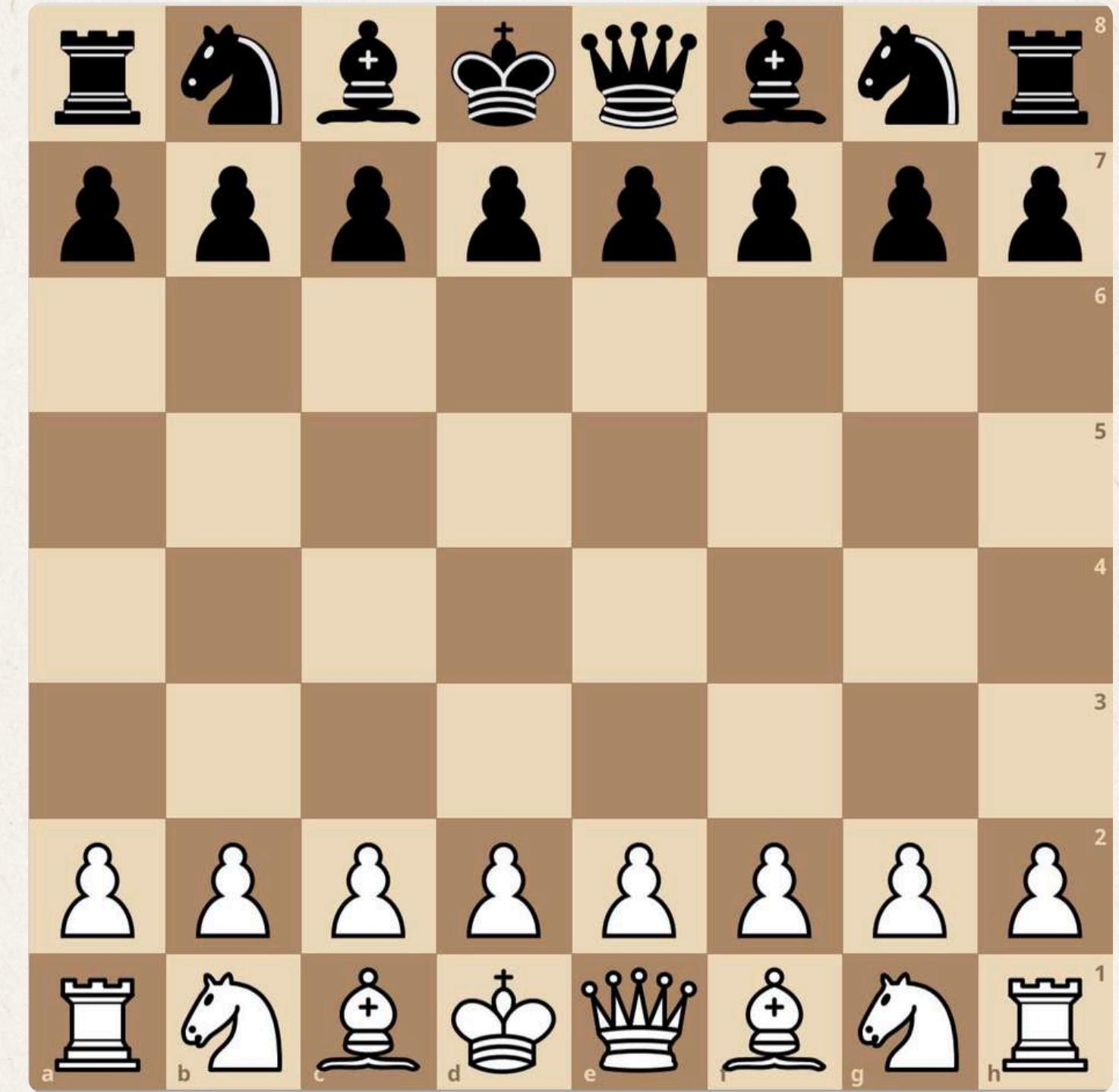


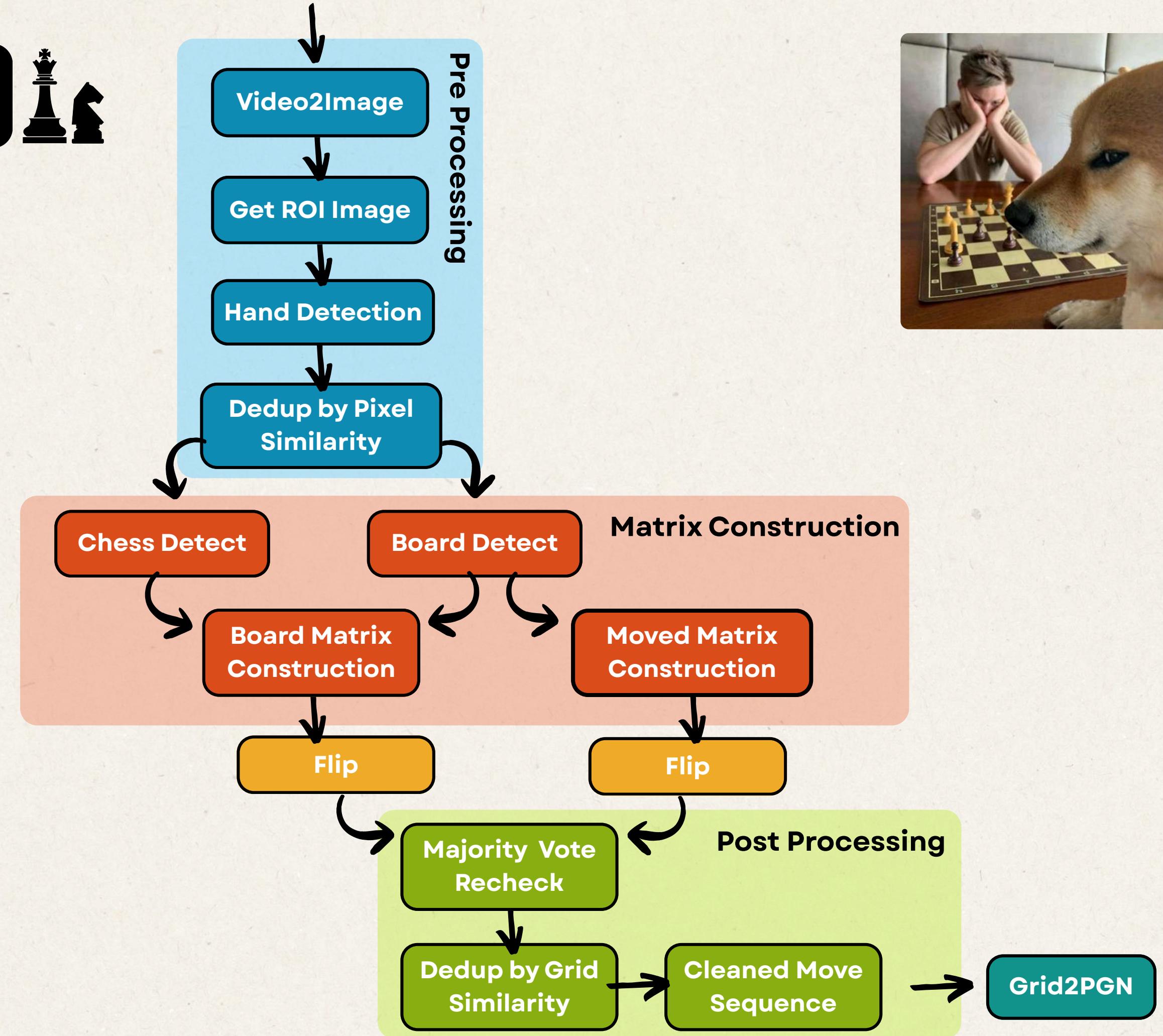


CHESS DETECTION COMPETITION

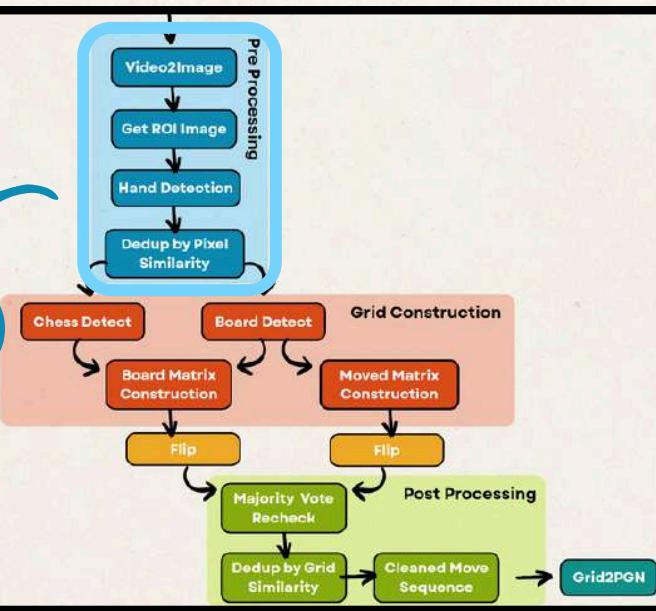
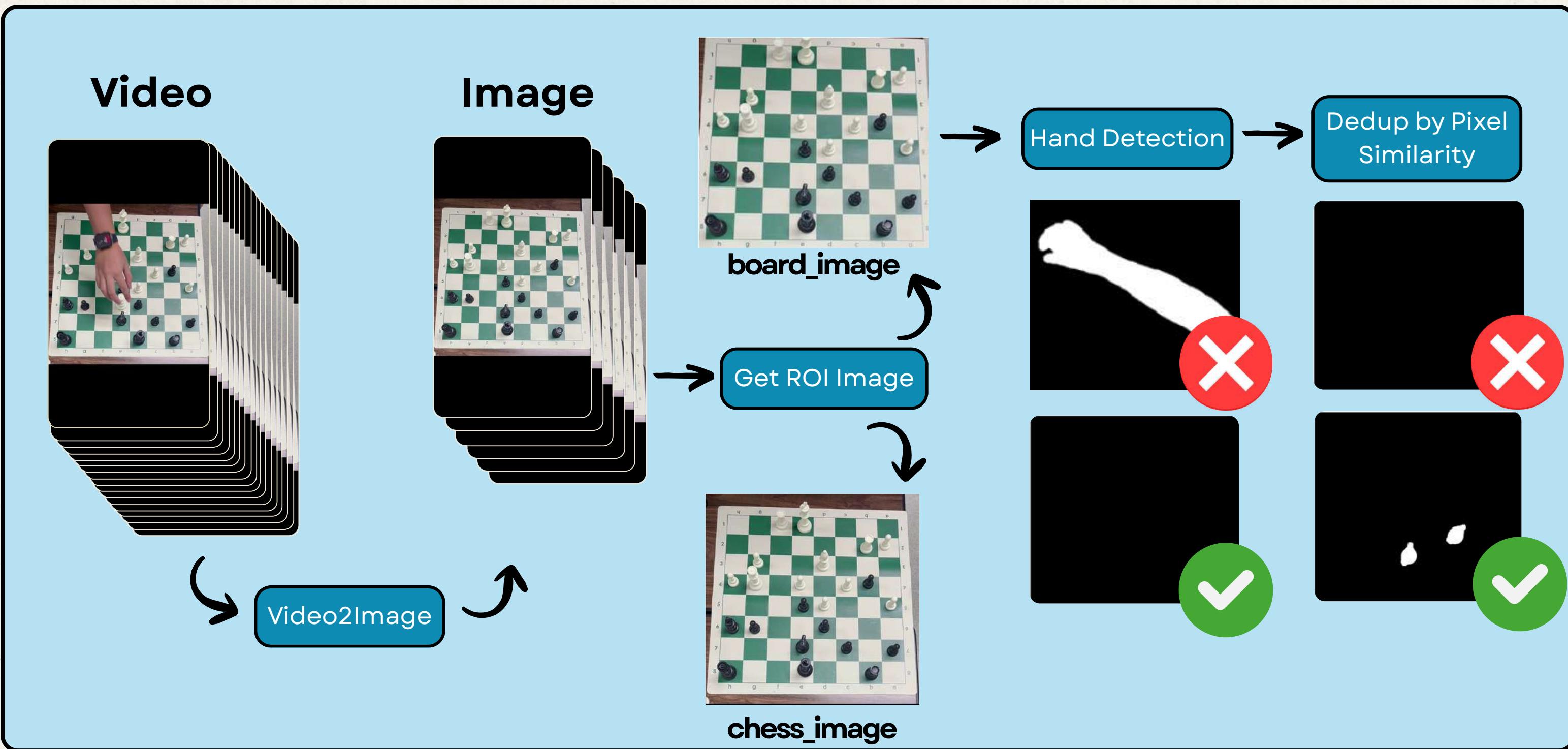
TEAM: JUJU อย่าลืมทำงาน



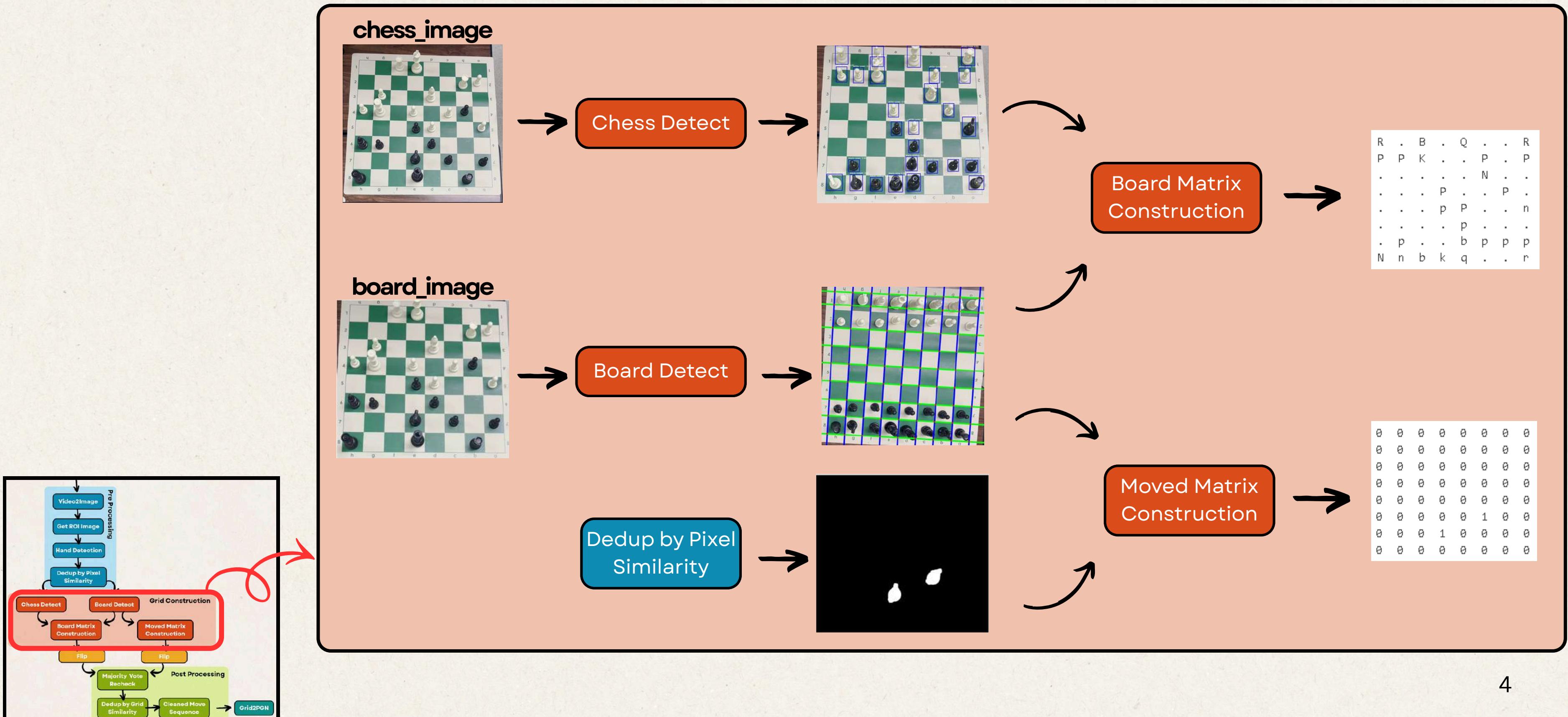
Pipeline : Overall



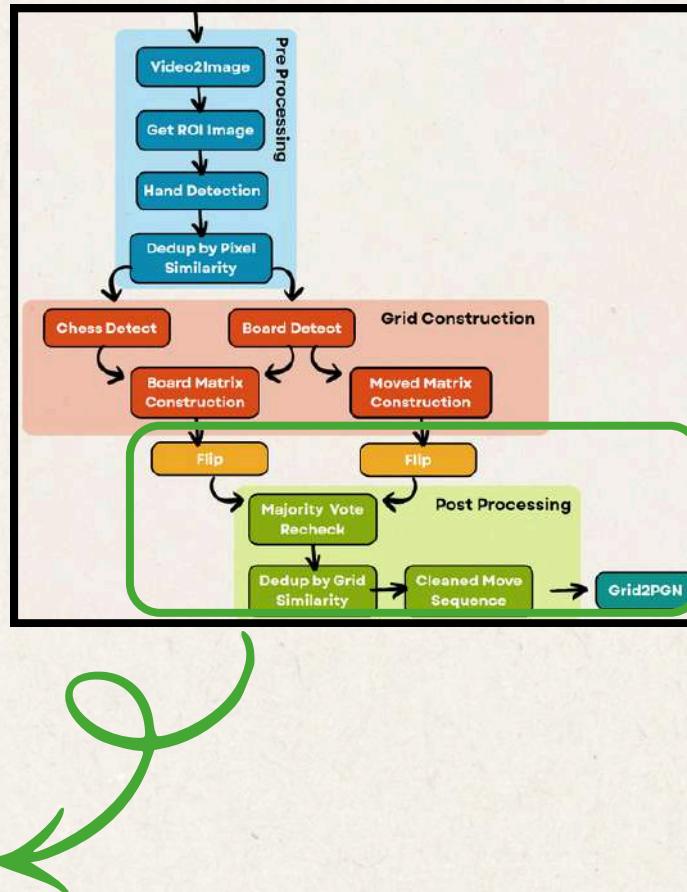
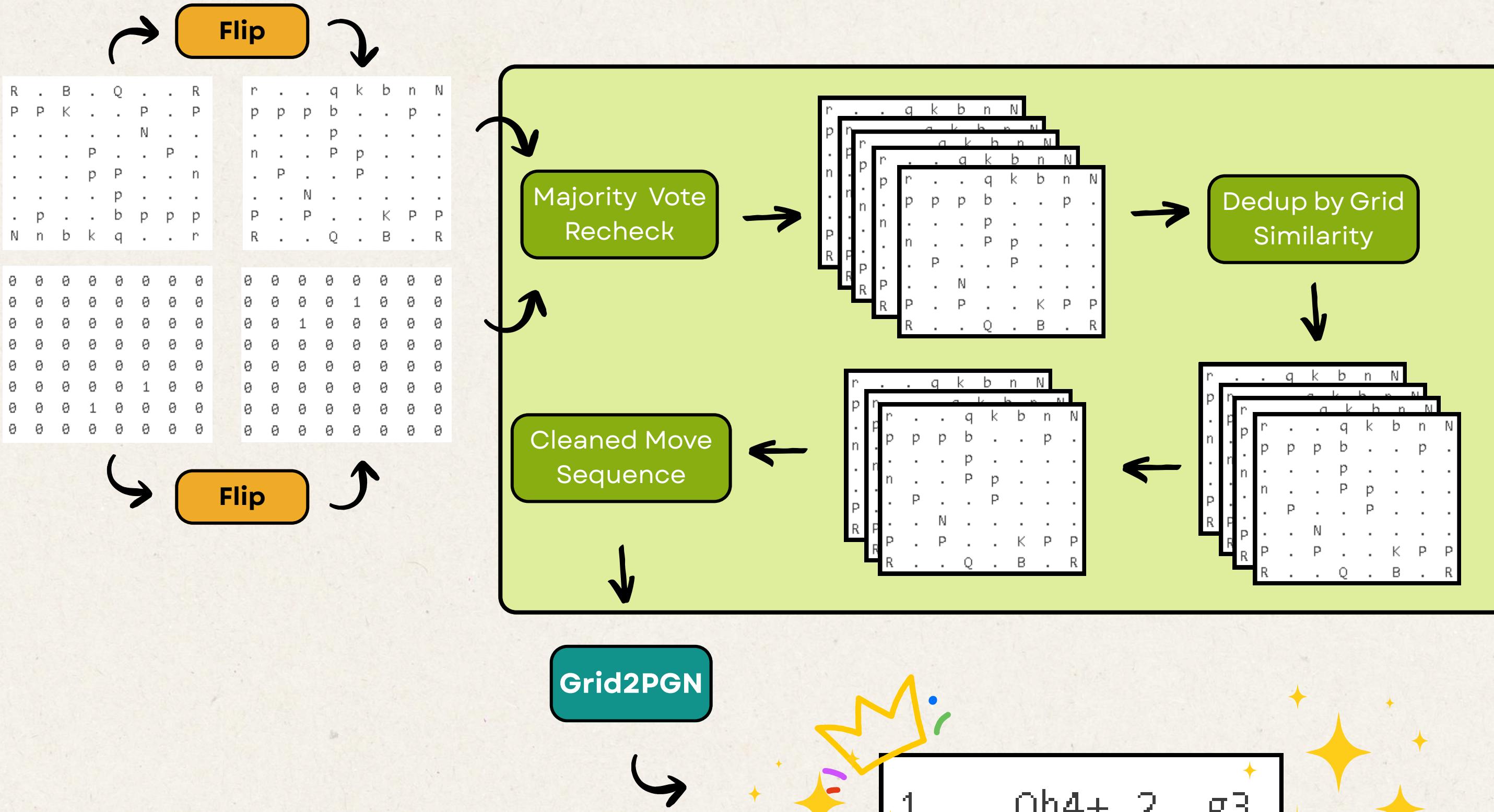
Pipeline : Pre - Processing



