Scan2CapMMT

Dense Captioning for 3D Scenes with Transformers

Scan2CapMMT

I. Scan2CapMMT Recap

II. Improving Scan2CapMMT

III. Quantitative & Qualitative Results

IV. Detection with Transformers

V. Timeline until the Final Presentation

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I. Scan2Cap Recap

Point Cloud

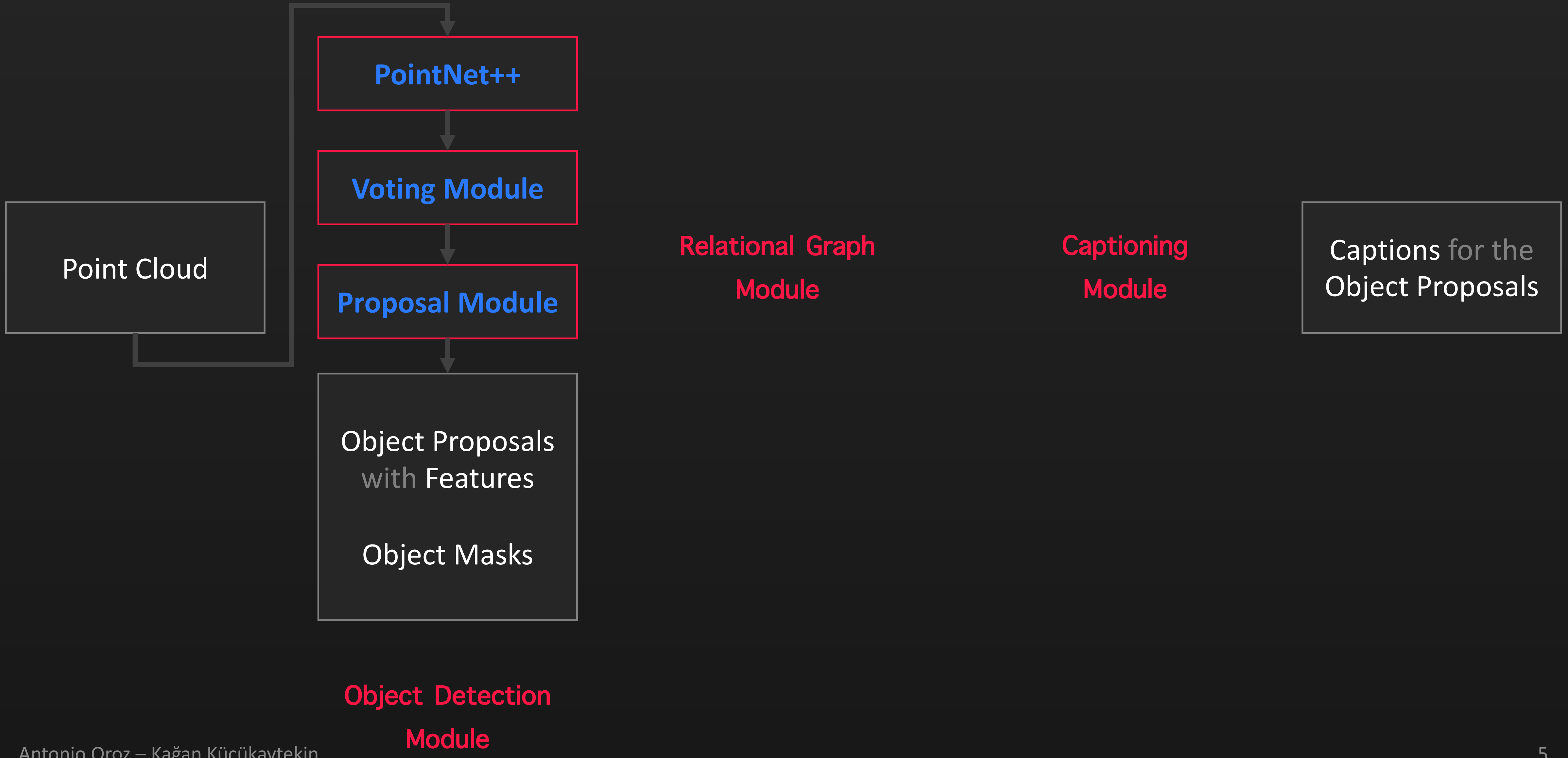
Object Detection Module

Relational Graph Module

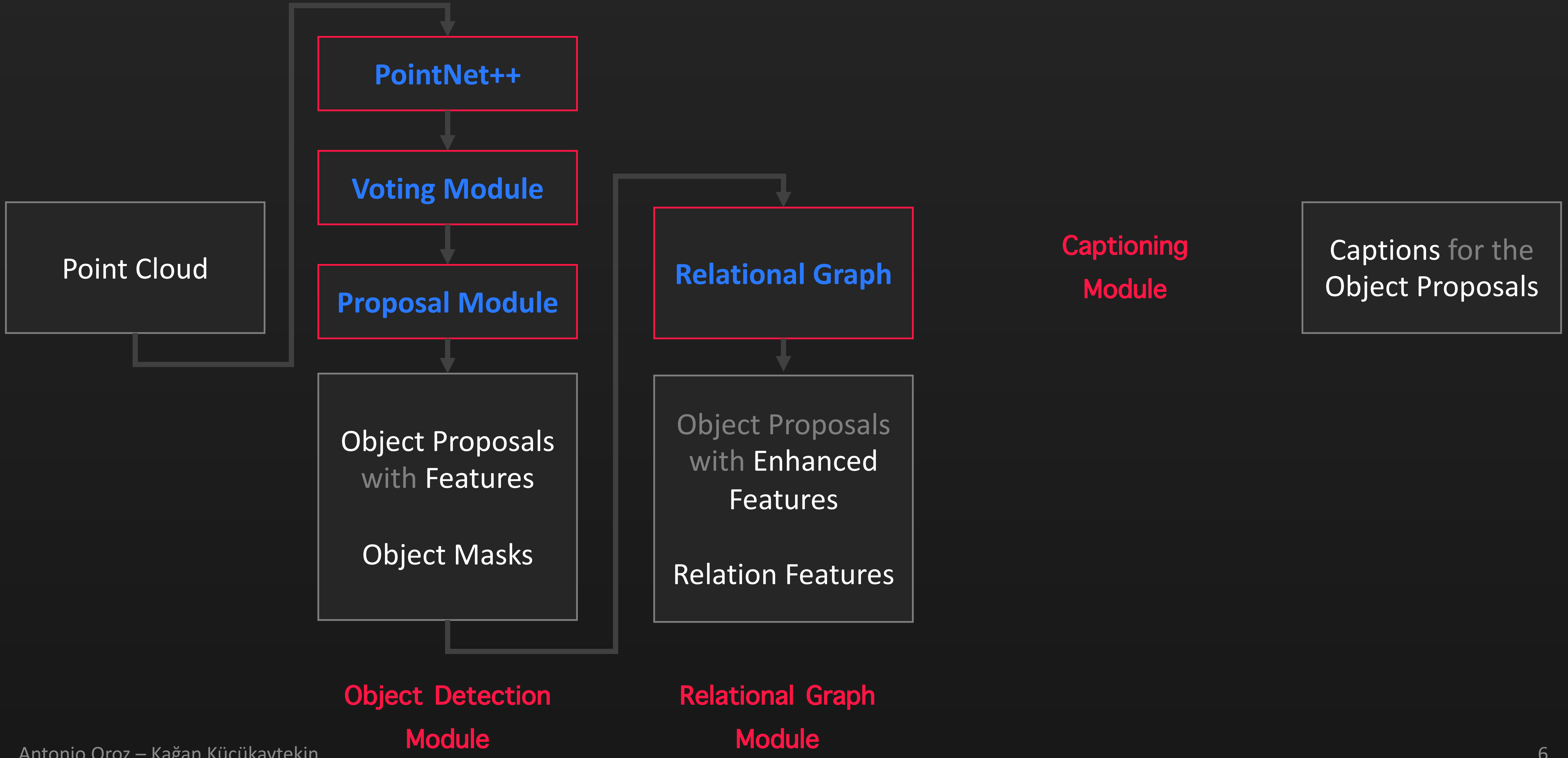
Captioning Module

Captions for the Object Proposals

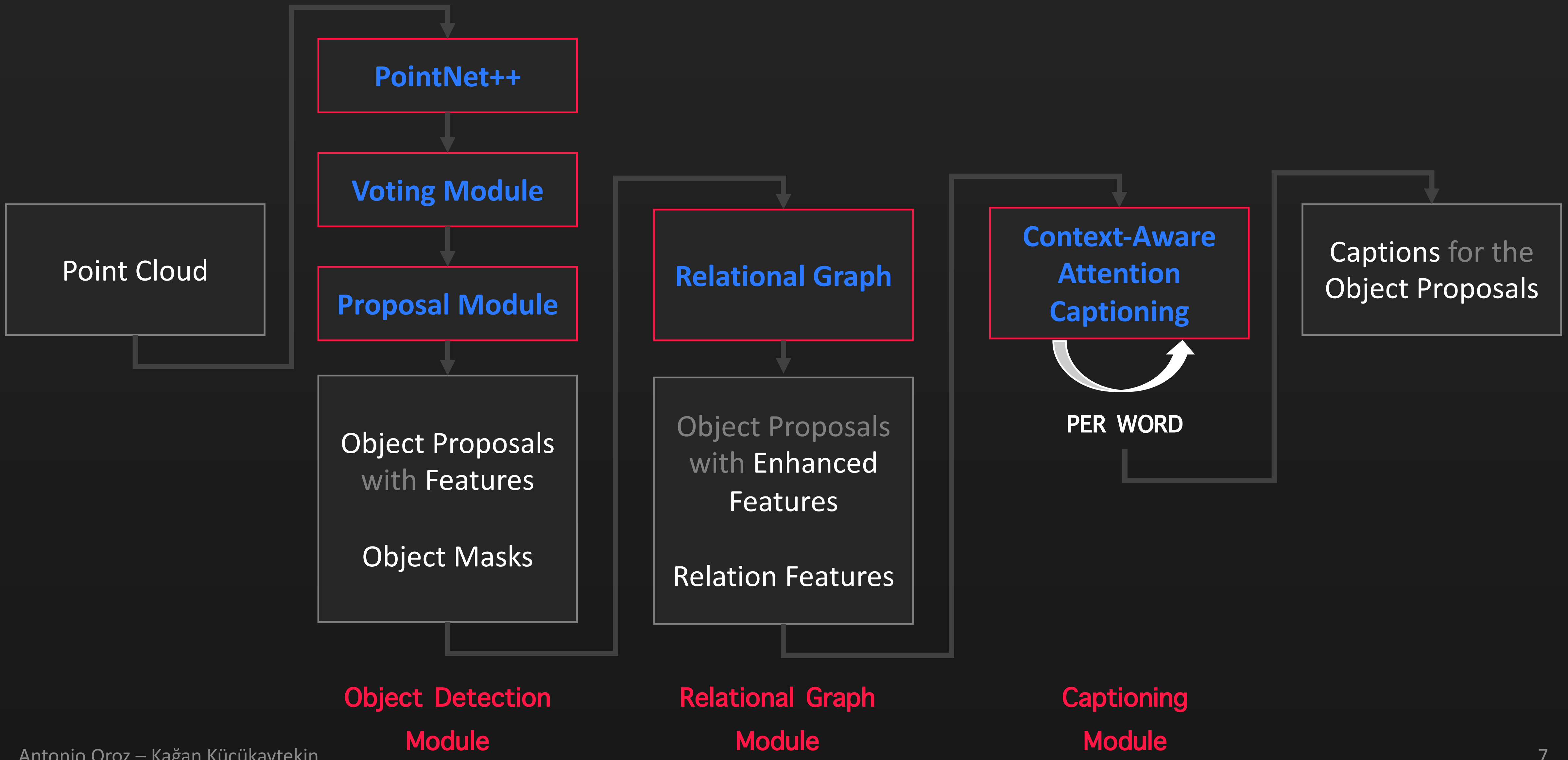
I. Scan2Cap Recap



