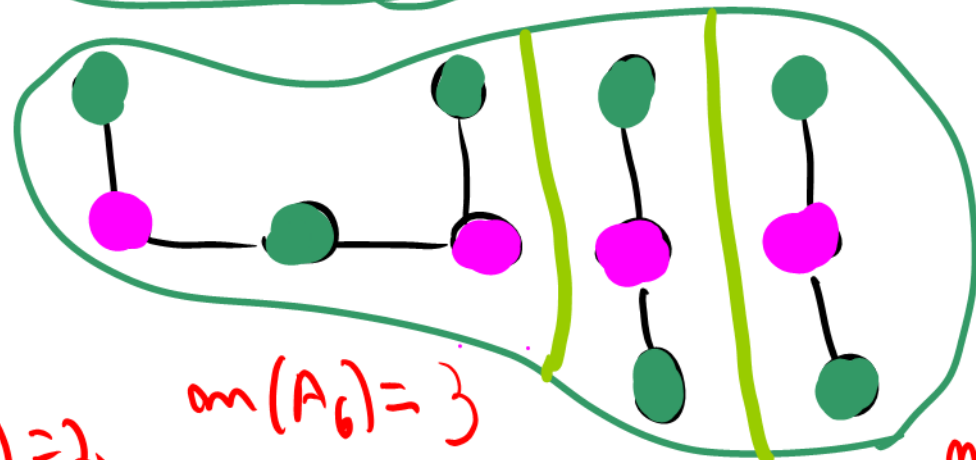
$m(A_1)=3$

$m(A_2)=2$



$m(A_4)=2$

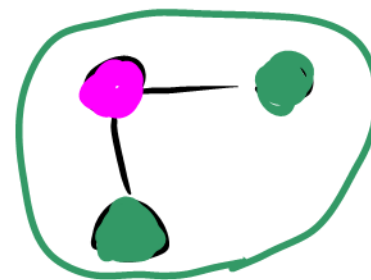
$m(A_6)=3$



$m(A_7)=2$

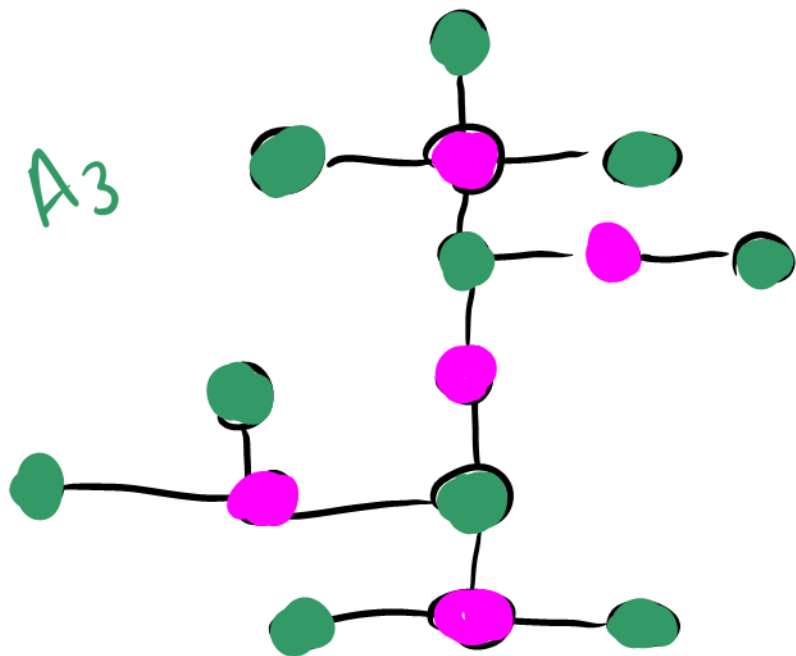
$m(A_8)=2$

$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_q\}$



$m(A_4)=2$

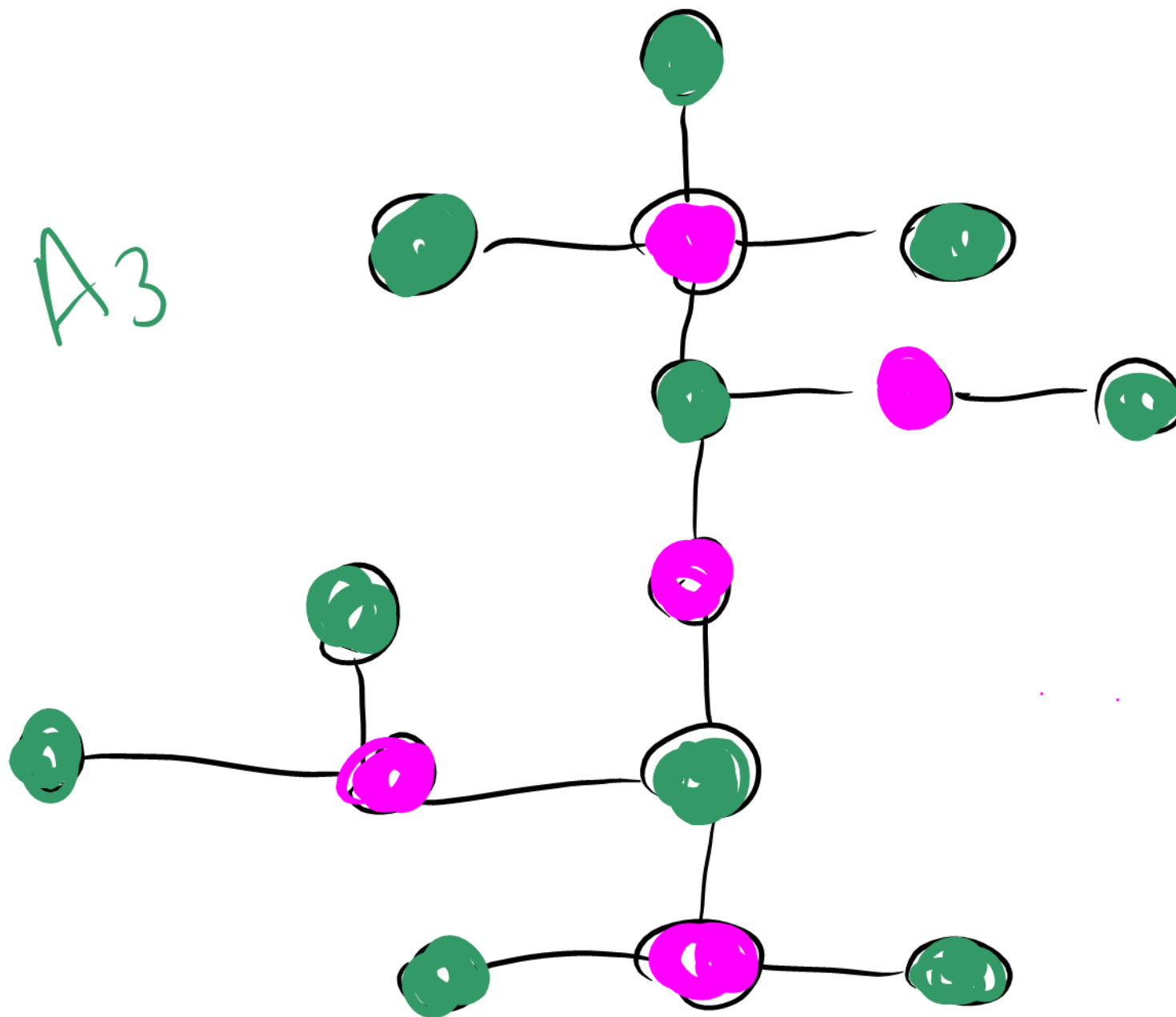
A_3



$m(A_3)$

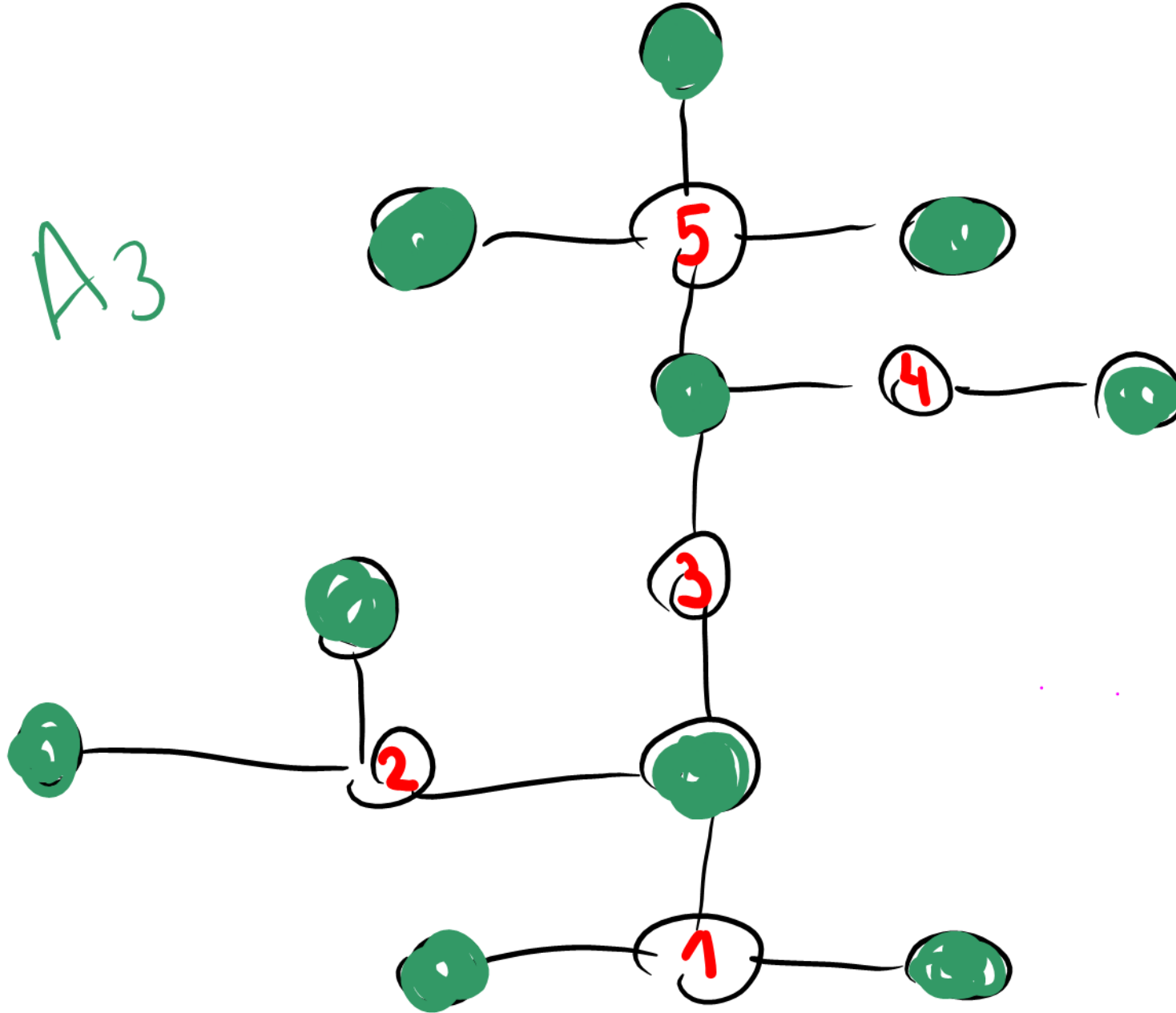
$m(A_3)$

A_3



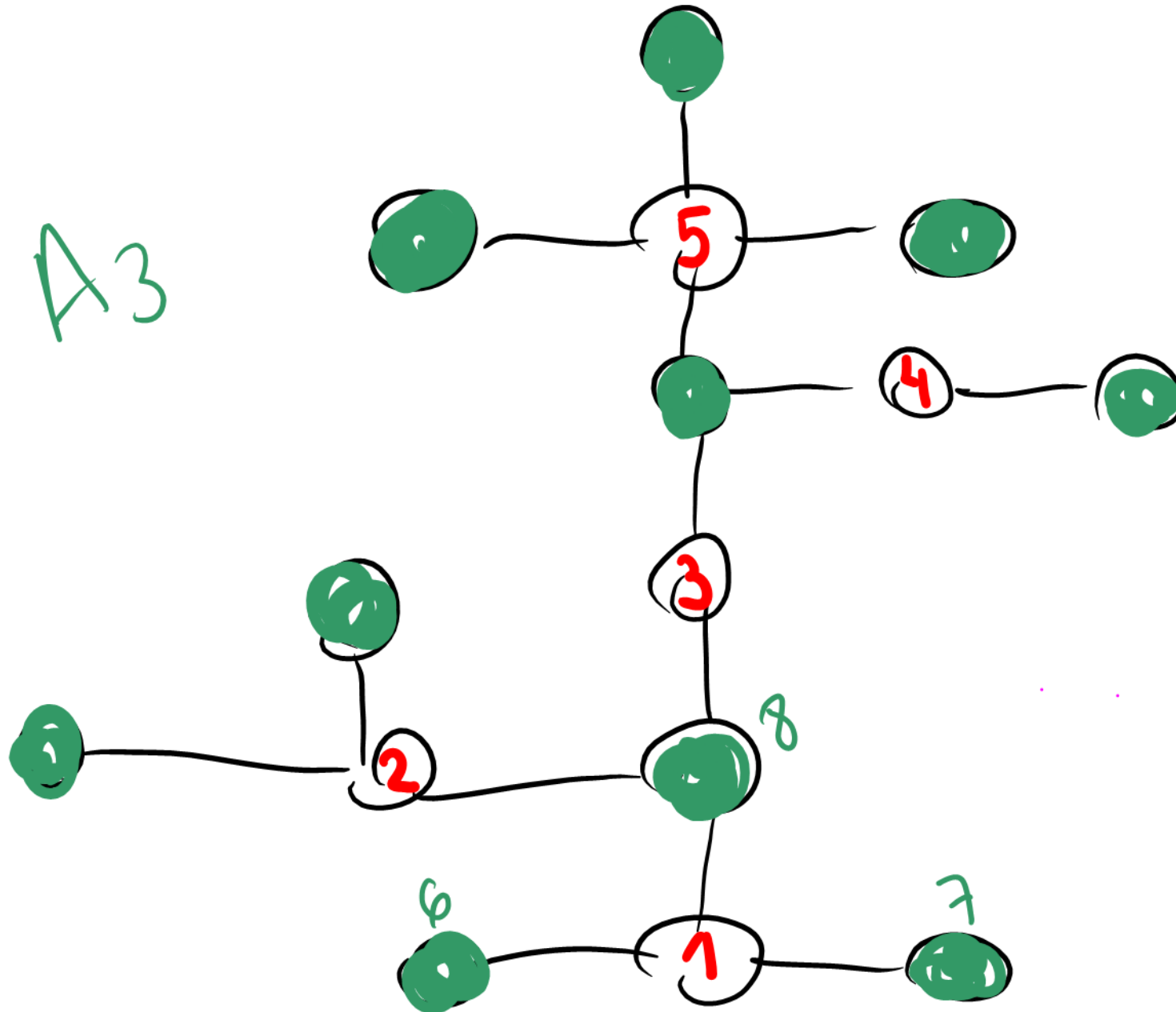
$m(A_3)$

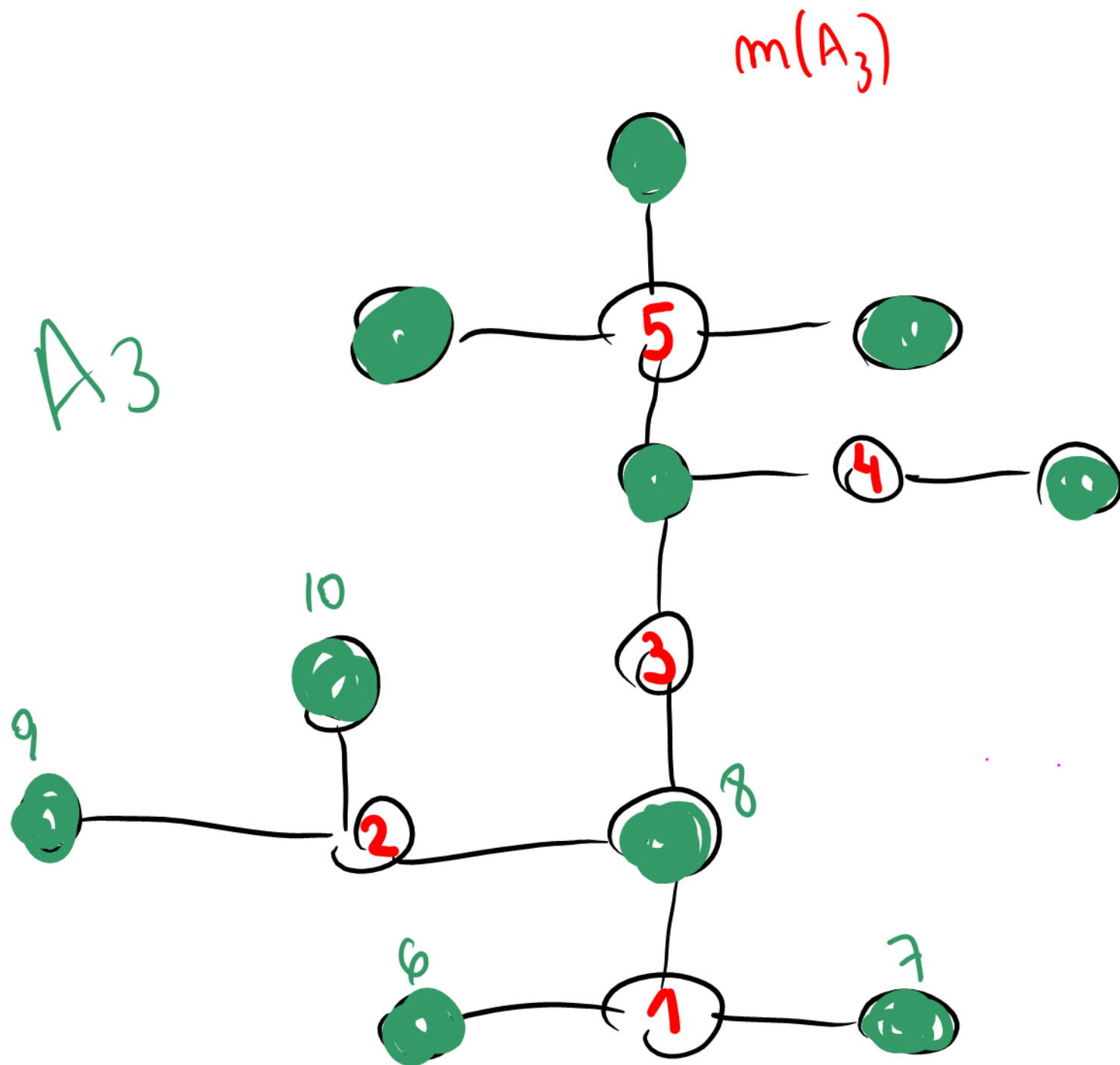
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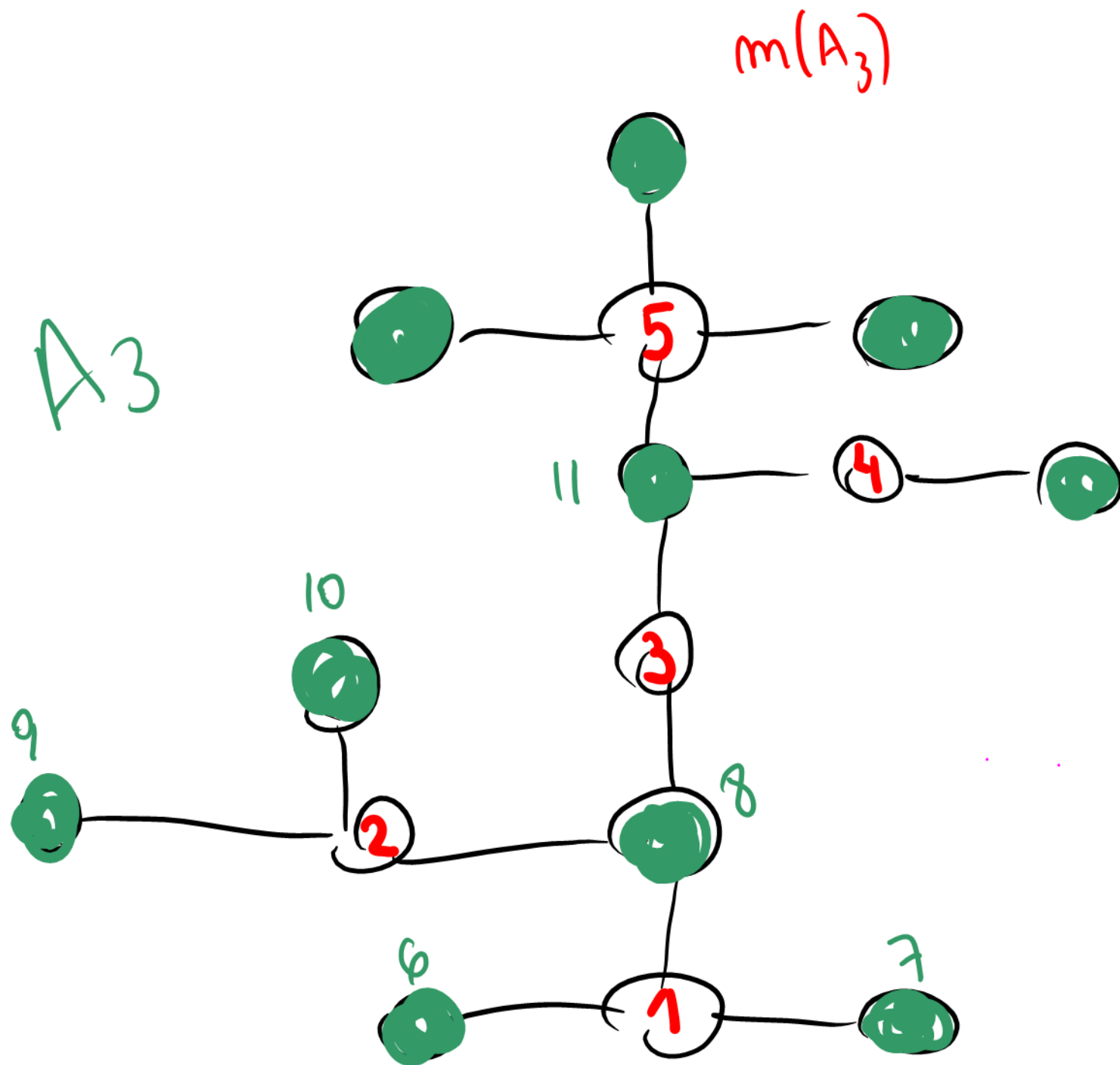