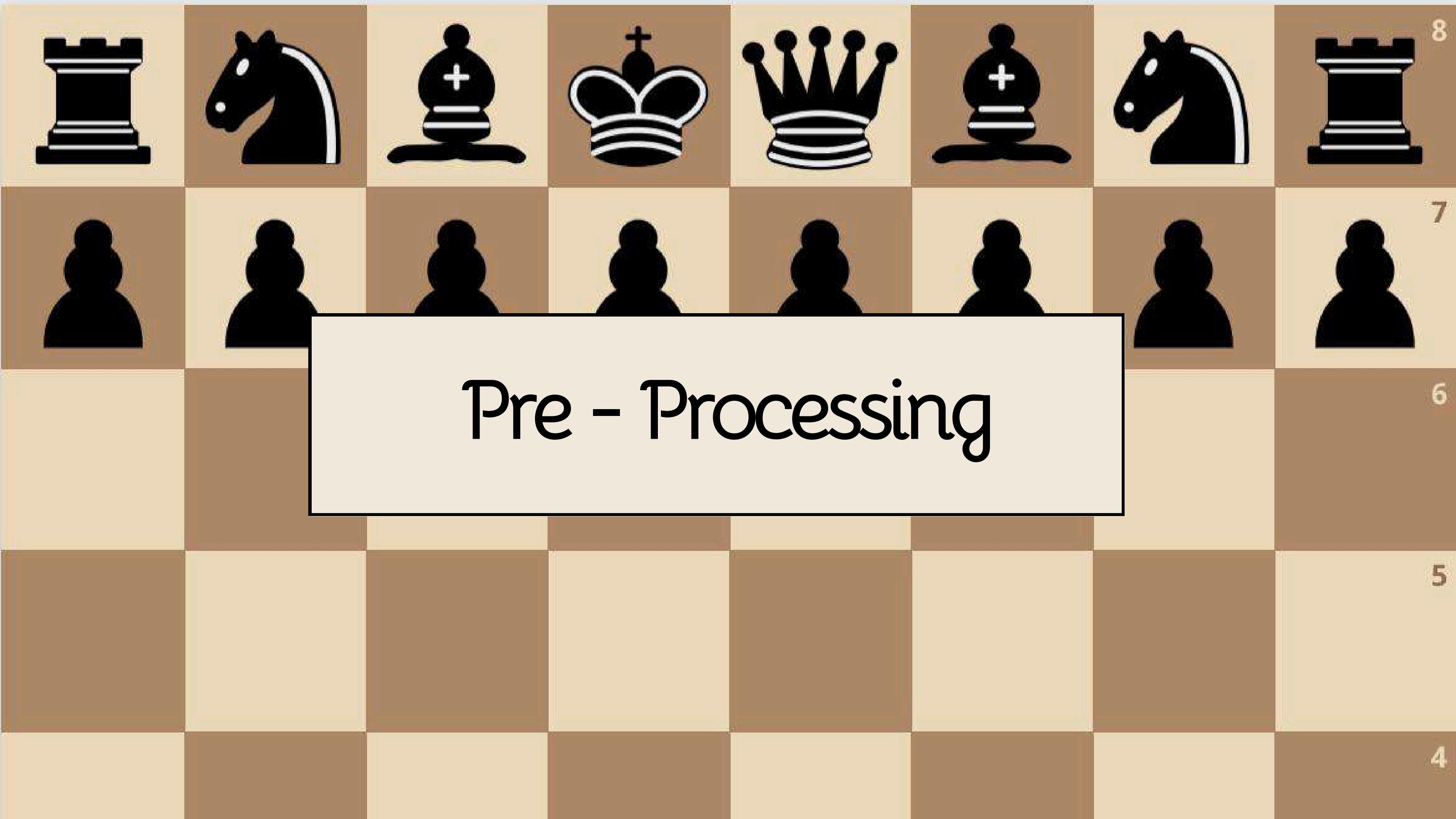
Pipeline : Matrix Construction



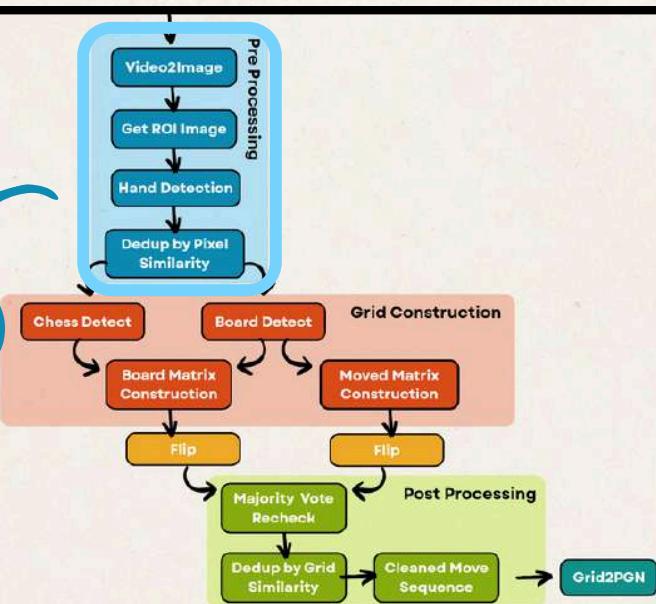
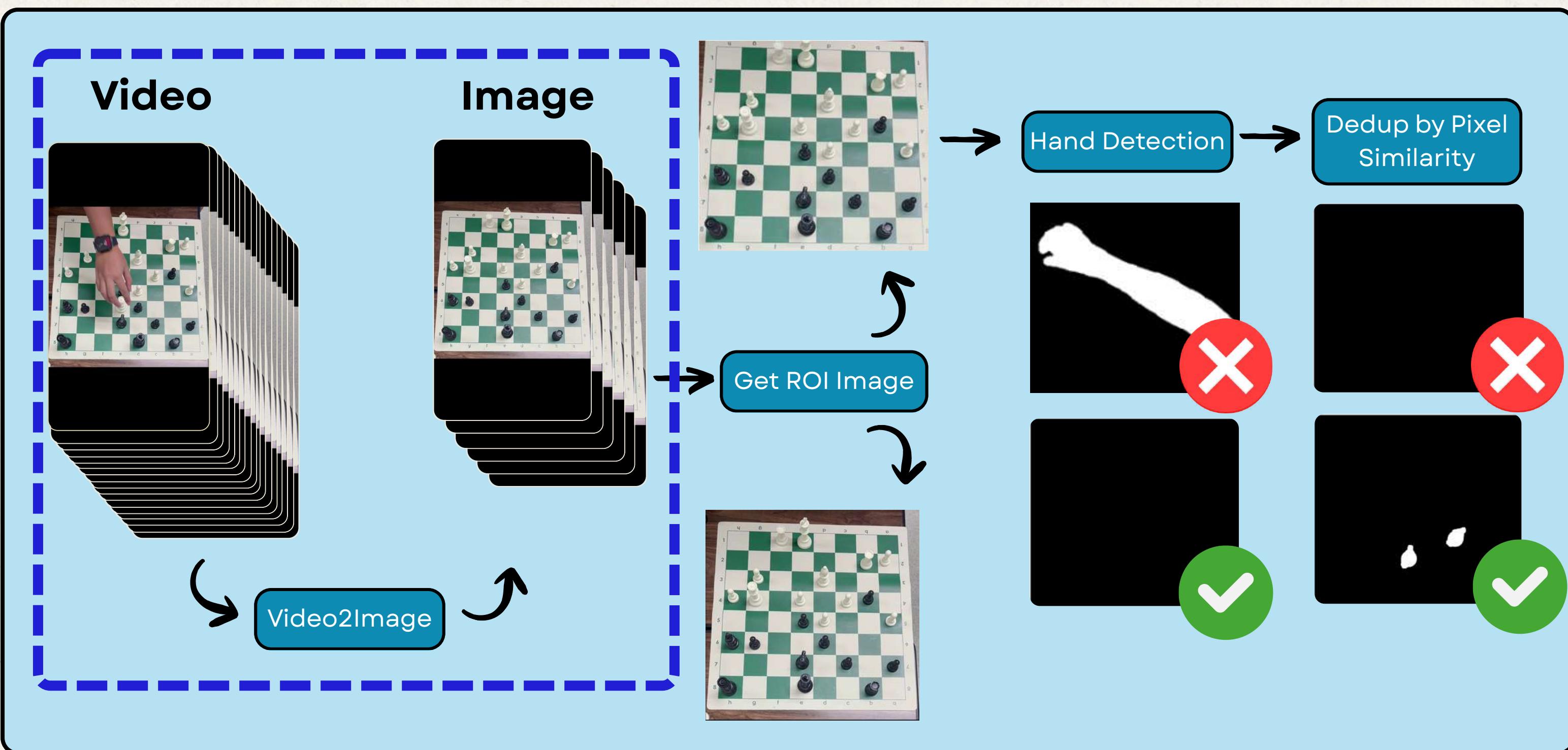
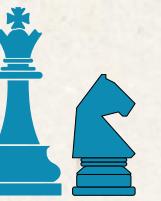
Pipeline : Post - Processing



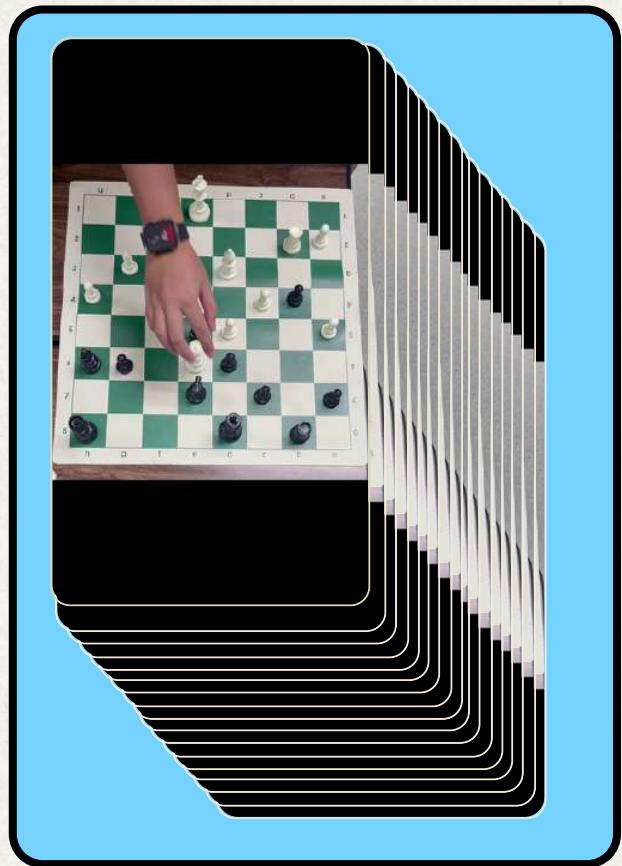
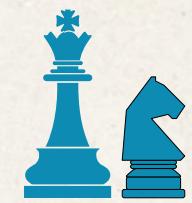
Pre - Processing



Pipeline : Pre - Processing



Video2Image



Video

Frame 15	Frame 30	Frame 45	Frame 60	Frame 75	Frame 90
clean	clean	block	block	block	clean

save

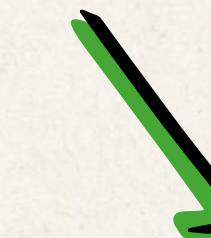
save

By Yolov8 nano

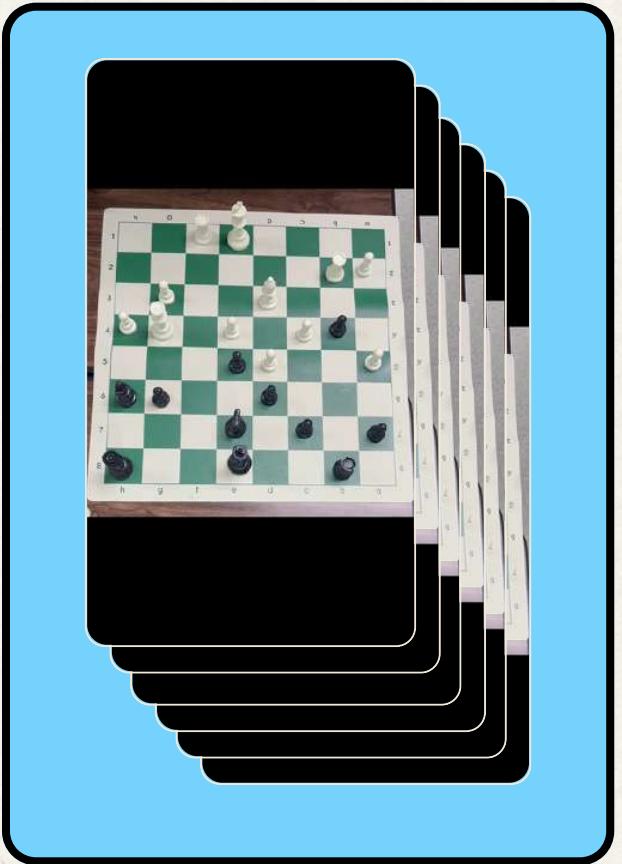
⚠️
Found Hand



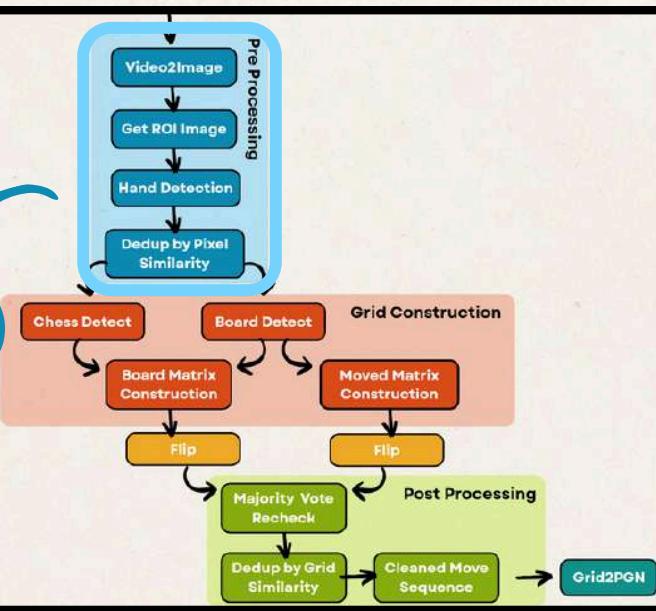
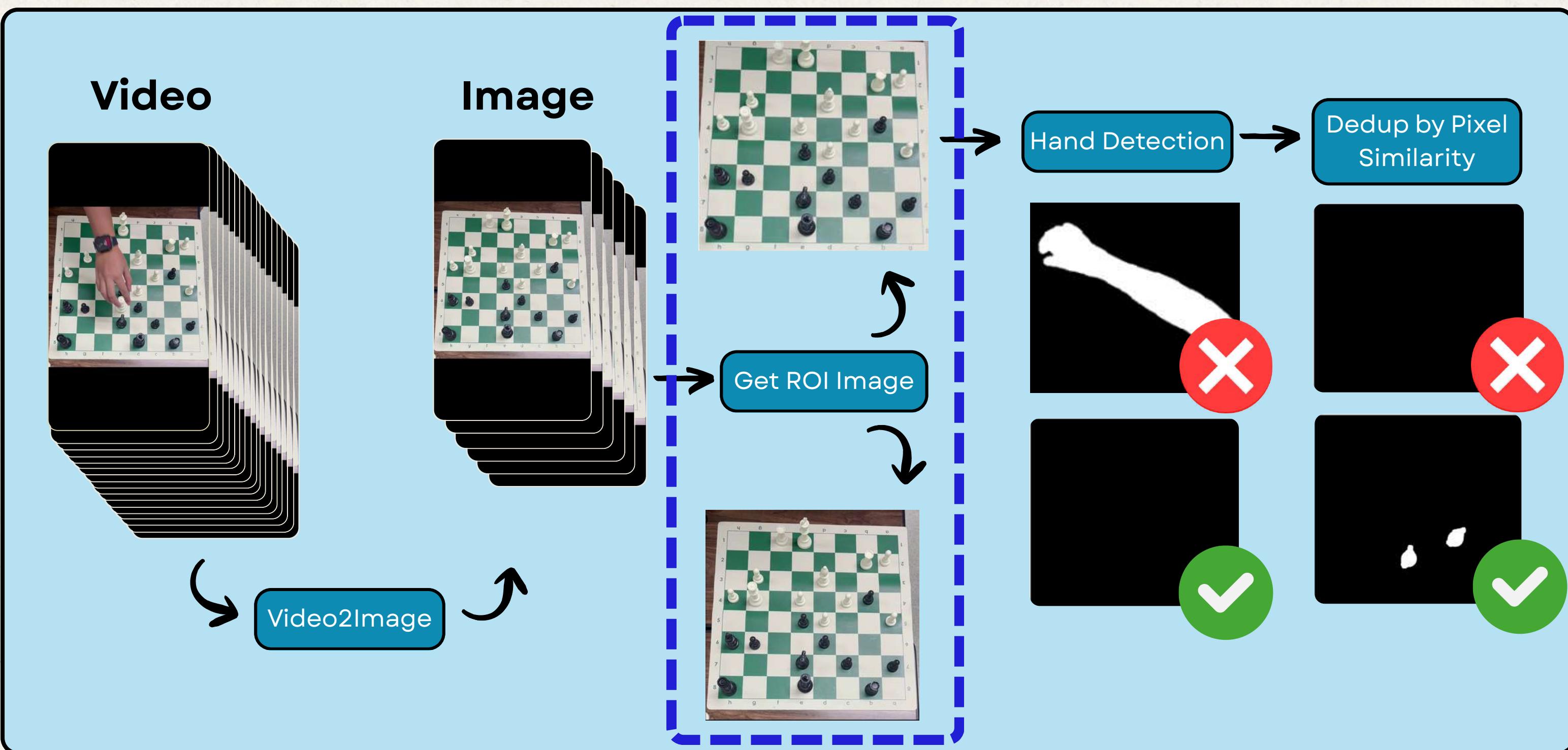
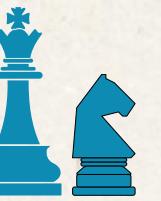
👍
Not Found Hand



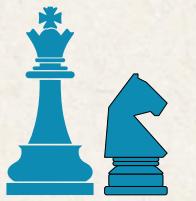
Image



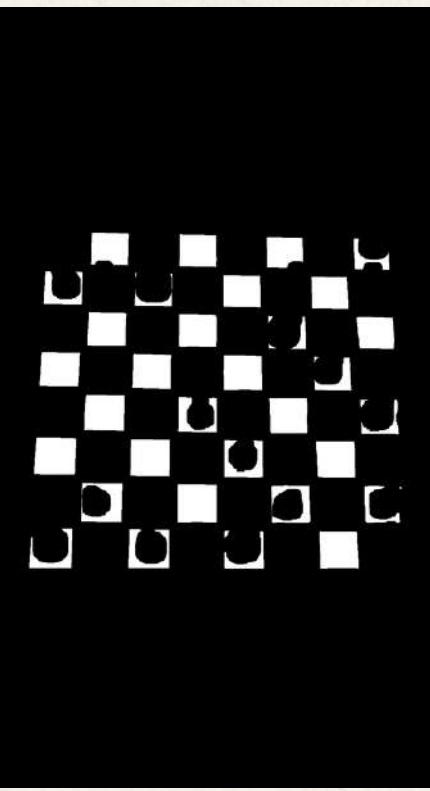
Pipeline : Pre - Processing



ROI Image



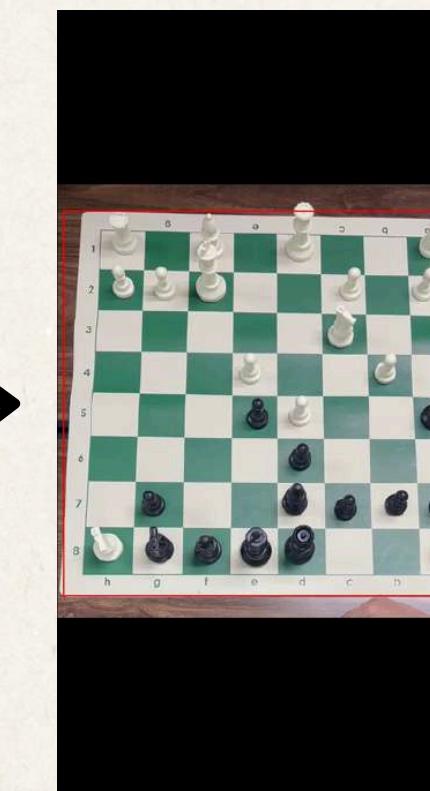
Original Frame



Green Mask
Opening



Mask Overlay



Frame with Box

+ Grid padding



Board Image



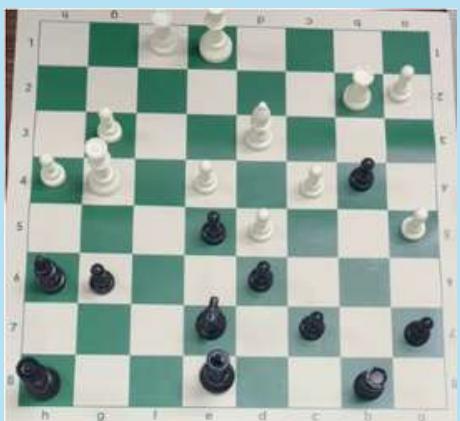
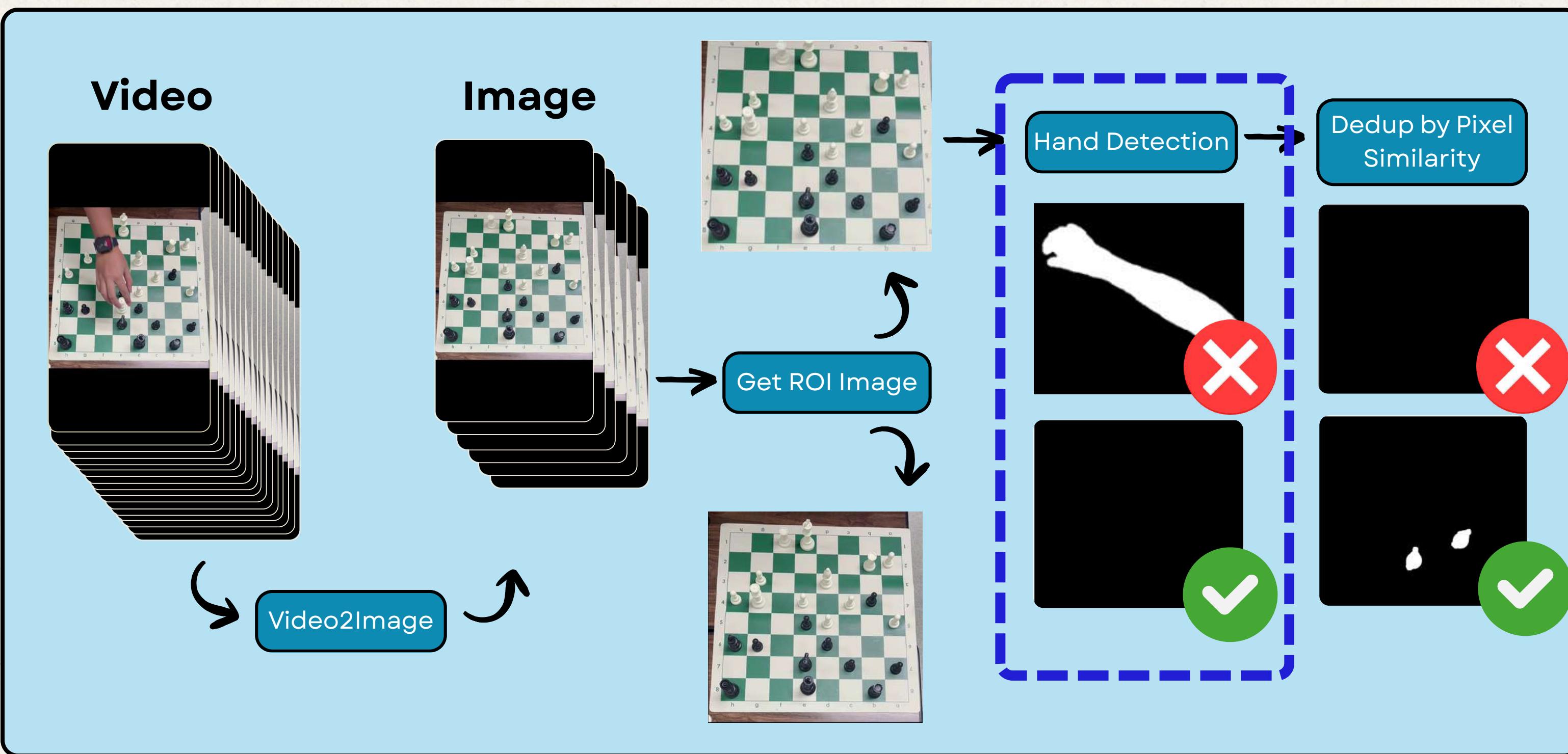
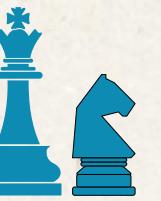
Cropped Image