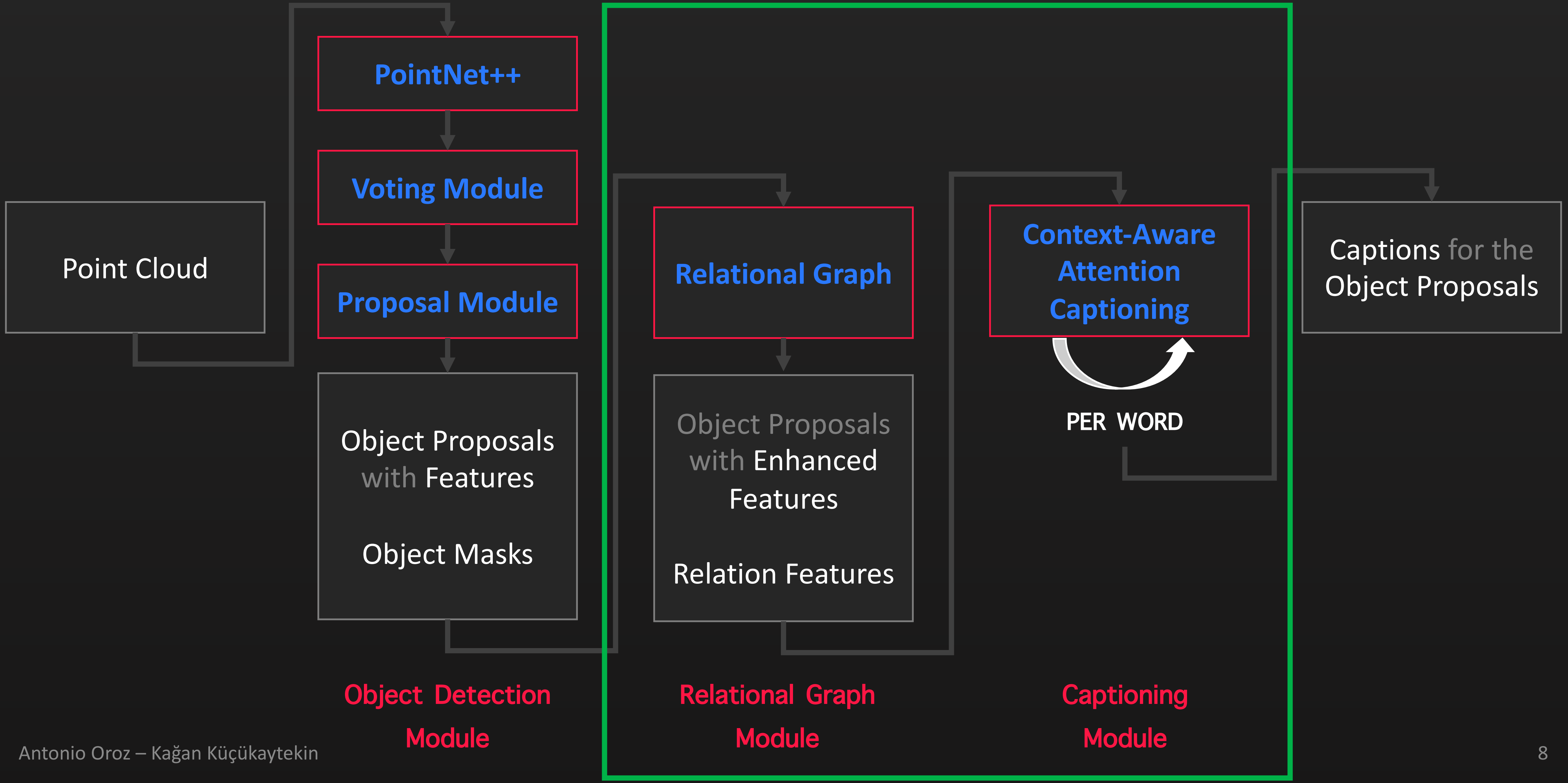
I. Scan2Cap Recap



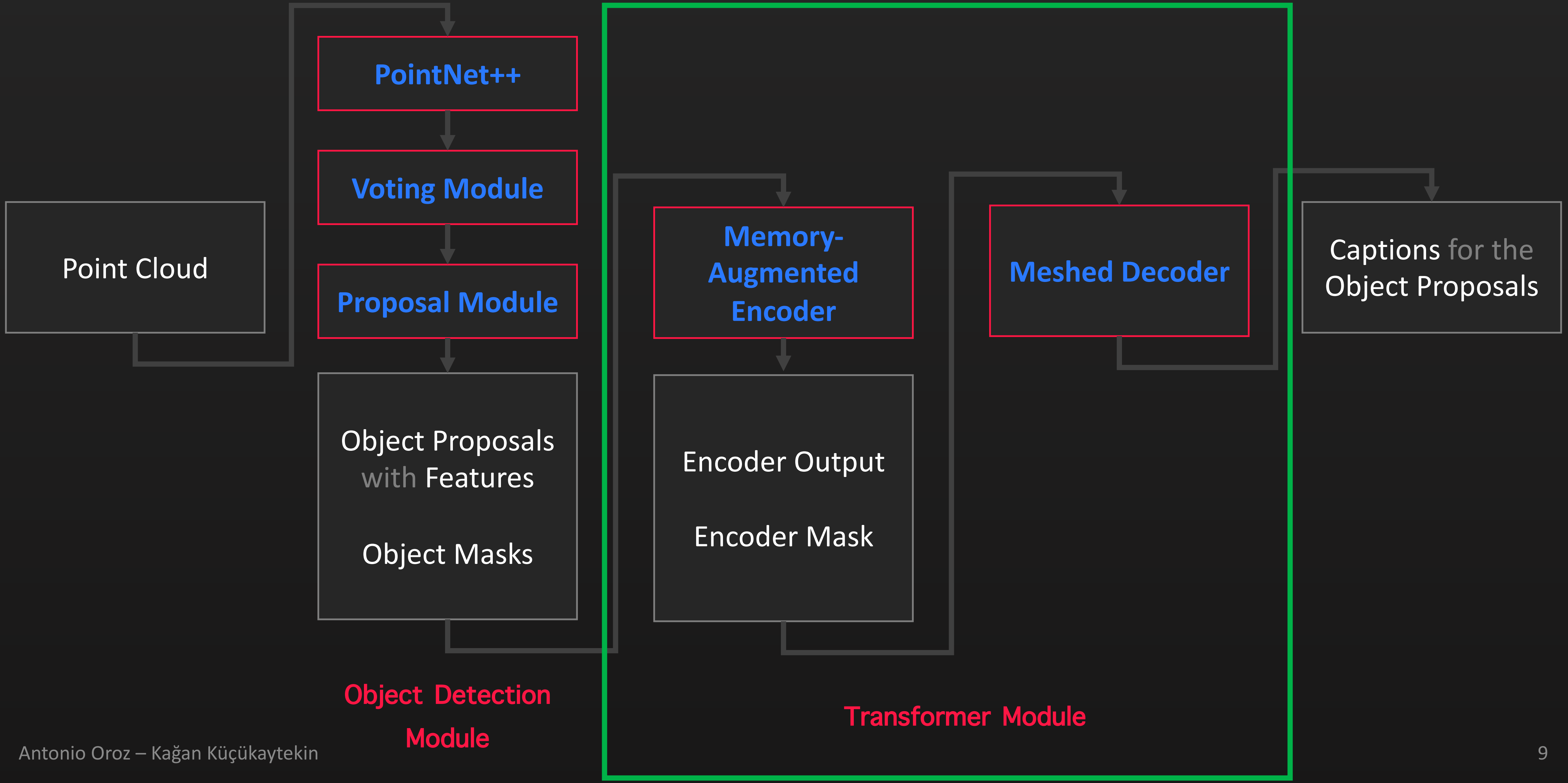
I. Scan2Cap Recap



I. Scan2Cap Recap



I. Scan2CapMMT Recap



Scan2CapMMT

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II. Improving Scan2CapMMT

Beam Search

ITERATIVE SEARCH

A	CHAIR

