

4. 2017/18

Algorithms / Lists

Normal Lists / Array

Operations

Cost (Time)

Insert, delete, search, min, max

Dictionary ()

Hashing

Insert (D, a)

Delete (D, a)

Search (D, k)

Min (D)

Max (D)

Successor (D, a)

Predecessor (D, a)

Dic-Item

Dic-Items

Operations

Time

Insert $O(1)$
Delete $O(1)$
Search $O(h)$

Insert $O(h)$
 Delete $O(h)$
 Search $O(h)$
 min, max $O(1)$

Delete, Insert $O(h)$

Search $O(\log h)$
 min, max $O(1)$

Successor $O(1)$
 Predecessor $O(1)$

Node

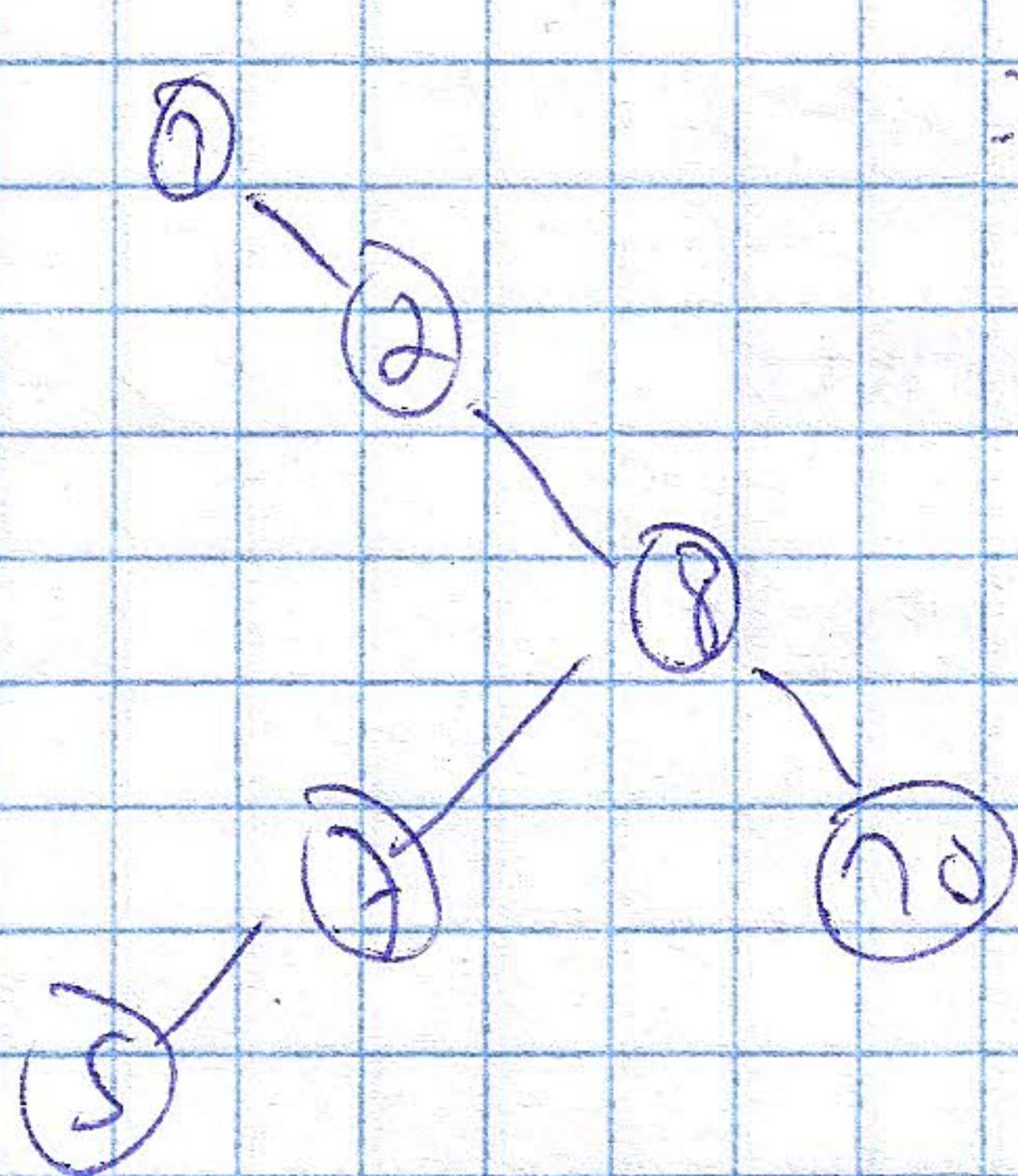
Dictionary

Node

Node

Node

Node



Node

Node

Node

Node

for tree

pre order in order post order
node, left, right left, node, right right, left, node