+ Image padding



Chess Image

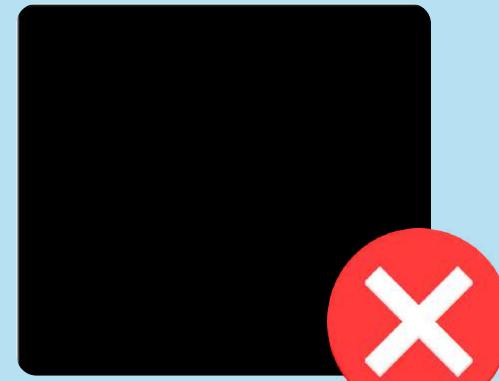
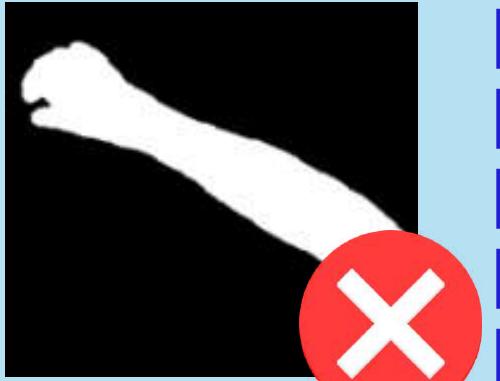
Pipeline : Pre - Processing



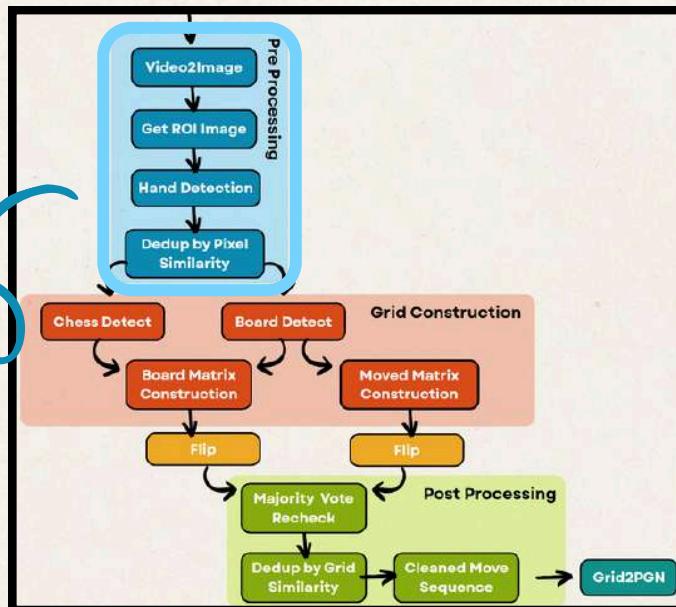
Get ROI Image

Hand Detection

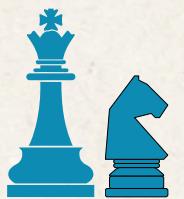
Dedup by Pixel Similarity



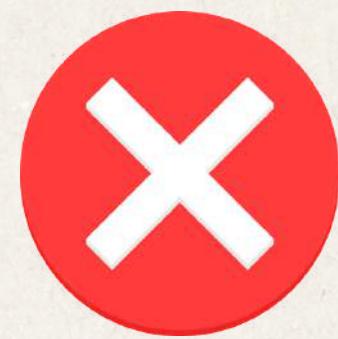
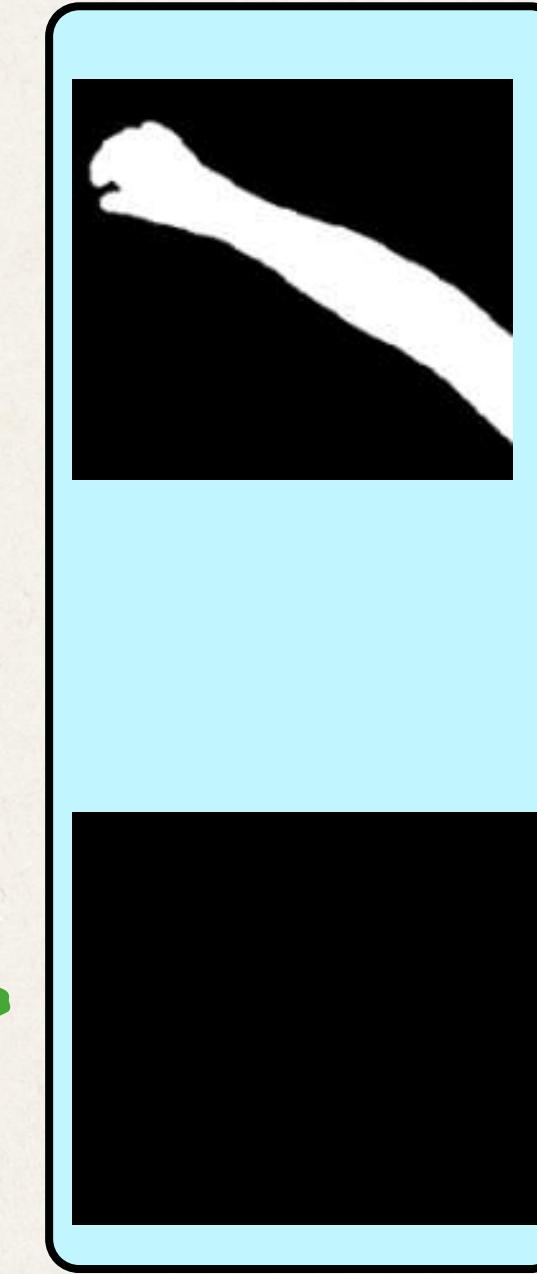
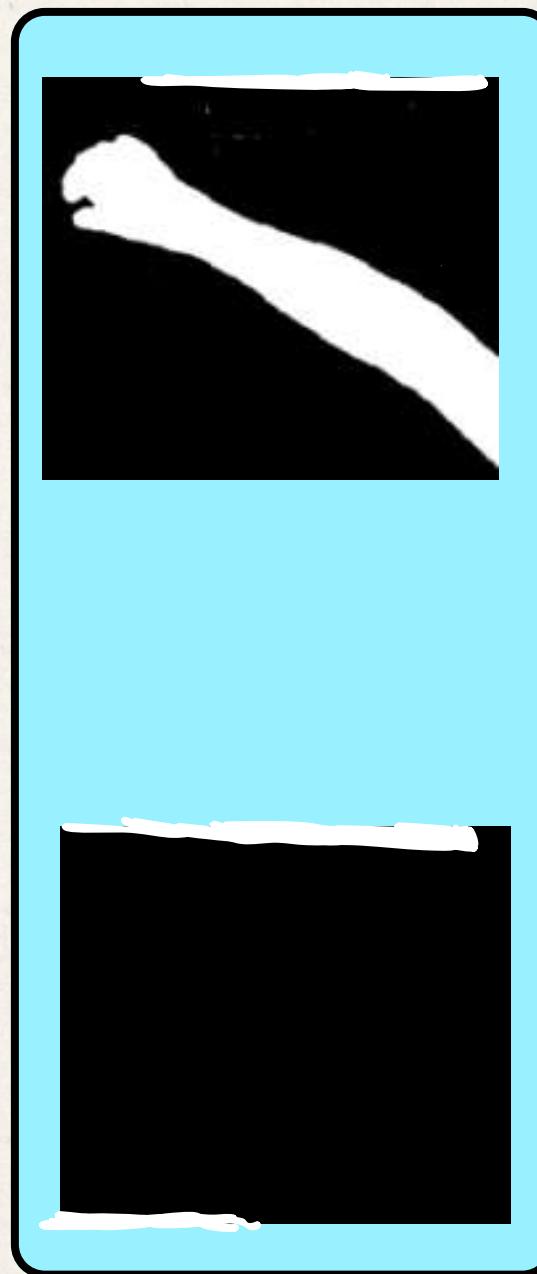
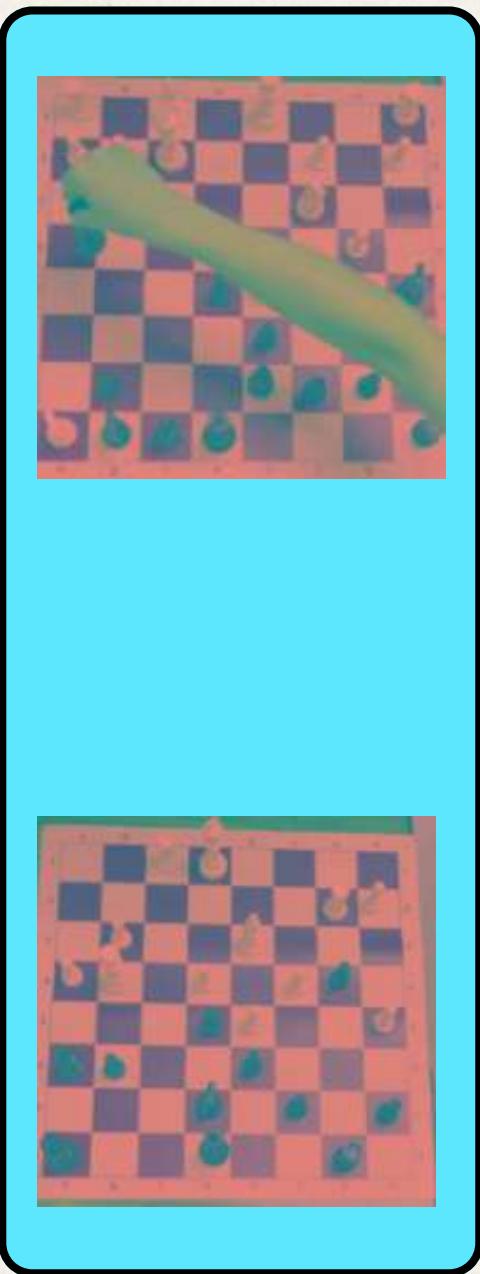
Video2Image



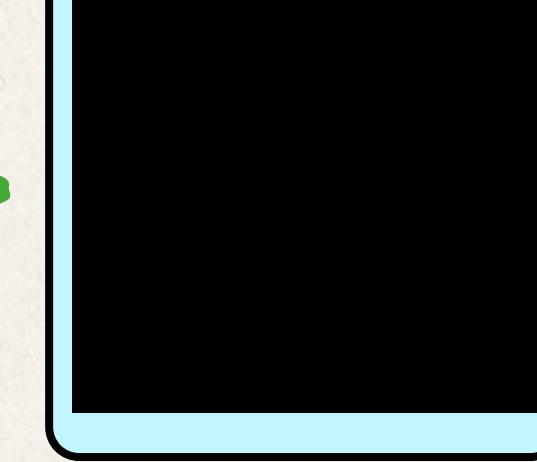
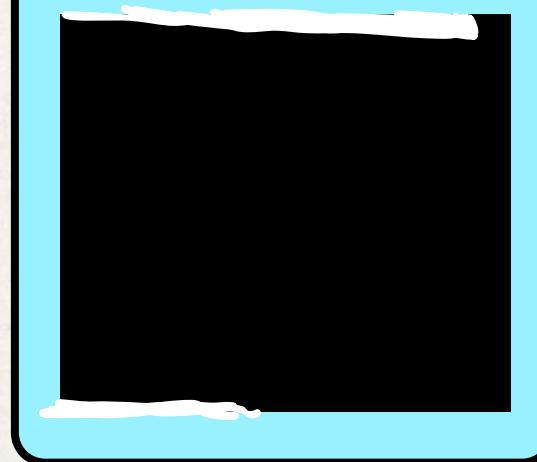
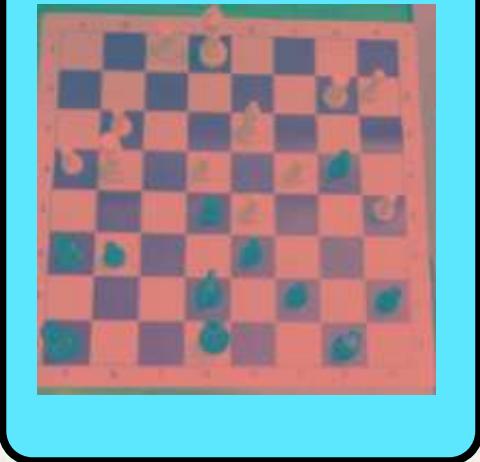
Hand Detection



With Hand



Without Hand

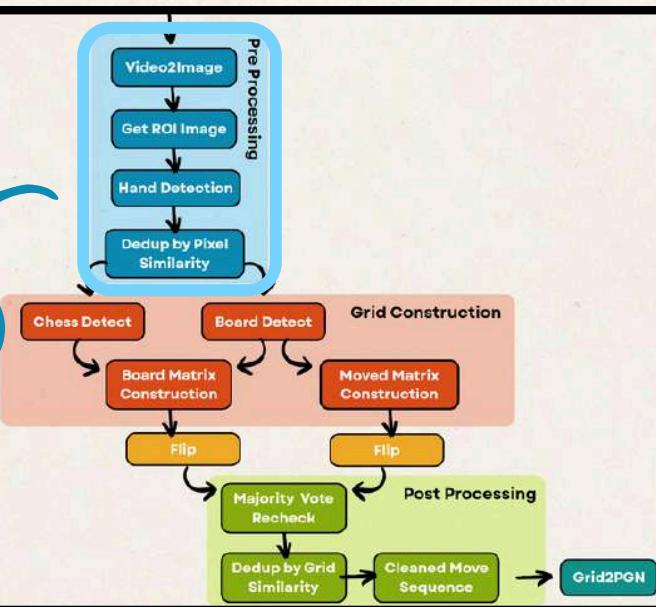
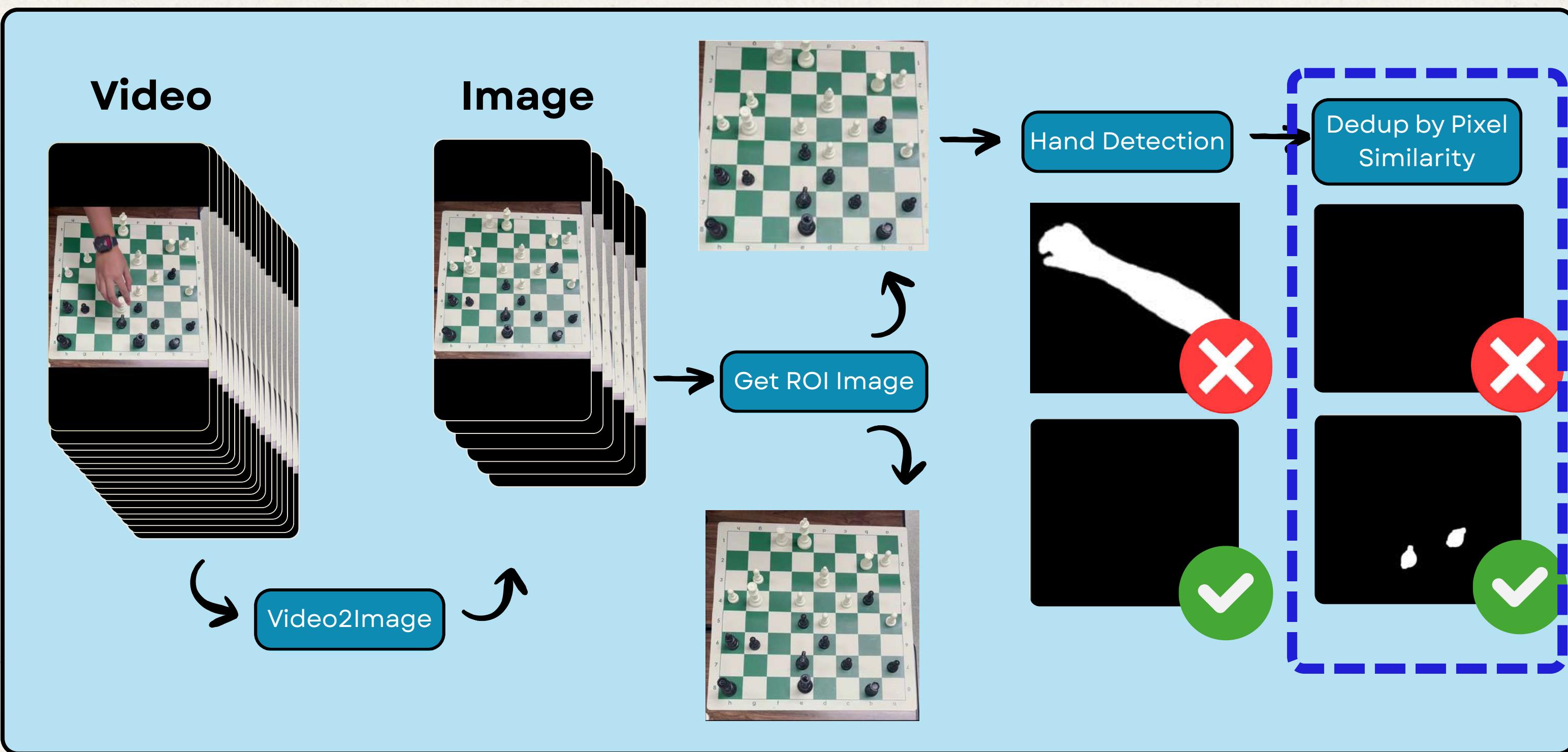


BGR2YCrCb

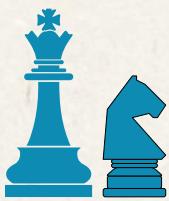
Thresholding
0/255

Crop + Morphology
(Noise Suppression)

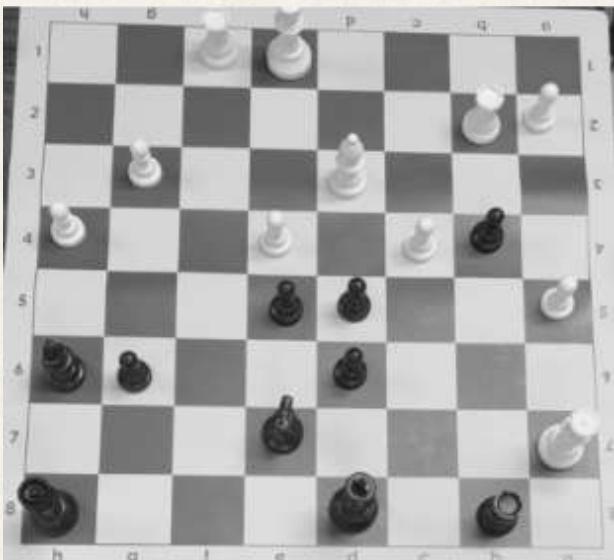
Pipeline : Pre - Processing



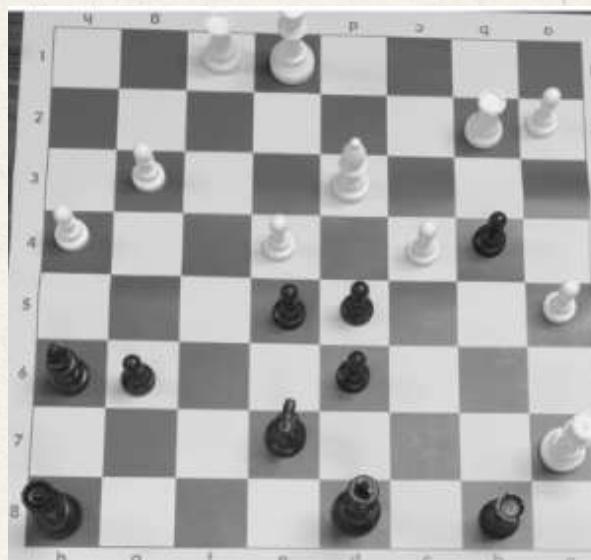
Dedup by pixels similarity



Same Frame



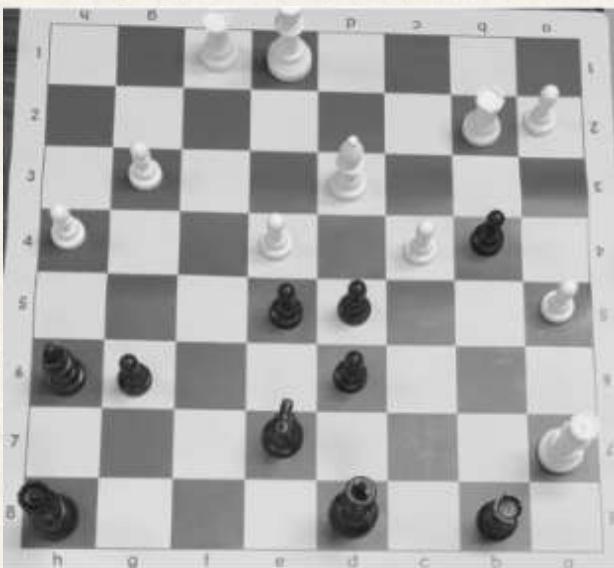
Current Frame
(Gray Scale)



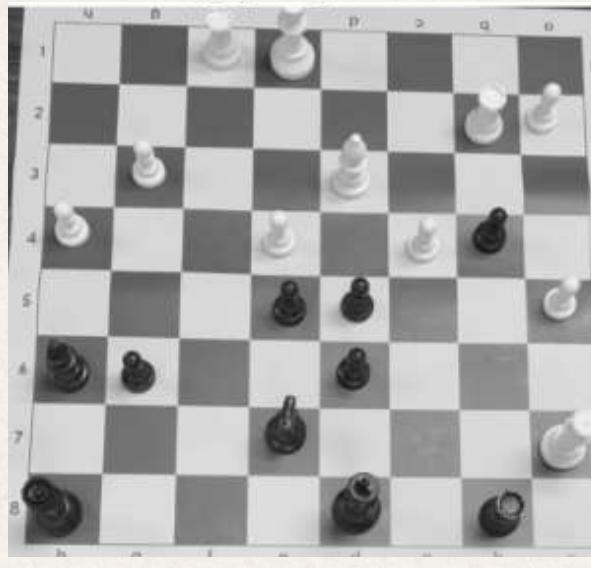
Current Frame
(Gaussian Blur)



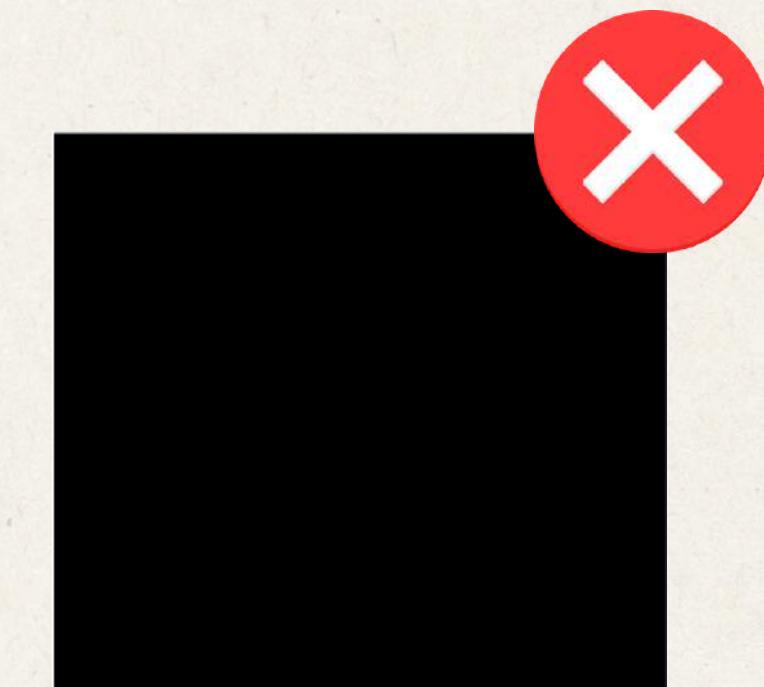
Difference Image
after Thresholding
(Pixel Change Detection)