II. Improving Scan2CapMMT

Beam Search

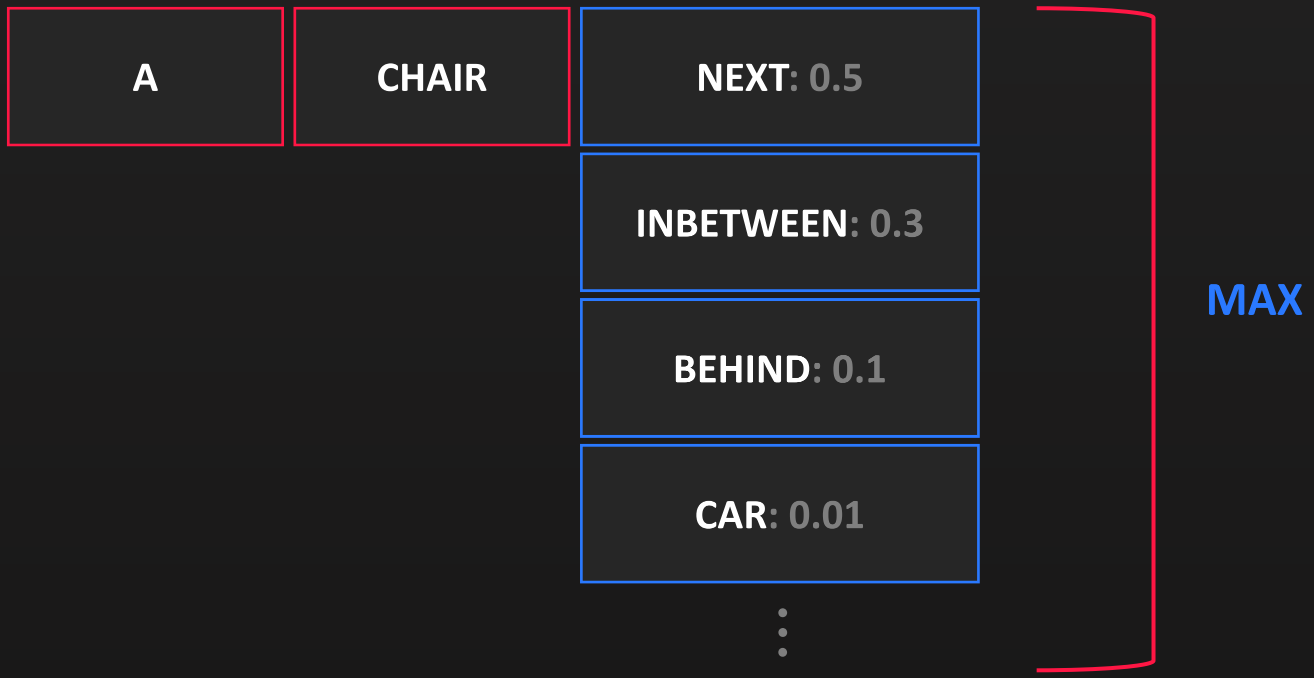
ITERATIVE SEARCH

A	CHAIR	NEXT: 0.5
		INBETWEEN: 0.3
		BEHIND: 0.1
		CAR: 0.01
		⋮

II. Improving Scan2CapMMT

Beam Search

ITERATIVE SEARCH



II. Improving Scan2CapMMT

Beam Search

ITERATIVE SEARCH

A	CHAIR	NEXT: 0.5	...

II. Improving Scan2CapMMT

Beam Search

A: 0.9	CHAIR: 0.4

BEAM SEARCH
SIZE 2

A: 0.9	TABLE: 0.3

II. Improving Scan2CapMMT

Beam Search

BEAM SEARCH
SIZE 2

A: 0.9	CHAIR: 0.4	NEXT: 0.5
		INBETWEEN: 0.3
		BEHIND: 0.1
		⋮

A: 0.9	TABLE: 0.3	NEXT: 0.3
		INBETWEEN: 0.2
		⋮

II. Improving Scan2CapMMT

Beam Search

BEAM SEARCH
SIZE 2

A: 0.9	CHAIR: 0.4	NEXT: 0.5	0.9 * 0.4 * 0.5 = 0.18
		INBETWEEN: 0.3	0.9 * 0.4 * 0.3 = 0.108
		BEHIND: 0.1	0.9 * 0.4 * 0.1 = 0.036
		⋮	
A: 0.9	TABLE: 0.3	NEXT: 0.3	0.9 * 0.3 * 0.3 = 0.081
		INBETWEEN: 0.2	0.9 * 0.3* 0.2 = 0.054
		⋮	