node, left, right

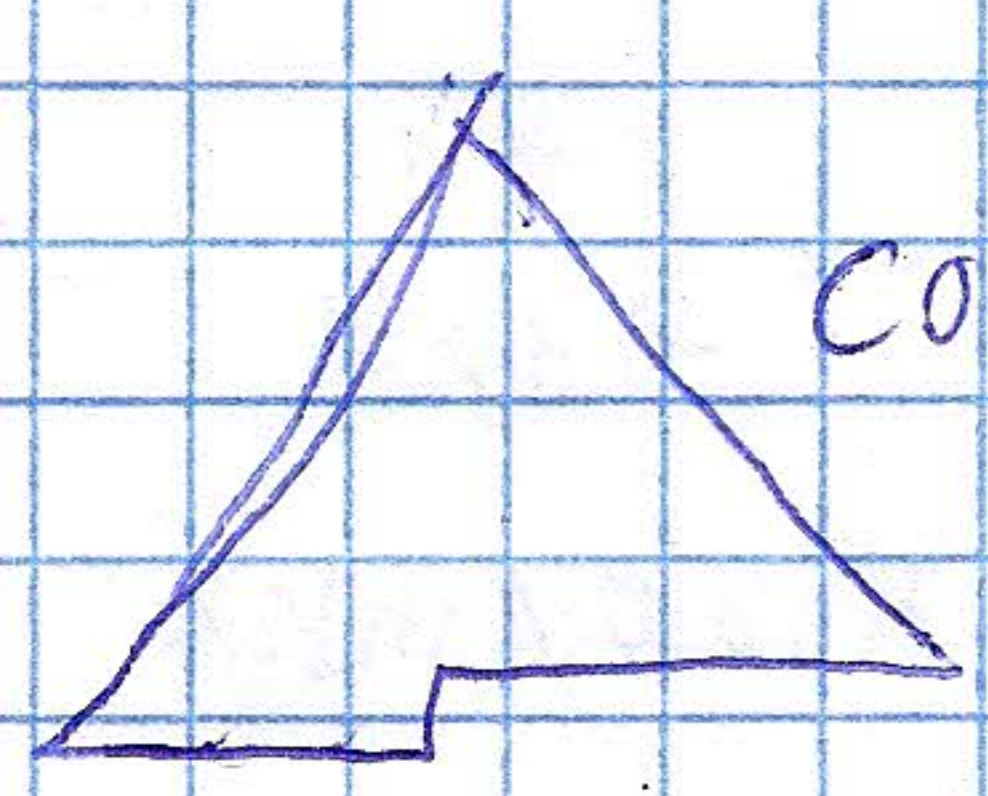
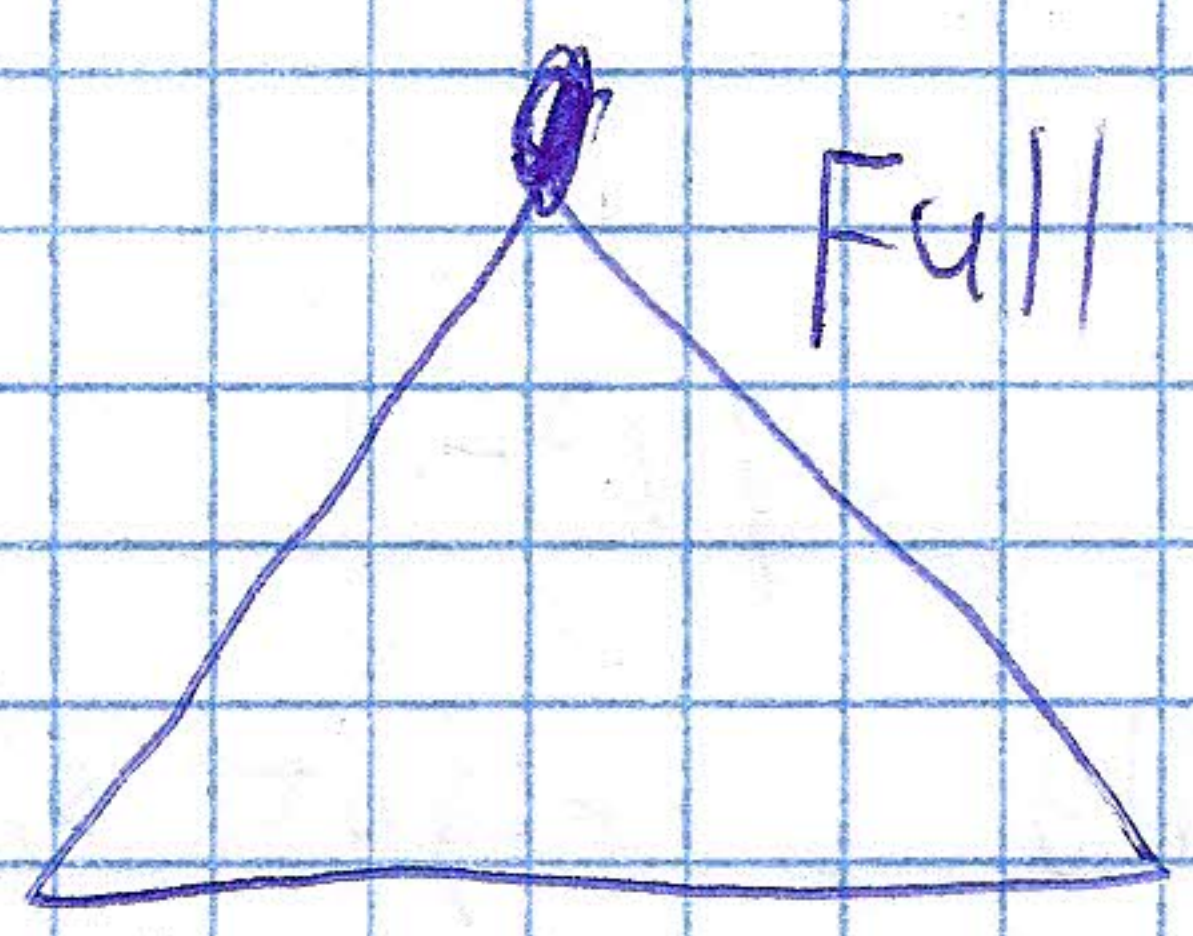
node, left, right