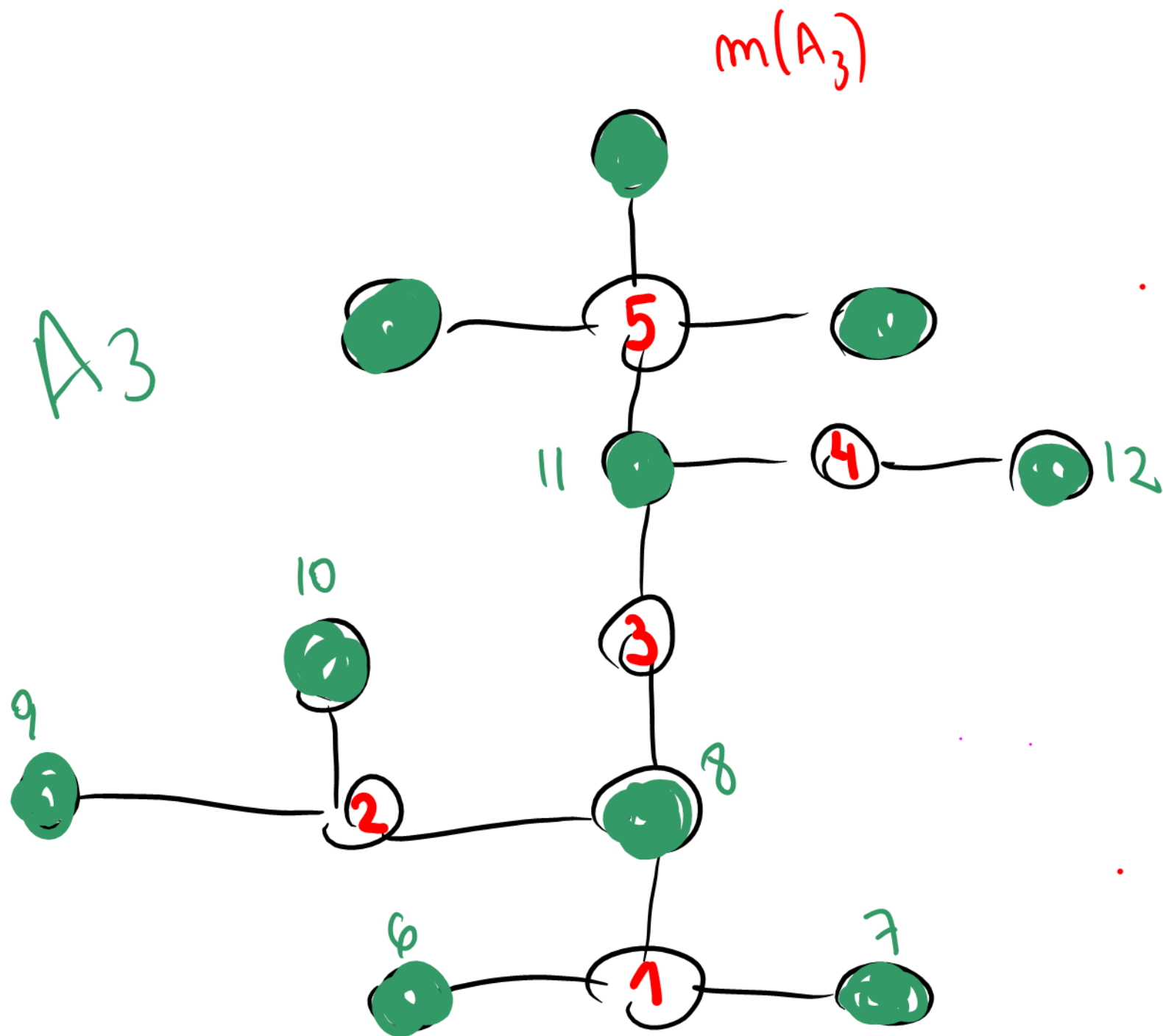
$m(A_3)$

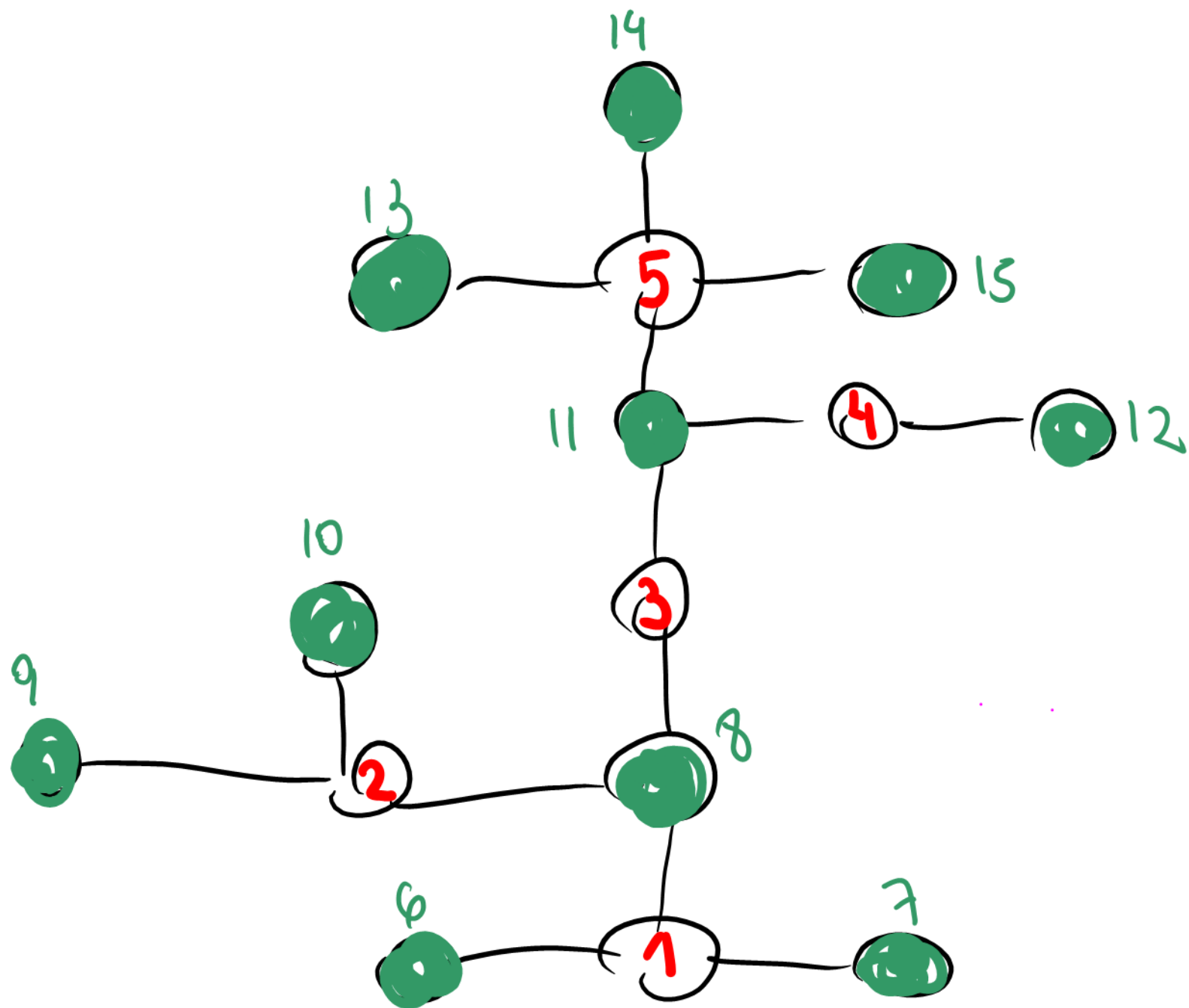
A_3

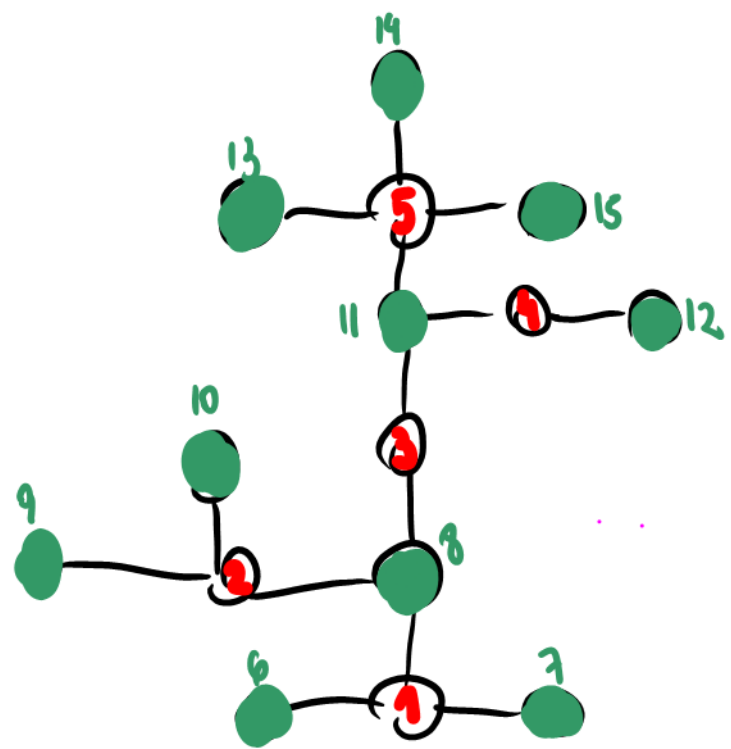








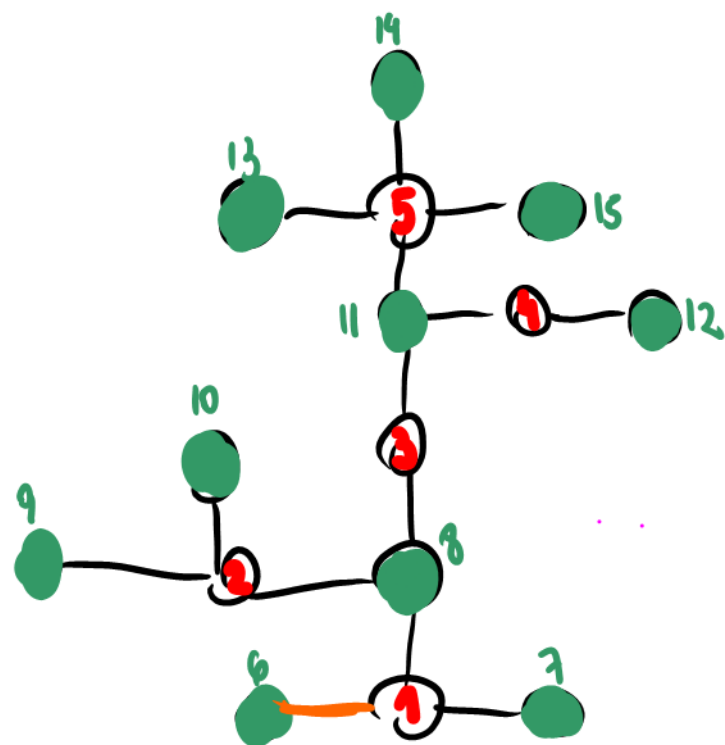






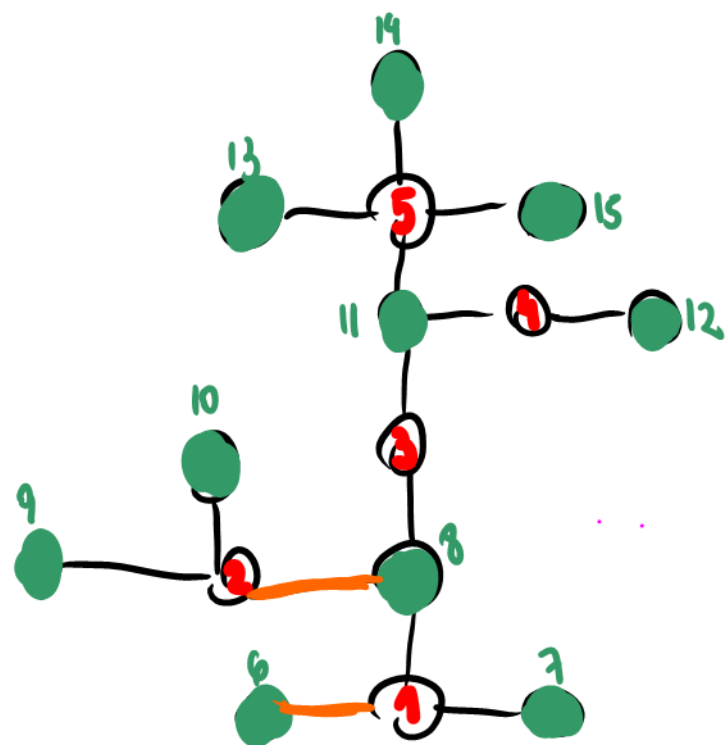
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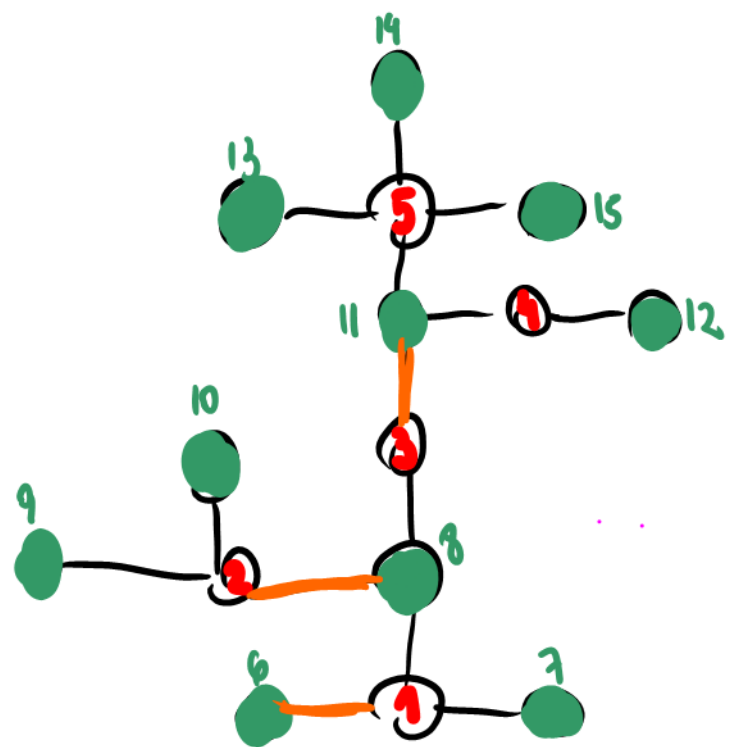
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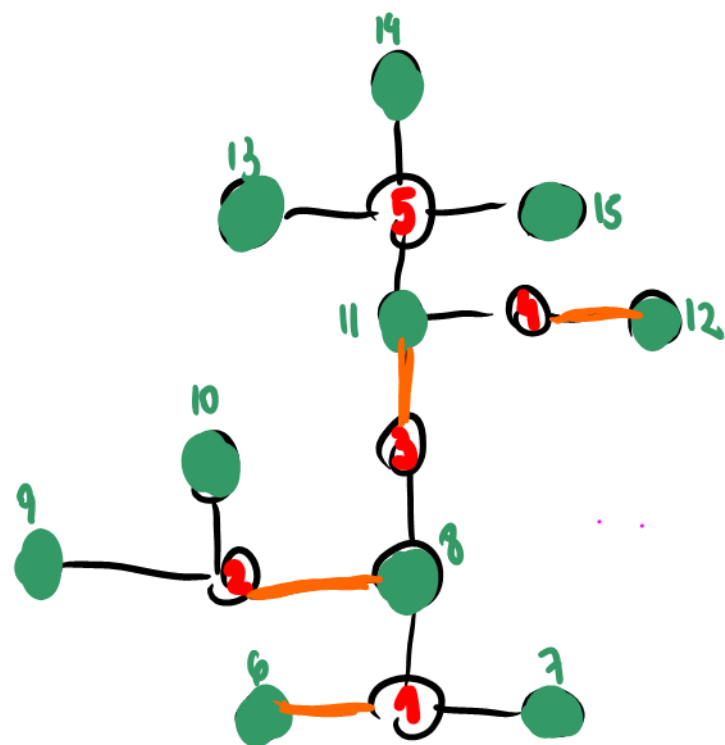
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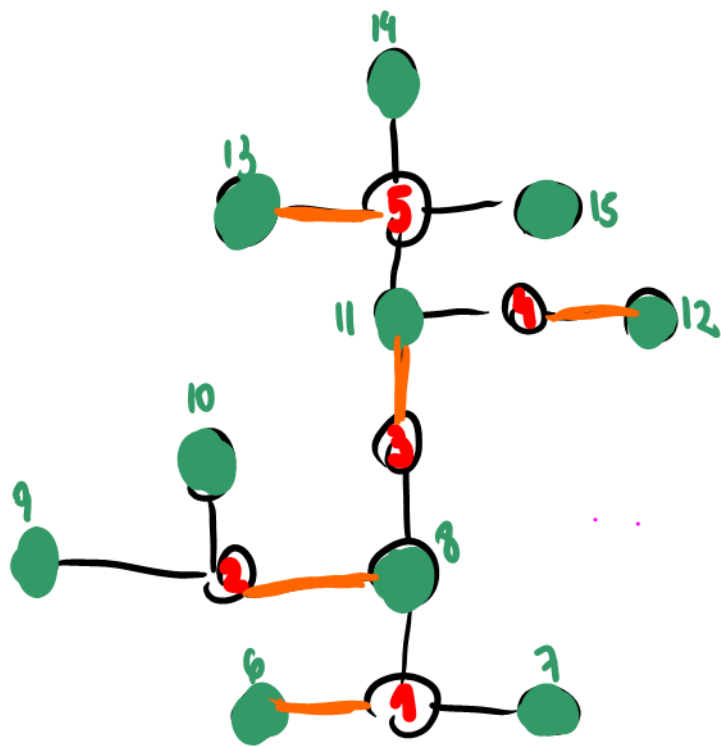
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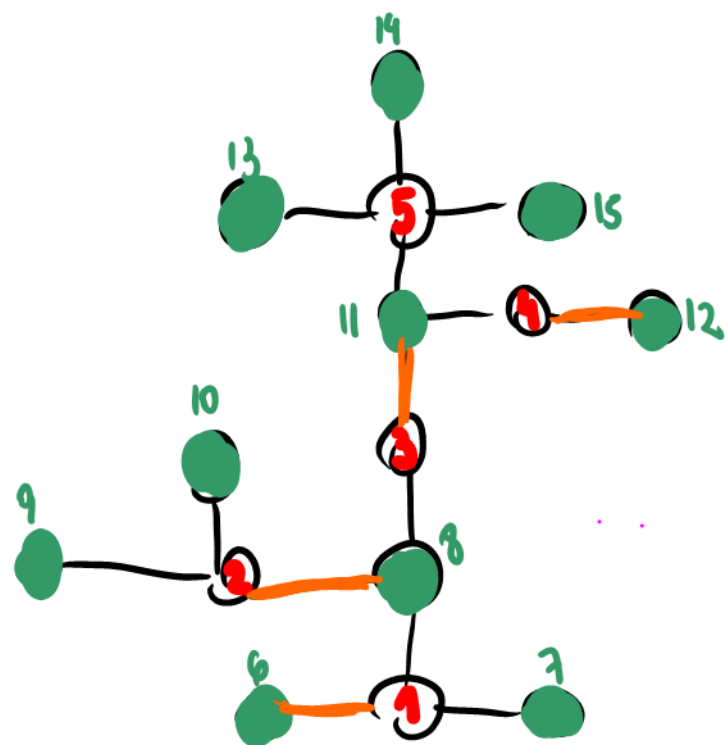
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	1	2	3	4	5
①	6	8	11	12	13



①

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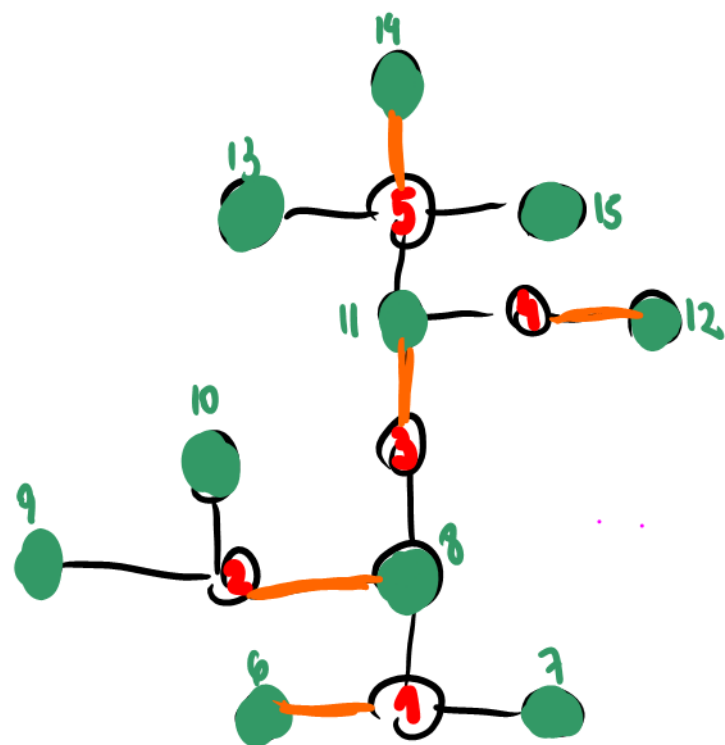
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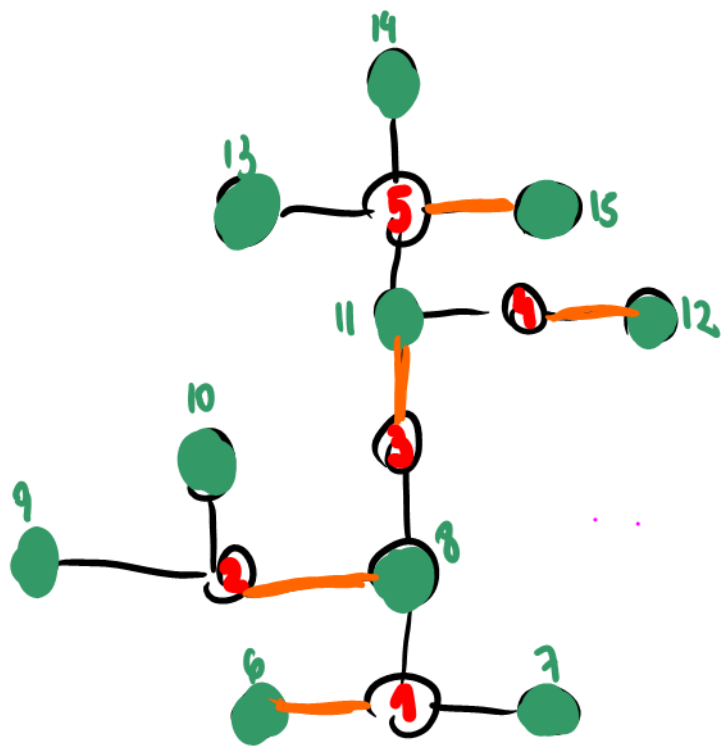
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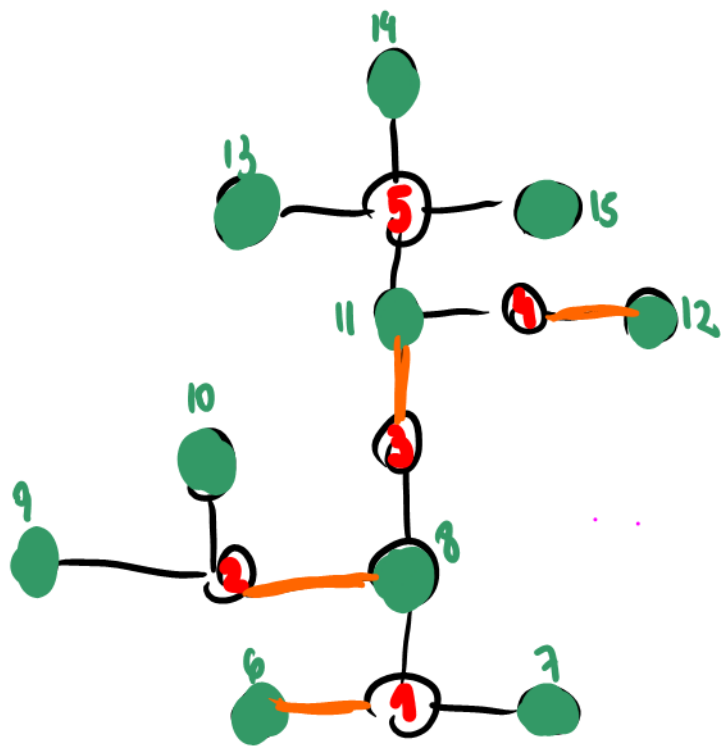
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14



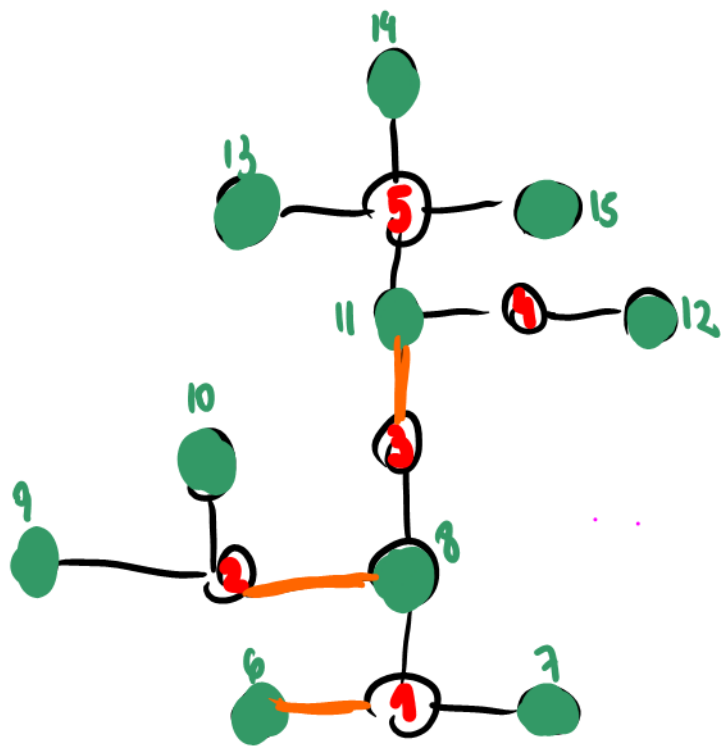
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	1	2	3	4	5
①	6	8	11	12	13
②					14
③					15
④					

Q ← tiene
¿recursos
asportados
no usados?

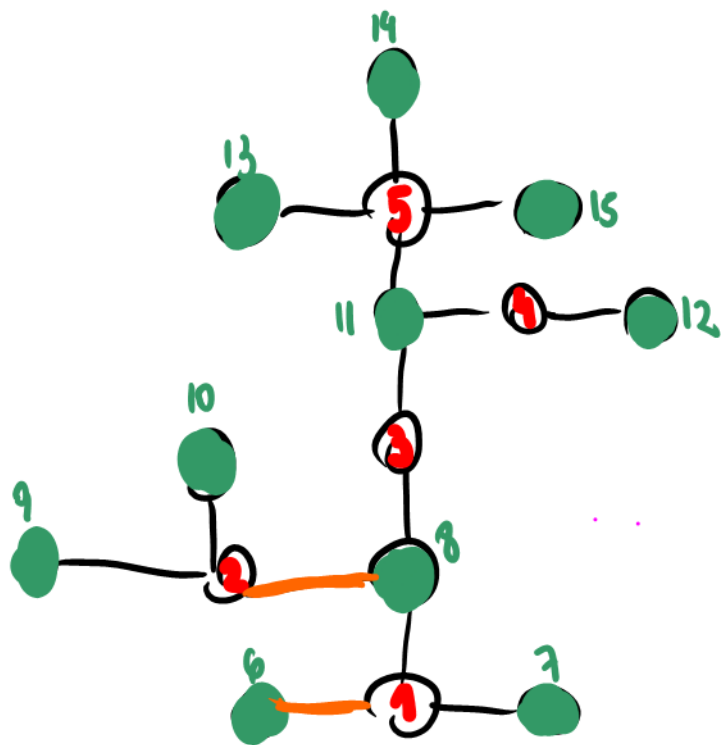


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tiene
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aportados
no usados?

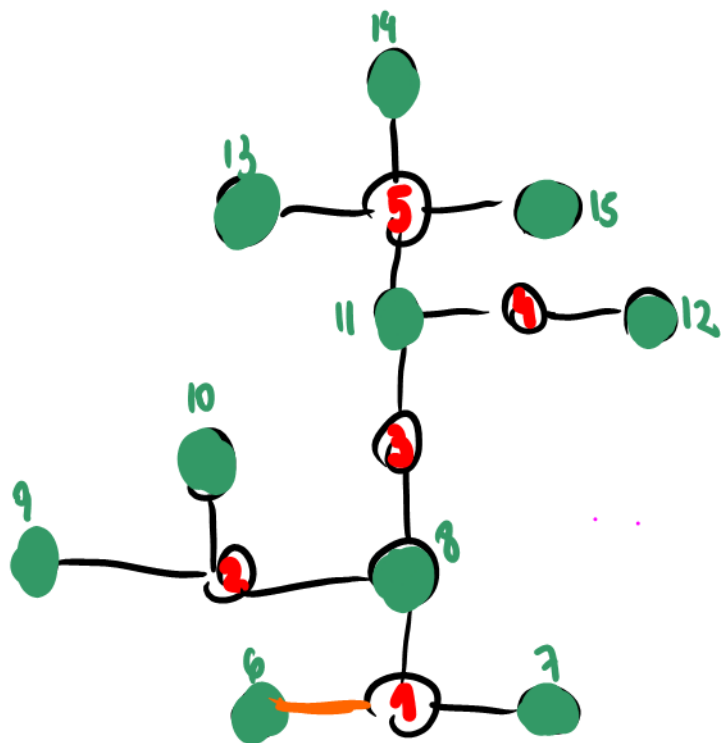


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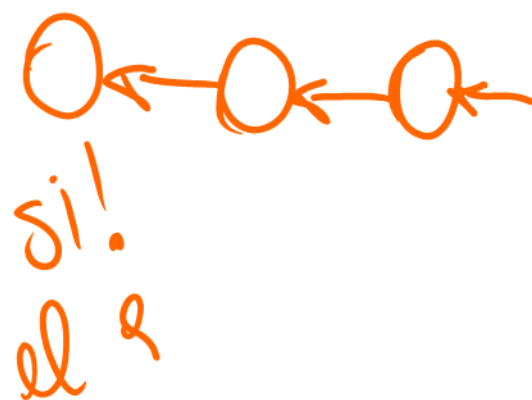


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¿recursos
aportados
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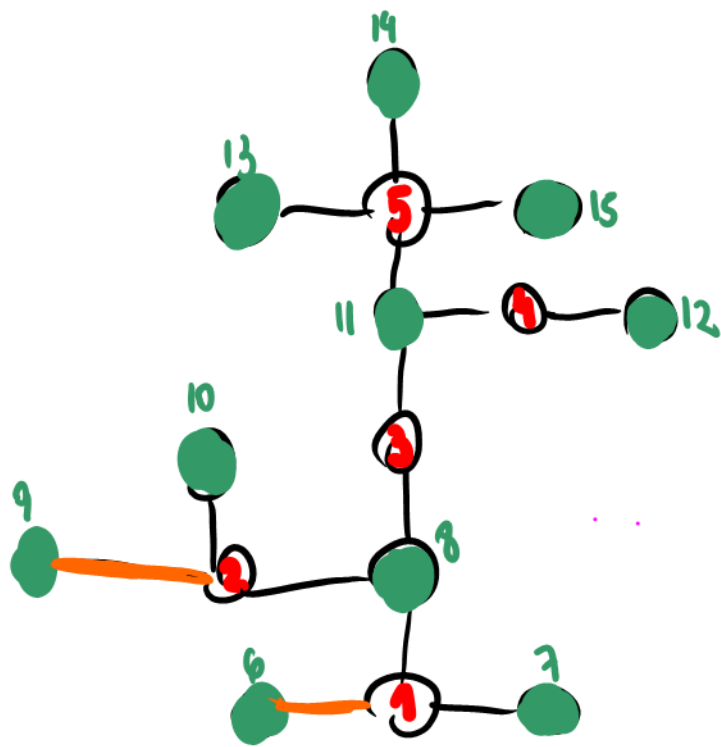


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tiene
¿recimos
aportados
no usados?