Previous Frame
(Gray Scale)



Previous Frame
(Gaussian Blur)



Crop+ Morphological
(Noise Suppression)



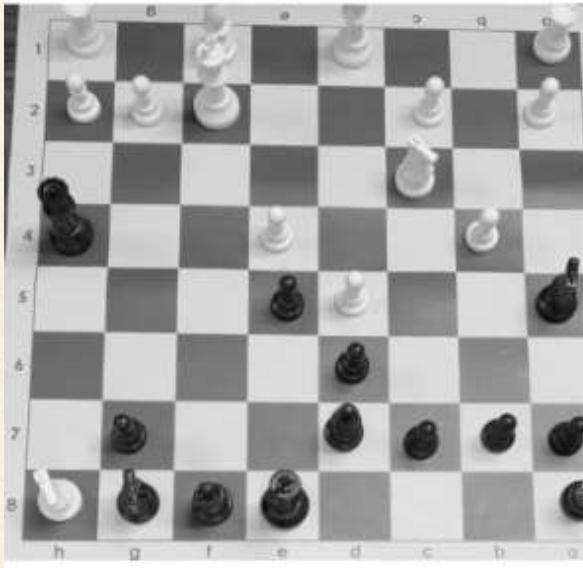
Dedup by pixels similarity



Different Frame



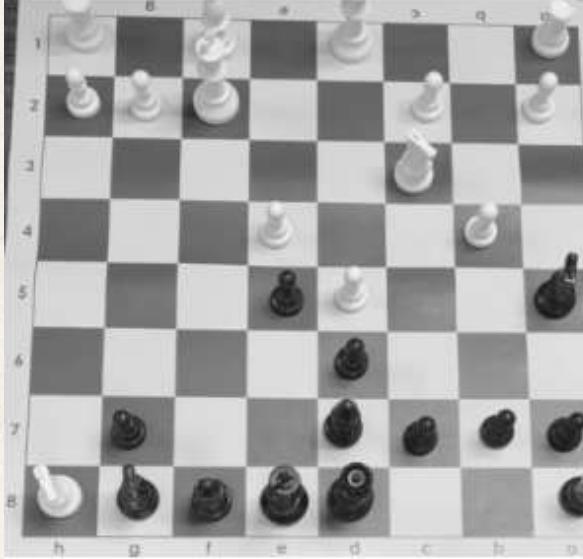
Current Frame
(Gray Scale)



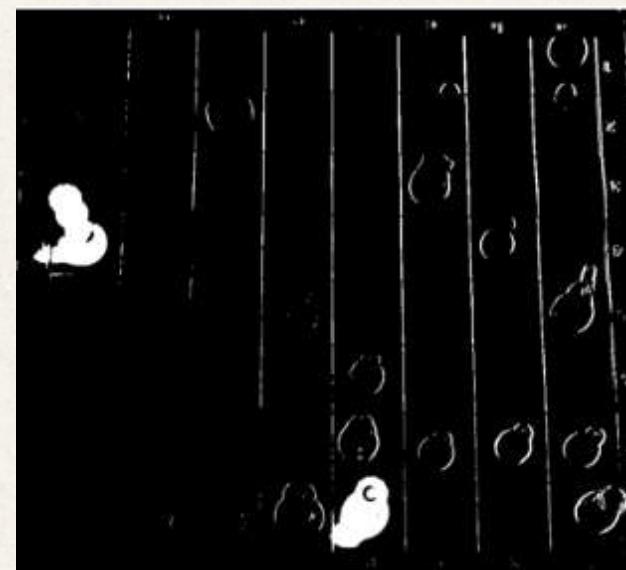
Current Frame
(Gaussian Blur)



Previous Frame
(Gray Scale)



Previous Frame
(Gaussian Blur)



Difference Image
after Thresholding
(Pixel Change Detection)



Crop+ Morphological
(Noise Suppression)



Matrix Construction

8

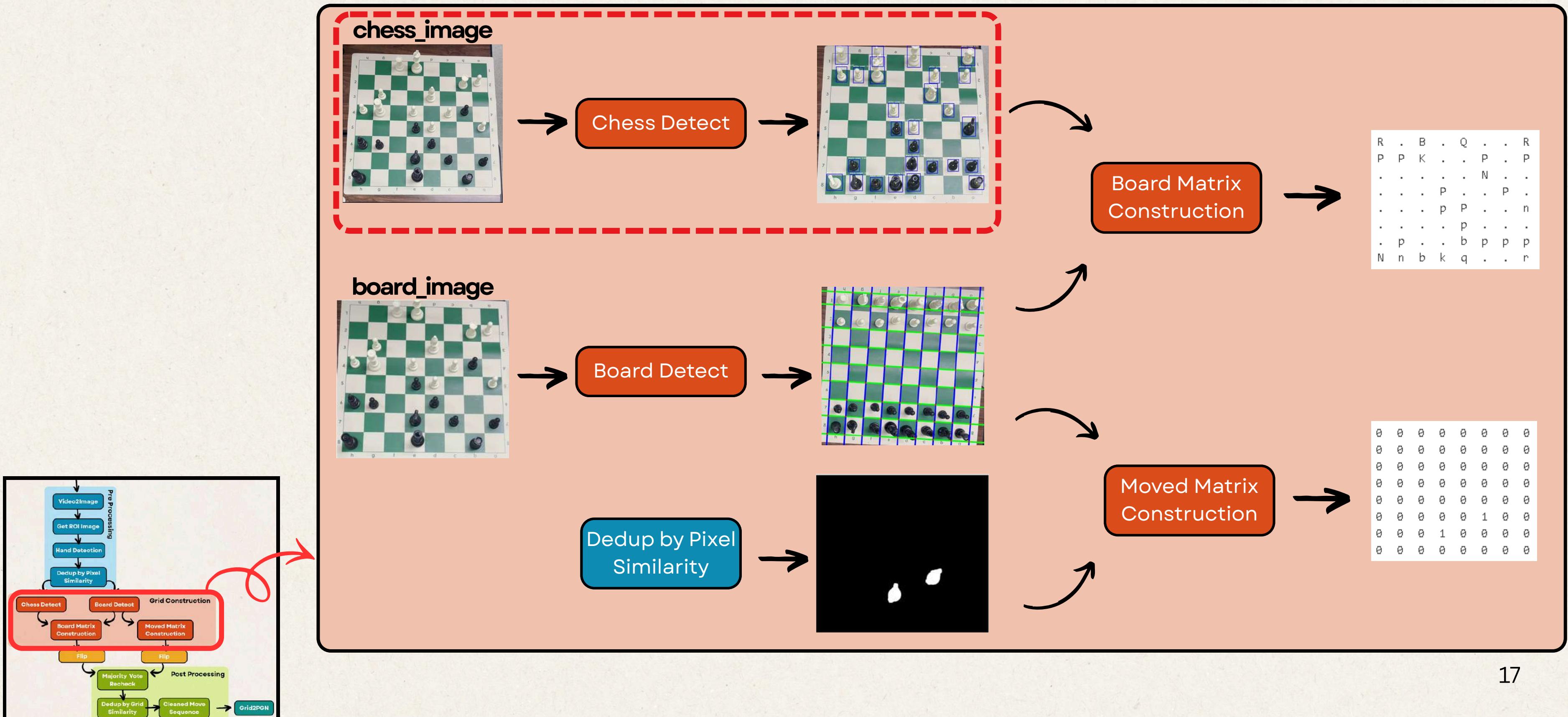
7

6

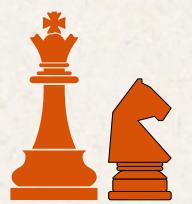
5

4

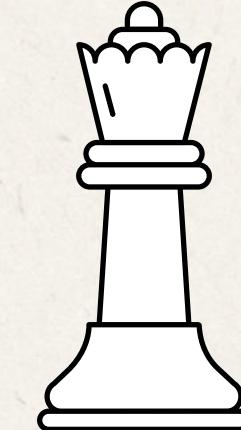
Pipeline : Matrix Construction



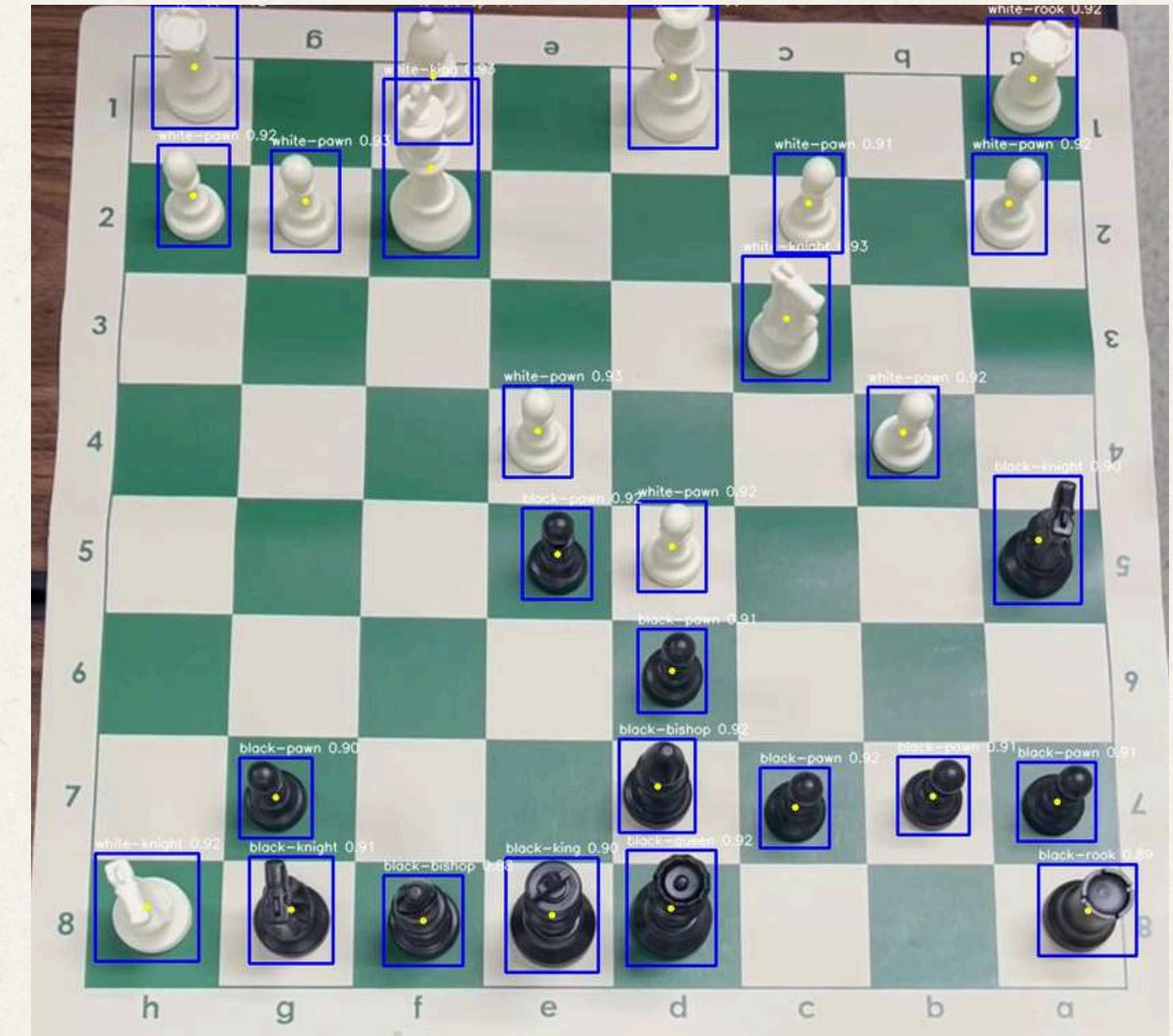
Pieces Detection



b :"black-bishop"
k :"black-king"
n :"black-knight"
p :"black-pawn"
q :"black-queen"
r :"black-rook"

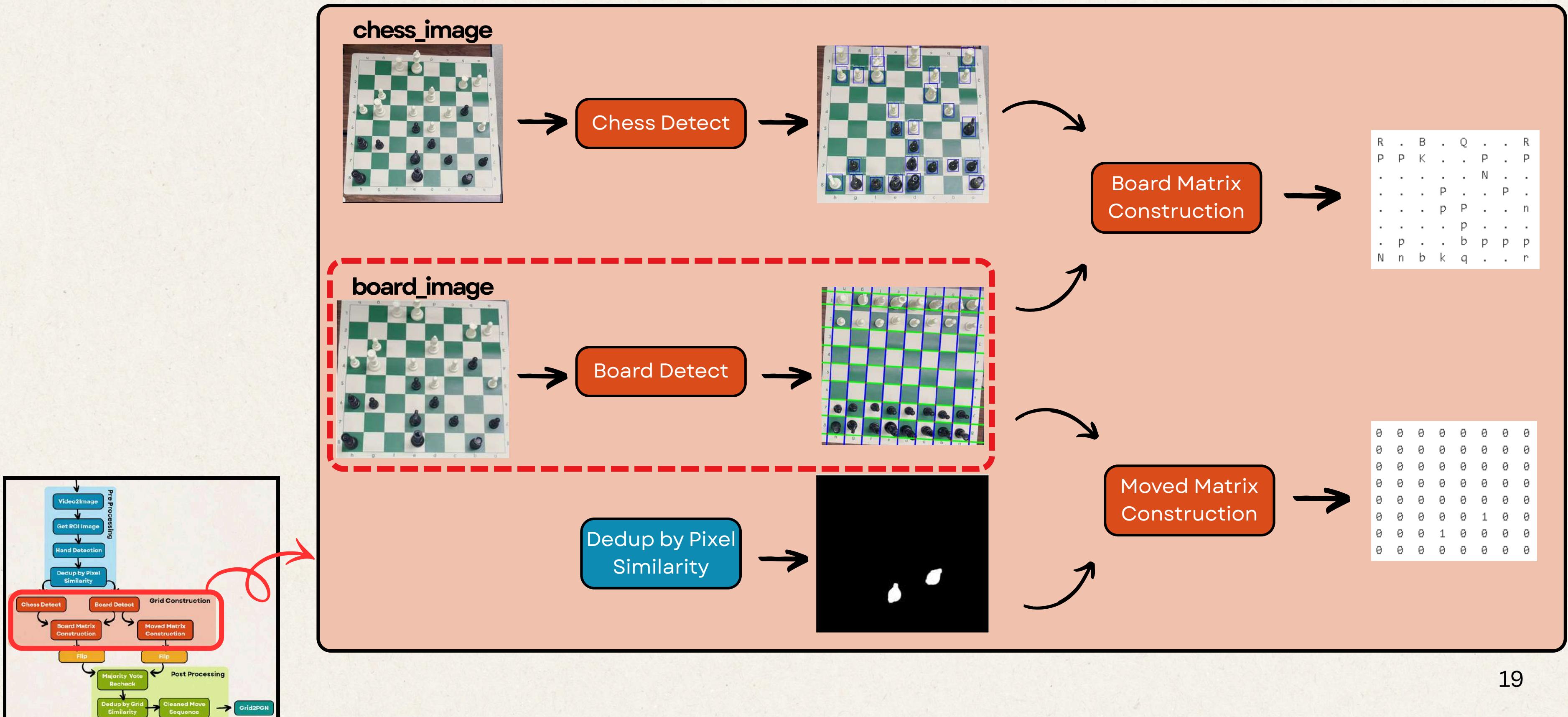


B : "white-bishop"
K : "white-king"
N : "white-knight"
P : "white-pawn"
Q : "white-queen"
R : "white-rook"

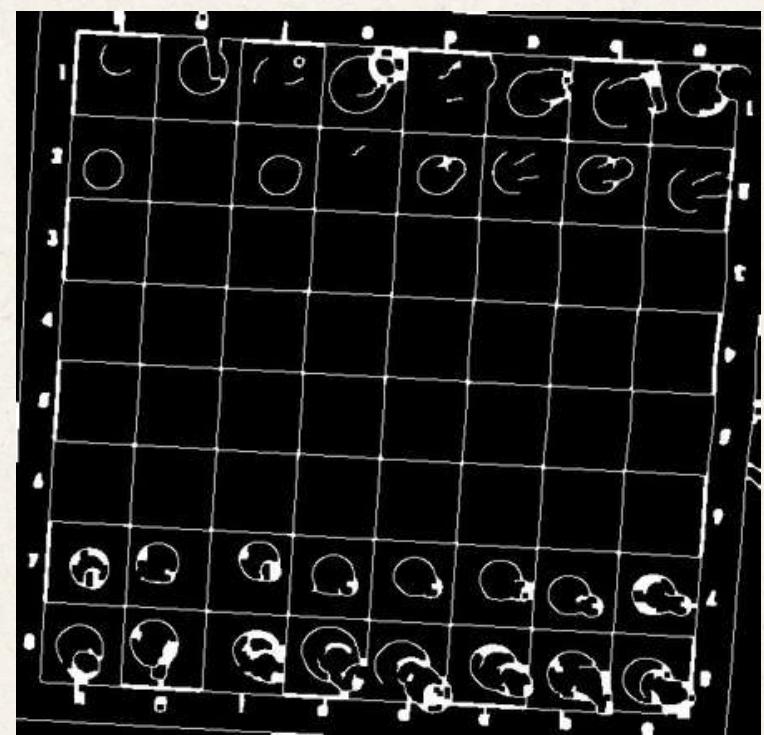
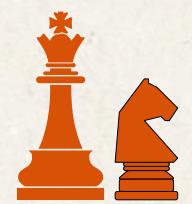