node, left, right

node, left, right

node, left, right

for tree



Complete

node, left, right

node, left, right

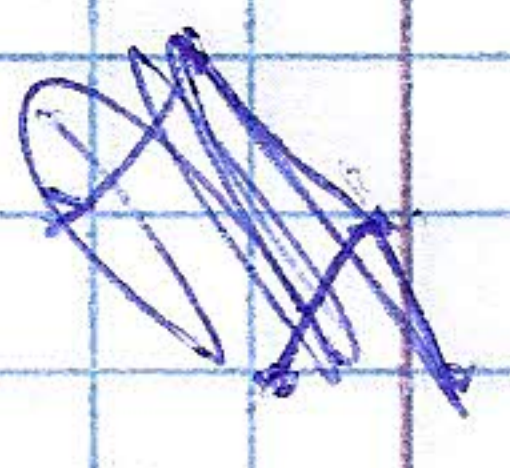
node, left, right

node, left, right

node, left, right

node, left, right

node, left, right



node, left, right

node, left, right

Handwritten text at the top left, possibly a title or header.

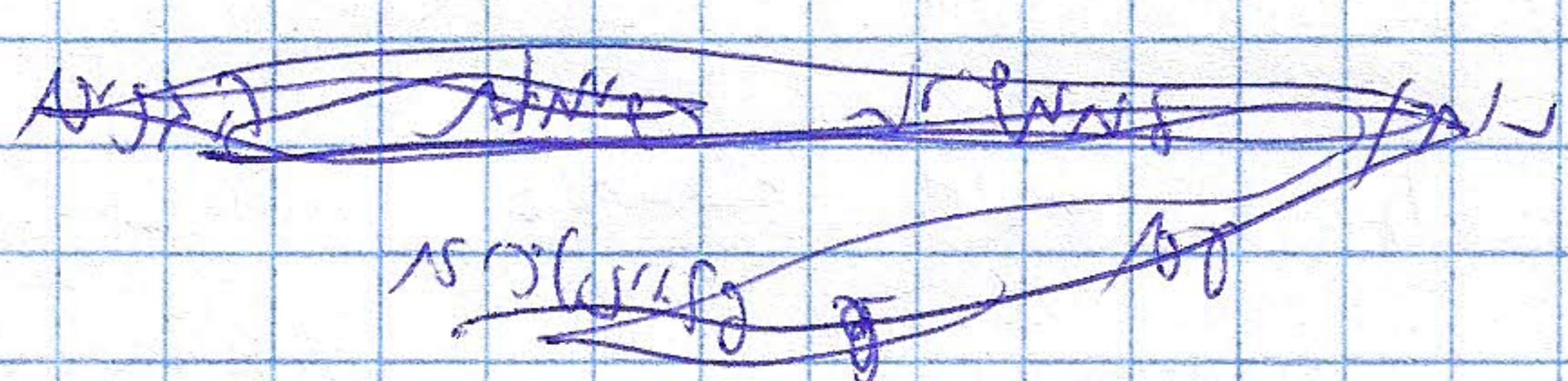
Handwritten notes in the upper middle section, including some mathematical symbols like $\frac{1}{2}$.

Handwritten notes in a box on the right side of the page.

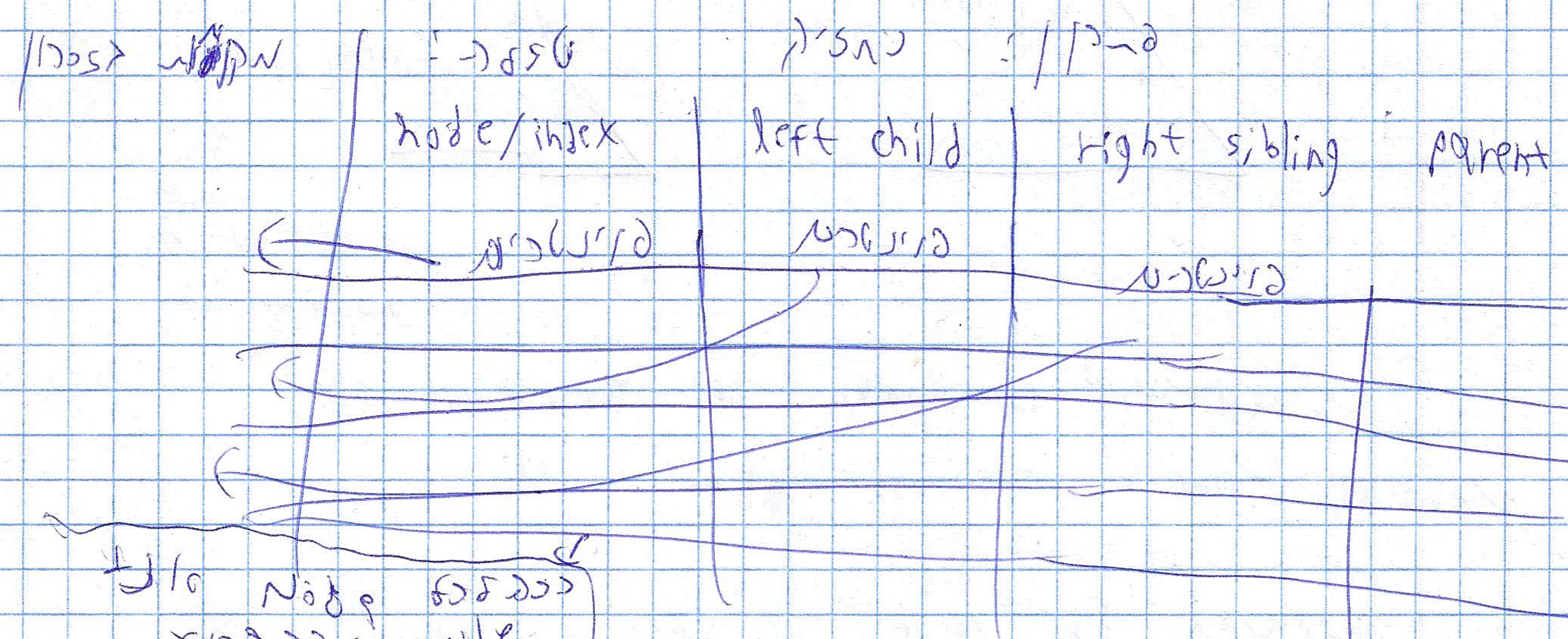
Handwritten text in the middle section, possibly a definition or explanation.