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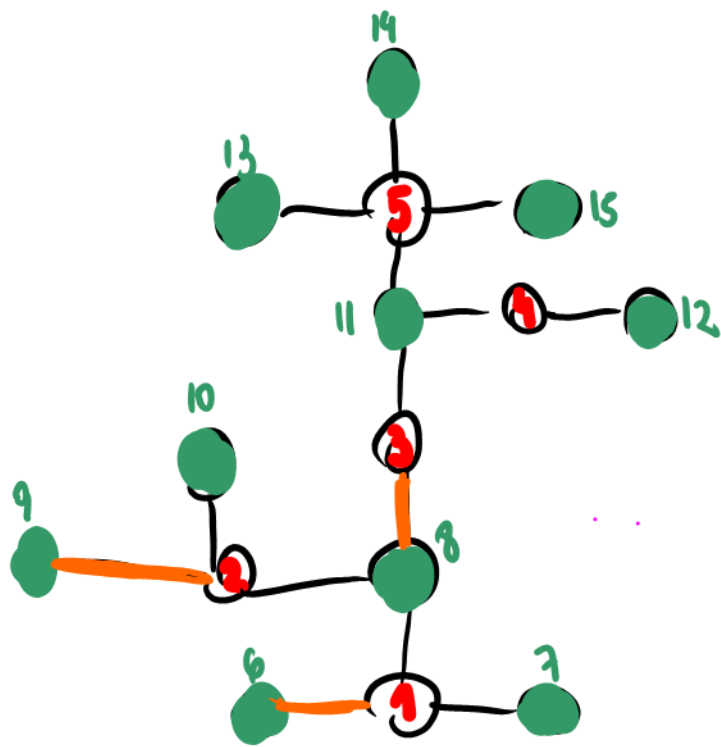
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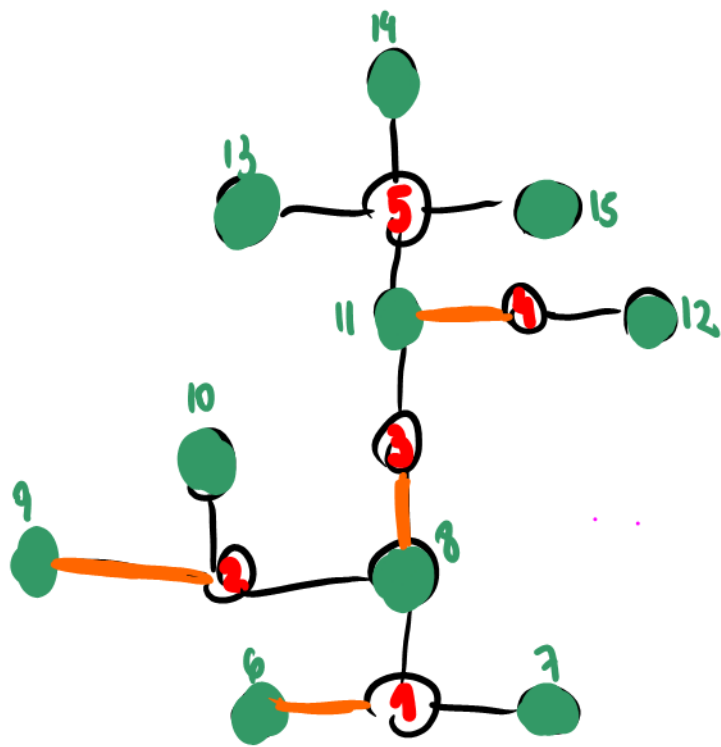
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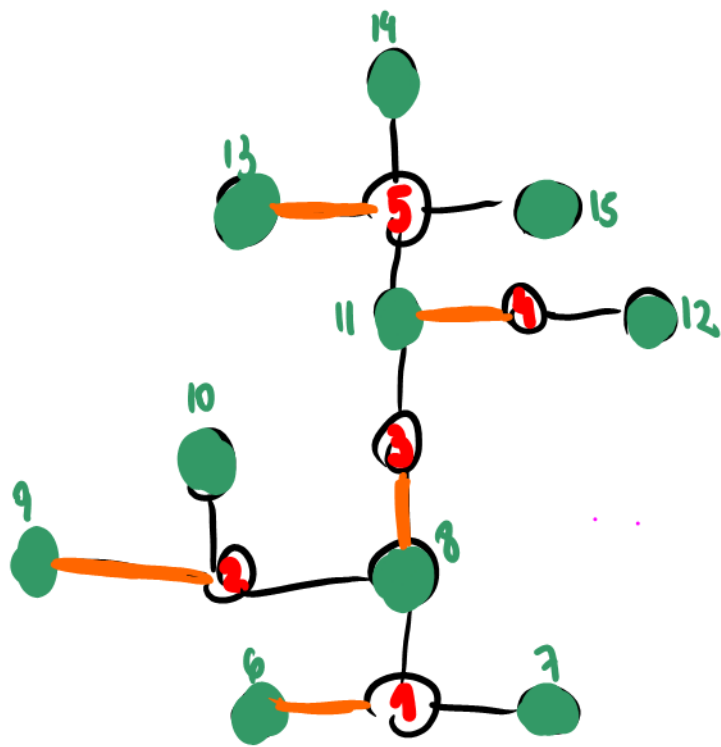
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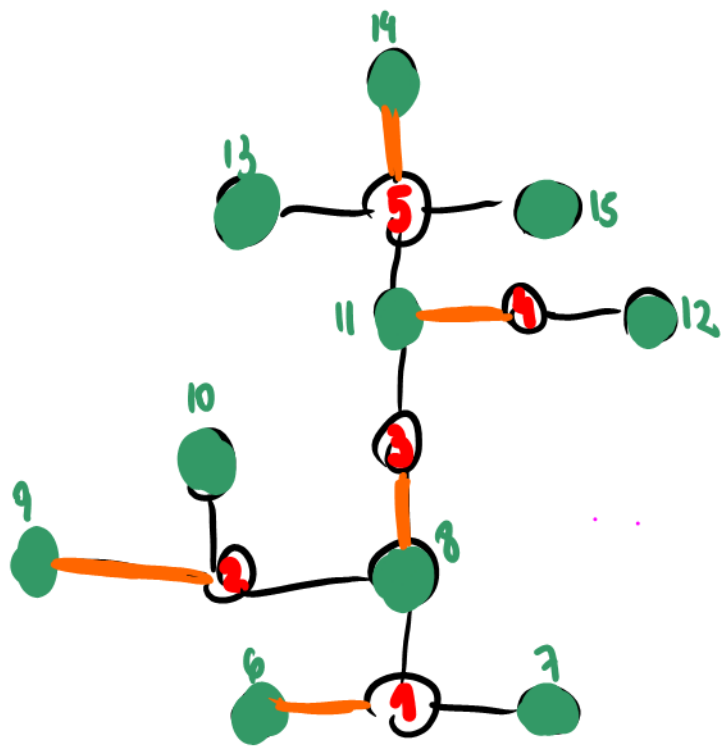
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	9	8	11	



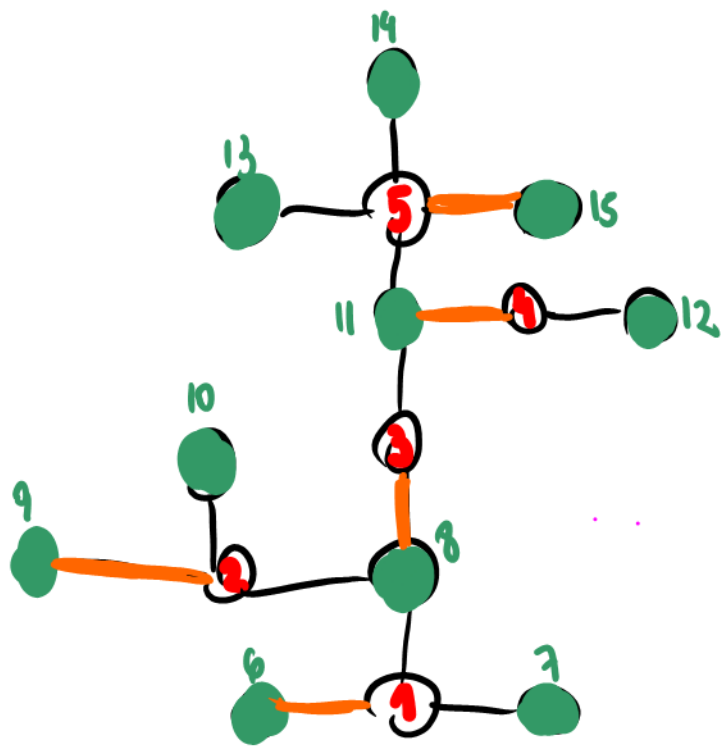
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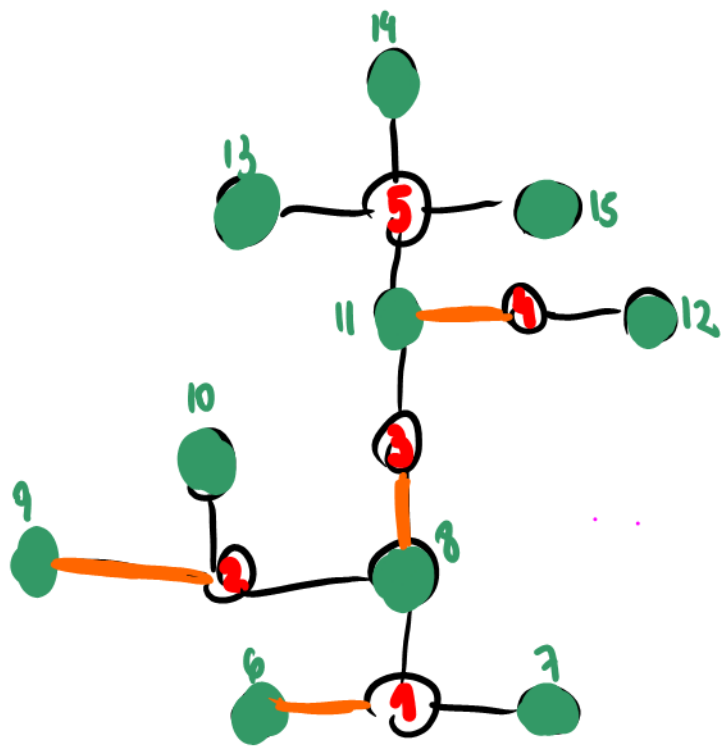
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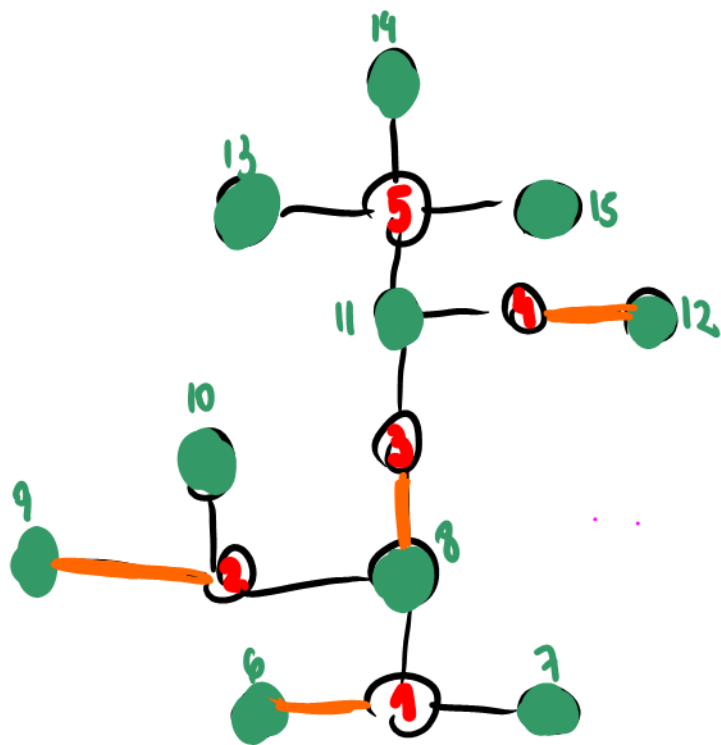
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	9	8	11	13
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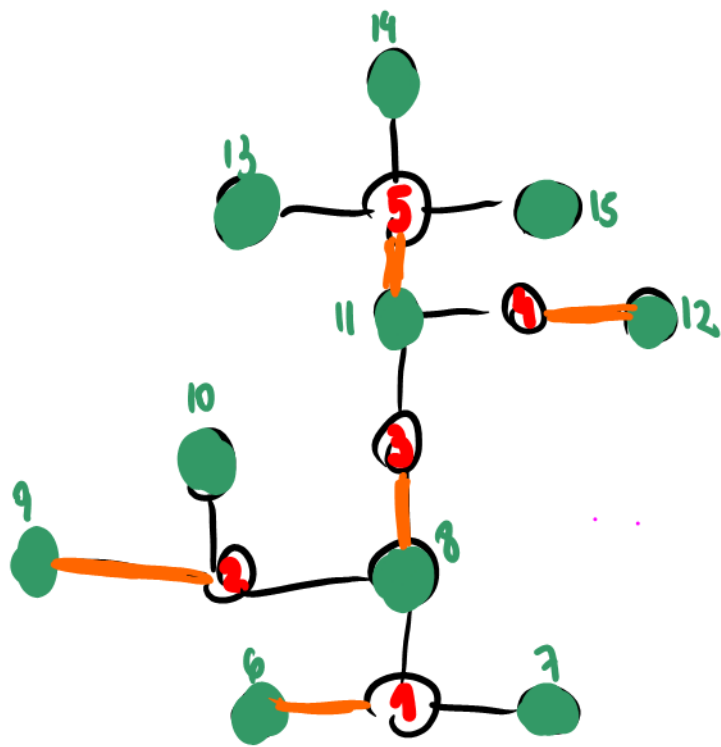
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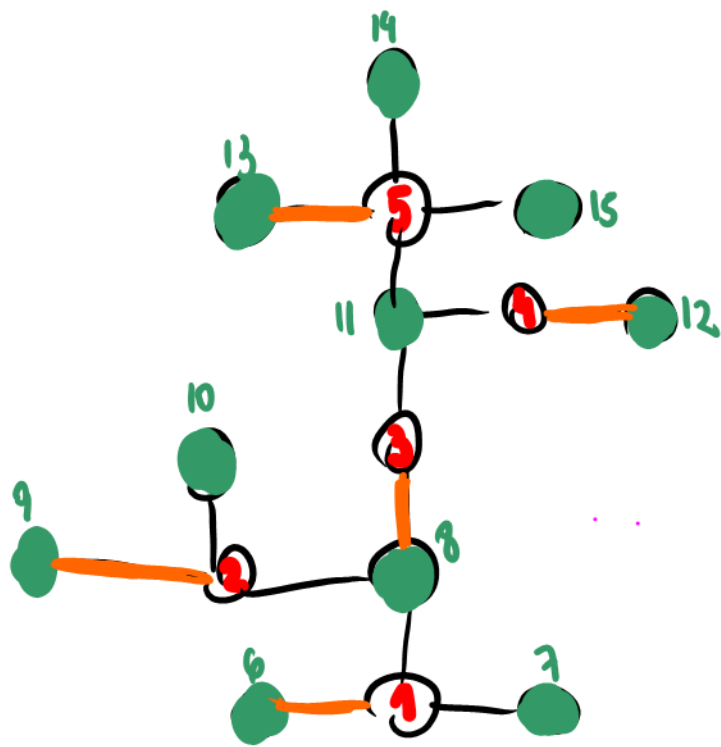
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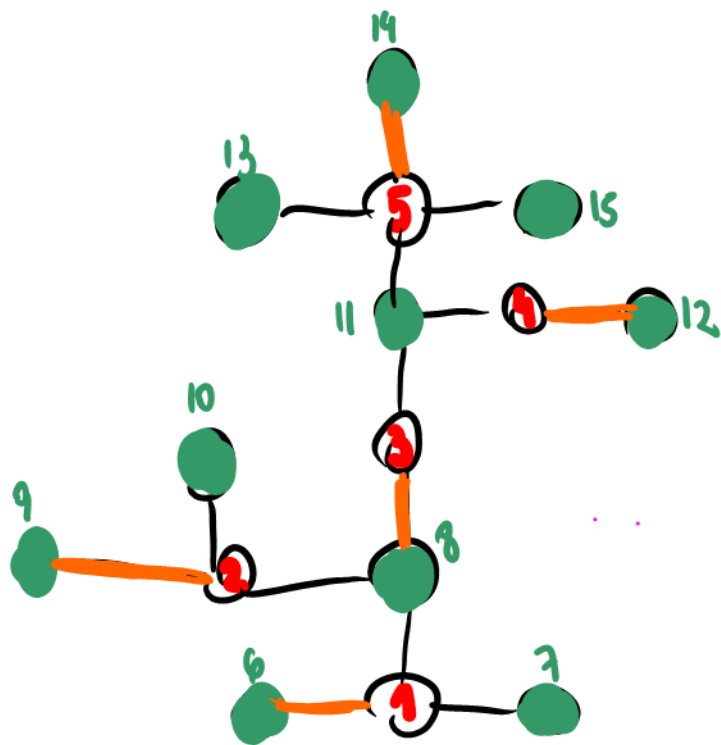


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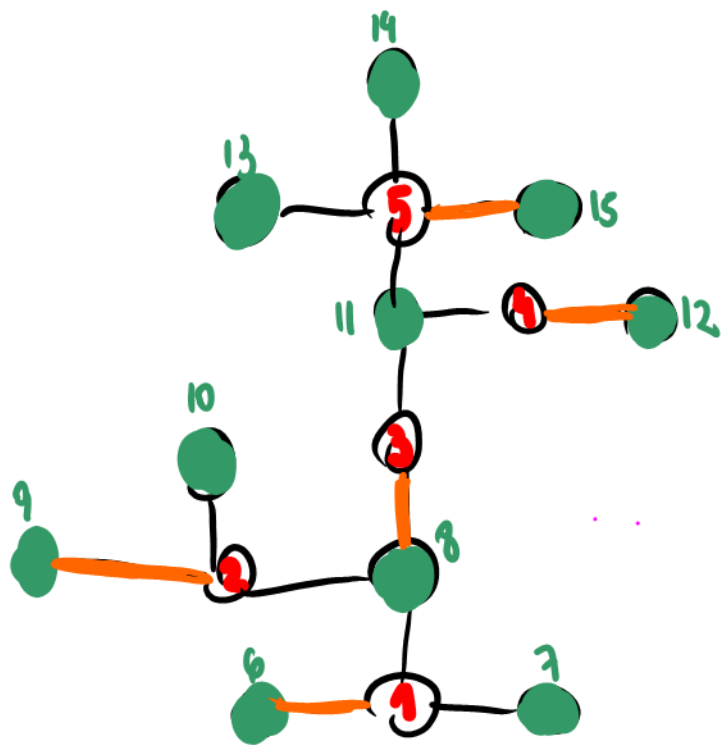
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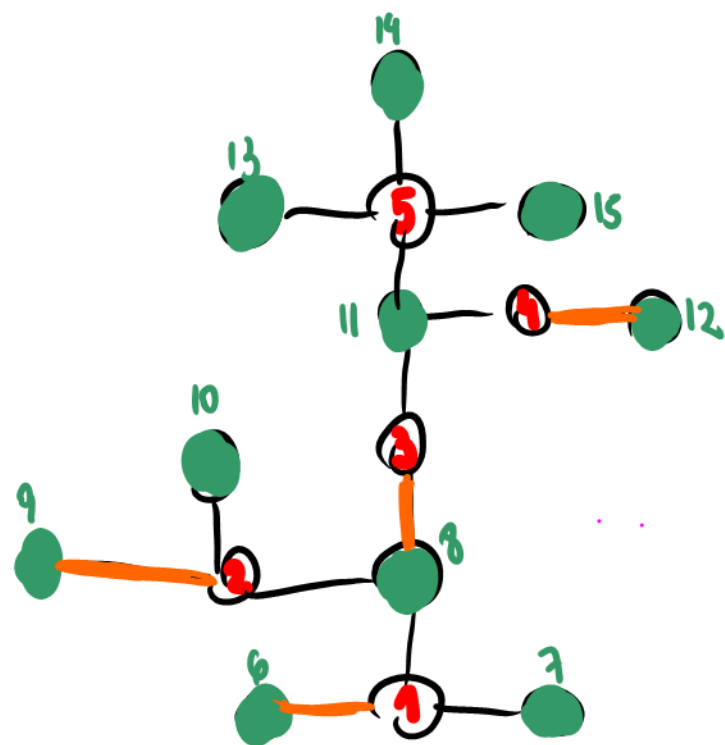
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③		↓			15
④		9	8	11	13
⑤					14
⑥					15
⑦				12	11
⑧					13



	1	2	3	4	5
①	6	8	11	12	13
②		↓			14
③		↓			15
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⑥					15
⑦				12	11
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⑨					14

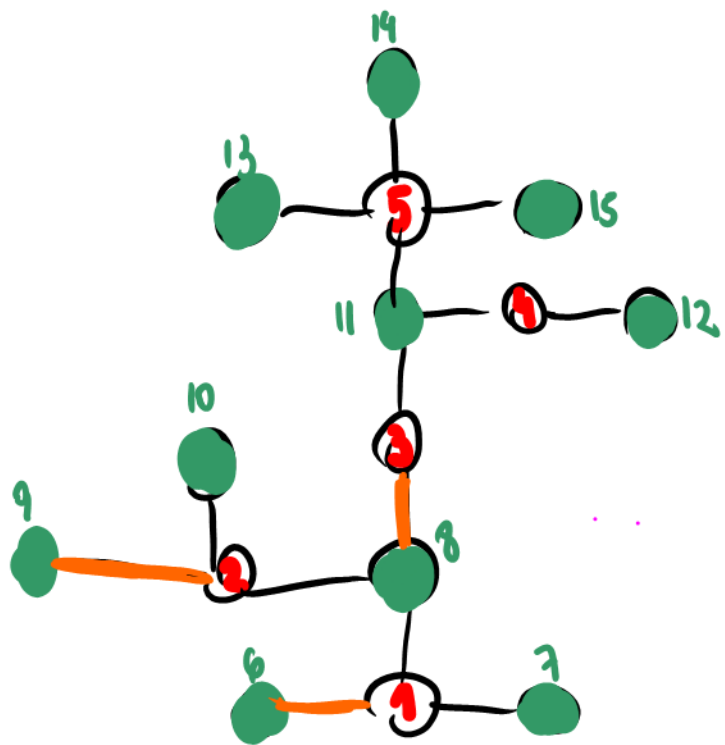


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③		↓			15
④		9	8	11	13
⑤					14
⑥					15
⑦				12	11
⑧					13
⑨					14
⑩					15



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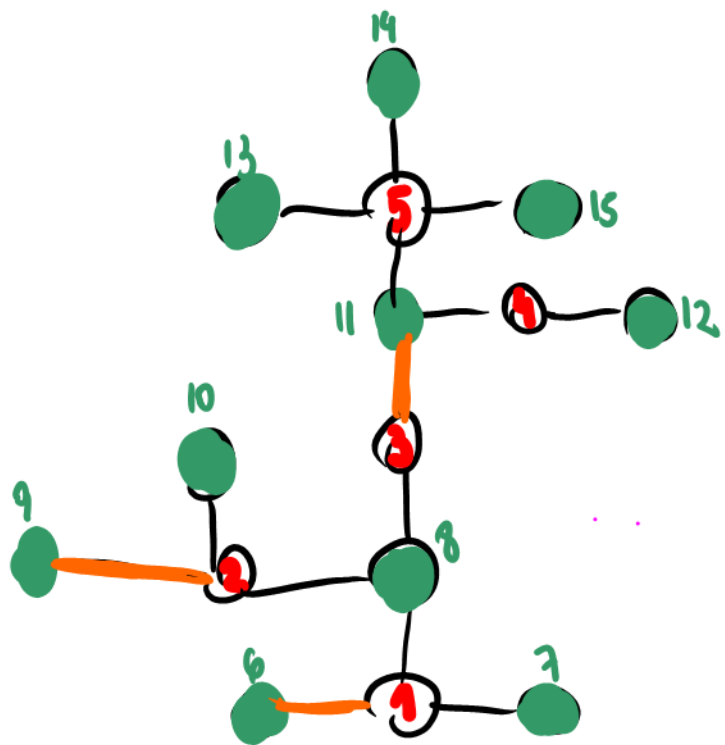
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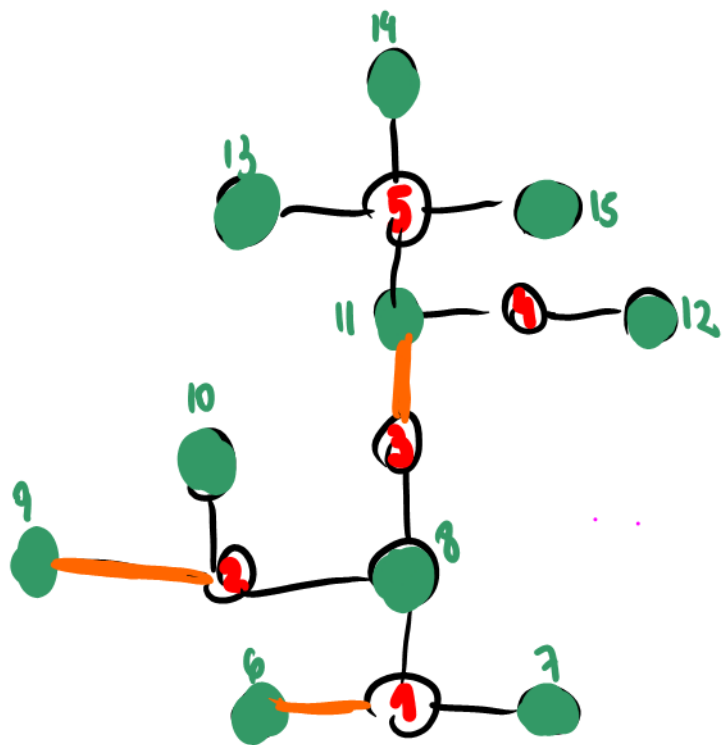
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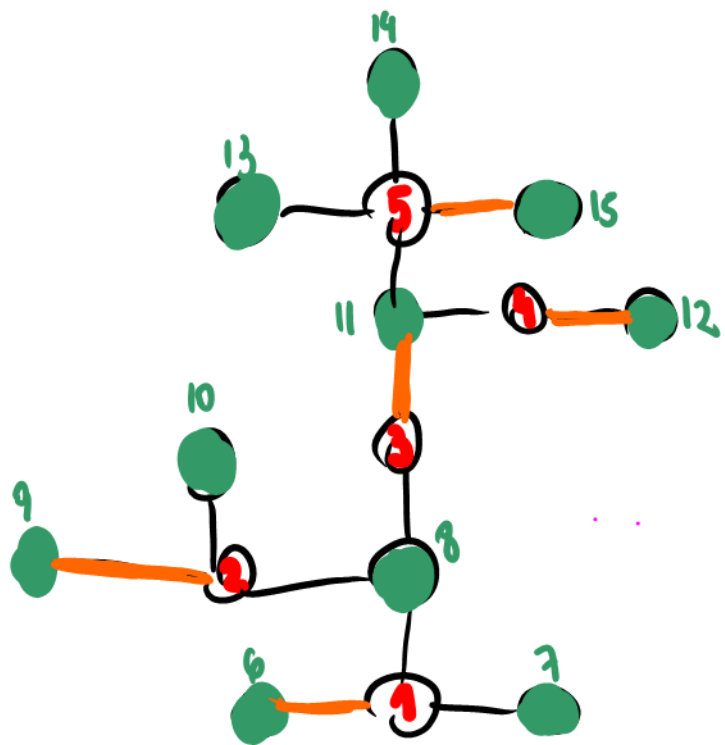




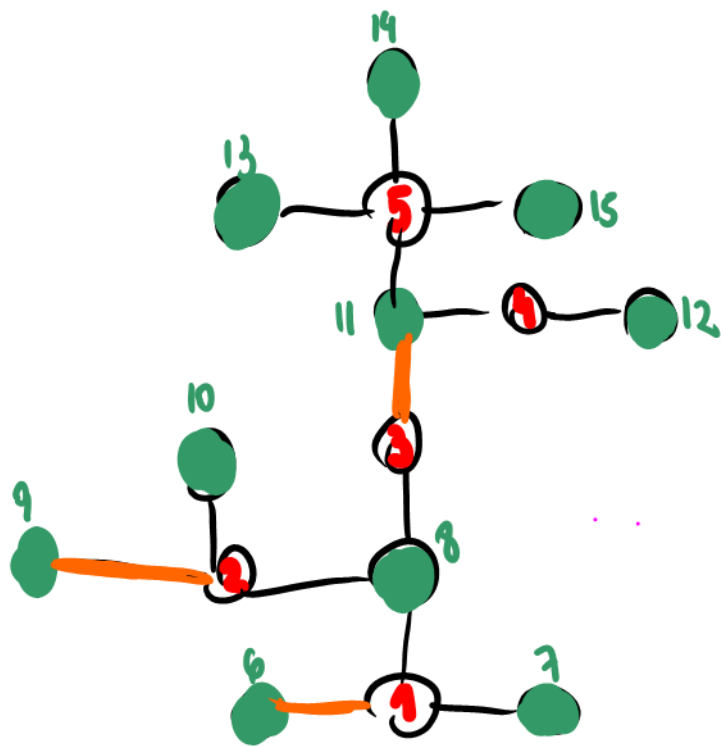
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⑩			5		15
⑪			11		



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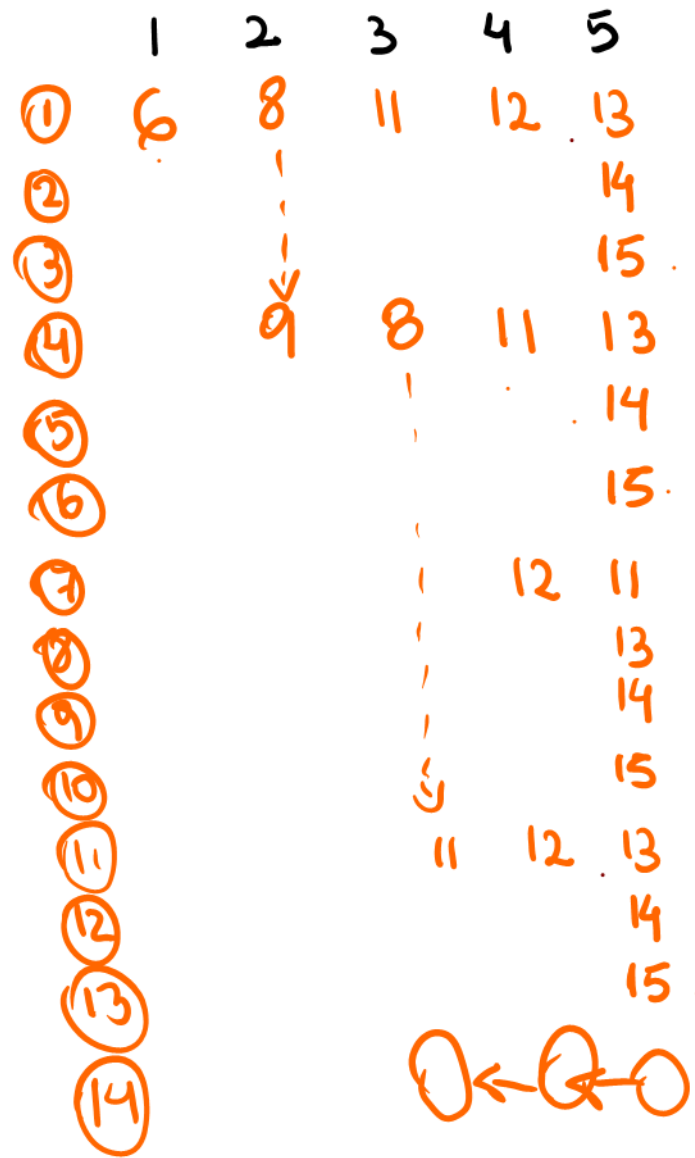