Special Yolo8m

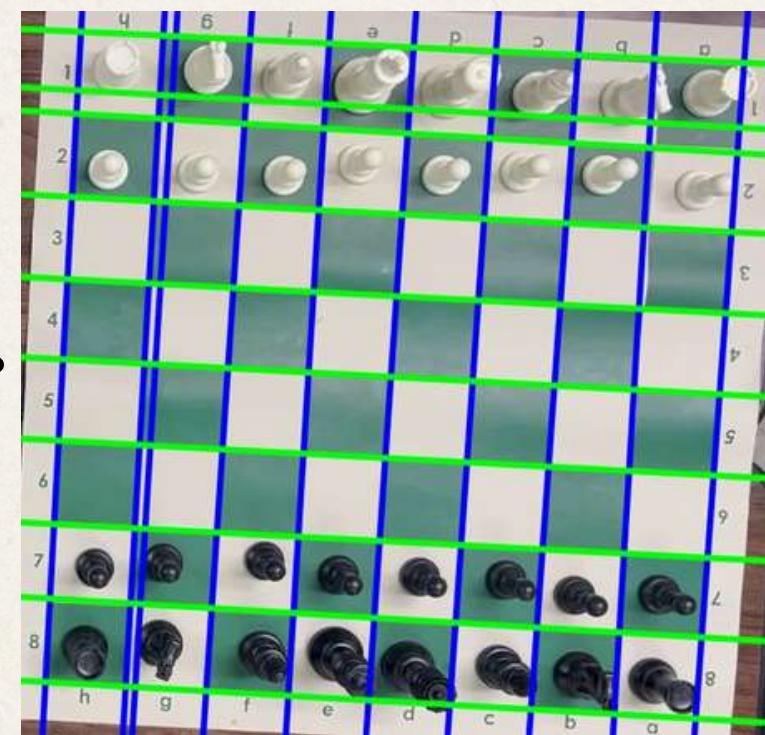
Pipeline : Matrix Construction



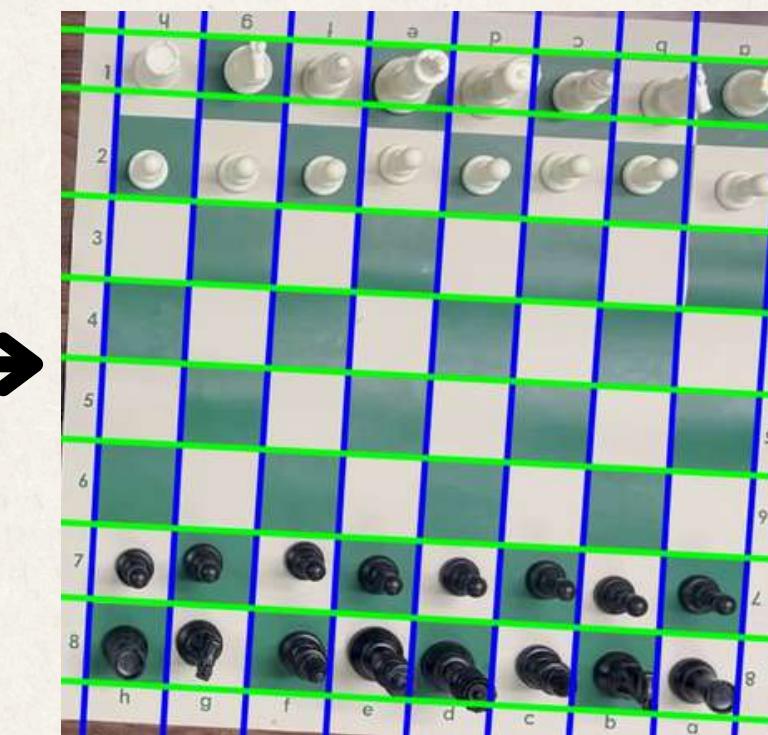
Board Detection



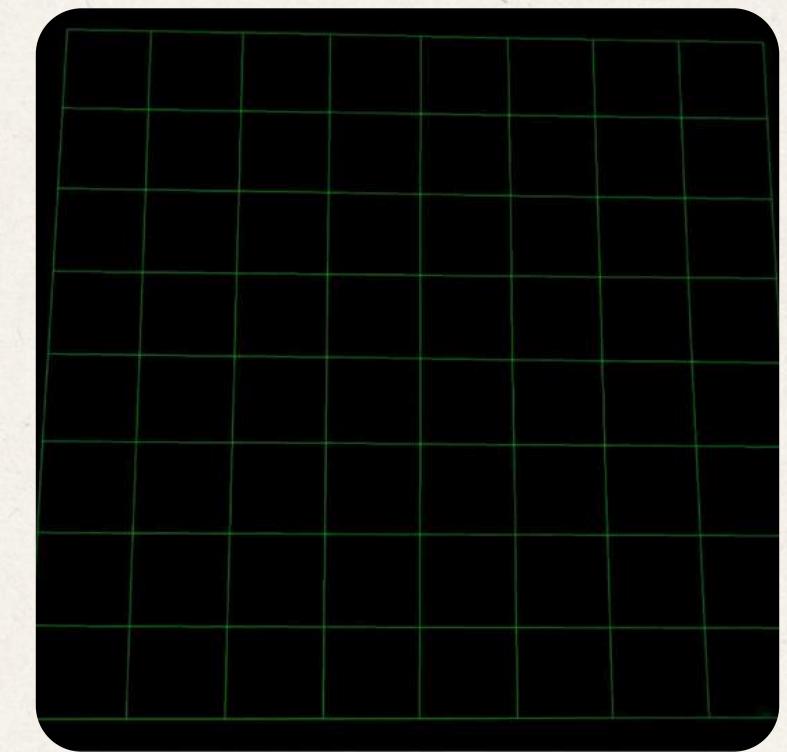
Canny Edge
Closing



LSD

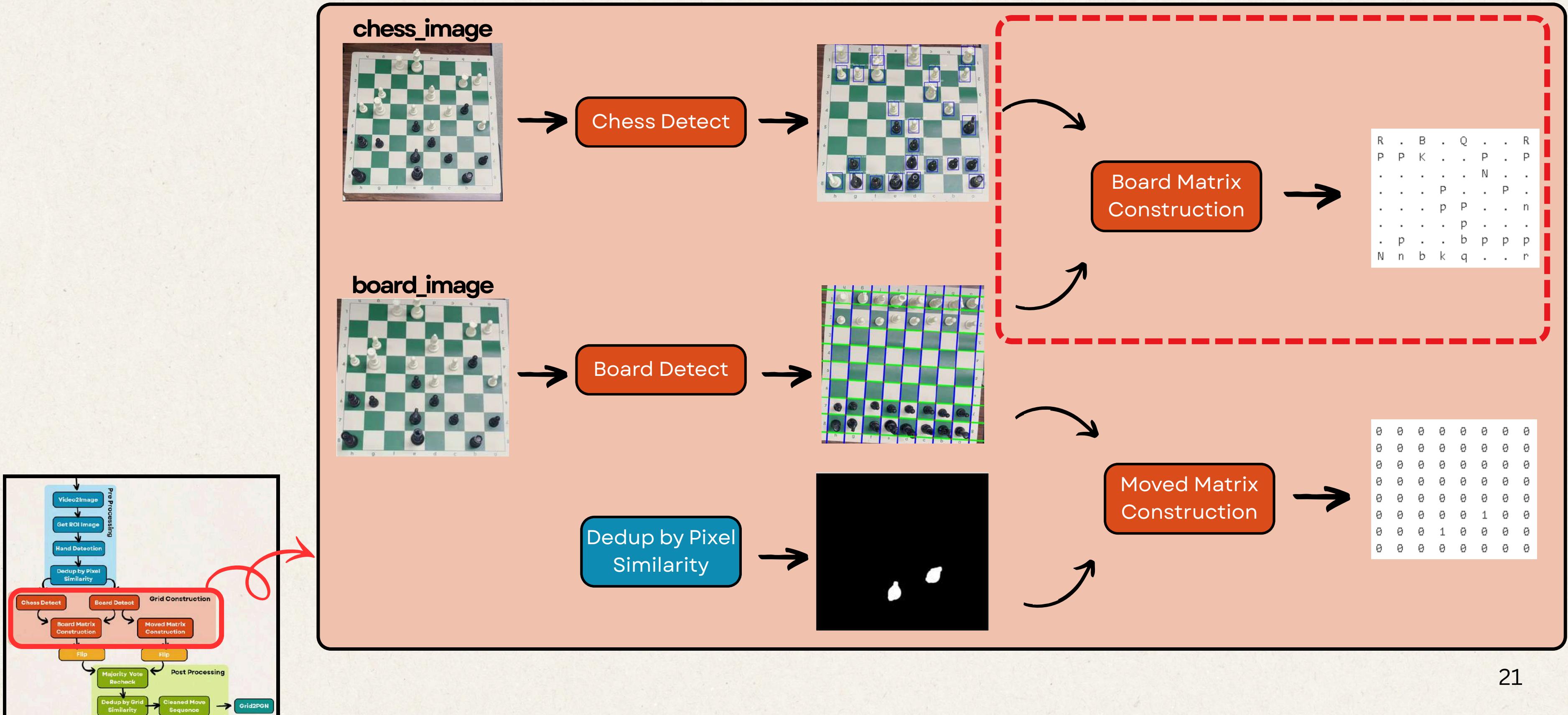


Hungarian

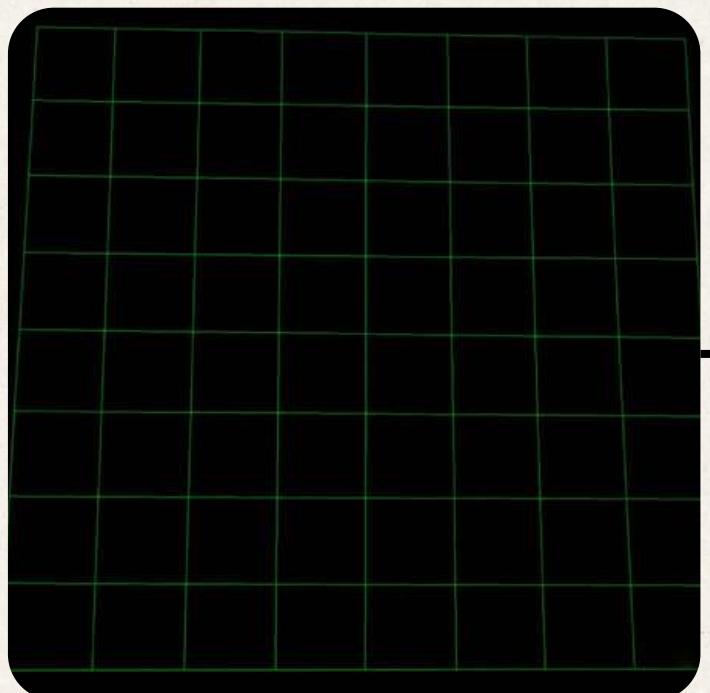
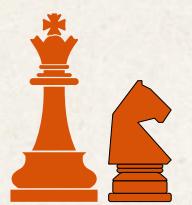


Board Grid

Pipeline : Matrix Construction



Board Matrix



Board Detection



Chess Detection

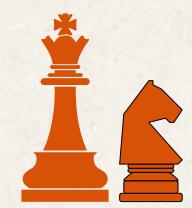


ChessBoard Detection

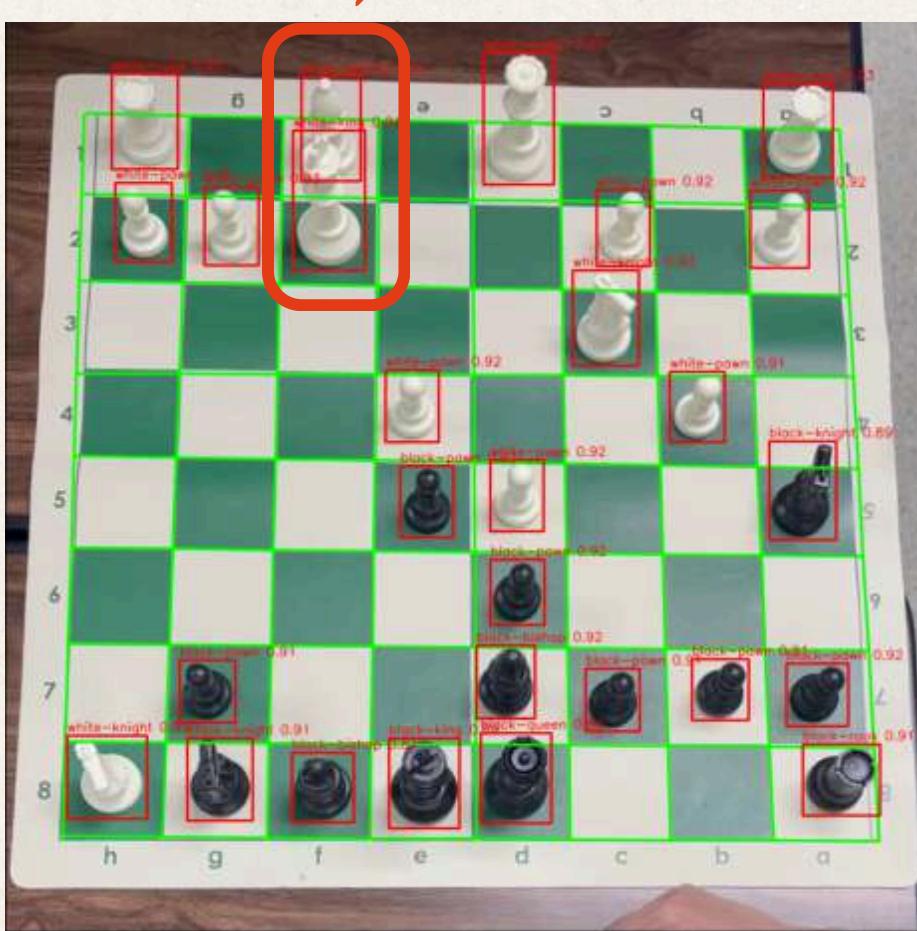


R	.	B	.	Q	.	R
P	P	K	.	P	.	P
.	.	.	.	N	.	.
.	.	.	P	.	P	.
.	.	P	P	.	n	.
.	.	.	P	.	.	.
.	P	.	b	P	P	P
N	n	b	k	q	.	r

Board Matrix

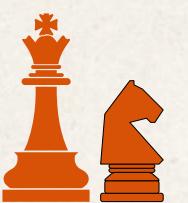


Score = Piece area in Cell / Piece area in Board

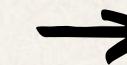
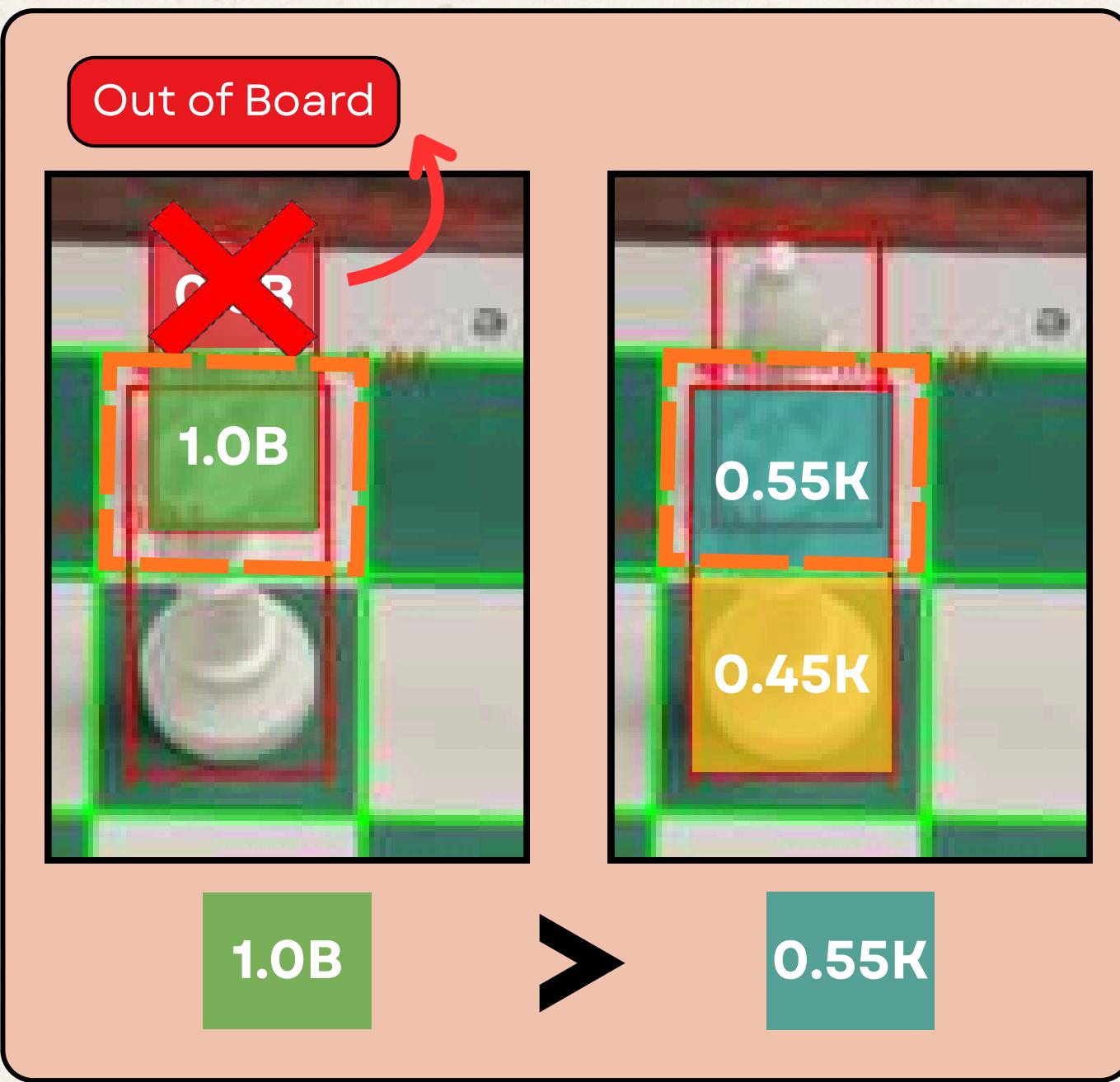


- Red Box = Area B out of Cell
- Green Box = Area B in Cell
- Blue Box = Area K in Cell
- Yellow Box = Area K out of Cell
- Orange Outline = Cell boundary

Board Matrix



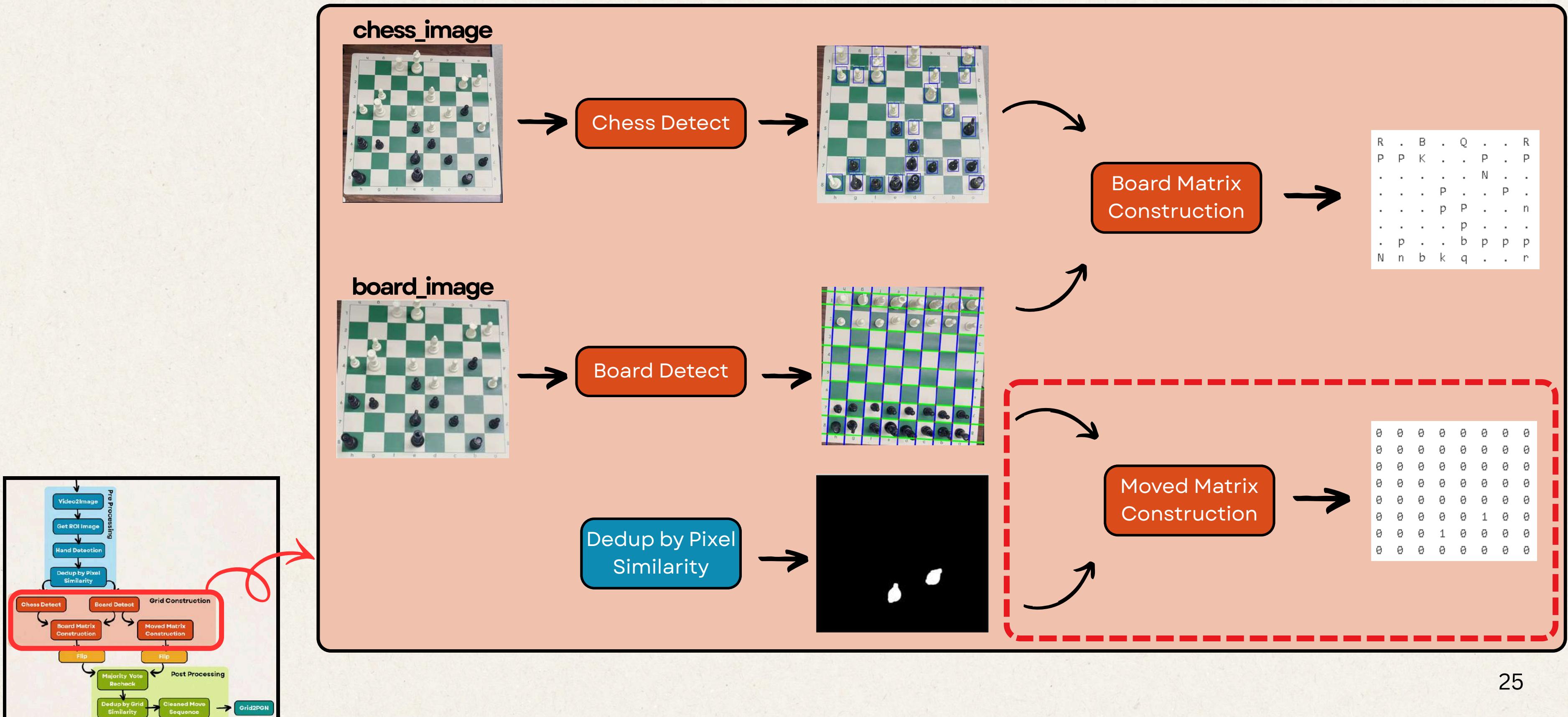
Score = Piece area in Cell / Piece area in Board



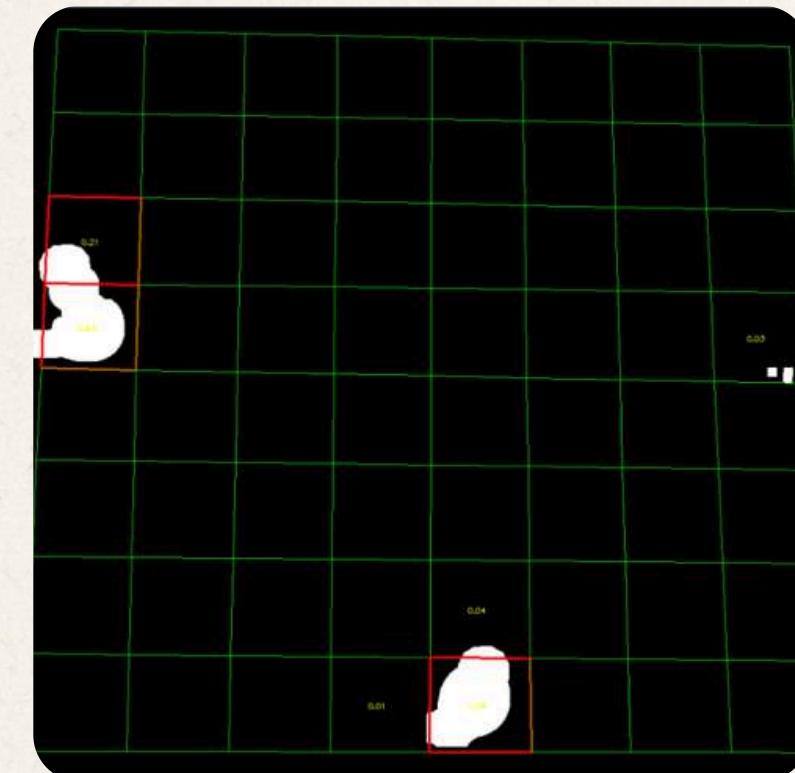
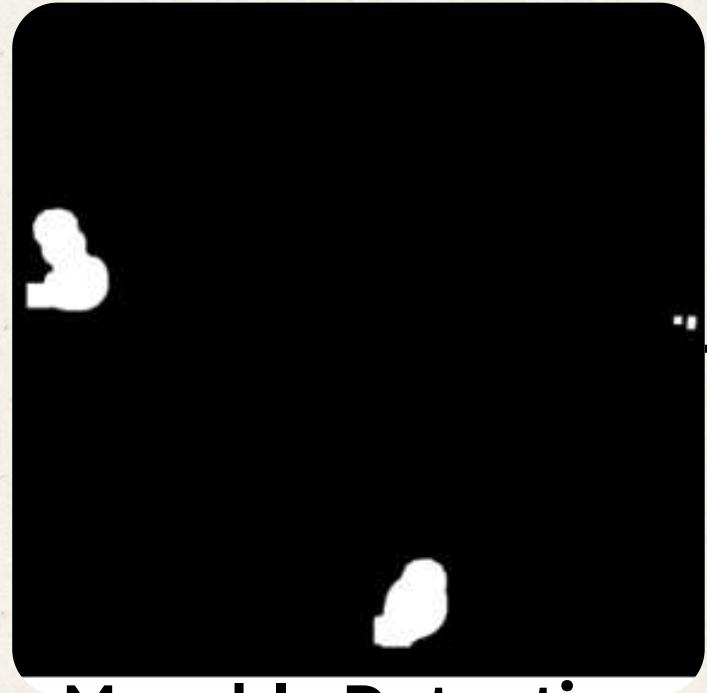
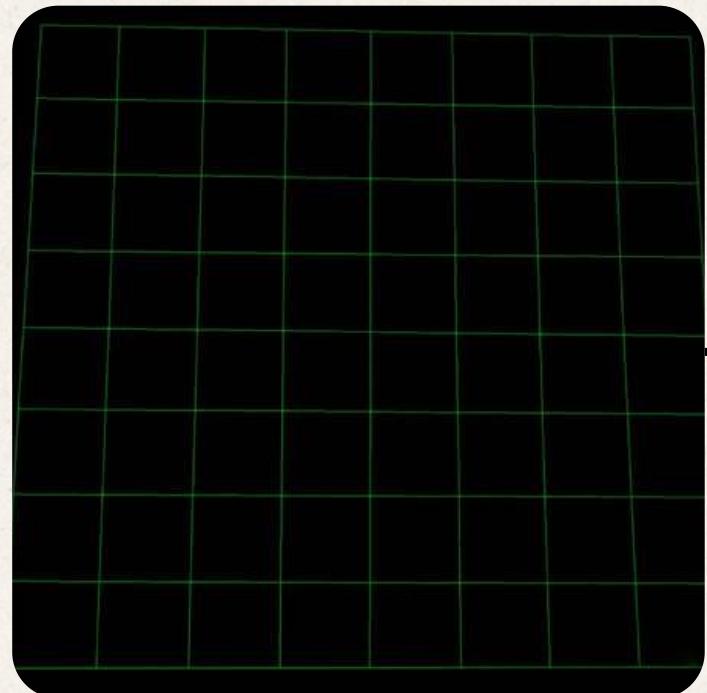
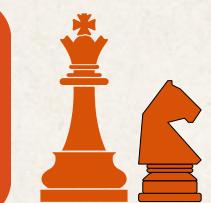
B Won !!