Handwritten text below the middle section.

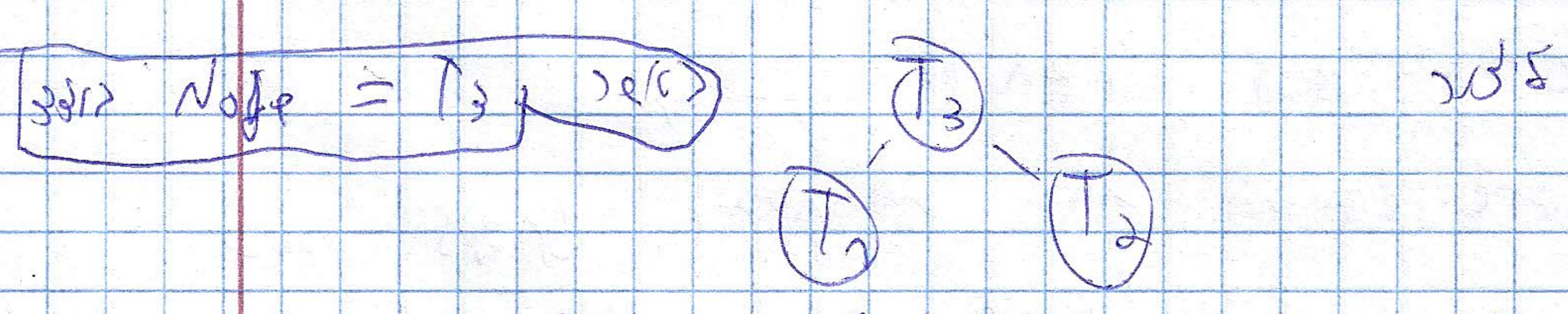
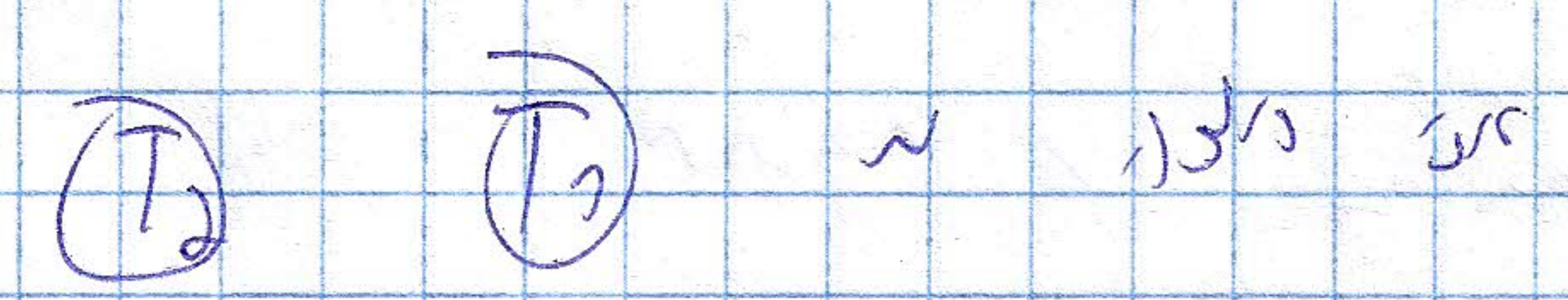
Handwritten text in the lower middle section.



Handwritten text below the diagram, possibly a caption or label.



Handwritten notes below the large diagram, possibly explaining its components.



Handwritten text at the bottom of the page, possibly a conclusion or final note.

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$$\frac{k^h}{k^h + \dots + k^2 + k + 1}$$

$$= \frac{k^h}{k^{h+1} - 1}$$

$$= \frac{k^h (k-1)}{k^{h+1} - 1}$$

$$= \frac{k-1}{k - \frac{1}{k^h}}$$

$$\geq \frac{k-1}{k}$$

\rightarrow