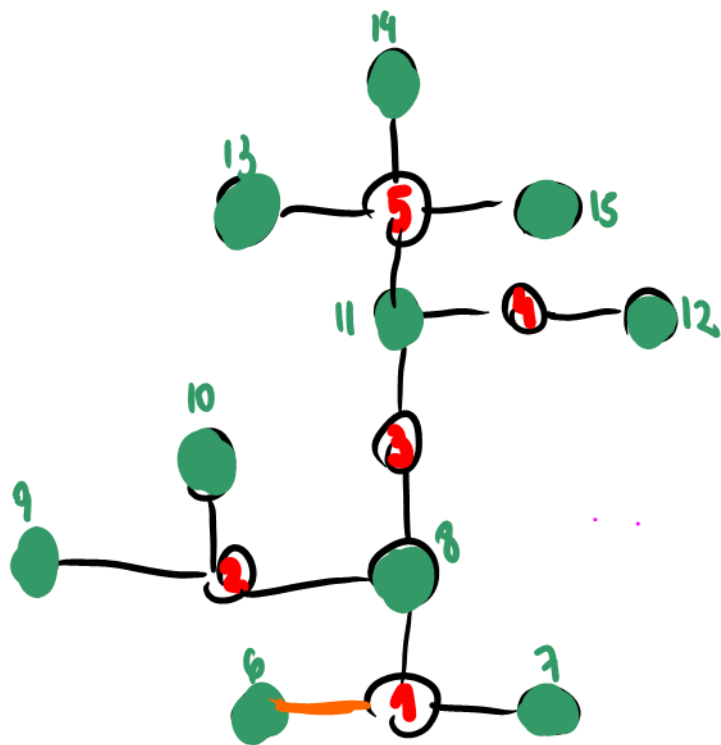
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⑥					15
⑦				12	11
⑧					13
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⑩			9		15
⑪			11	12	13
⑫					14
⑬					15



	1	2	3	4	5
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②		8			14
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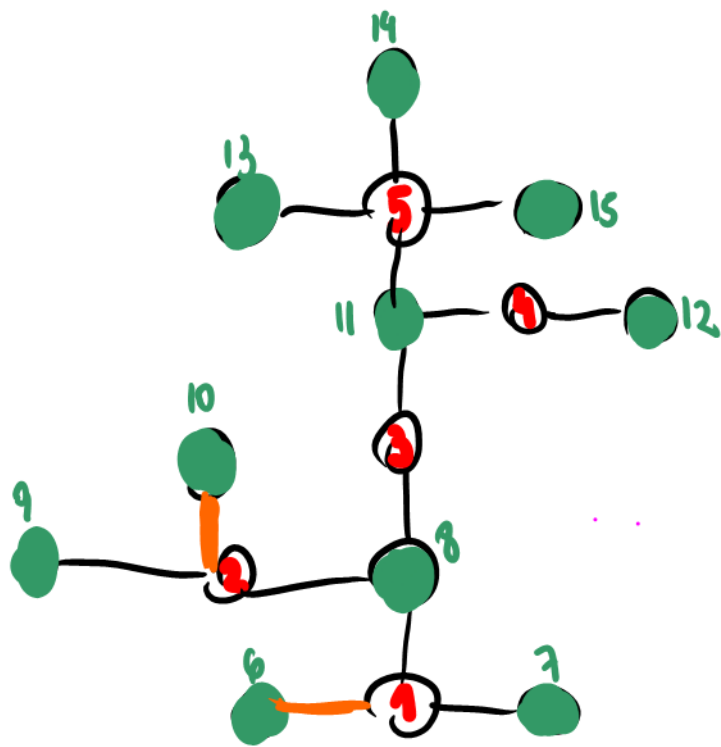
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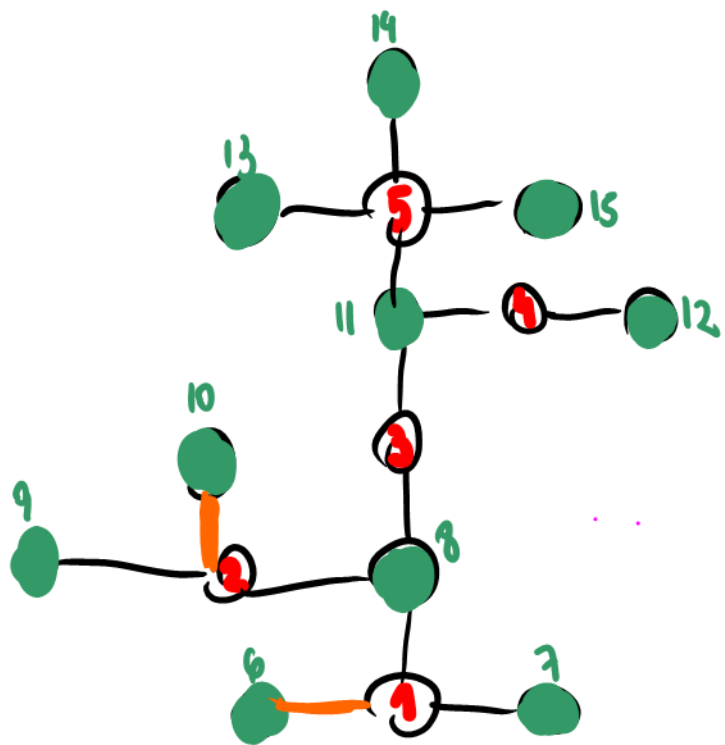


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⑧			↓		13
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⑭					

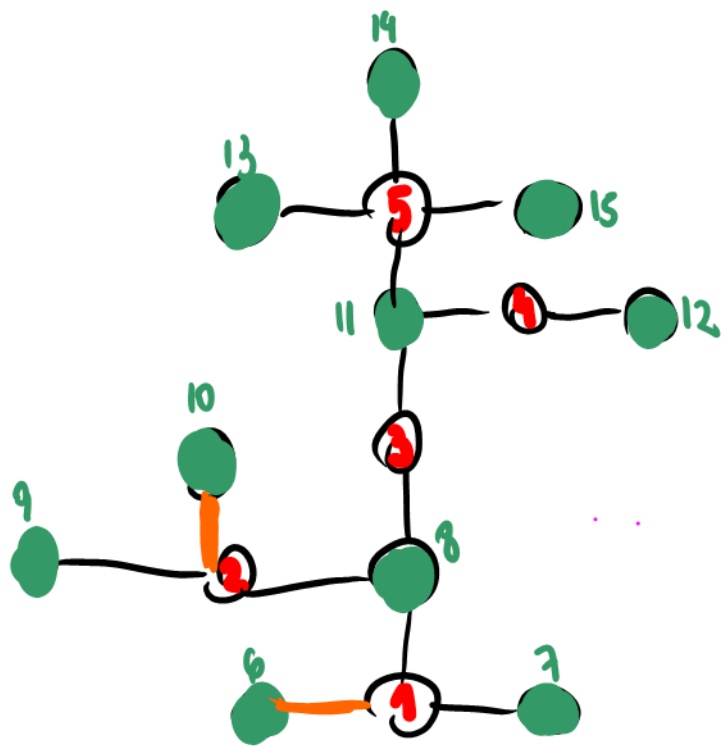
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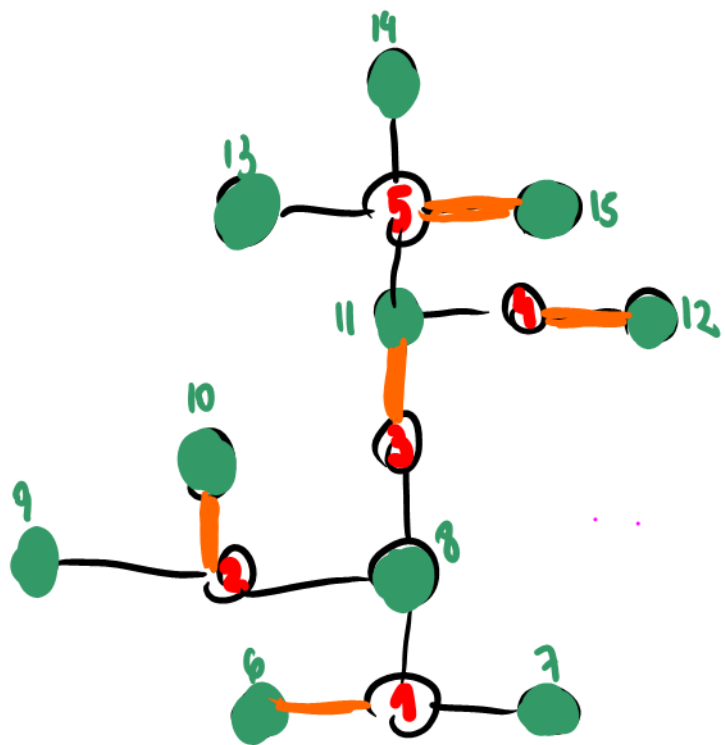
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⑤		↓	↓		14
⑥		↓	↓		15
⑦		↓	↓	12	11
⑧		↓	↓		13
⑨		↓	↓		14
⑩		↓	↓		15
⑪		↓	↓	11	12
⑫		↓	↓		13
⑬		↓	↓		14
⑭		↓	↓		15
⑮		↓	↓		



	1	2	3	4	5
①	6	8	11	12	13
②					14
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④		9	8	11	13
⑤					14
⑥					15
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⑧					13
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⑮					

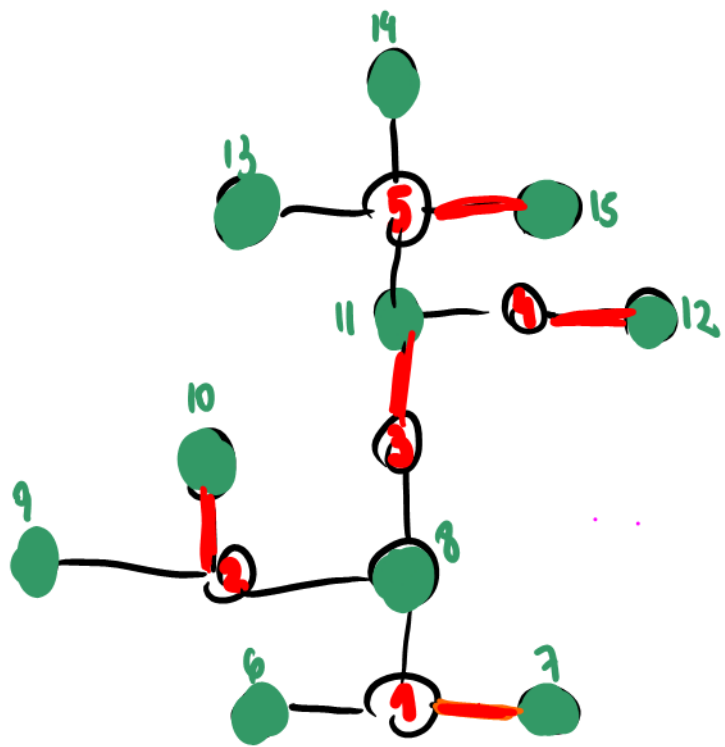


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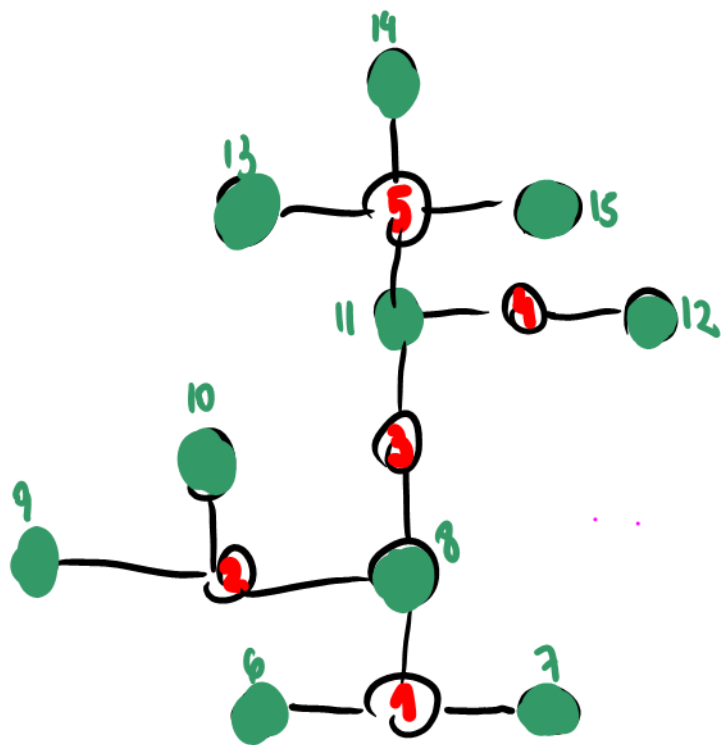


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⑫			11	12	13
⑬					14
⑭		10	8	11	13
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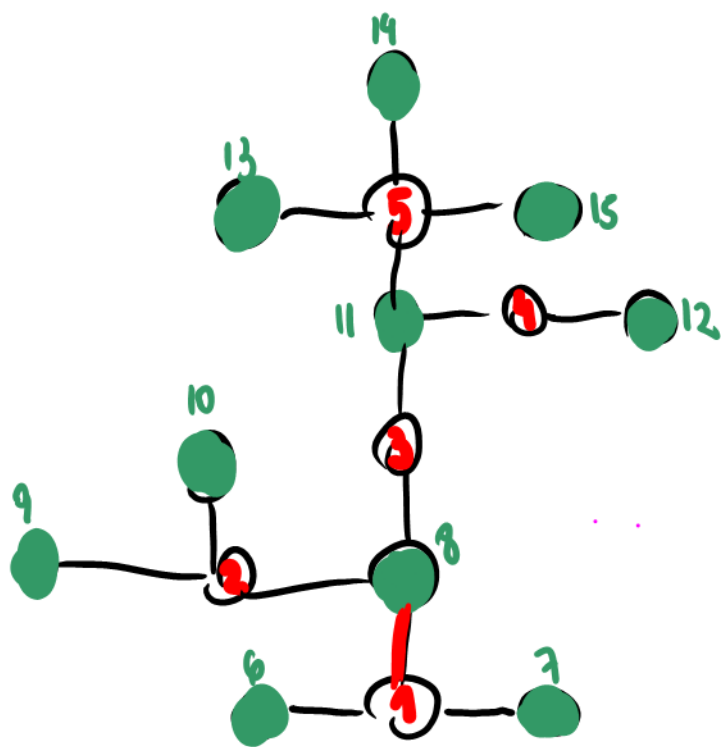
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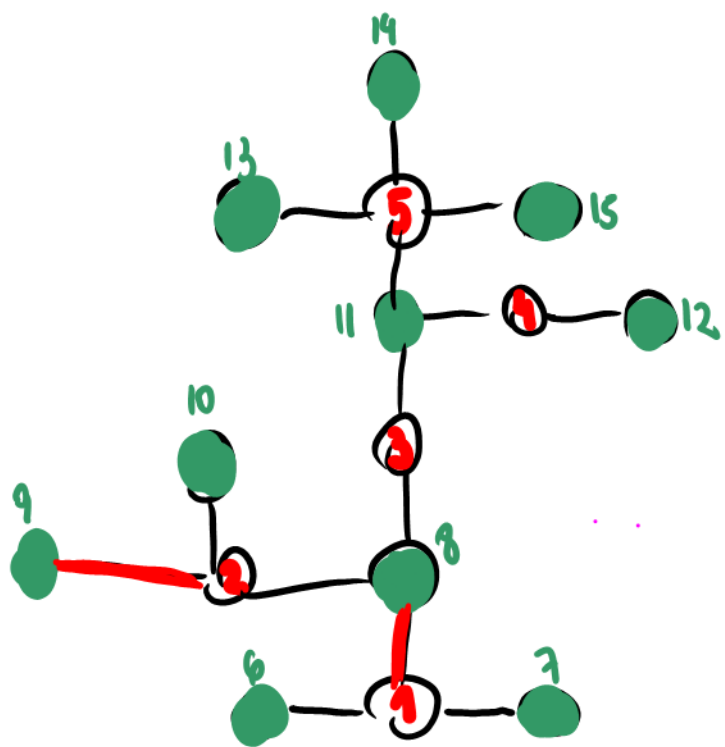
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④		8	8	11	13			8	8	11	13
⑤					14						14
⑥					15						15
⑦				12	11					12	11
⑧					13						13
⑨					14						14
⑩					15						15
⑪			6		15				6		15
⑫			"	12	13				"	12	13
⑬					14						14
⑭					15						15
⑮		10	8	11	13			10	8	11	13
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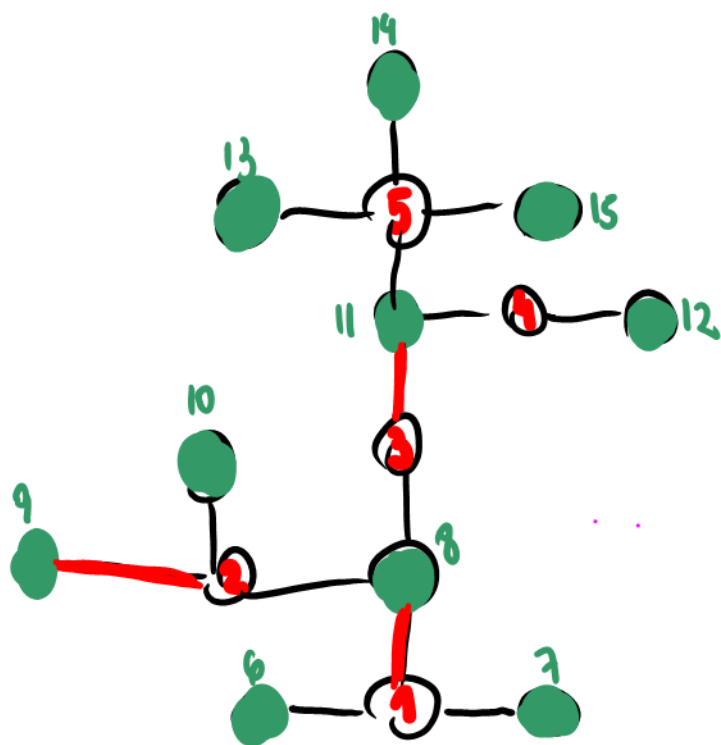
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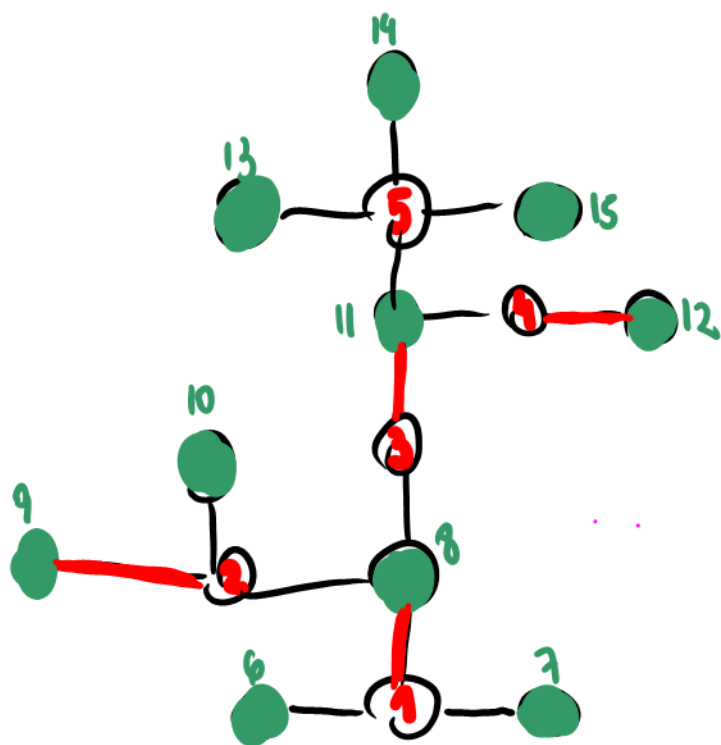
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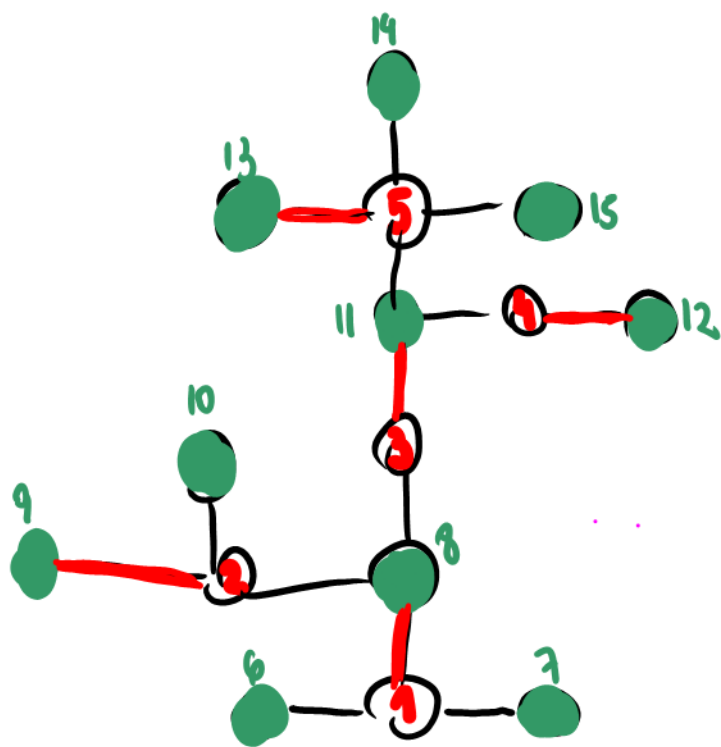
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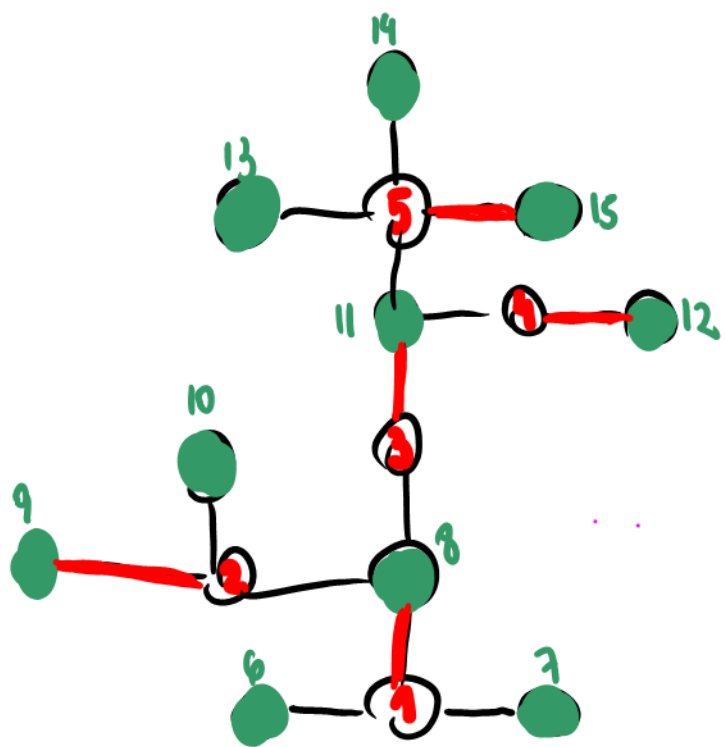
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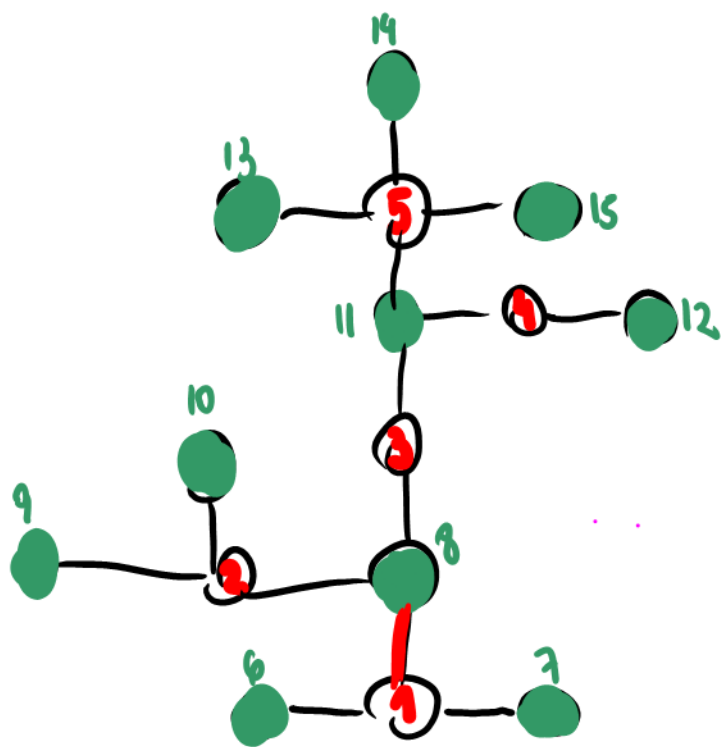
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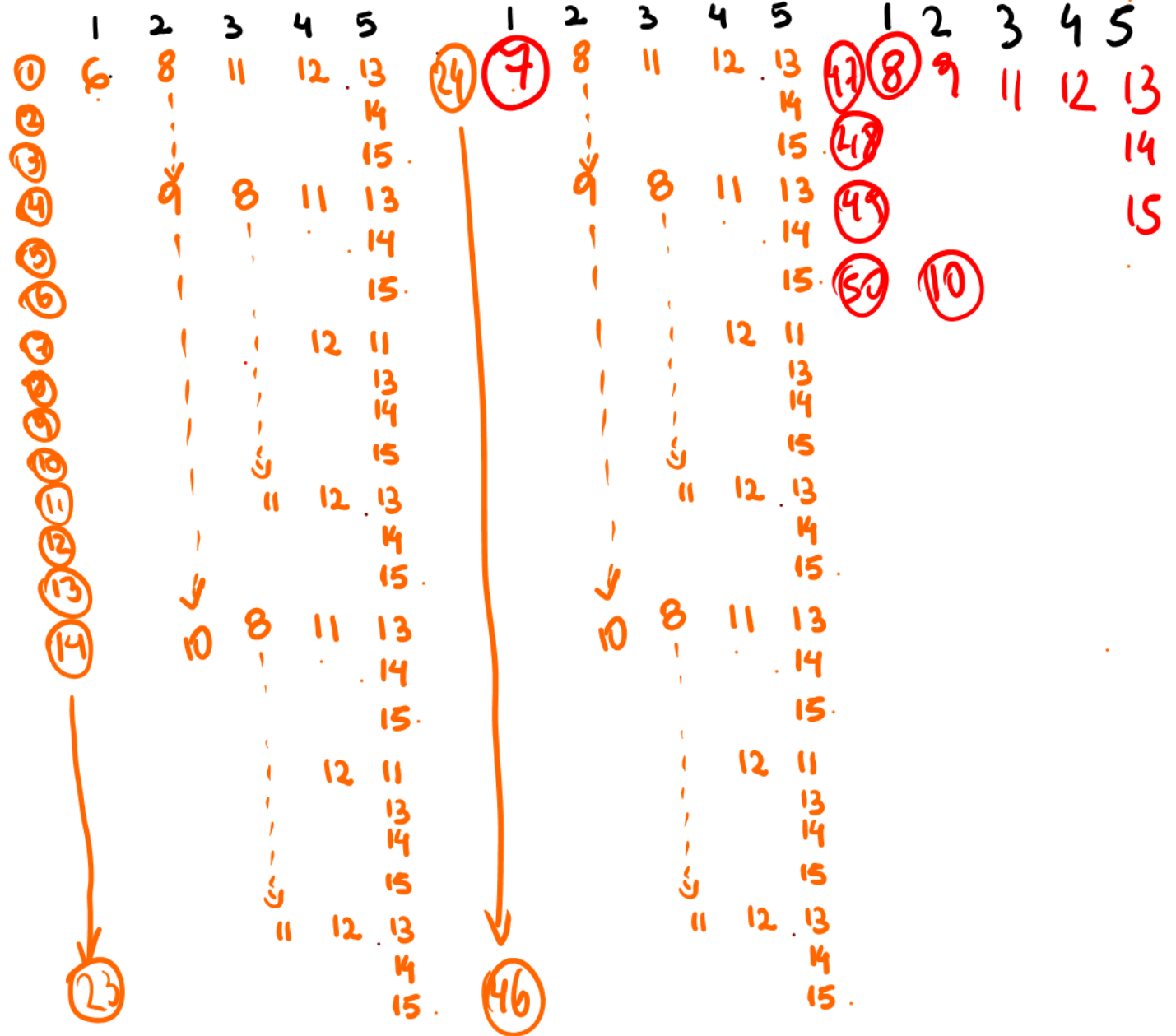
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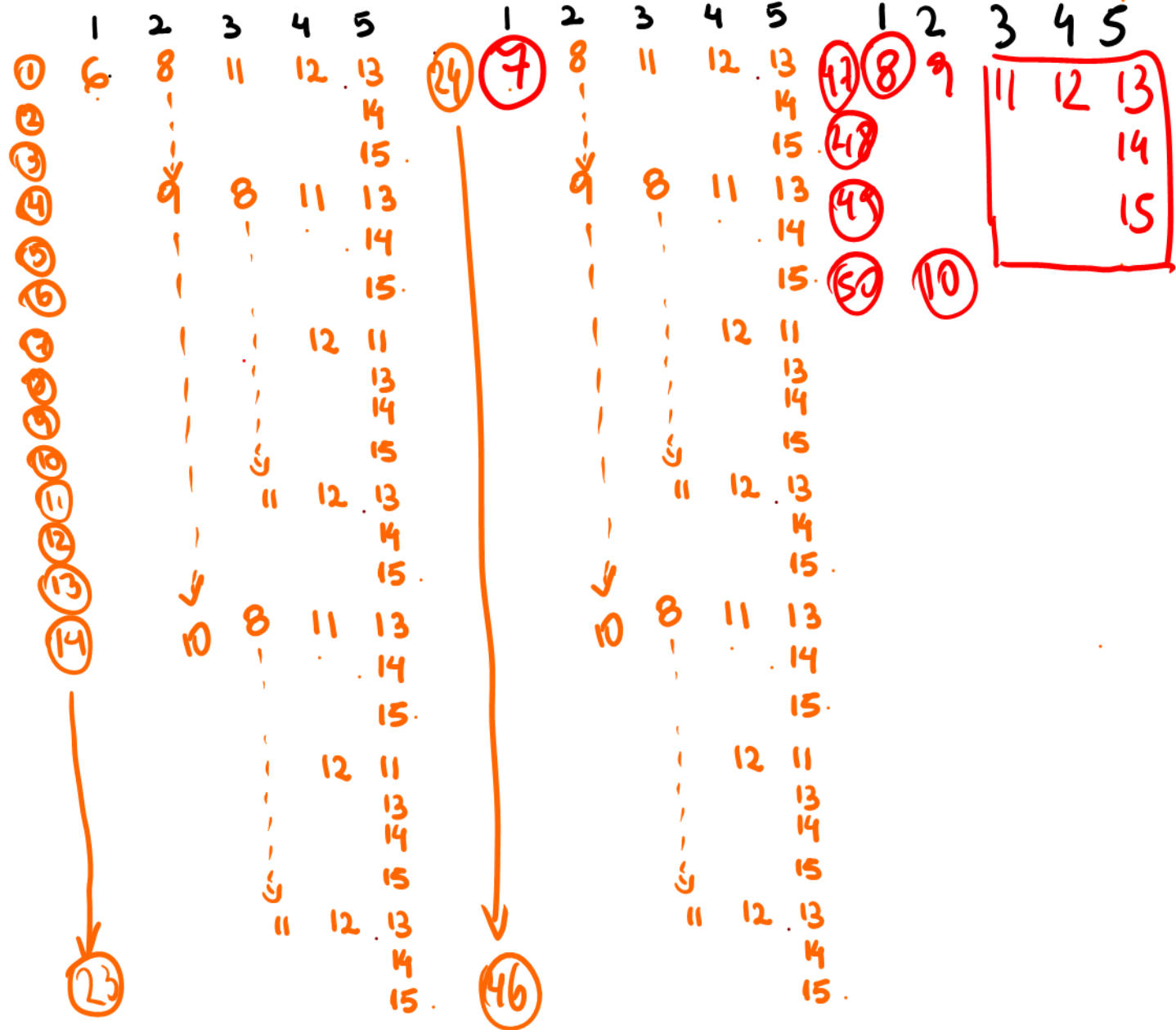