R	.	B	Q	.	R
P	P	K	P	P	P
.	.	.	N	P	N
.	.	.	P	P	P
.	.	.	P	P	P
.	p	.	b	p	p
N	n	b	k	q	r

Pipeline : Matrix Construction



Moved Matrix



Movable Detection



0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	1	0	0

Post - Processing

8

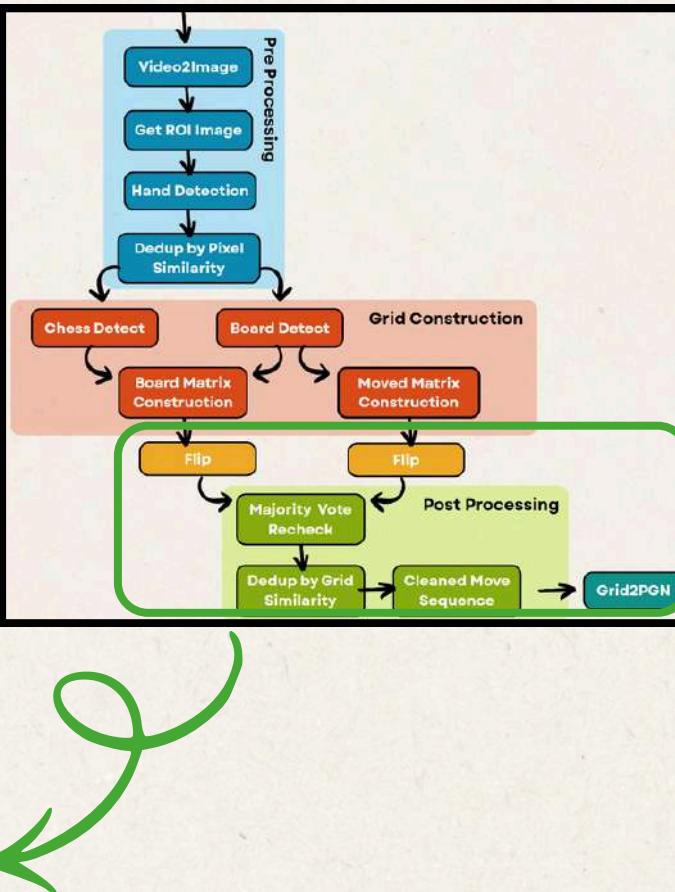
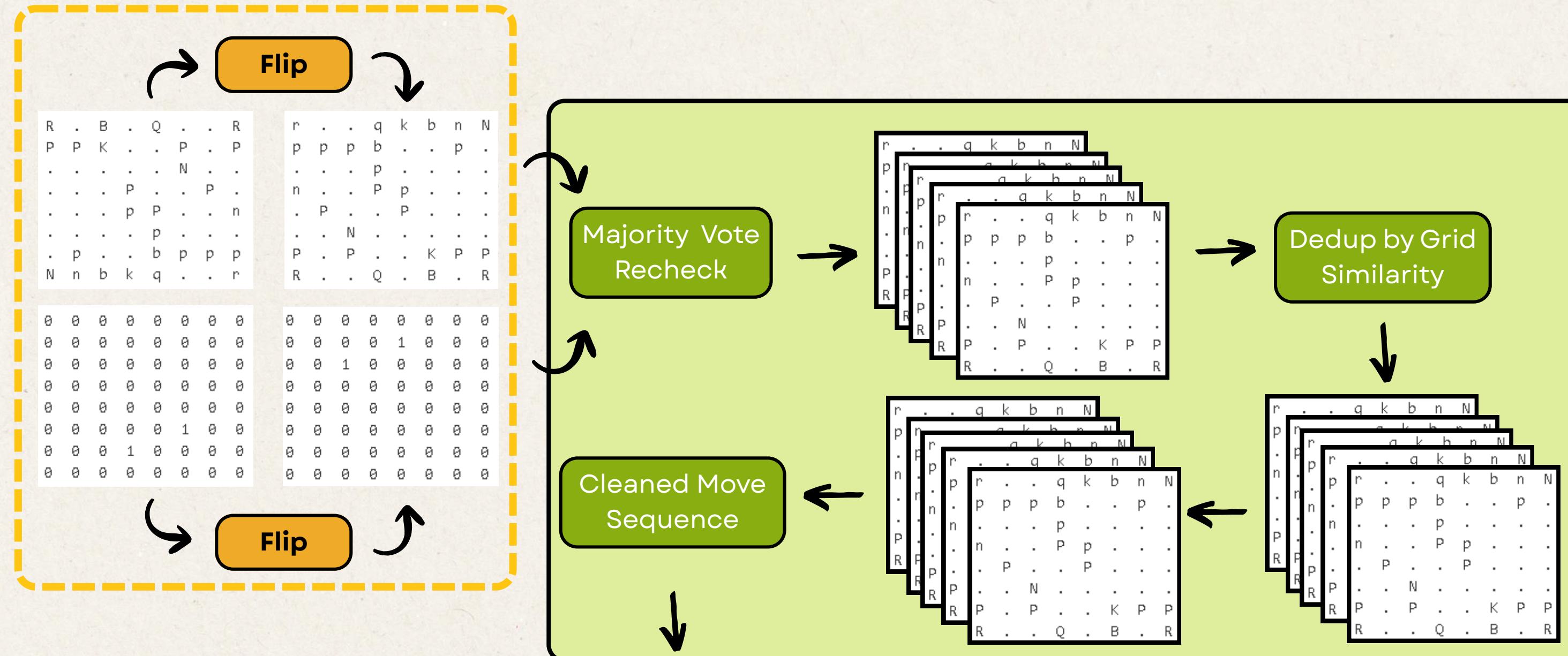
7

6

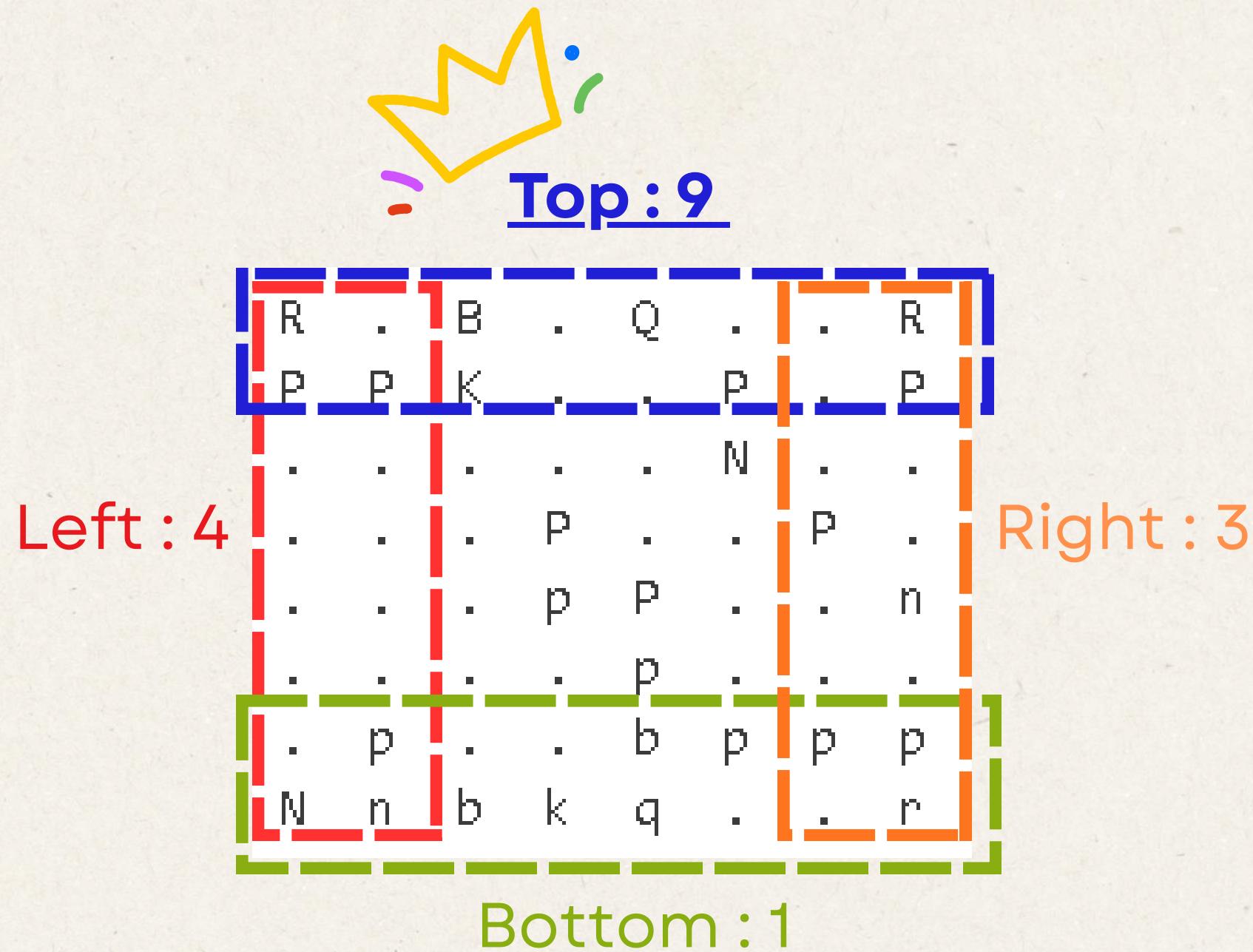
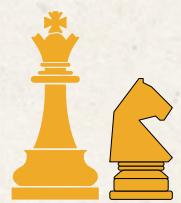
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4

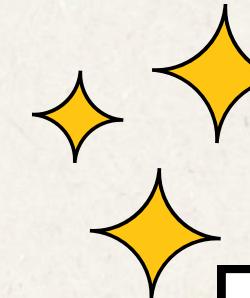
Pipeline : Post - Processing



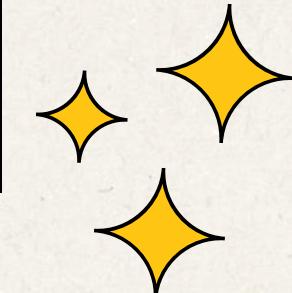
Flip / Rotation



90° x 2

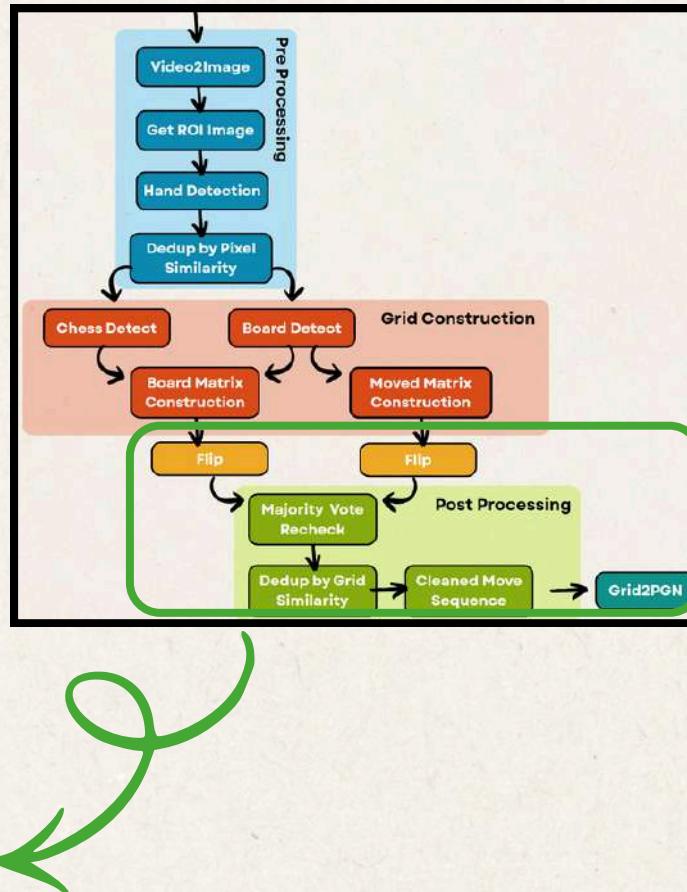
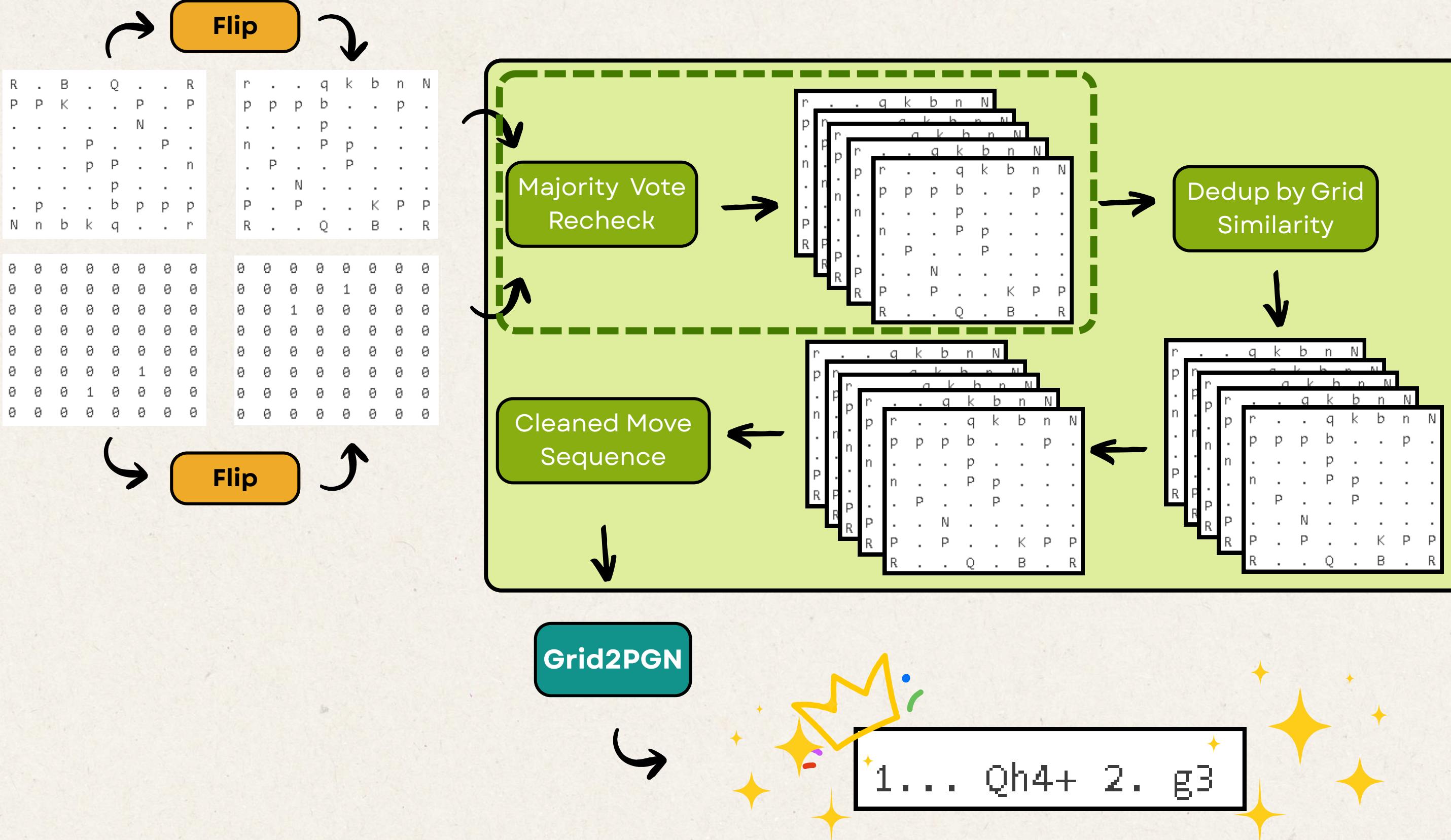


r	.	.	q	k	b	n	N
p	p	p	b	.	.	p	.
.	.	.	p
n	.	.	P	P	.	.	.
.	P	.	.	P	.	.	.
.	.	N
P	.	P	.	.	K	P	P
R	.	.	Q	.	B	.	R

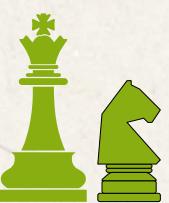


Standard Layout Board Matrix

Pipeline : Post - Processing



Majority Vote Recheck



0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0



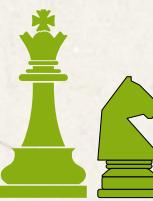
When To Move

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
1	0	1	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

MOVE !

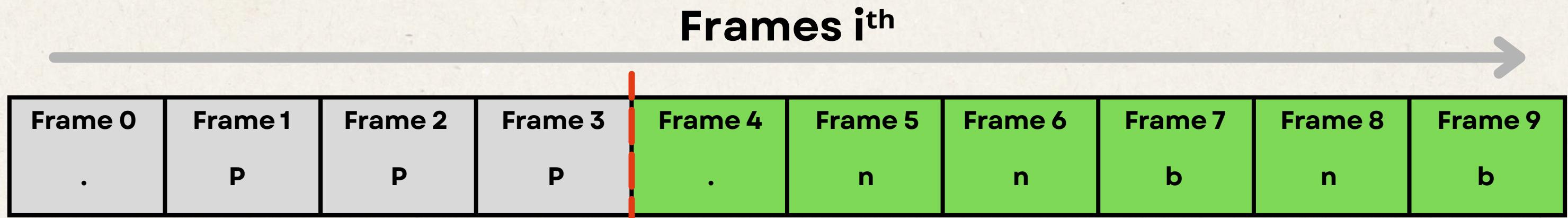


Majority Vote Recheck



.	.	.	r	.	.	r	
p	p	p	.	.	Q	.	p
.	.	k	n	.	.	p	
.	
.	
P	P	P	.	.	P	P	
R	.	B	.	K	B	.	R

.	.	.	r	.	.	r	
p	p	p	.	.	Q	.	p
.	.	k	.	.	.	p	
.	
.	
P	P	P	.	.	P	P	
R	.	B	.	K	B	.	R



Group 1



Group 2



Majority vote

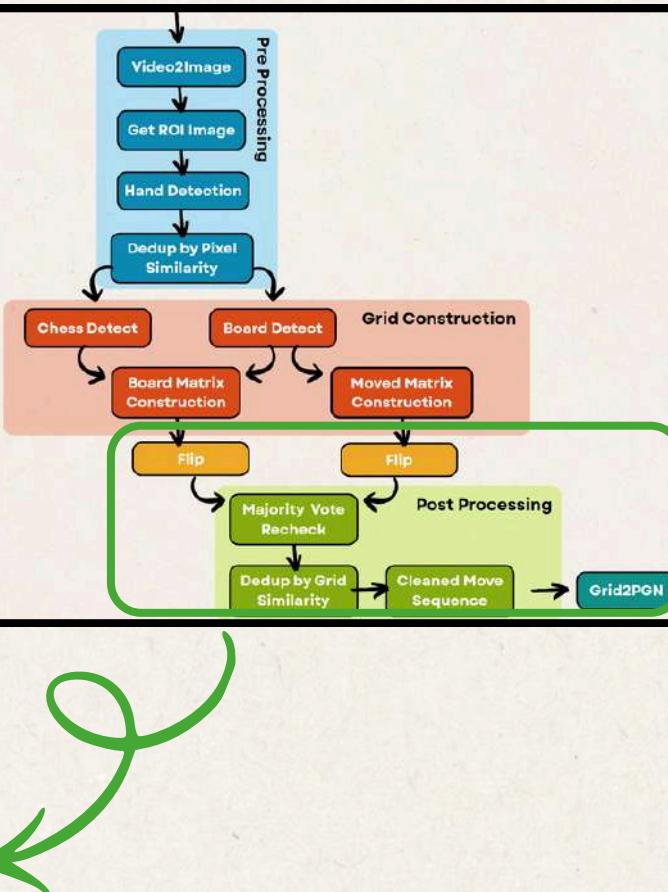
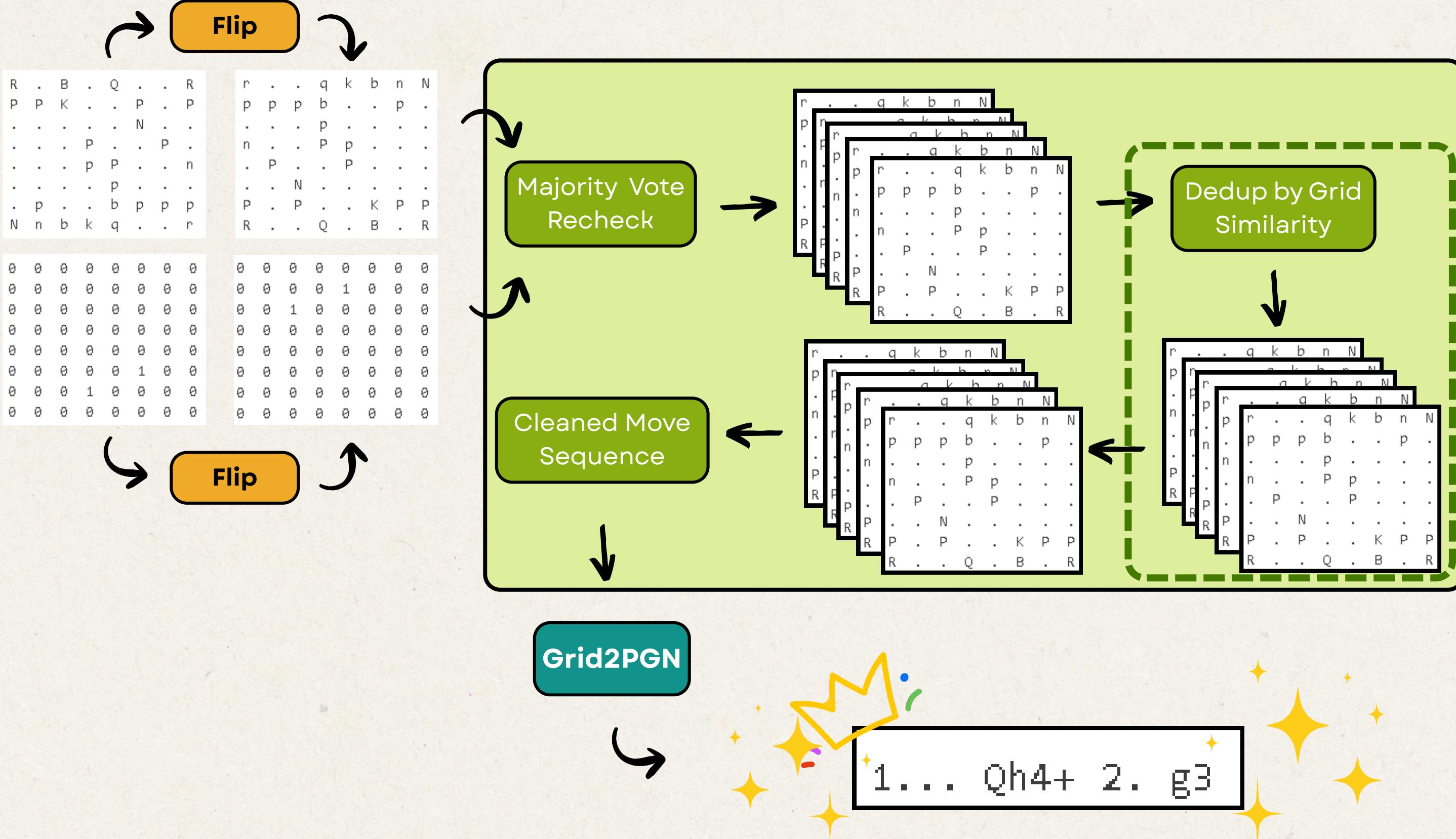
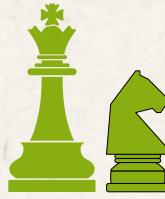
Frame 0	Frame 1	Frame 2	Frame 3
P	P	P	P

Group 1

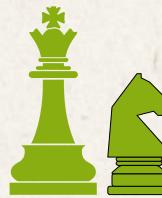
Frame 4	Frame 5	Frame 6	Frame 7	Frame 8	Frame 9
n	n	n	n	n	n

Group 2

Pipeline : Post - Processing



Deduplication (Grid Similarity)



- Start by keeping the **first board** as the initial unique frame
- For each next frame:
Compare with the last kept board using array_equal
 - If different → keep it
 - If identical → skip it (duplicate)



r	.	.	q	k	b	n	N
p	p	p	b	.	.	p	.
.	.	.	p
.	.	.	p
n	.	.	P	p	.	.	.
.	P	.	P	p	.	.	.
.	N
P	.	P	.	K	P	P	P
R	.	.	Q	.	B	.	R