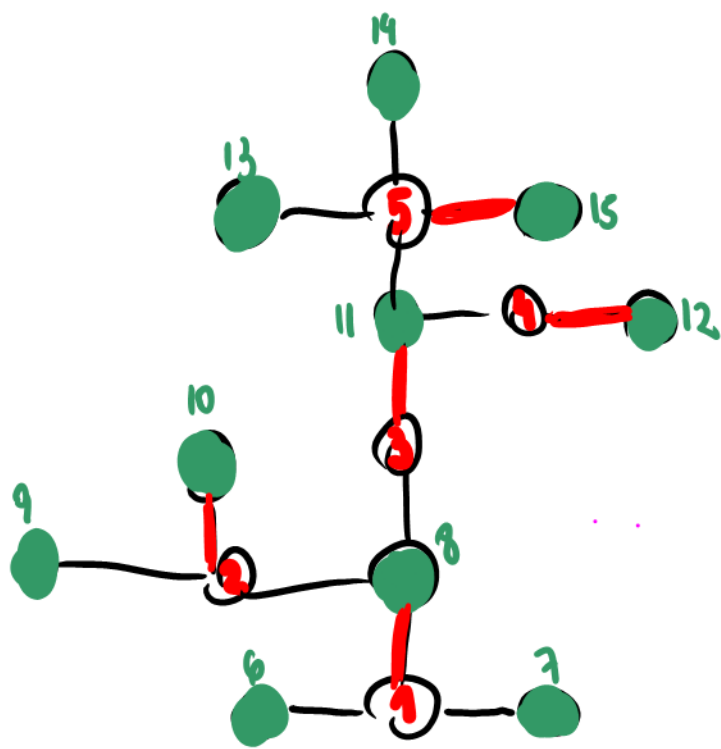
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㊳					14					14					
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㊹			6		15										
㊺			11	12	13				11	12	13				
㊻					14					14					
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㊽			8	11	13				8	11	13				
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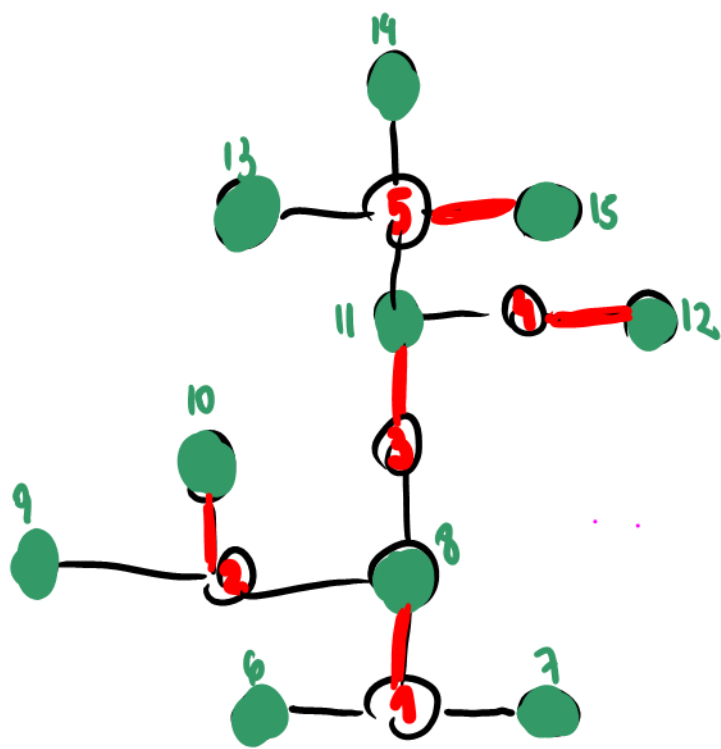
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
①	6	8	11	12	13	24	7	8	11	12	47	8	9	11	12
②					14						48				13
③					15						49				14
④			8	11	13			8	11	13					15
⑤					14					14					
⑥					15					15					
⑦				12	11				12	11					
⑧					13					13					
⑨					14					14					
⑩					15					15					
⑪			6						6						
⑫			11	12	13				11	12	13				
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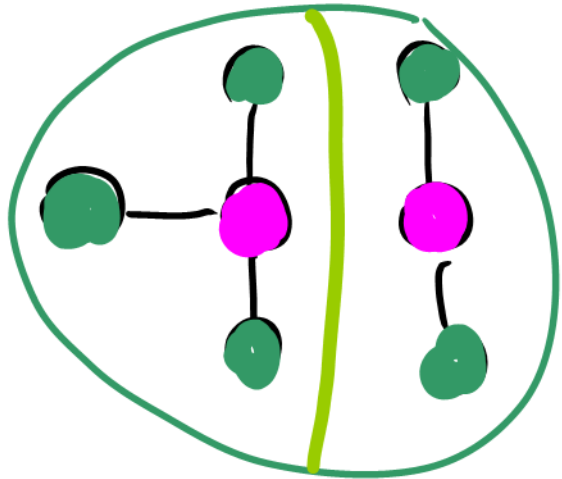
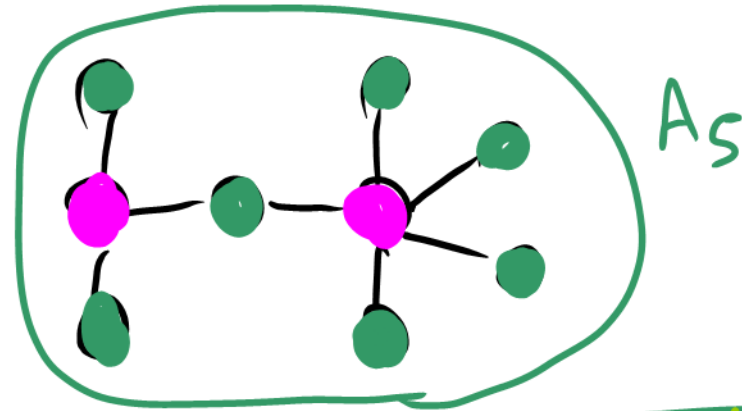
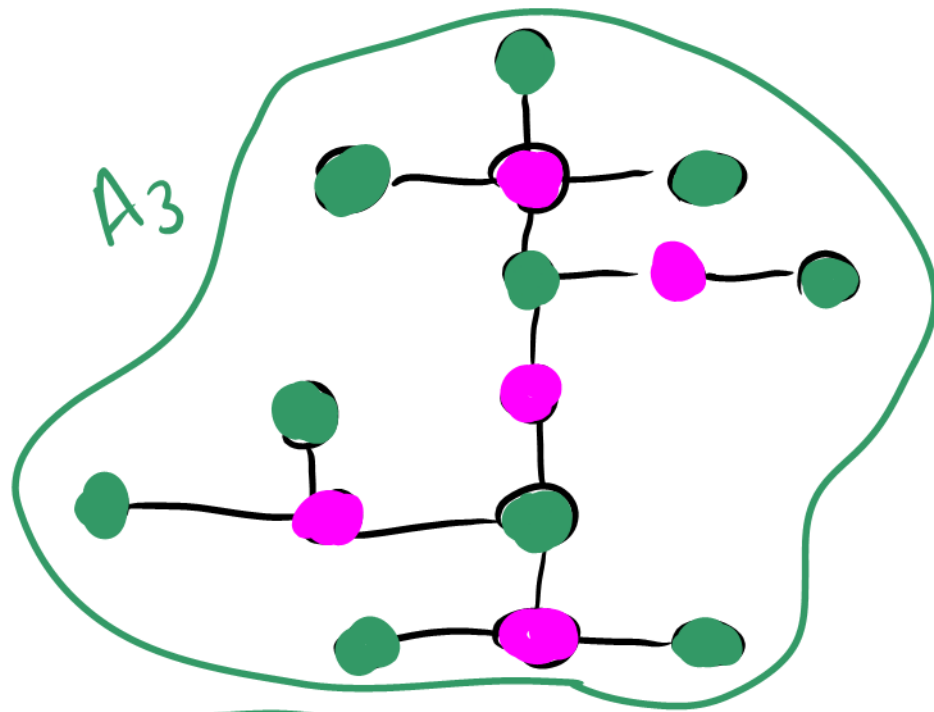
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①	6	8	11	12	13	24	7	8	11	12	47	8	9	11	12	13
②					14						48					14
③			8	11	13			8	11	13	49					15
④					14					14	50	10	11	12	13	
⑤					15					15	51					14
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⑪			8	11	13			8	11	13						
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	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
①	6	8	11	12	13	24	7	8	11	12	47	8	9	11	12
②					14						48				13
③					15						49				14
④			8	11	13			8	11	13	50				15
⑤					14					14	51	10	11	12	13
⑥					15					15	52				14
⑦				12	11				12	11					15
⑧					13					13					
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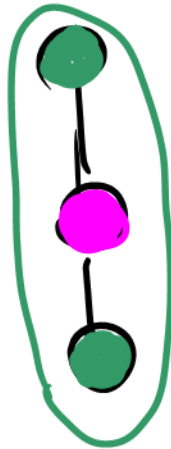
$$m(A_3) = 52$$

$$3 \cdot 2 \cdot m(A_3) + 2 \cdot m(A_5) + 3 \cdot 2 \cdot 2 \cdot 2$$



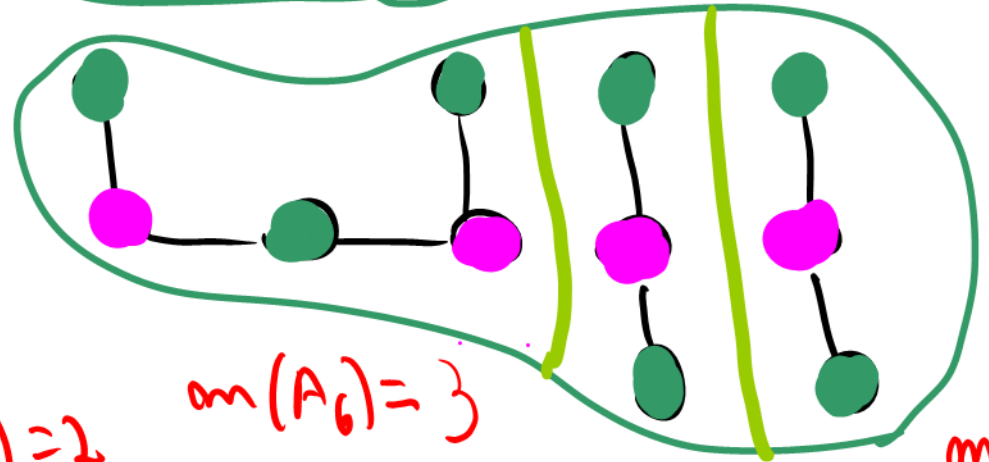
$$m(A_1) = 3$$

$$m(A_2) = 2$$



$$m(A_4) = 2$$

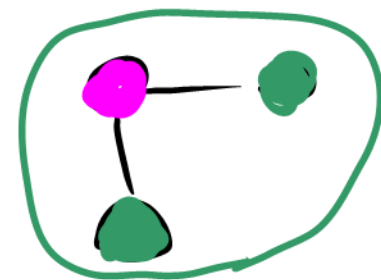
$$m(A_6) = 3$$



$$m(A_2) = 2$$

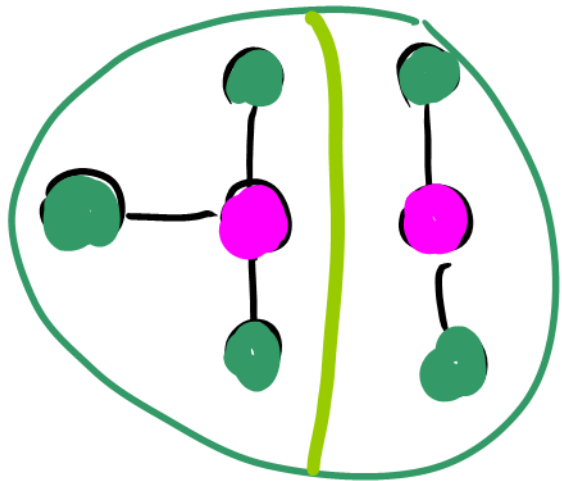
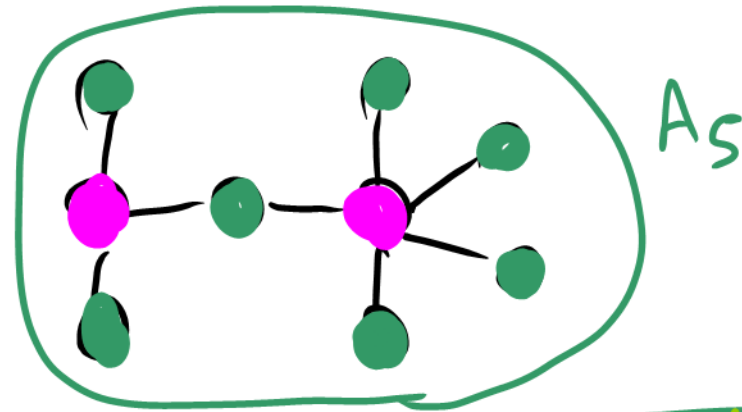
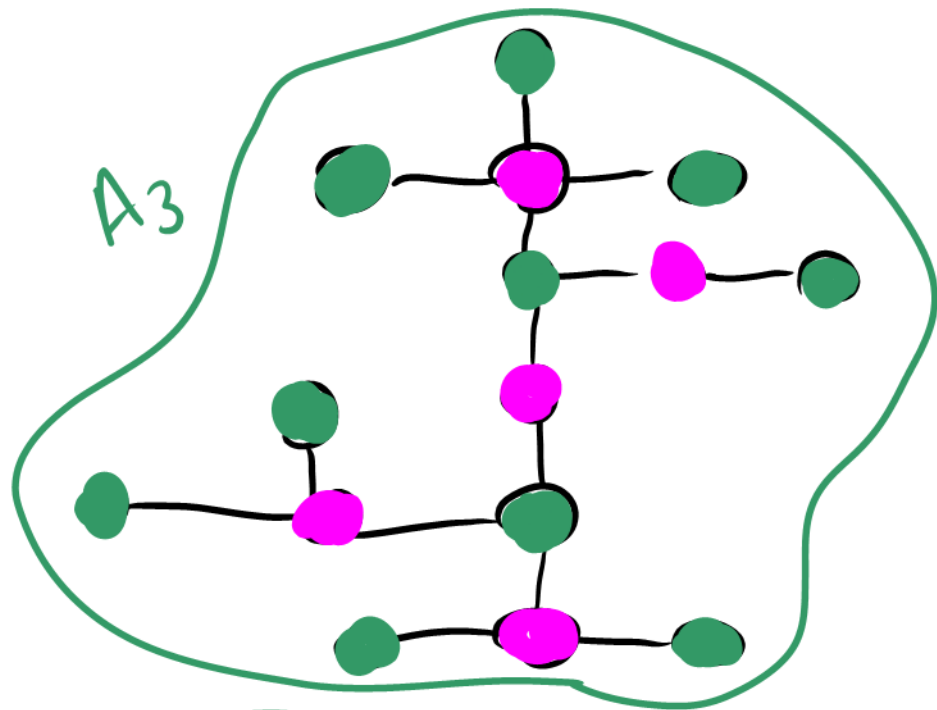
$$m(A_8) = 2$$

$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_q\}$$



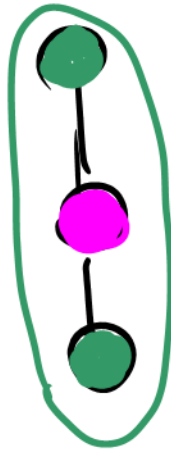
$$m(A_9) = 2$$

$$3 \cdot 2 \cdot \textcircled{52} \cdot 2 \cdot m(A_3) \cdot 3 \cdot 2 \cdot 2 \cdot 2$$

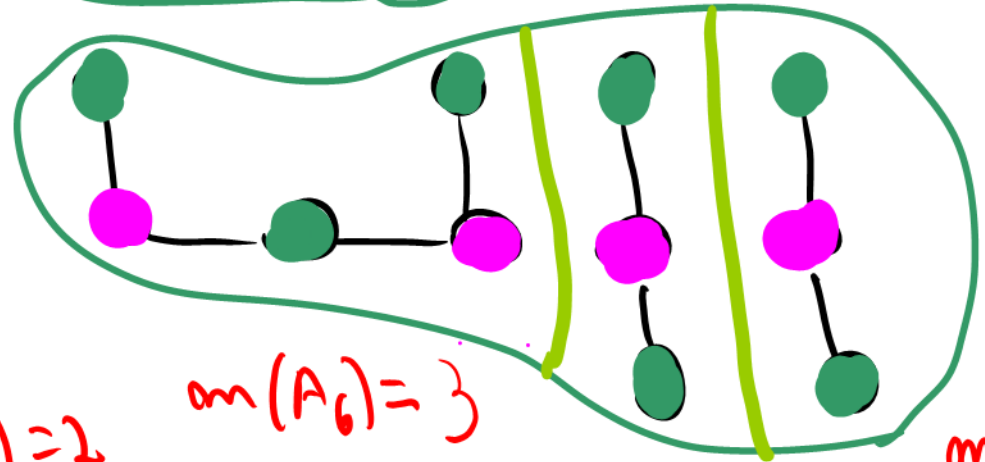


$$m(A_1) = 3$$

$$m(A_2) = 2$$



$$m(A_4) = 2$$

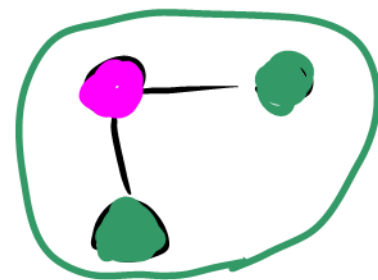


$$m(A_6) = 3$$

$$m(A_7) = 2$$

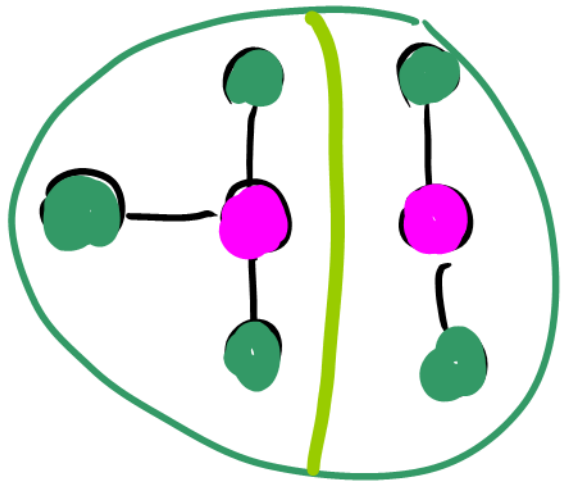
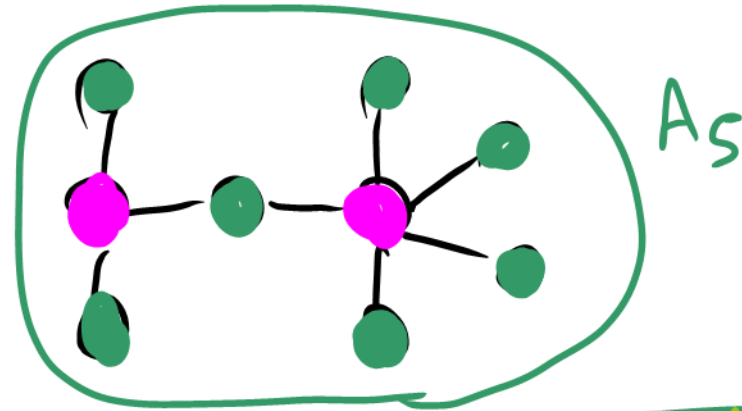
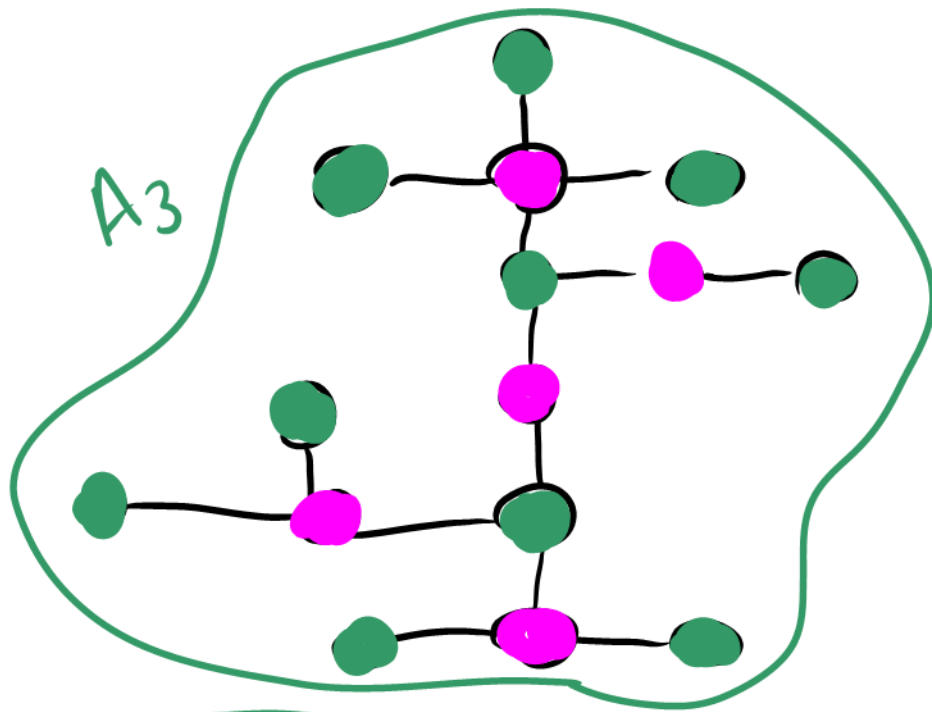
$$m(A_8) = 2$$

$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_9\}$$



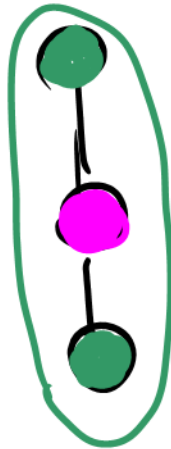
$$m(A_9) = 2$$

$$3 \cdot 2 \cdot 52 \cdot 2 \cdot \underbrace{m(A_3)}_{3} \cdot 2 \cdot 2 \cdot 2$$

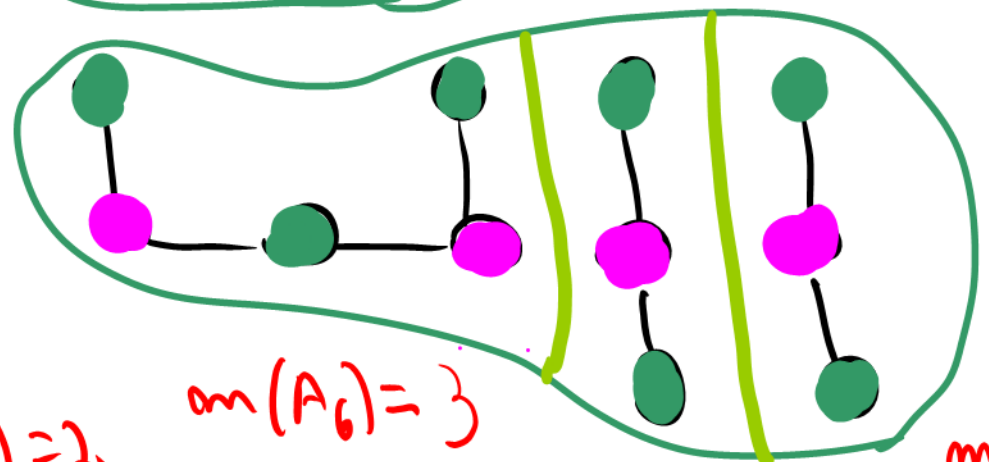


$$m(A_1) = 3$$

$$m(A_2) = 2$$



$$m(A_4) = 2$$

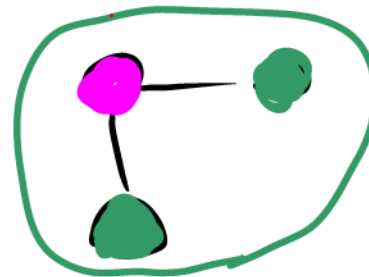


$$m(A_6) = 3$$

$$m(A_7) = 2$$

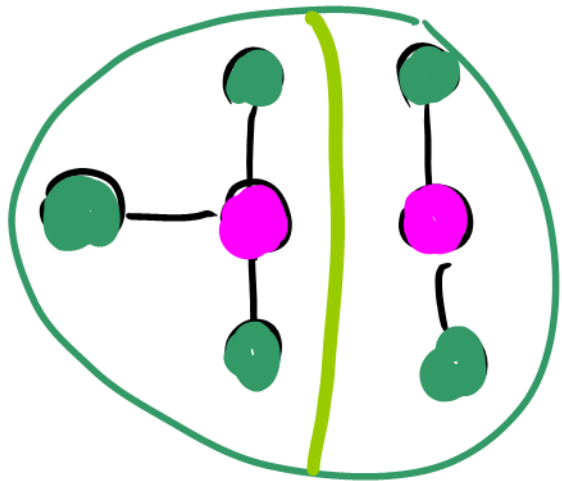
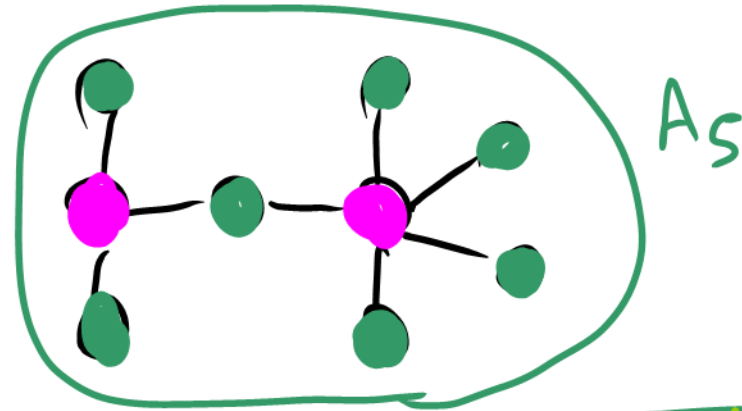
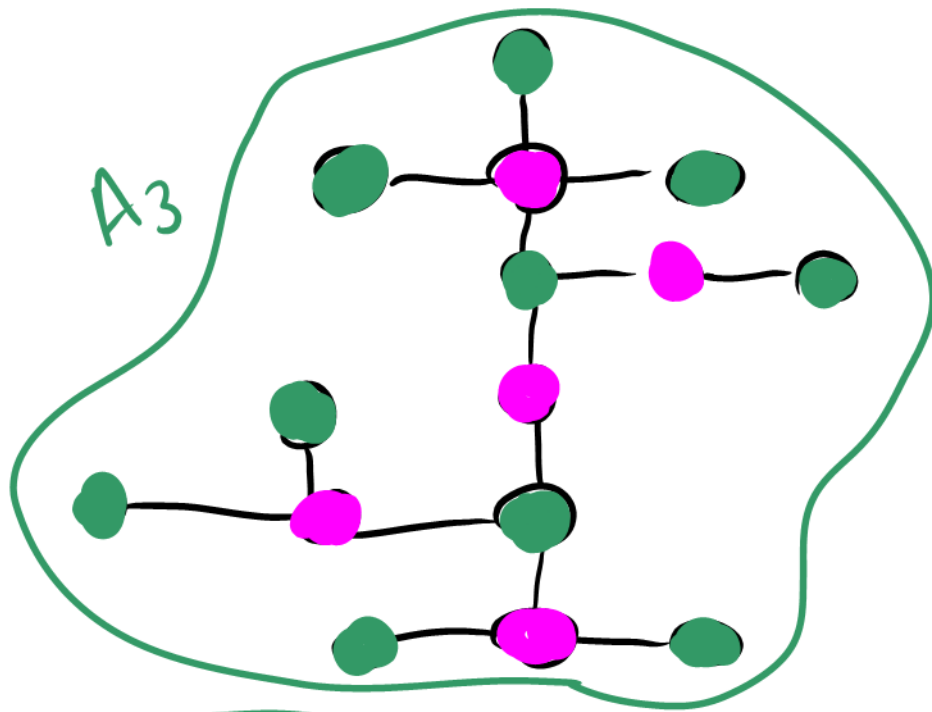
$$m(A_8) = 2$$

$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_q\}$$



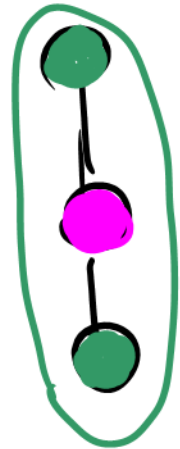
$$m(A_9) = 2$$

$$3 \cdot 2 \cdot 52 \cdot 2 \cdot \underbrace{m(A_5)}_{3} \cdot 2 \cdot 2 \cdot 2$$

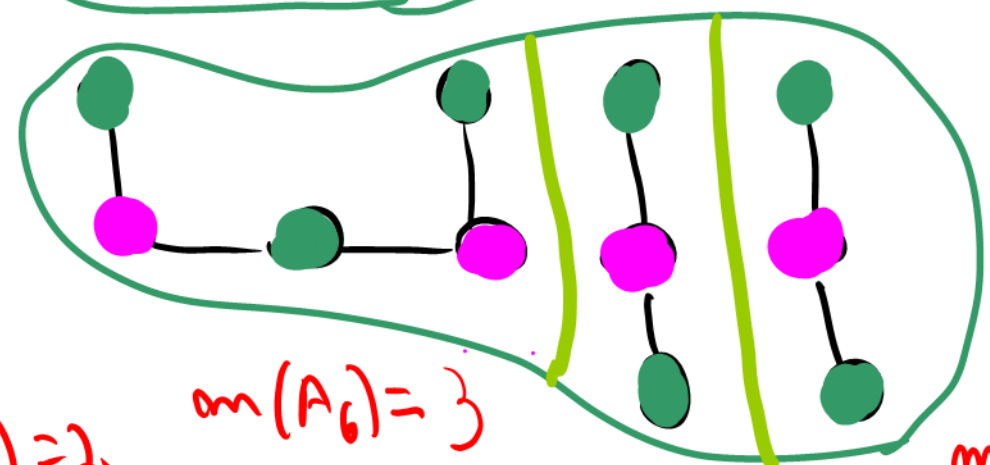


$$m(A_1) = 3$$

$$m(A_2) = 2$$



$$m(A_4) = 2$$

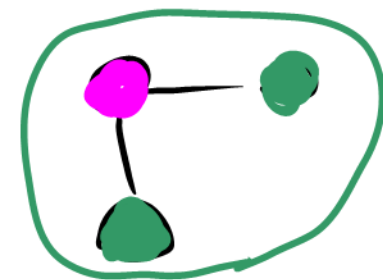


$$m(A_6) = 3$$

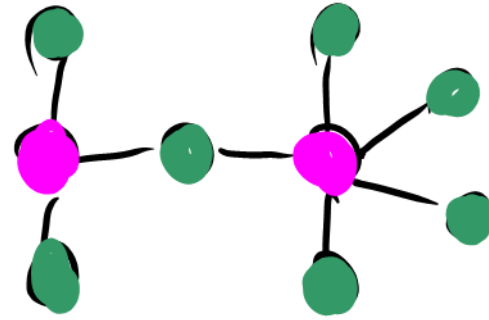
$$m(A_7) = 2$$

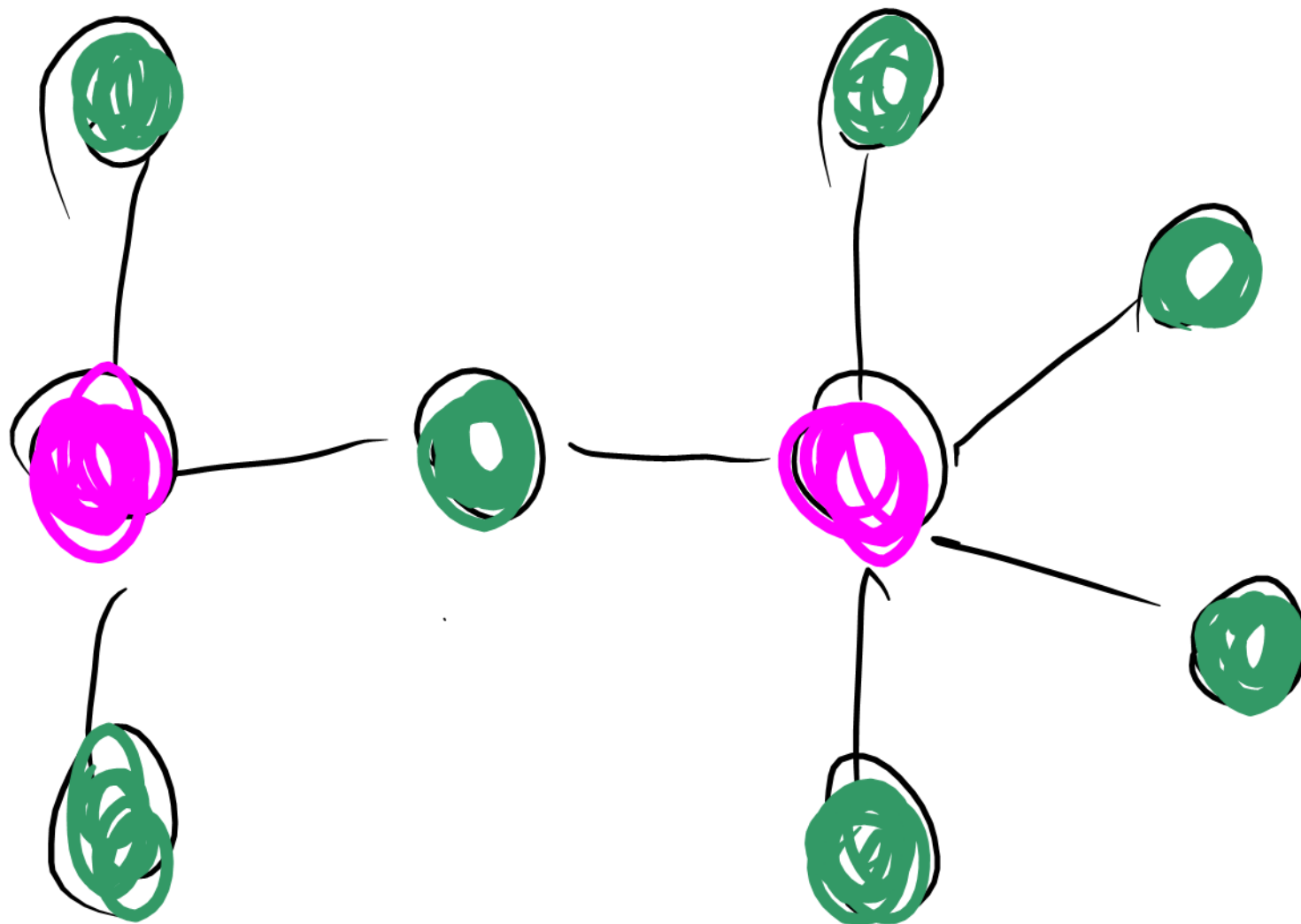
$$m(A_8) = 2$$

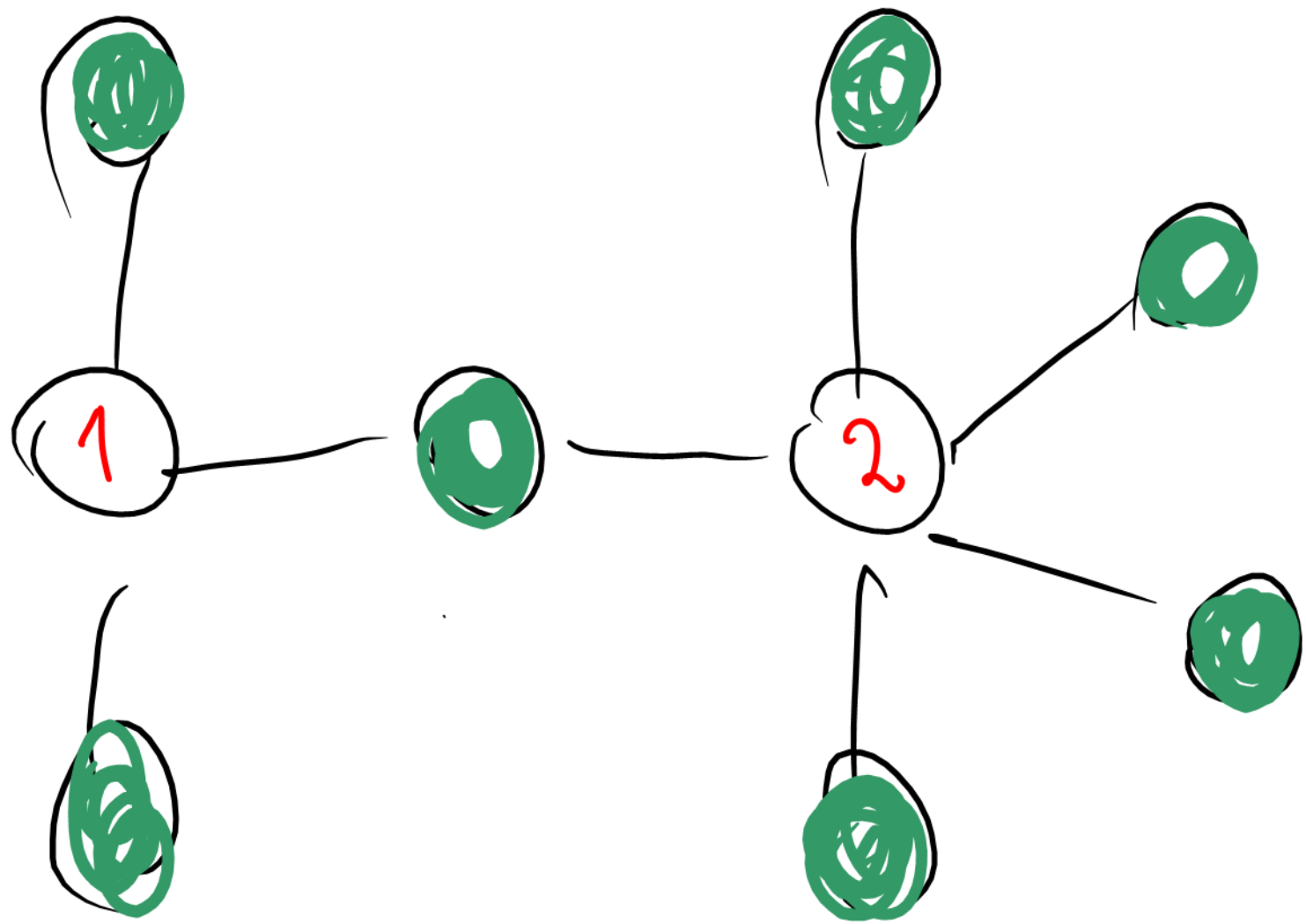
$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_9\}$$