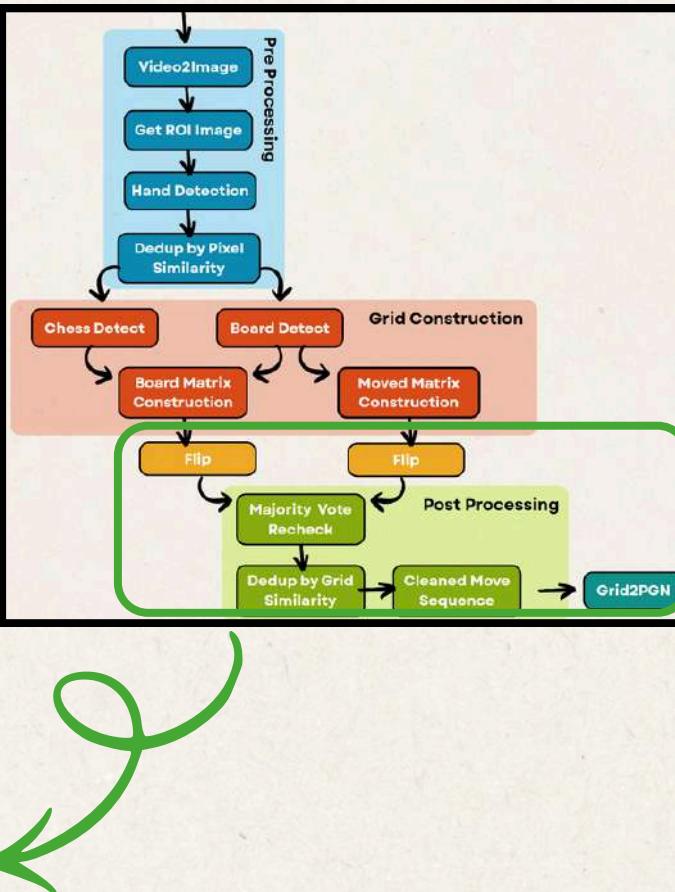
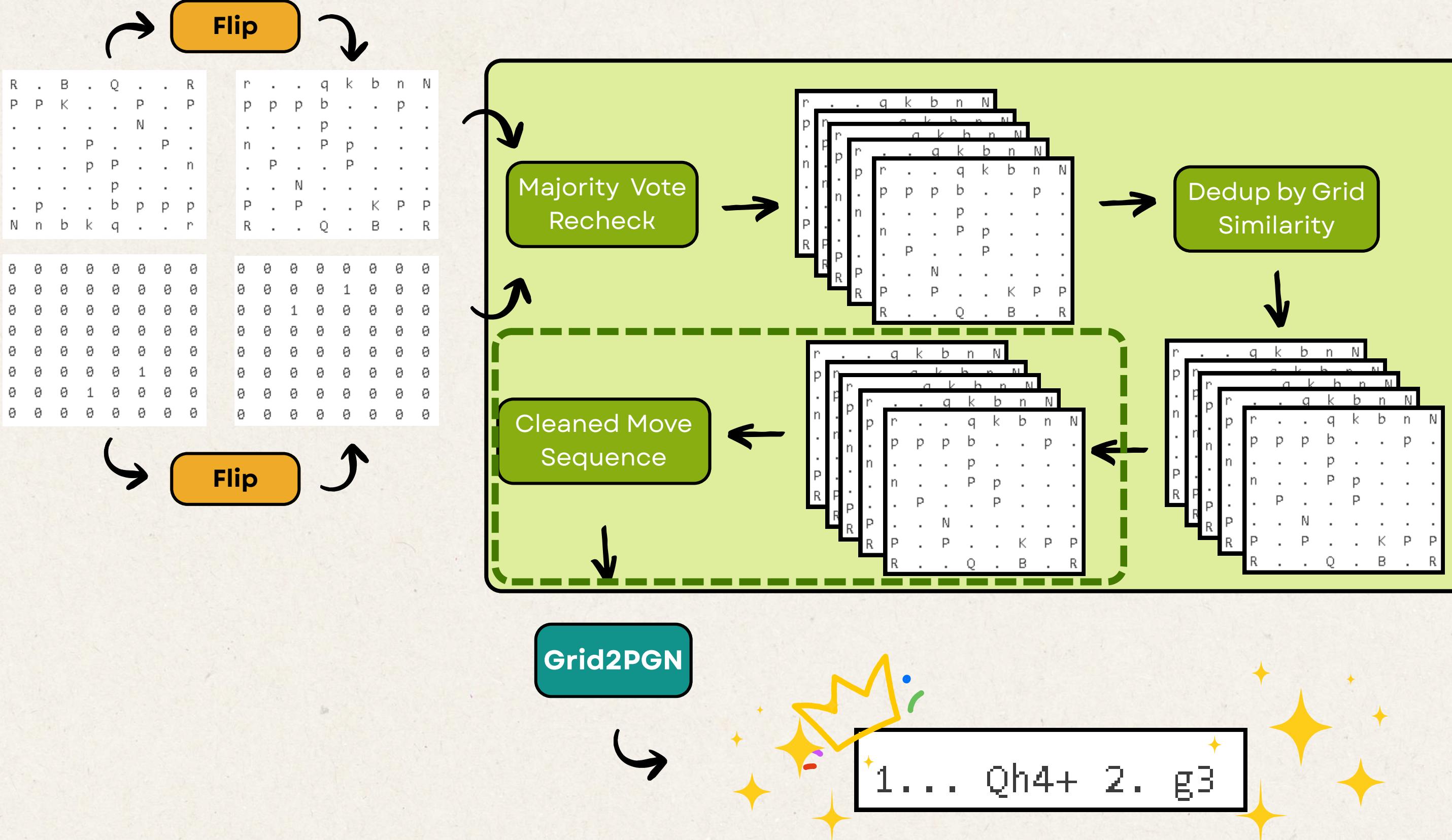
r	.	.	q	k	b	n	N
p	p	p	b	.	.	p	.
.
.
n
.	P
.	P
P	.	P	.	K	P	P	P
R	.	.	Q	.	B	.	R

r	.	.	q	k	b	n	N
p	p	p	b	.	.	p	.
.	.	.	p
.	.	.	p
n	.	.	P	p	.	.	.
.	P	.	P	p	.	.	.
.	P	.	P	p	.	.	.
P	.	P	.	K	P	P	P
R	.	.	Q	.	B	.	R

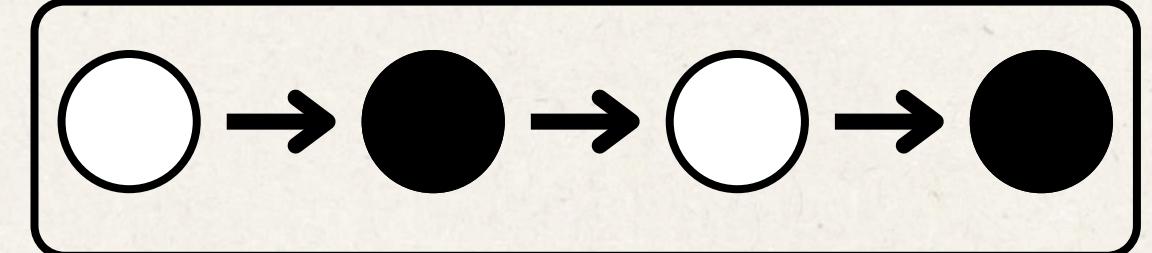
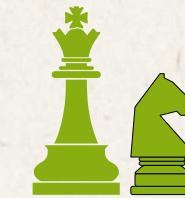


r	.	.	q	k	b	n	N
p	p	p	b	.	.	p	.
.	.	.	p
.	.	.	p
n	.	.	P	p	.	.	.
.	P	.	P	p	.	.	.
.	P	.	P	p	.	.	.
P	.	P	.	K	P	P	P
R	.	.	Q	.	B	.	R

Pipeline : Post - Processing



Clean Board Sequence



.	.	.	r	.	b	.	r
p	p	p	.	.	Q	.	p
.	.	k
.	P	.	.
.
.
p	p	p	.	P	.	P	P
R	.	B	.	K	B	.	R



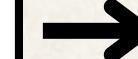
.	.	.	r	.	Q	.	r
p	p	p	.	.	Q	.	p
.	.	k
.	P	.	.
.
.
p	p	p	.	P	.	P	P
R	.	B	.	K	B	.	R

Black move



.	.	.	r	.	Q	.	r
p	p	p	.	.	Q	.	p
.	.	k
.	P	.	.
.
.
p	p	p	.	P	.	P	P
R	.	B	.	K	B	.	R

White move



.	.	.	r	.	Q	.	r
p	p	p	.	.	Q	.	p
.	.	k	.	.	P	.	.
.	.	b
.
.
p	p	p	.	P	.	P	P
R	.	B	.	K	B	.	R

Black move

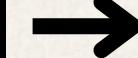


.	.	.	r	.	b	.	r
p	p	p	.	.	Q	.	p
.	.	k
.	P	.	.
.
.
p	p	p	.	P	.	P	P
R	.	B	.	K	B	.	R



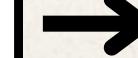
.	.	.	r	.	b	.	r
p	p	p	.	.	Q	.	p
.	.	k
.	P	.	.
.
.
p	p	p	.	P	.	P	P
R	.	B	.	K	B	.	R

White move



.	.	.	r	.	Q	.	r
p	p	p	.	.	Q	.	p
.	.	k	.	.	b	.	.
.	.	b	.	.	P	.	.
.
.
p	p	p	.	P	.	P	P
R	.	B	.	K	B	.	R

Black move

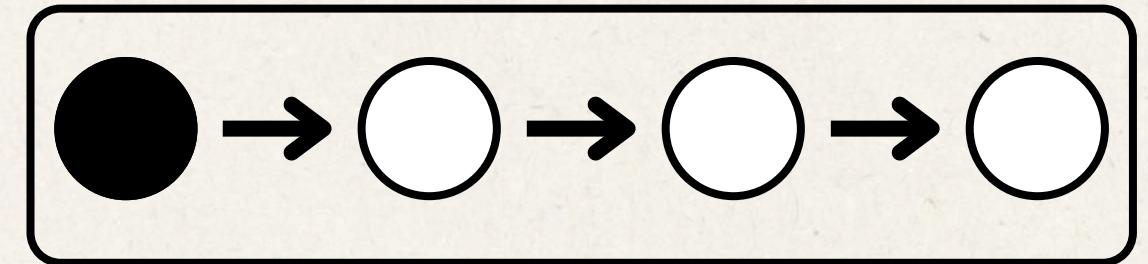


.	.	.	r	.	Q	.	r
p	p	p	.	.	Q	.	p
.	.	k	.	.	b	.	.
.	.	b	.	.	P	.	.
.
.
p	p	p	.	P	.	P	P
R	.	B	.	K	B	.	R

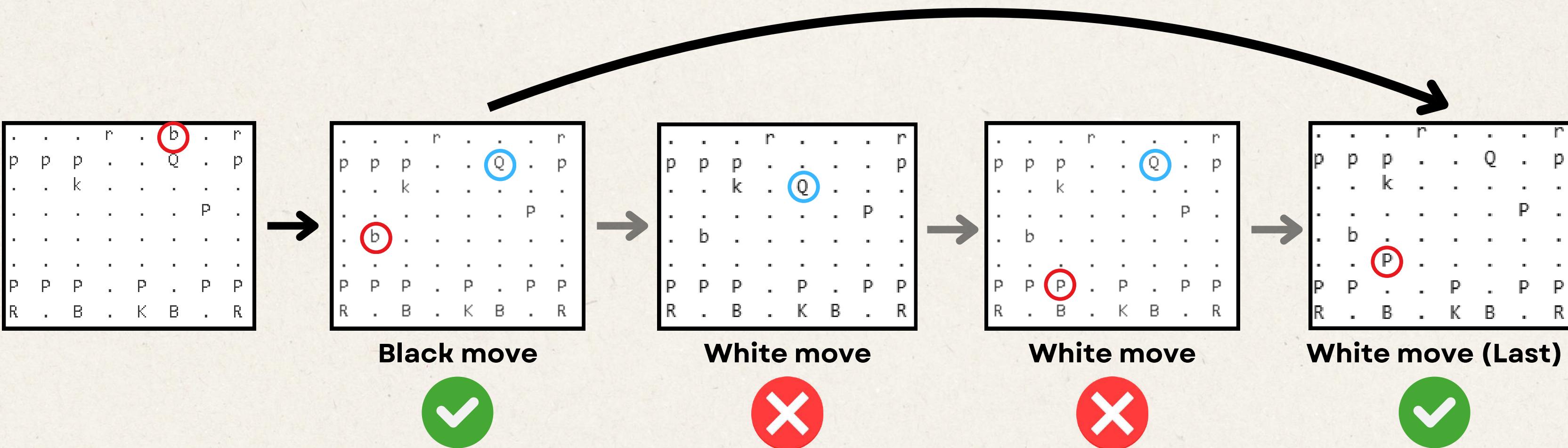
White move



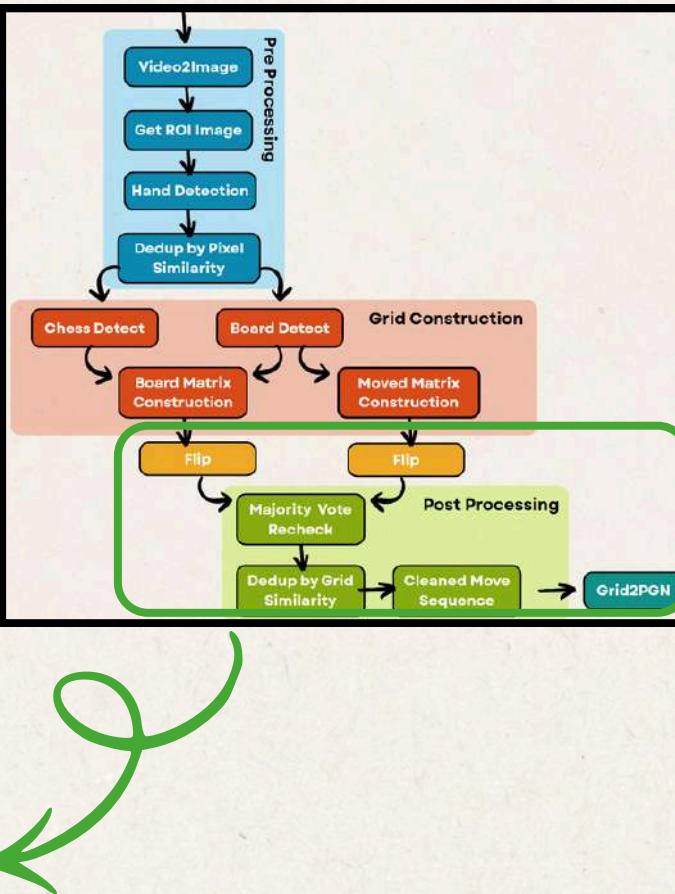
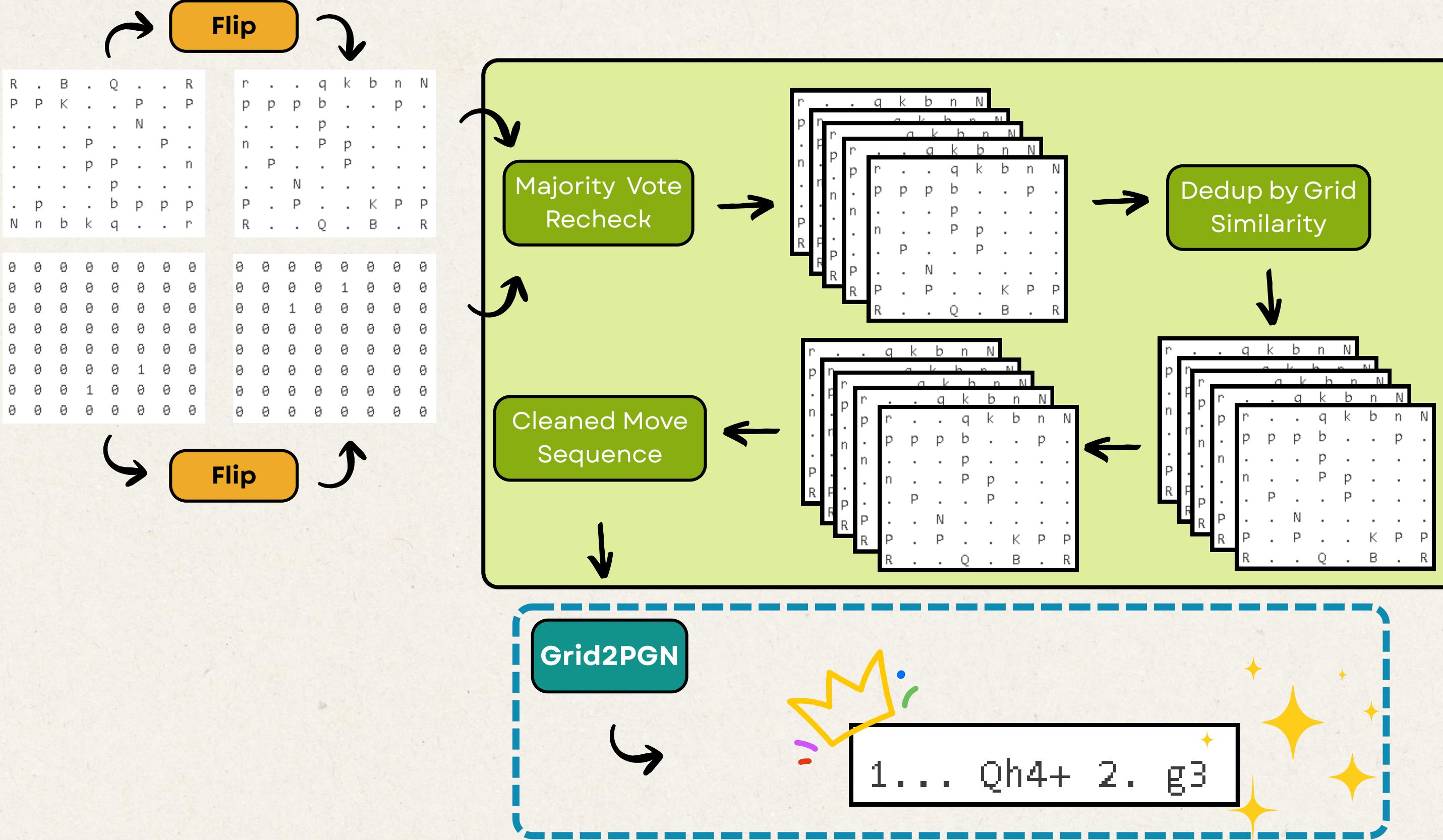
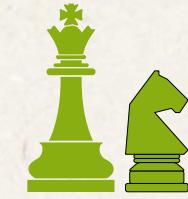
Clean Board Sequence



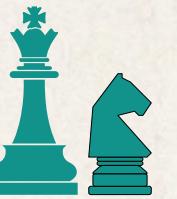
SKIP !



Pipeline : Post - Processing



PGN



```
[  
    [ 'r', 'n', 'b', 'q', 'k', 'b', 'n', 'N' ],  
    [ 'p', 'p', 'p', 'b', ' ', 'p', ' ', ' ' ],  
    [ ' ', ' ', ' ', 'p', ' ', ' ', ' ', ' ' ],  
    [ 'n', ' ', ' ', 'P', 'P', ' ', ' ', ' ' ],  
    [ ' ', 'P', ' ', ' ', 'P', ' ', ' ', ' ' ],  
    [ ' ', ' ', 'N', ' ', ' ', ' ', ' ', ' ' ],  
    [ 'P', ' ', 'P', ' ', ' ', 'K', 'P', 'P' ],  
    [ 'R', ' ', ' ', 'Q', ' ', 'B', ' ', 'R' ]  
],  
  
[  
    [ 'r', 'n', 'b', 'q', 'k', 'b', 'n', 'N' ],  
    [ 'p', 'p', 'p', 'b', ' ', 'p', ' ', ' ' ],  

```

Finally !!



1... Qh4+ 2. g3

PGN format

Evaluation & Analysis

8

7

6

5

4

Result

Score !!!