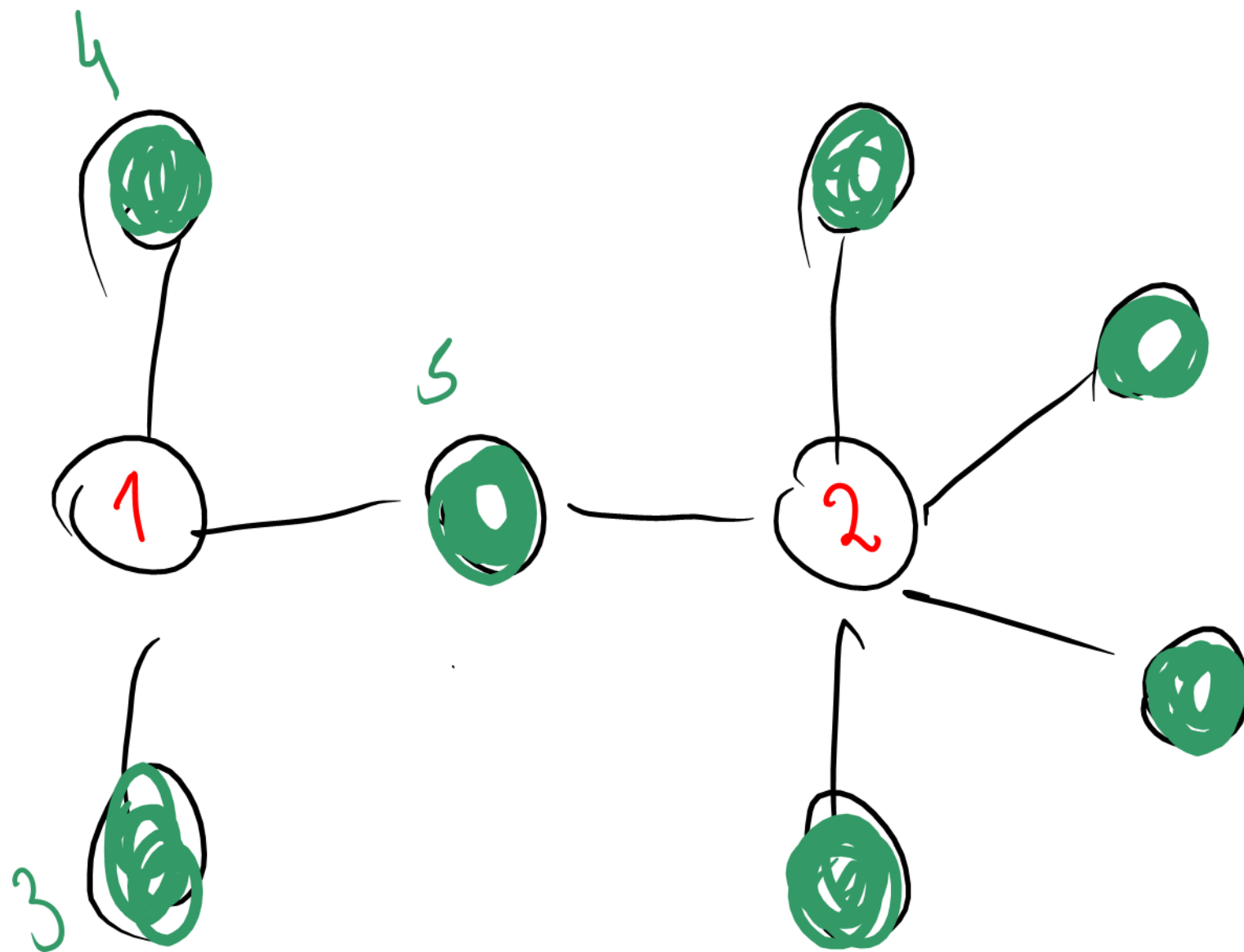


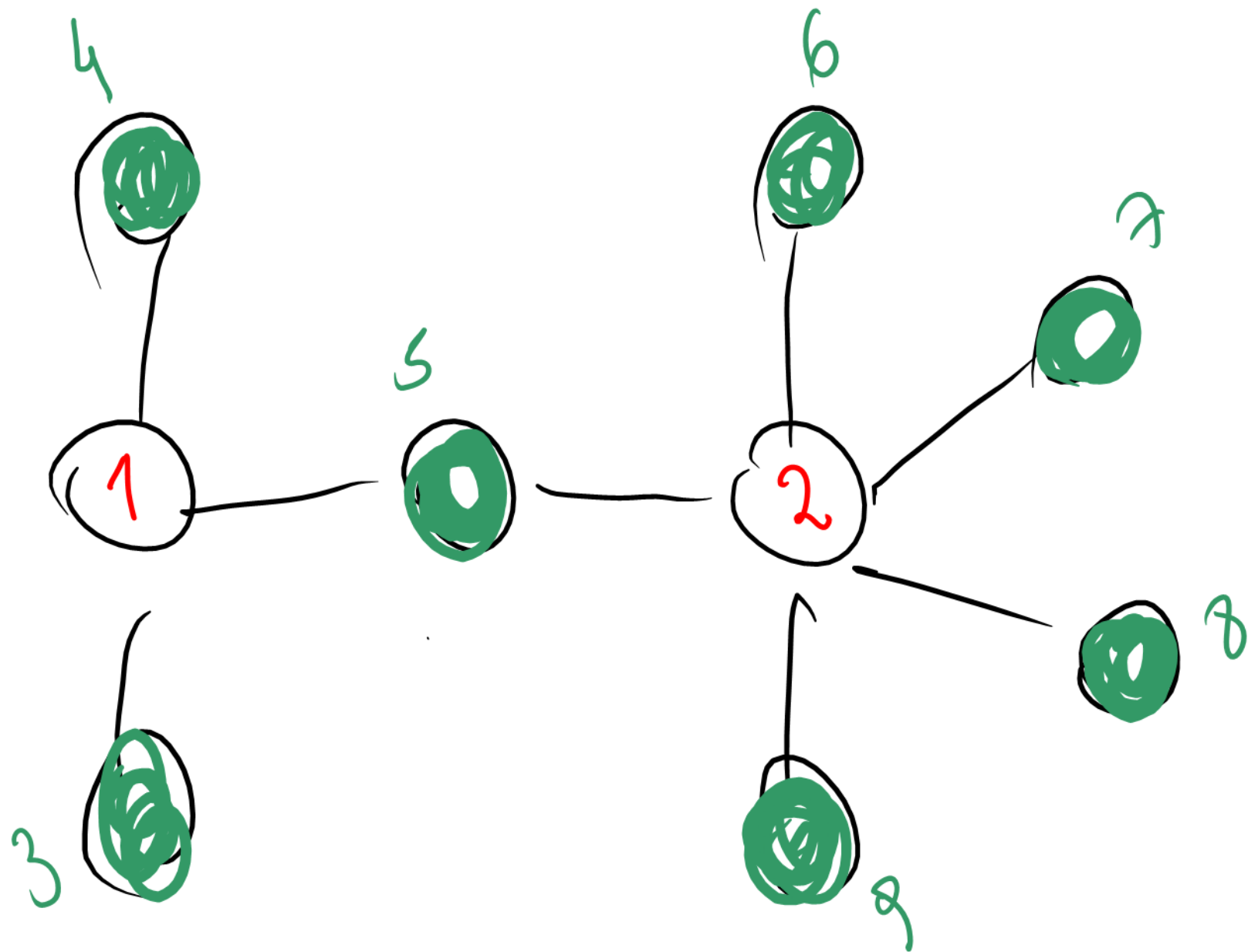
$$m(A_9) = 2$$

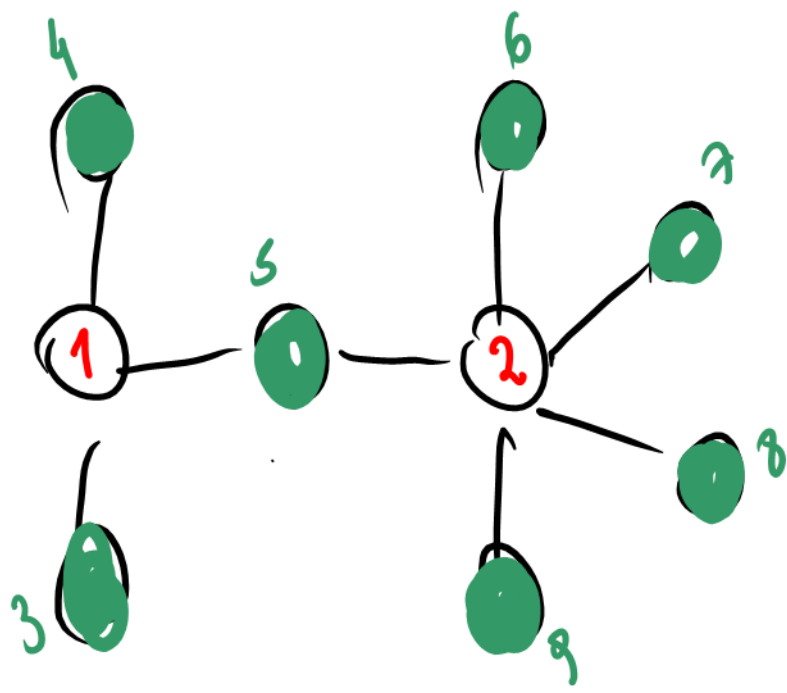






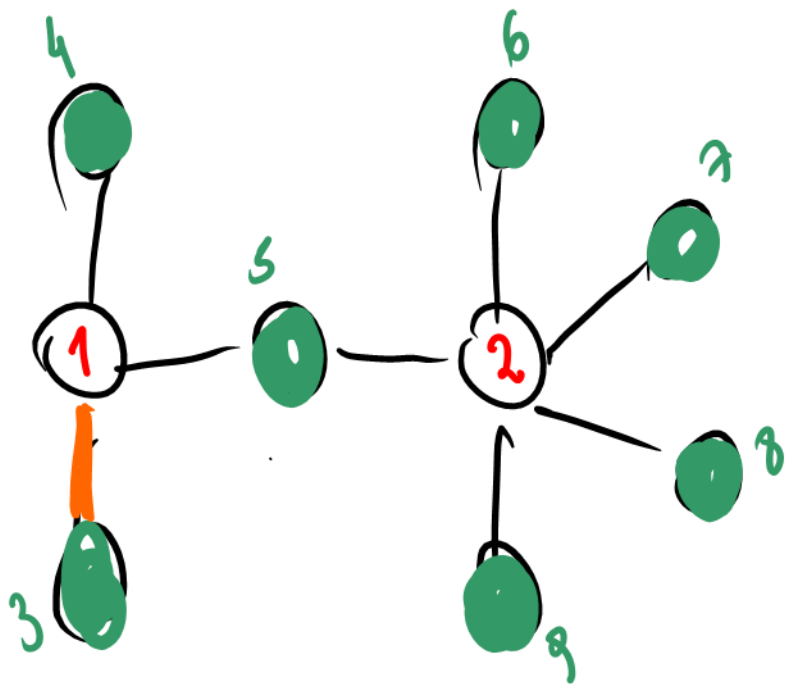






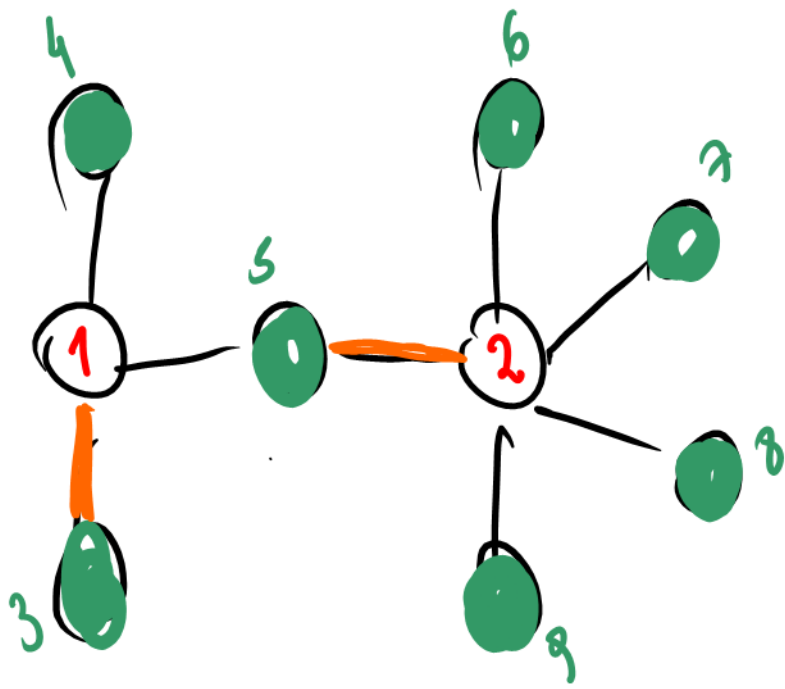
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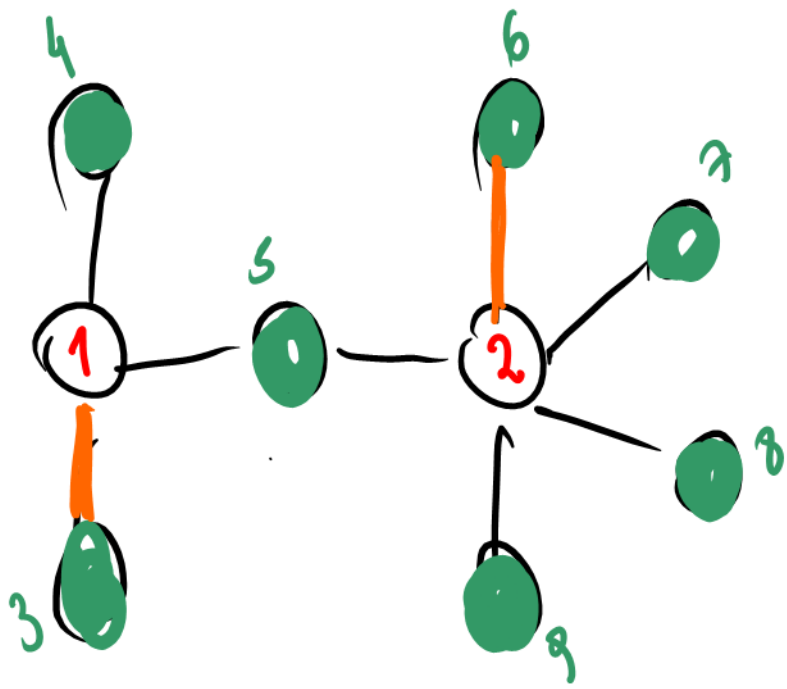
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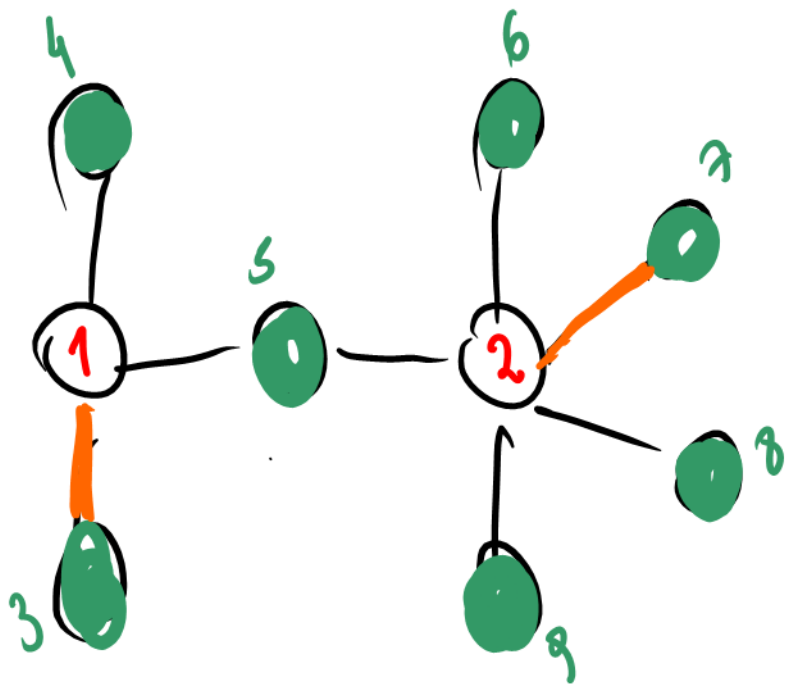
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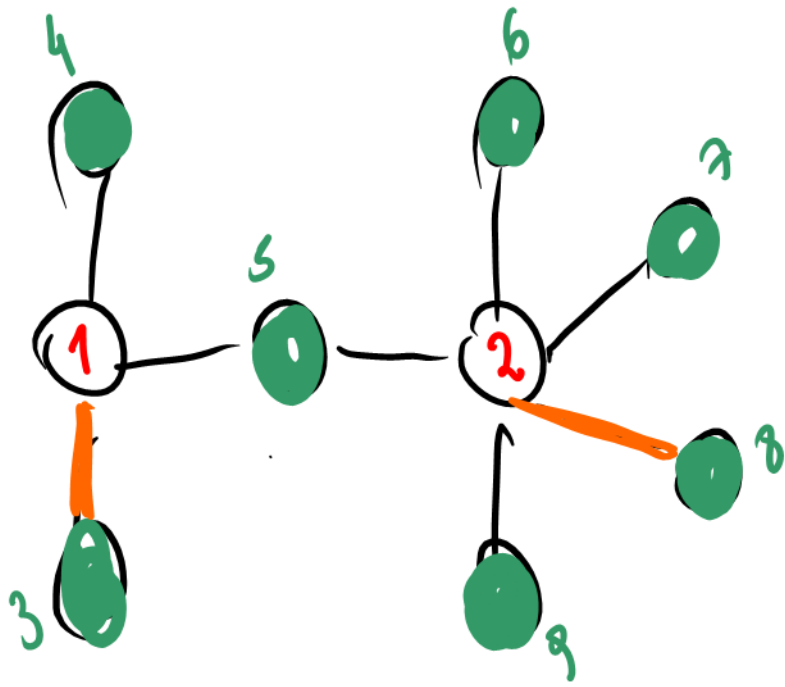
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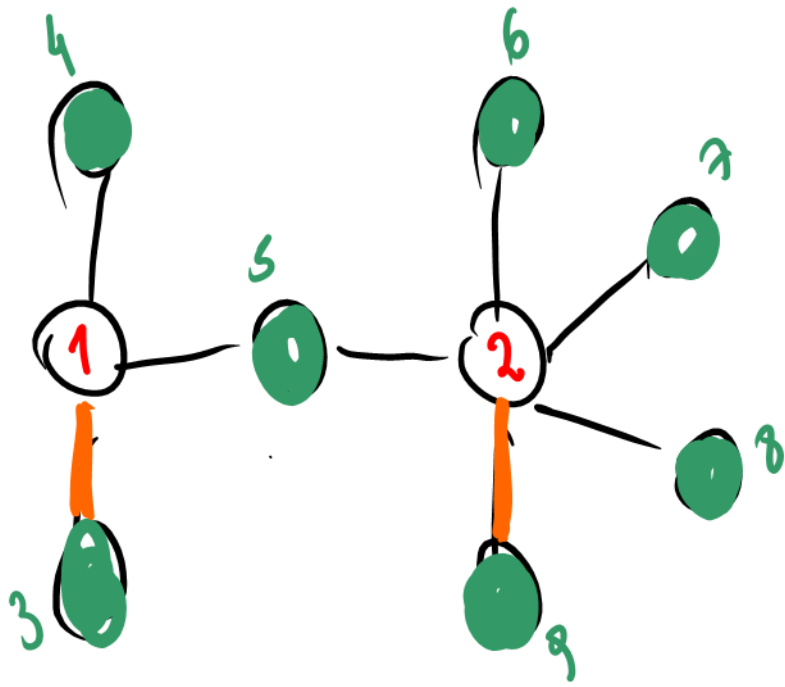
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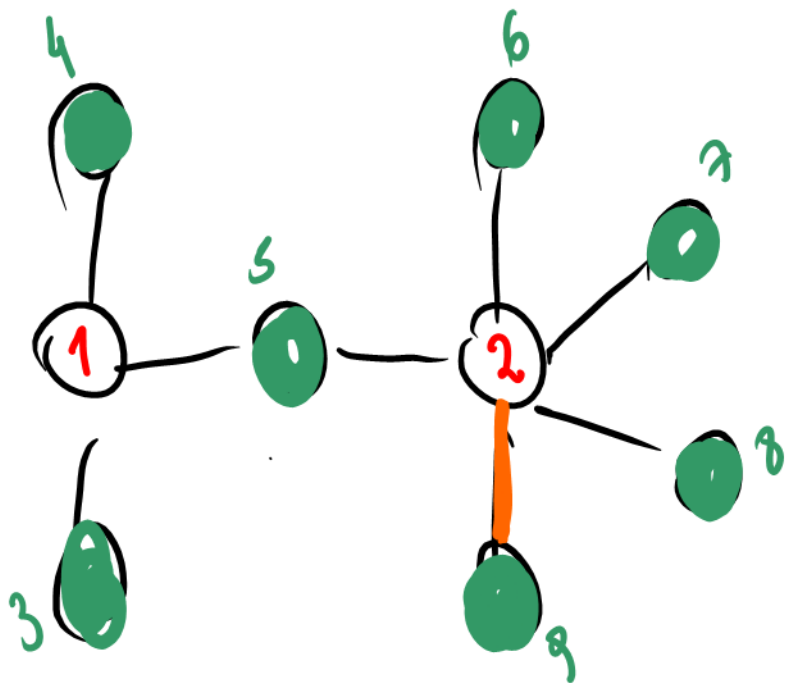
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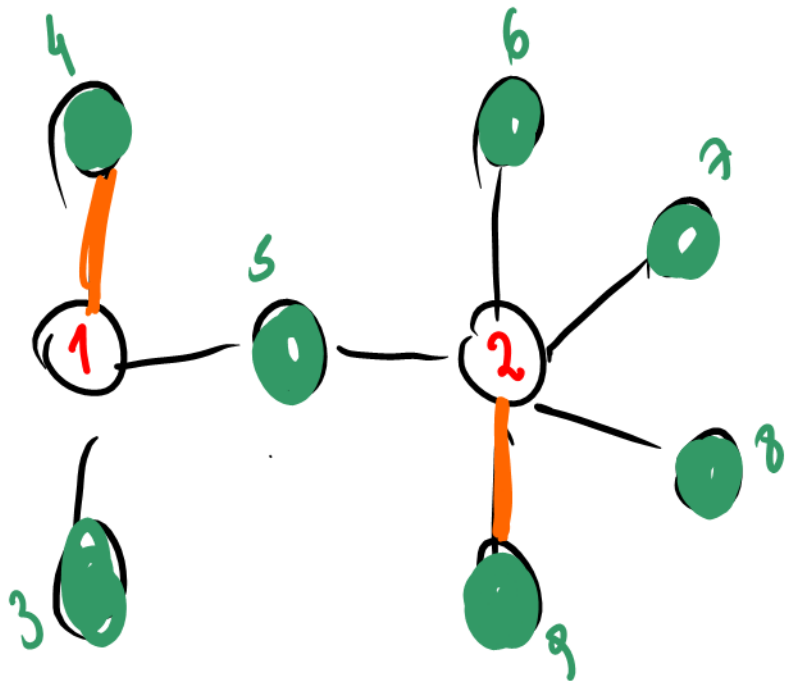


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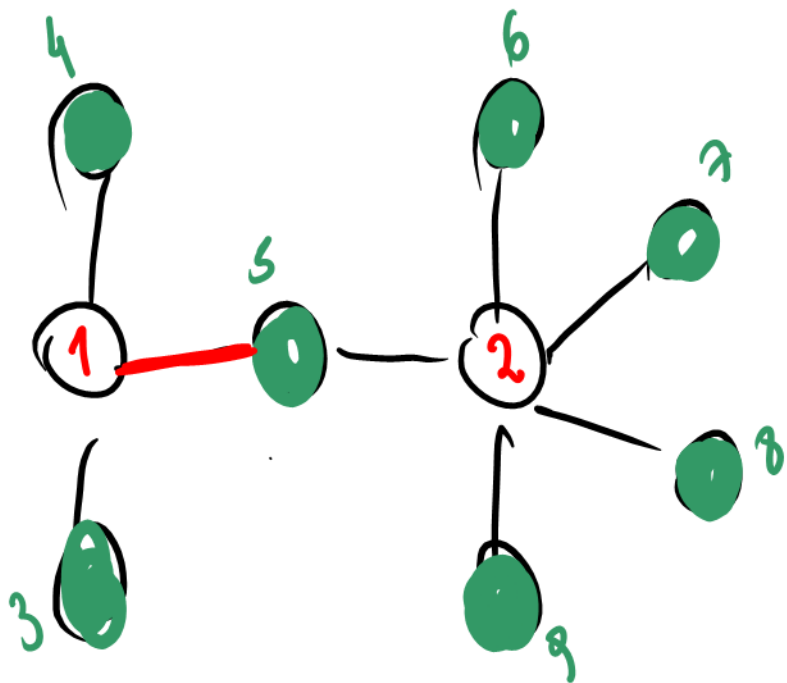


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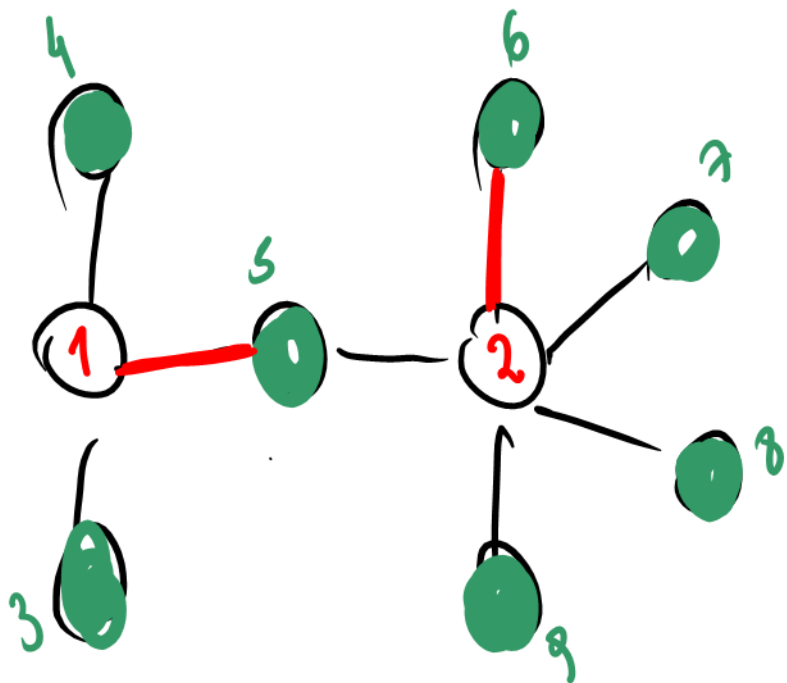
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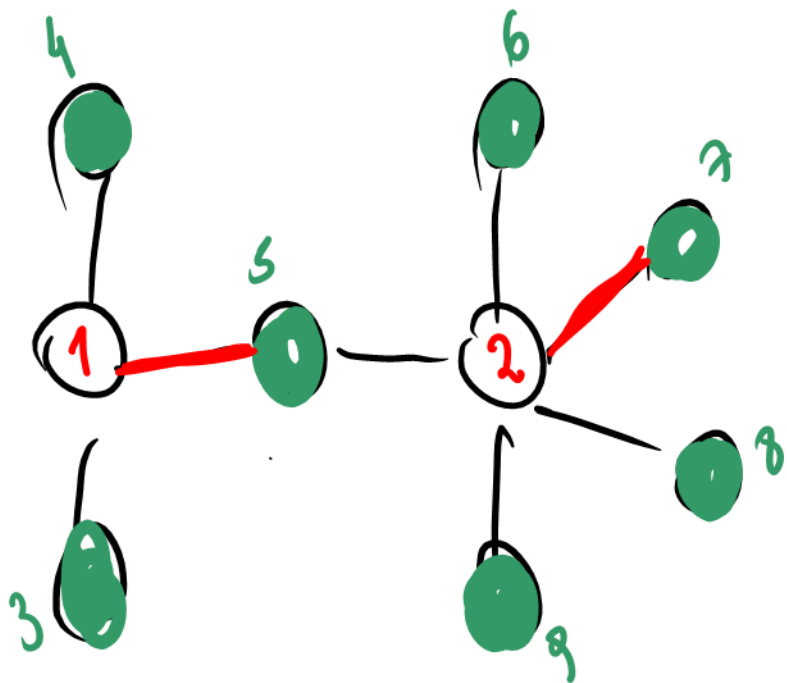
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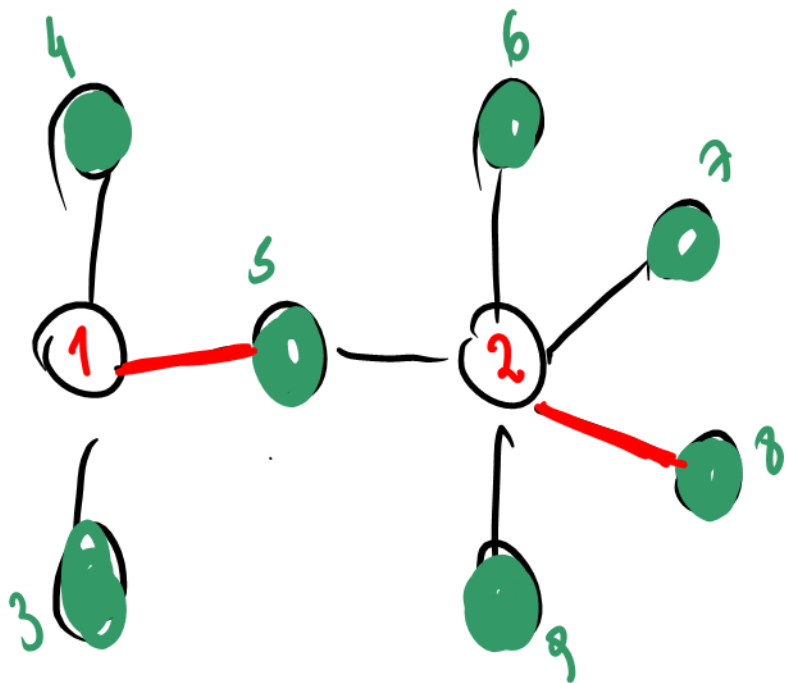
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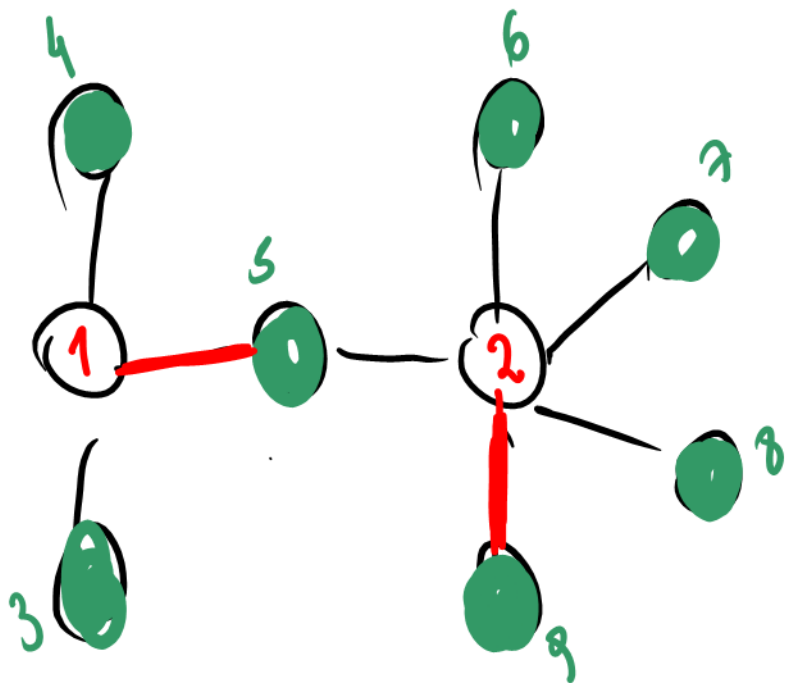
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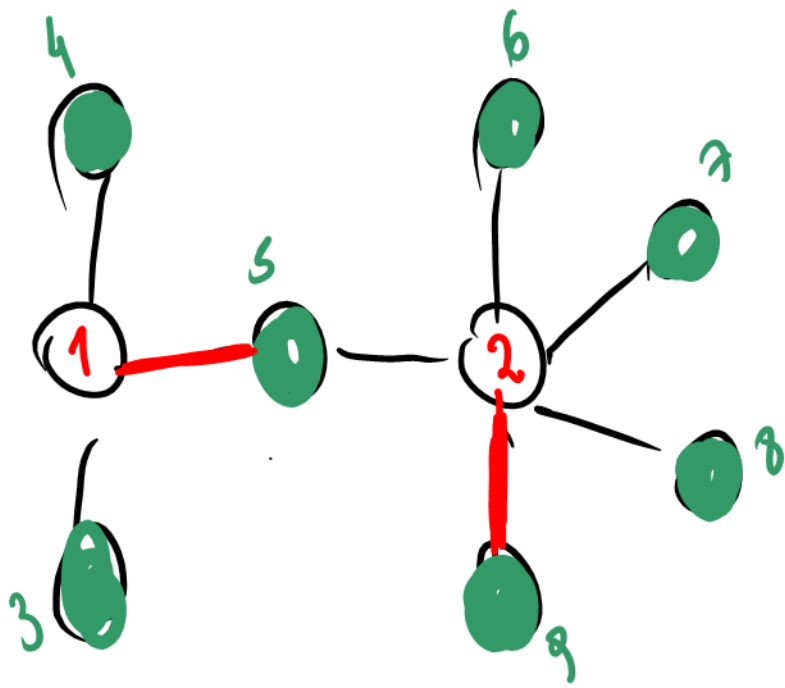
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$$m(A_3) = 14$$

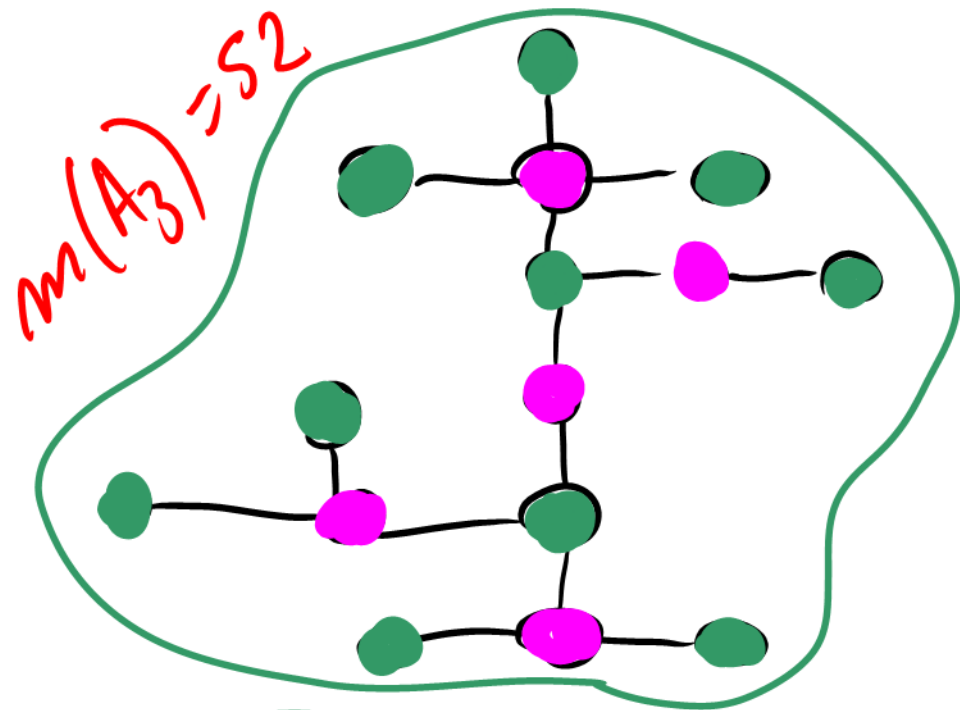
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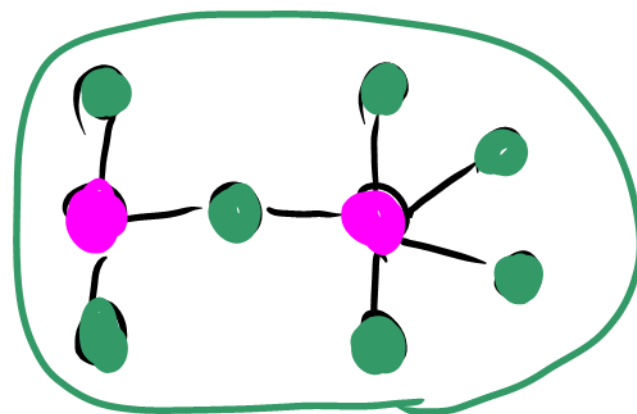
④

⑤

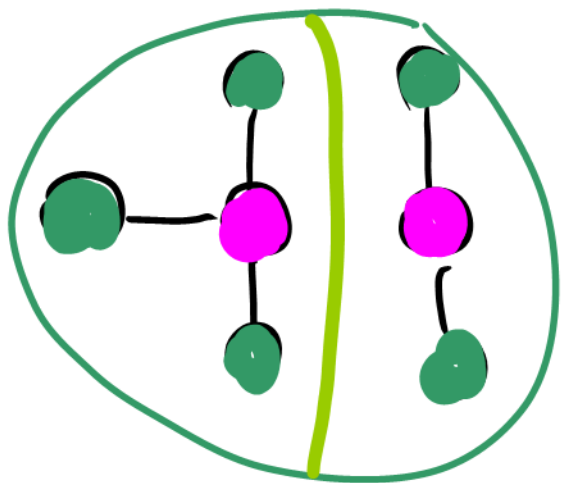
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$$3 \cdot 2 \cdot 52 \cdot 2 \cdot \textcircled{14} \cdot 3 \cdot 2 \cdot 2 \cdot 2$$

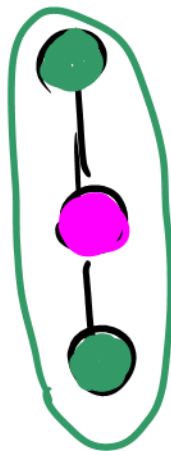


$m(A_5) = 14$

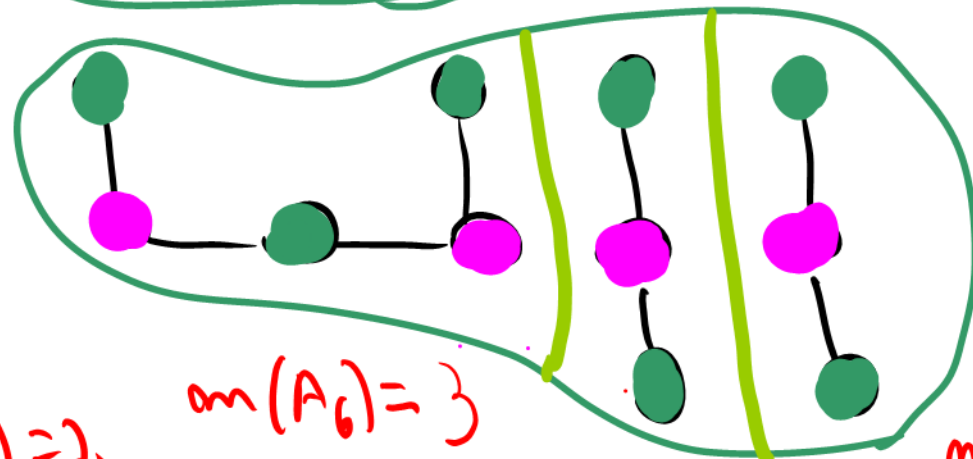


$m(A_1) = 3$

$m(A_2) = 2$



$m(A_4) = 2$

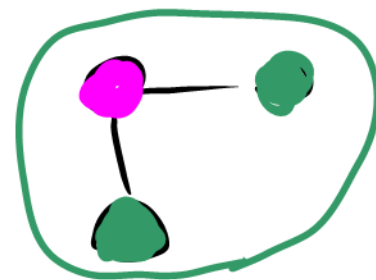


$m(A_6) = 3$

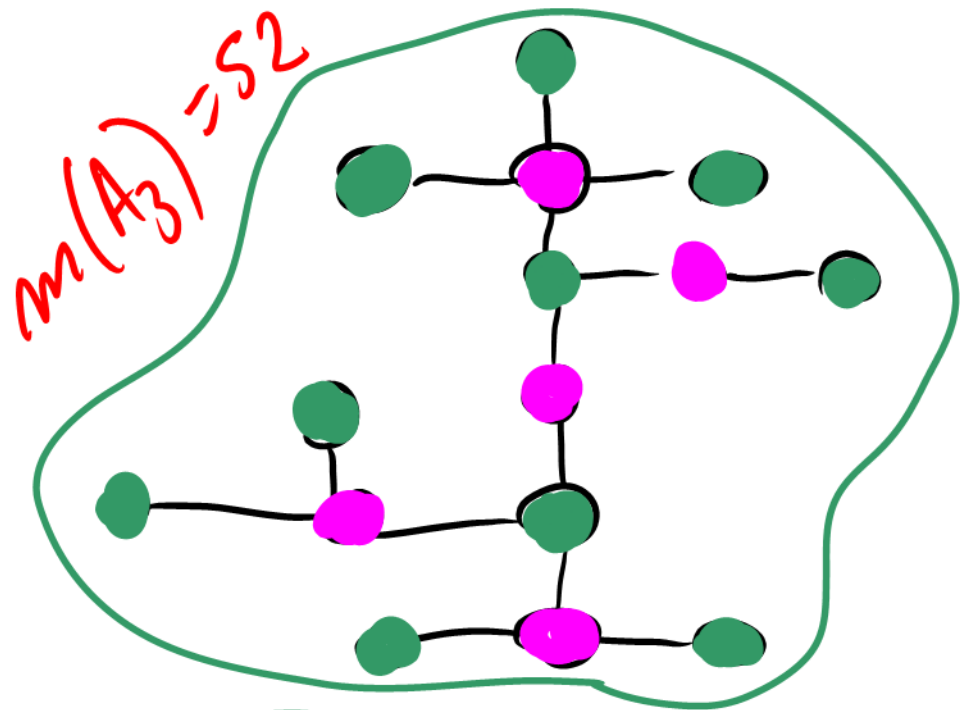
$m(A_7) = 2$

$m(A_8) = 2$

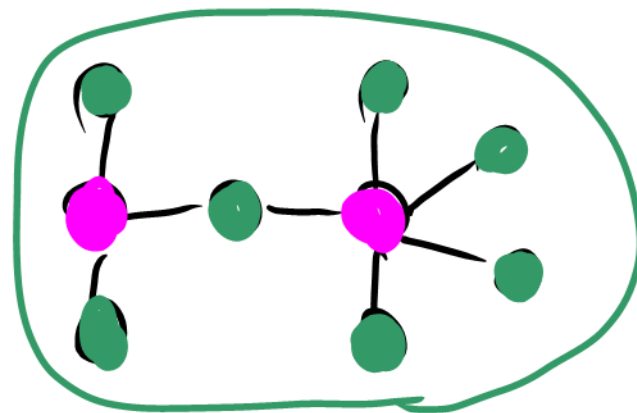
$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_9\}$$



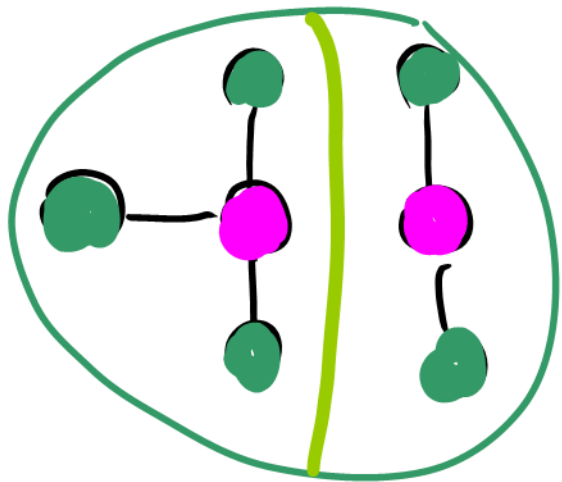
$m(A_9) = 2$



$$m(T) = 208\ 664$$

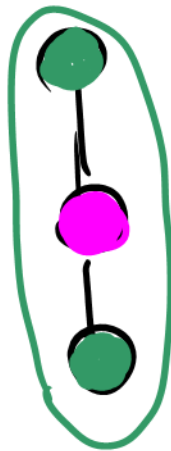


$$m(A_5) = 14$$



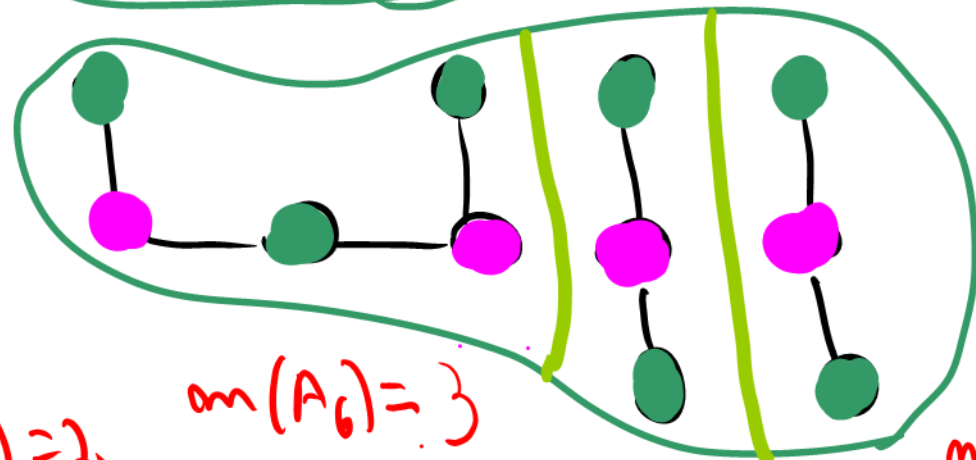
$$m(A_1) = 3$$

$$m(A_2) = 2$$



$$m(A_4) = 2$$

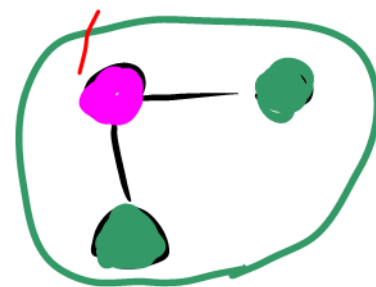
$$m(A_6) = 3$$



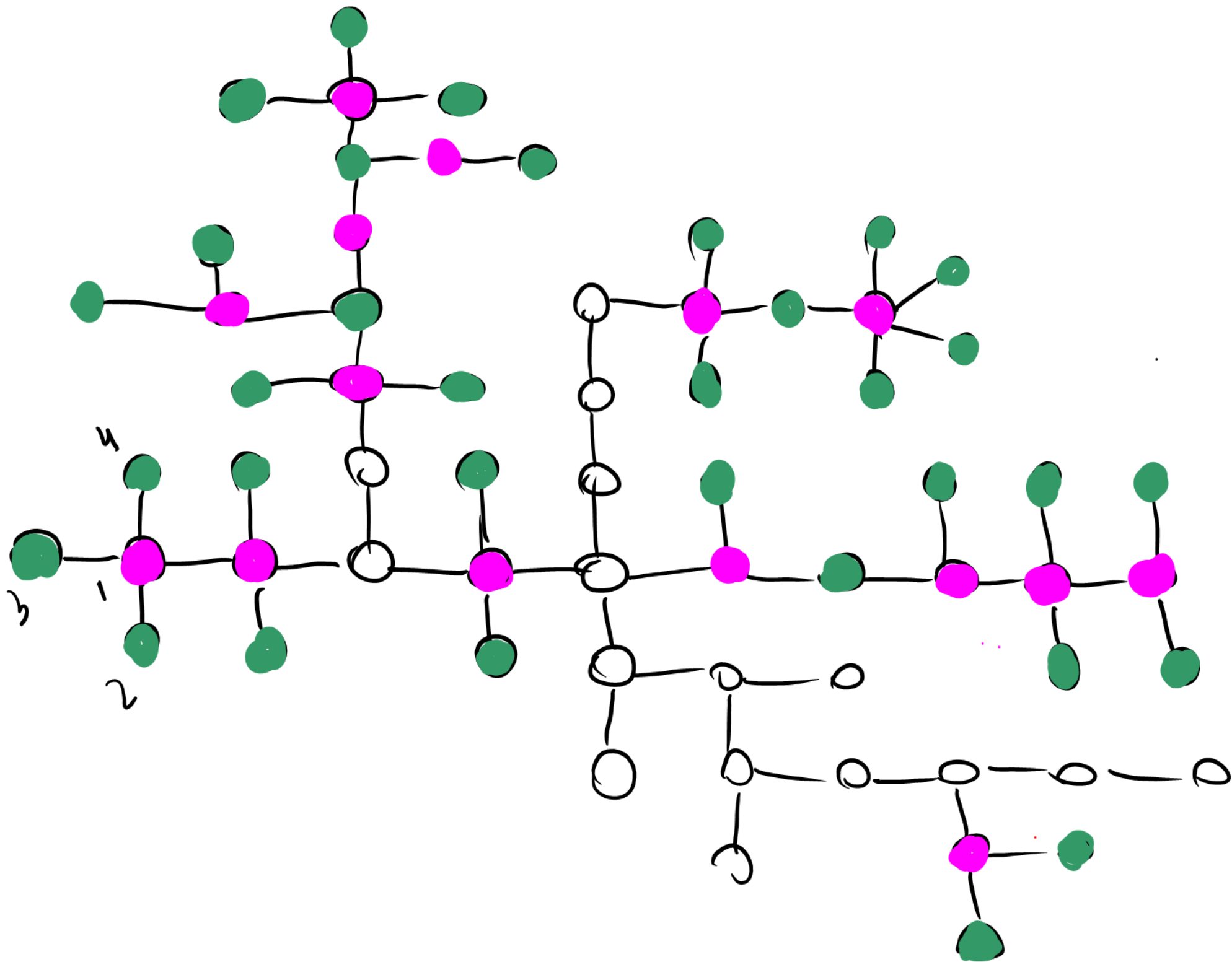
$$m(A_7) = 2$$

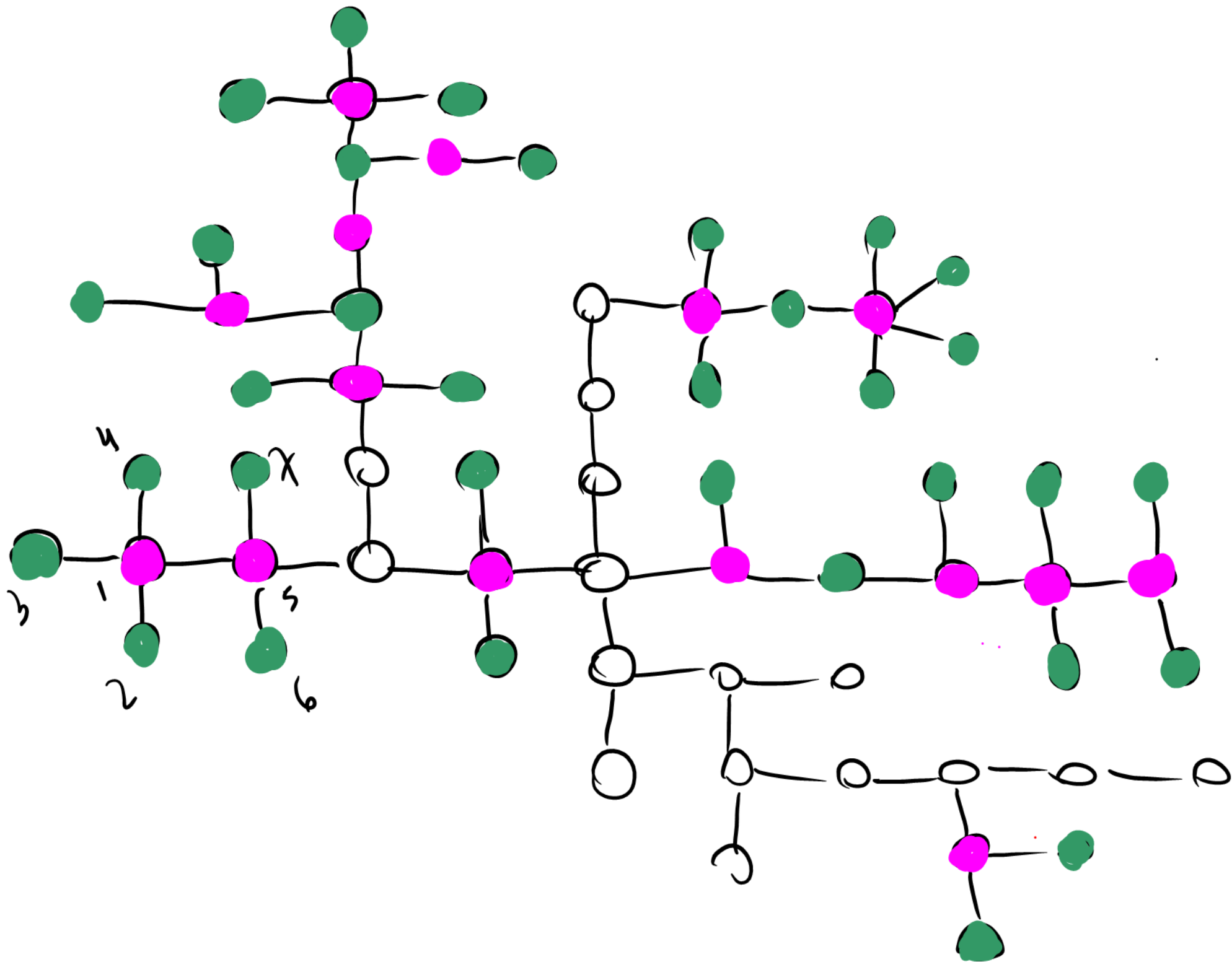
$$m(A_8) = 2$$

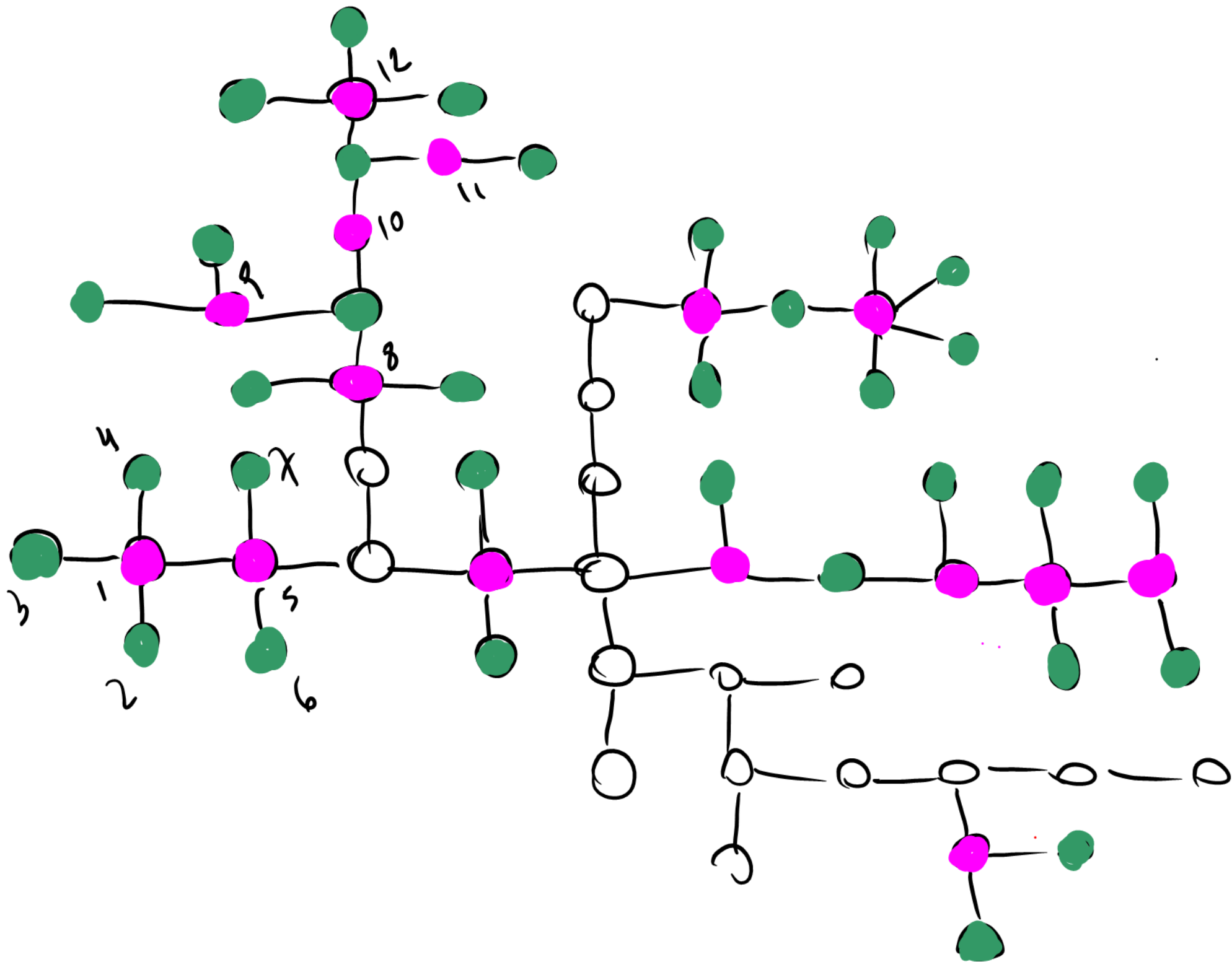
$$\mathcal{F}_{cs}(T) = \{A_1, \dots, A_9\}$$

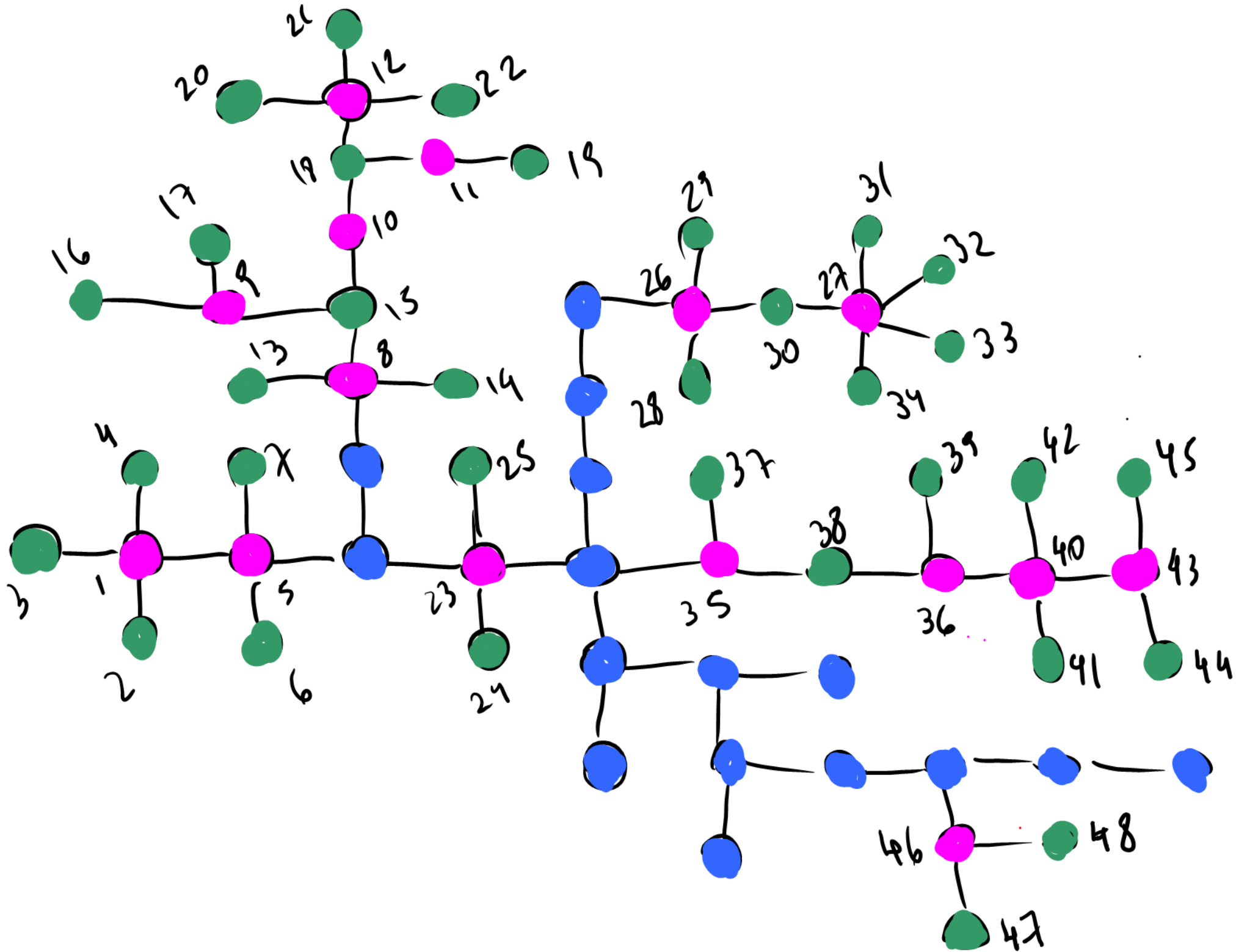


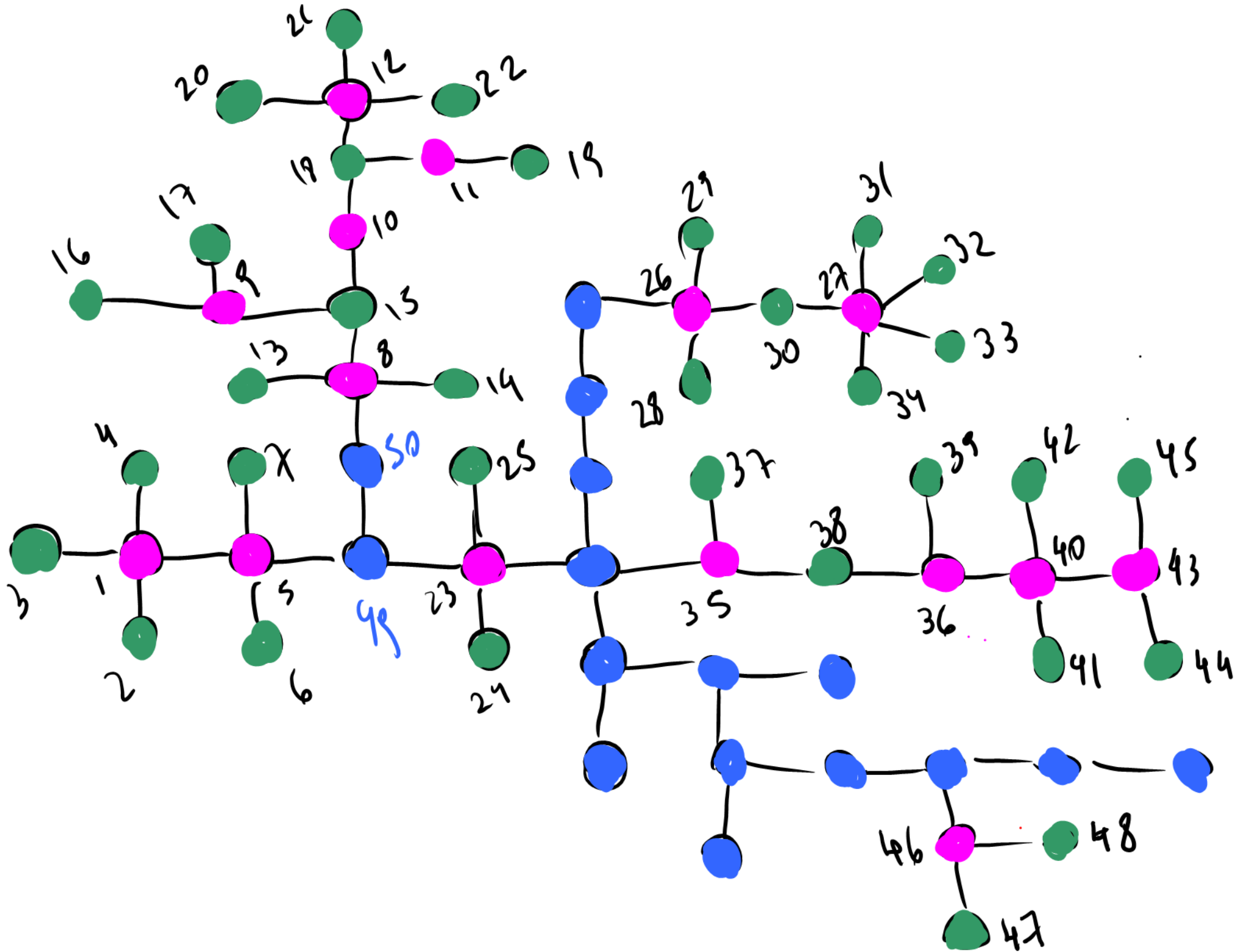
$$m(A_9) = 2$$

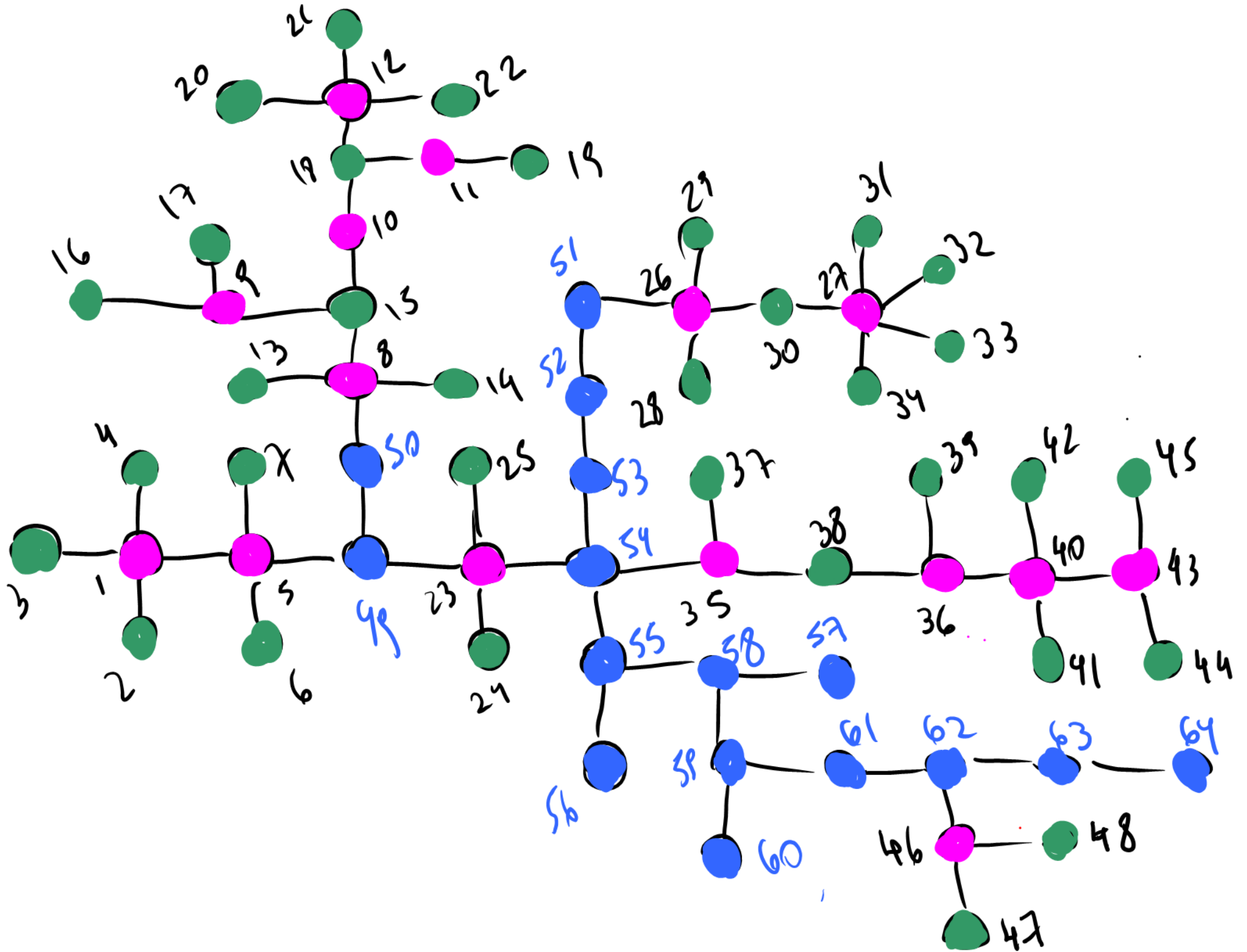


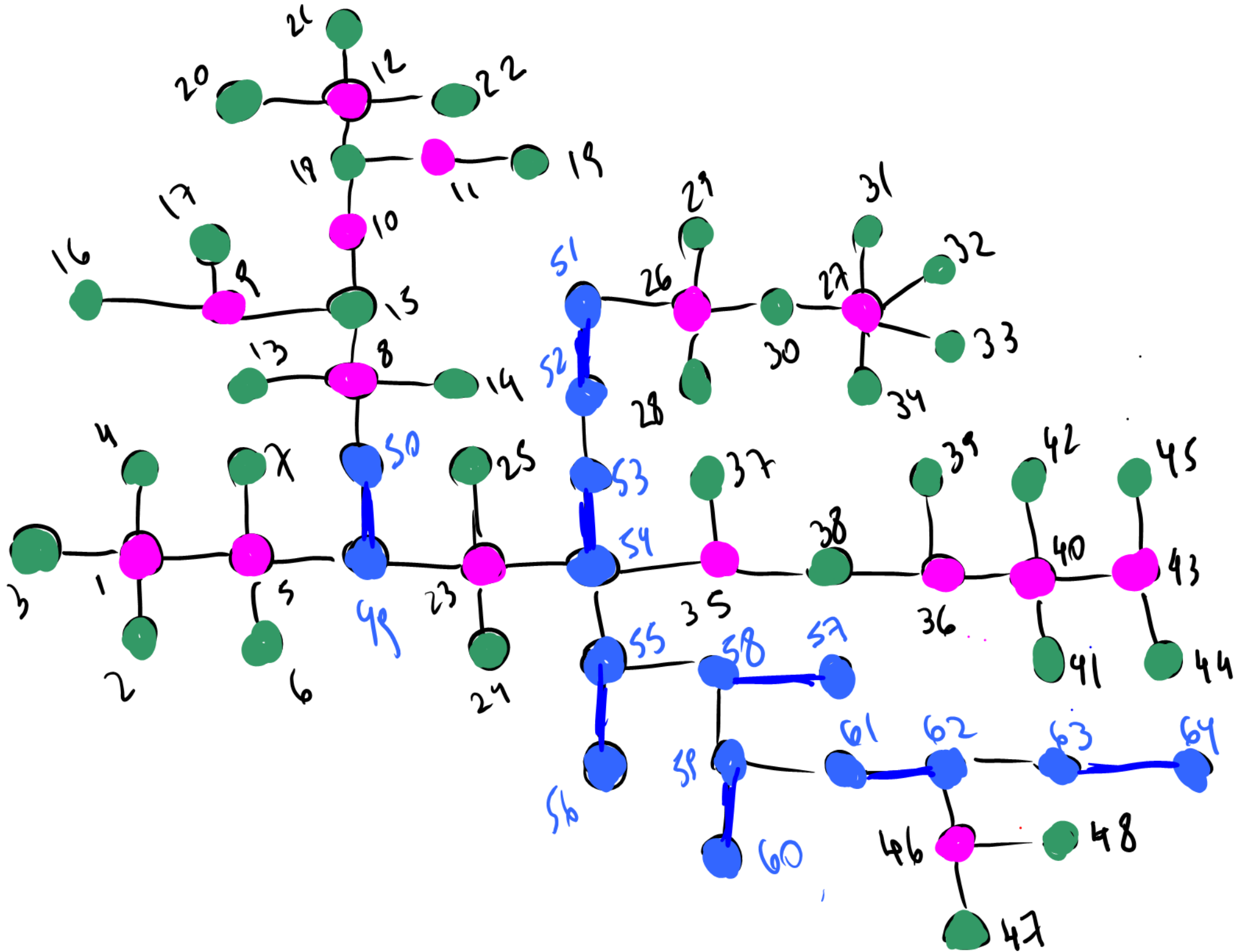












A ₁	A ₂	A ₃					A ₄	A ₅		A ₆		A ₇	A ₈	A ₉
1	5	8	9	10	11	12	23	26	27	35	36	40	43	46
2	6	13	15	18	19	20	24	28	30	37	38	41	44	47
3	7	↓					25	↓		37	39	42	45	48
4										38	39			
		15	17	18	19	22		30	34					

A ₁	A ₂	A ₃					A ₄	A ₅		A ₆		A ₇	A ₈	A ₉
1	5	8	9	10	11	12	23	26	27	35	36	40	43	46
2	6	13	15	18	19	20	24	28	30	37	38	41	44	47
3	7	↓					25	↓		37	38	42	45	48
4										38	39			
③	②	15	17	18	19	22		30	34			②	②	②
		⑤2					②	①0		③				

A ₁	A ₂	A ₃					A ₄	A ₅		A ₆		A ₇	A ₈	A ₉
1	5	8	9	10	11	12	23	26	27	35	36	40	43	46
2	6	13	15	18	19	20	24	28	30	37	38	41	44	47
3	7	↓					25	↓				42	45	48
4														
③	②	15	17	18	19	22		30	34			②	②	②
		⑤2					②	①0		③				

N₁

49-50

N₂

51-52

53-54

55-56

57-58

59-60

61-62

63-64

209 664

Takeaki Uno - 1993 -

Algorithm, for enumerating all perfect,
maximum, and maximal matchings
in bipartite graphs.

Th: $O(mn^{1/2} + nN_m)$ time

$O(m)$ space

COMPLETE DAD

COMPLETE DAD

Work in
Progress!