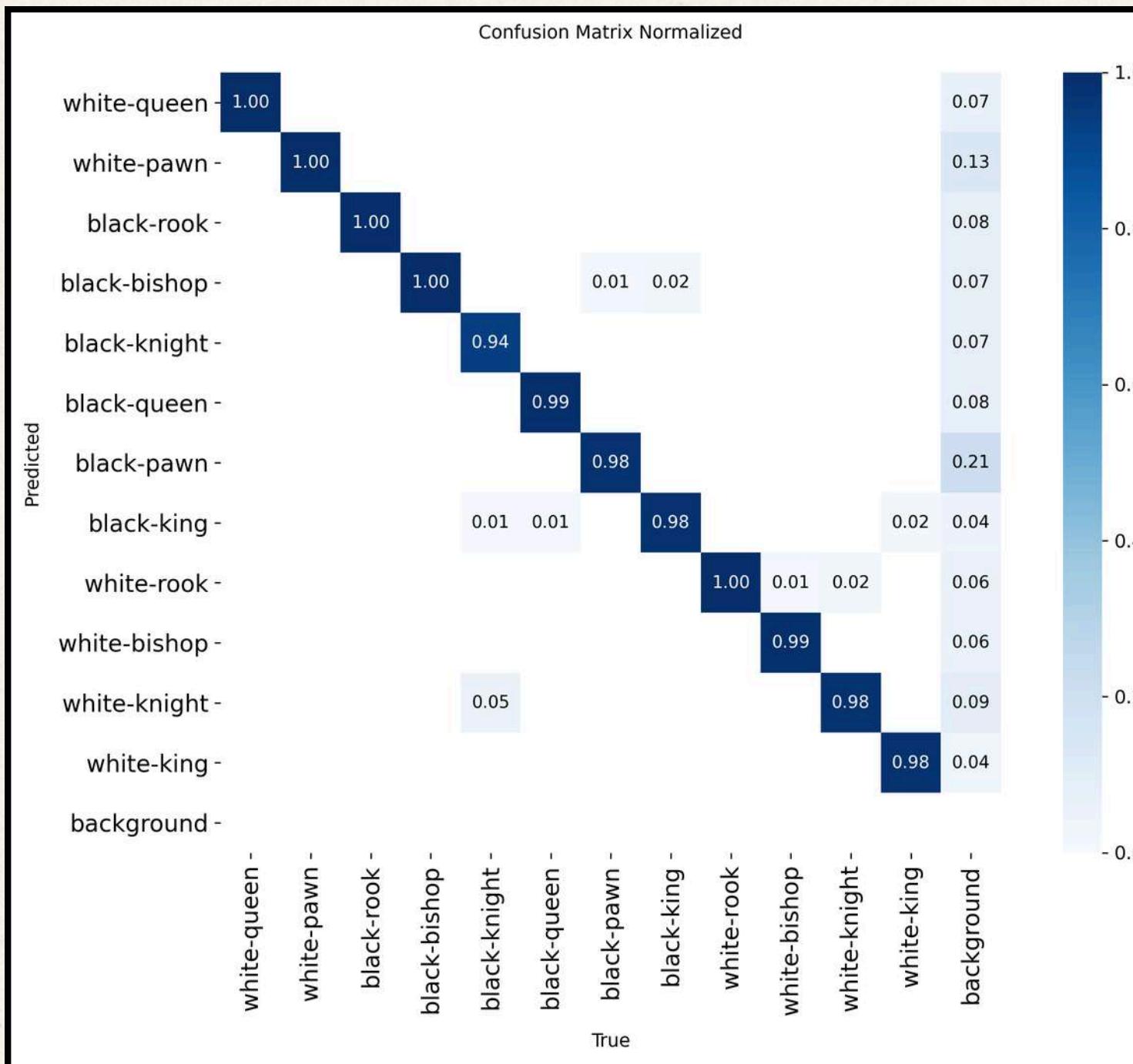
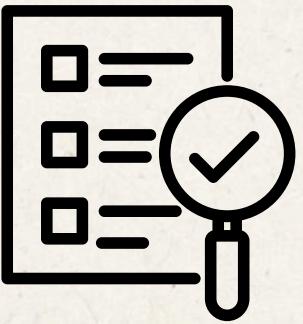
JuJu อายุลีนทำงาน



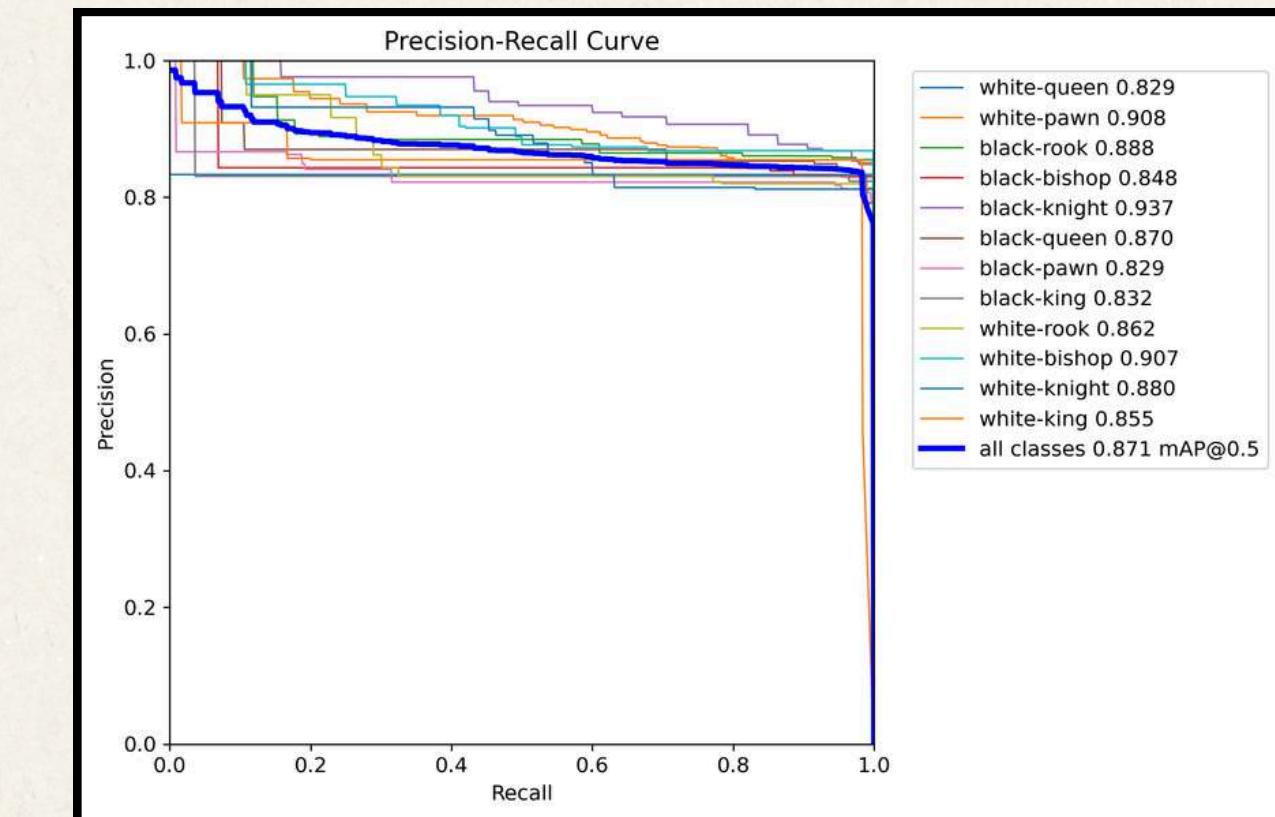
1.00



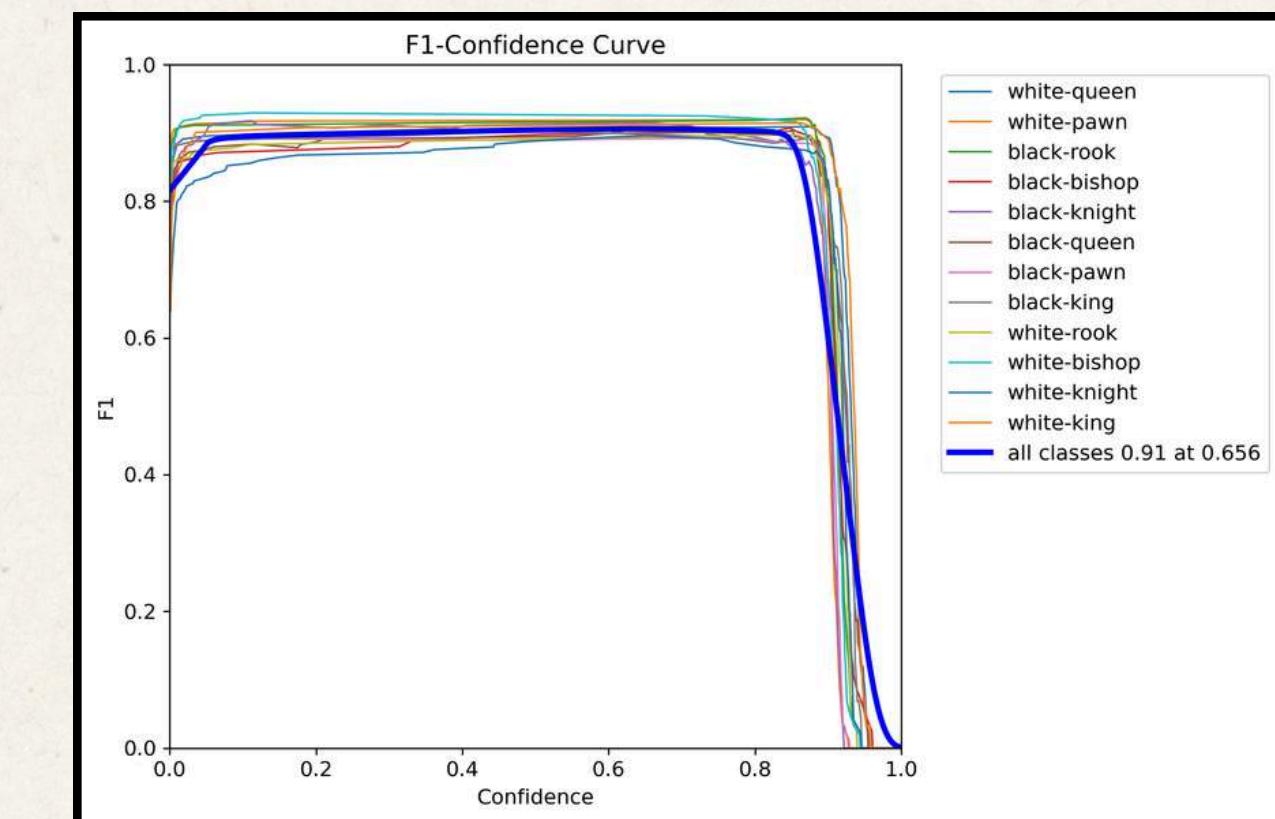
Evaluation



Confusion Matrix

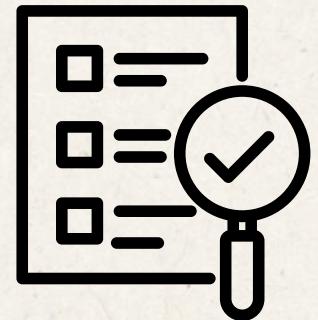


**Precision-Recall
Curve**



**F1-Confidence
Curve**

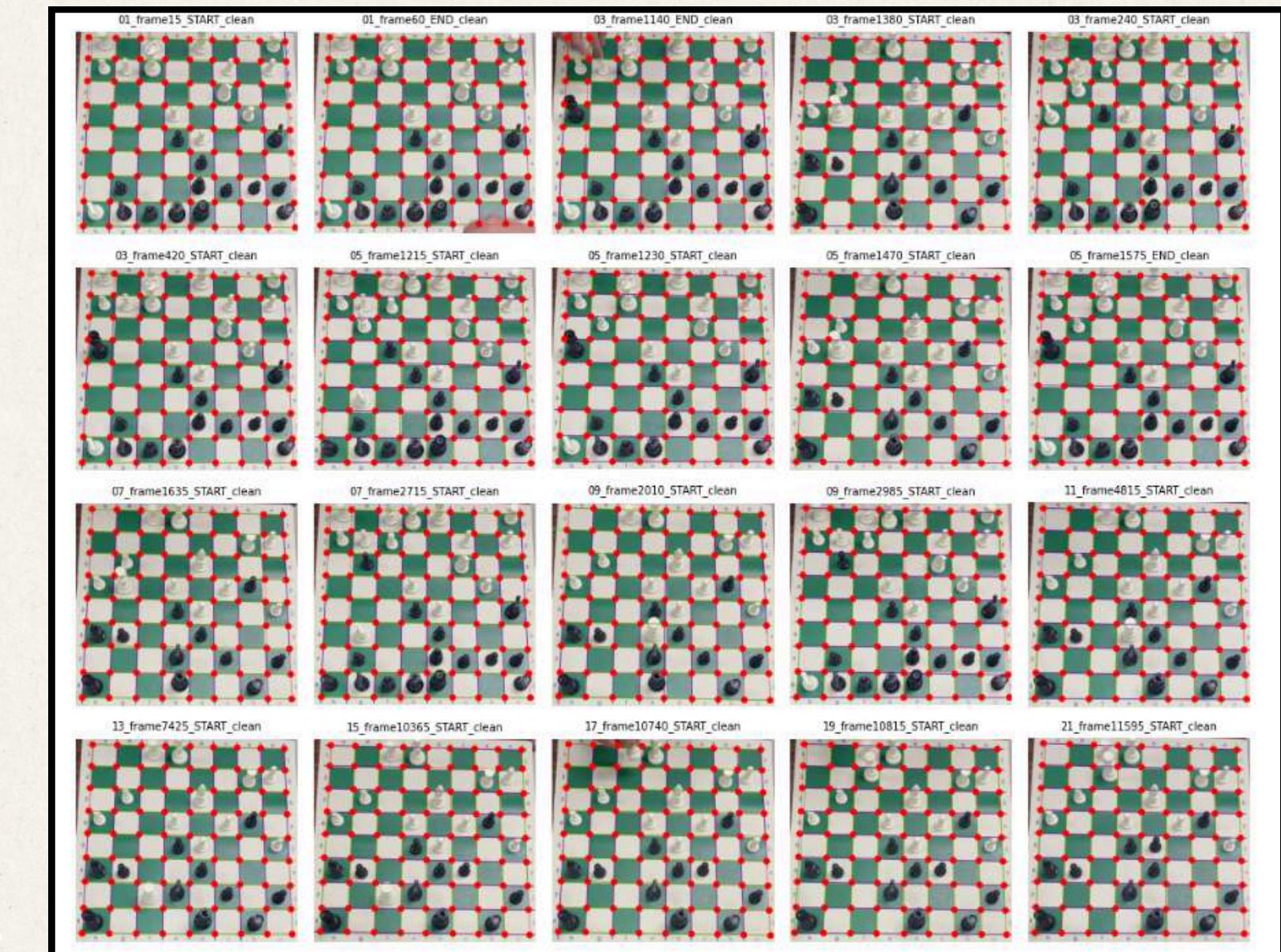
Evaluation



Class	Images	Instances	Box(P)	R	mAP50	mAP50-95:
all	69	1338	0.835	0.993	0.871	0.791
white-queen	54	90	0.83	1	0.829	0.767
white-pawn	49	211	0.85	1	0.908	0.808
black-rook	59	118	0.847	1	0.888	0.802
black-bishop	52	88	0.818	1	0.848	0.763
black-knight	58	95	0.868	0.968	0.937	0.833
black-queen	59	95	0.832	0.988	0.87	0.808
black-pawn	47	235	0.81	0.991	0.829	0.74
black-king	56	56	0.822	0.989	0.832	0.753
white-rook	47	83	0.808	1	0.862	0.796
white-bishop	59	112	0.867	0.992	0.907	0.814
white-knight	58	95	0.812	1	0.88	0.803
white-king	59	60	0.851	0.983	0.855	0.801
Speed: 5.7ms preprocess, 23.5ms inference, 0.0ms loss, 5.0ms postprocess per image						
Results saved to /content/runs/detect/val						
mAP50: 0.870537594161959						
mAP50-95: 0.7906270504917717						
Precision: 0.834624295974549						
Recall: 0.9926229111602661						

mAP50: 0.870537594161959
mAP50-95: 0.7906270504917717
Precision: 0.834624295974549
Recall: 0.9926229111602661

Chess detection



Board detection



Analysis



What helps improve our pipeline?

- **Defense in Depth (Hybrid Approach)**
 - **YOLOv8n and Hand Detection:** ensures only clean frames are used.
 - **Model and Chess Ratio Algorithm:** Improves piece-to-cell mapping.
 - **Majority Vote Recheck:** Ensure no-move, no change.
 - **Double Deduplication :** Reduces duplicated frame
- **Diverse training:** Enhances the YOLO model's ability to accurately detect chess pieces under various lighting, perspectives, and piece colors.

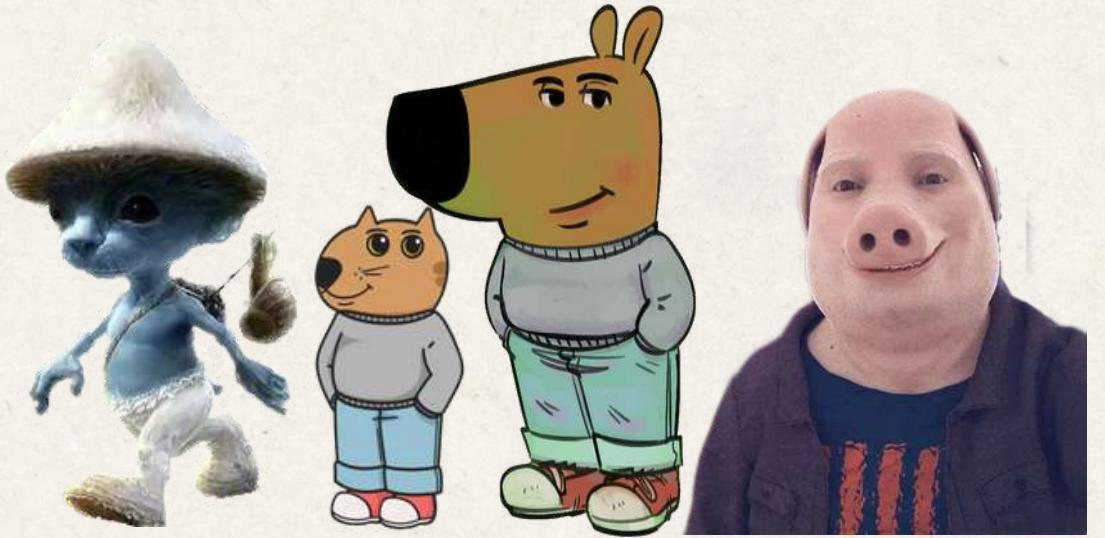
Analysis

Current Weakness and Further Improvement



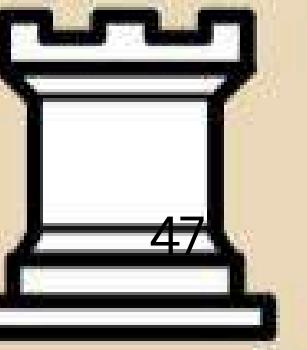
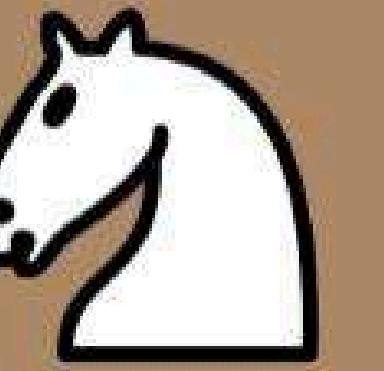
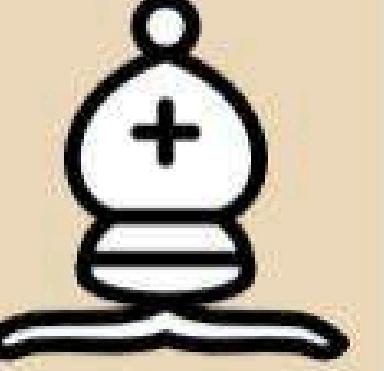
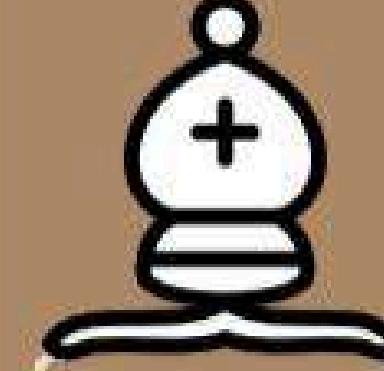
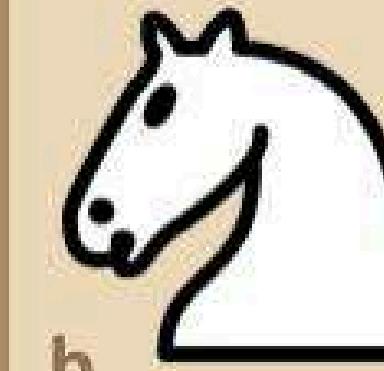
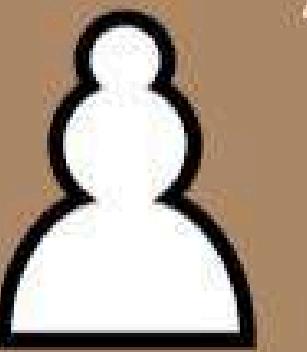
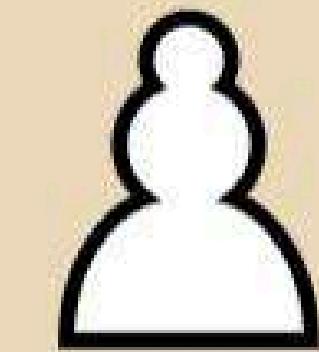
- Color Dependency: The board detection relies entirely on a specific green color mask, failing on other board styles.
 - Sensitive to steep camera angles.
 - Grid fails if corners are not visible.
 - **Sol:** Replace with a trained YOLO model to identify the board regardless of color or style.
- Orientation Weakness: The board rotation algorithm is too simple and will fail in specific endgame scenarios.
 - **Sol:** Use OCR to detect board Algebraic Notation.
- Logic Gaps: The hand-crafted PGN translator might not cover every case.
 - **Sol:** Use official pgn translator in python-chess.

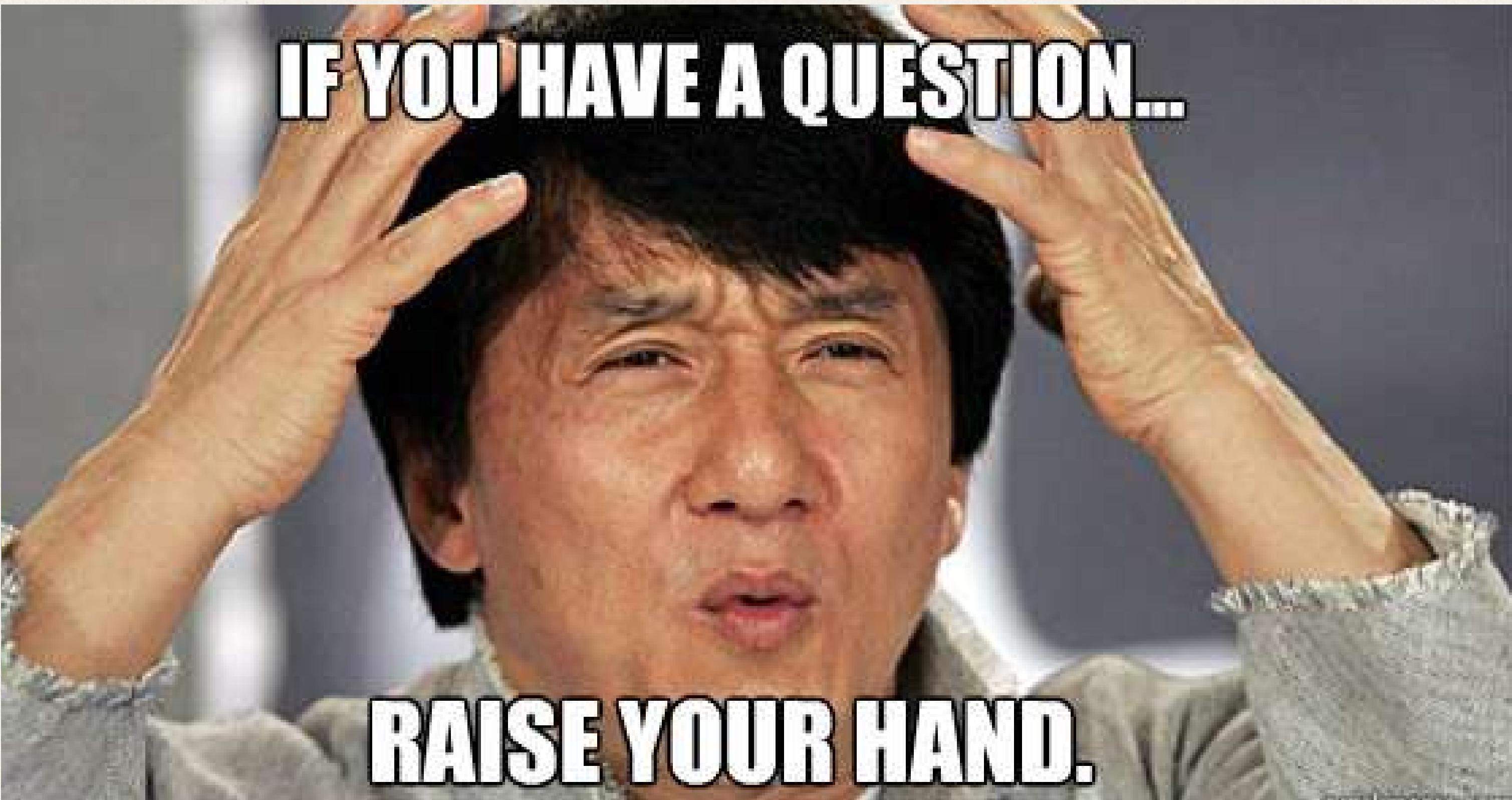
Role Description



กิตติพัฒน์ จูสิงห์ 6531304621	ROI, Board, Chess Detection, Evaluation
ณรรฤกฤช รีระรัชชานนท์ 6531315521	Chess Model Training, Slide for Presentation
รัชปัศย แบบประเสริฐ 6531338021	Data Preparation, Slide for Presentation
อธิระ ลิน 6532196321	Everything

Thank you for your attention.





IF YOU HAVE A QUESTION...

RAISE YOUR HAND.