II. Improving Scan2CapMMT

Beam Search

BEAM SEARCH
SIZE 2

A: 0.9 | CHAIR: 0.4 | NEXT: 0.5 | 0.9 * 0.4 * 0.5 = 0.18

INBETWEEN: 0.3 | 0.9 * 0.4 * 0.3 = 0.108

BEHIND: 0.1 | 0.9 * 0.4 * 0.1 = 0.036

⋮

A: 0.9 | TABLE: 0.3 | NEXT: 0.3 | 0.9 * 0.3 * 0.3 = 0.081

INBETWEEN: 0.2 | 0.9 * 0.3* 0.2 = 0.054

⋮

MAX

II. Improving Scan2CapMMT

Beam Search

BEAM SEARCH
SIZE 2

A: 0.9 | CHAIR: 0.4 | NEXT: 0.5 — 0.9 * 0.4 * 0.5 = 0.18

INBETWEEN: 0.3 — 0.9 * 0.4 * 0.3 = 0.108

BEHIND: 0.1 — 0.9 * 0.4 * 0.1 = 0.036

⋮

A: 0.9 | TABLE: 0.3 | NEXT: 0.3 — 0.9 * 0.3 * 0.3 = 0.081

INBETWEEN: 0.2 — 0.9 * 0.3* 0.2 = 0.054

⋮

MAX

II. Improving Scan2CapMMT

Beam Search

BEAM SEARCH
SIZE 2

A: 0.9	CHAIR: 0.4	NEXT: 0.5	...

A: 0.9	CHAIR: 0.4	INBETWEEN: 0.3	...

II. Improving Scan2CapMMT

Beam Search

Reinforcement Learning

	CIDEr
This is a white sink...	0.41
This white a rectangular...	0.32
This is kitchen white...	0.24
This white a to sink...	0.001
This is is white oven...	0.09

II. Improving Scan2CapMMT

Beam Search

Reinforcement Learning

	CIDEr
This is a white sink…	0.41
This white a rectangular…	0.32
This is kitchen white…	0.24
This white a to sink…	0.001
This is is white oven…	0.09

$$-\frac{1}{k}\sum_{i=1}^{k}\left(r\left(w^{i}\right)-b\right)\log\left(p\left(w^{i}\right)\right)$$

II. Improving Scan2CapMMT

Beam Search

Reinforcement Learning

This is a white sink…	CIDEr
This is a white sink…	0.41
This white a rectangular…	0.32
This is kitchen white…	0.24
This white a to sink…	0.001
This is is white oven…	0.09

MEAN
b=0.21

$$-\frac{1}{k}\sum_{i=1}^{k}\left(r\left(w^i\right)-b\right)\log\left(p\left(w^i\right)\right)$$

II. Improving Scan2CapMMT

Beam Search

Reinforcement Learning

$r(w^i) - b$

This is a white sink…	0.2
This white a rectangular…	0.11
This is kitchen white…	0.03
This white a to sink…	-0.21
This is is white oven…	-0.12

MEAN

b=0.21

$$-\frac{1}{k}\sum_{i=1}^{k}\left(r(w^i) - b\right)\log(p(w^i))$$

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Scan2CapMMT

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III. Quantitative Results: vs Scan2Cap

@0.5IoU

Model	CIDEr	Bleu-4	Meteor	Rouge
VoteNet+GRU	**34.31**	21.42	20.13	41.33
VoteNet+MMT *=Scan2CapMMT*	32.99	**21.92**	**20.96**	**44.40**

III. Quantitative Results: vs Scan2Cap

@0.5IoU

Model	CIDEr	Bleu-4	Meteor	Rouge
VoteNet+CAC	**36.15**	21.58	20.65	41.78
VoteNet+MMT *=Scan2CapMMT*	32.99	**21.92**	**20.96**	**44.40**

III. Quantitative Results: vs Scan2Cap

@0.5IoU

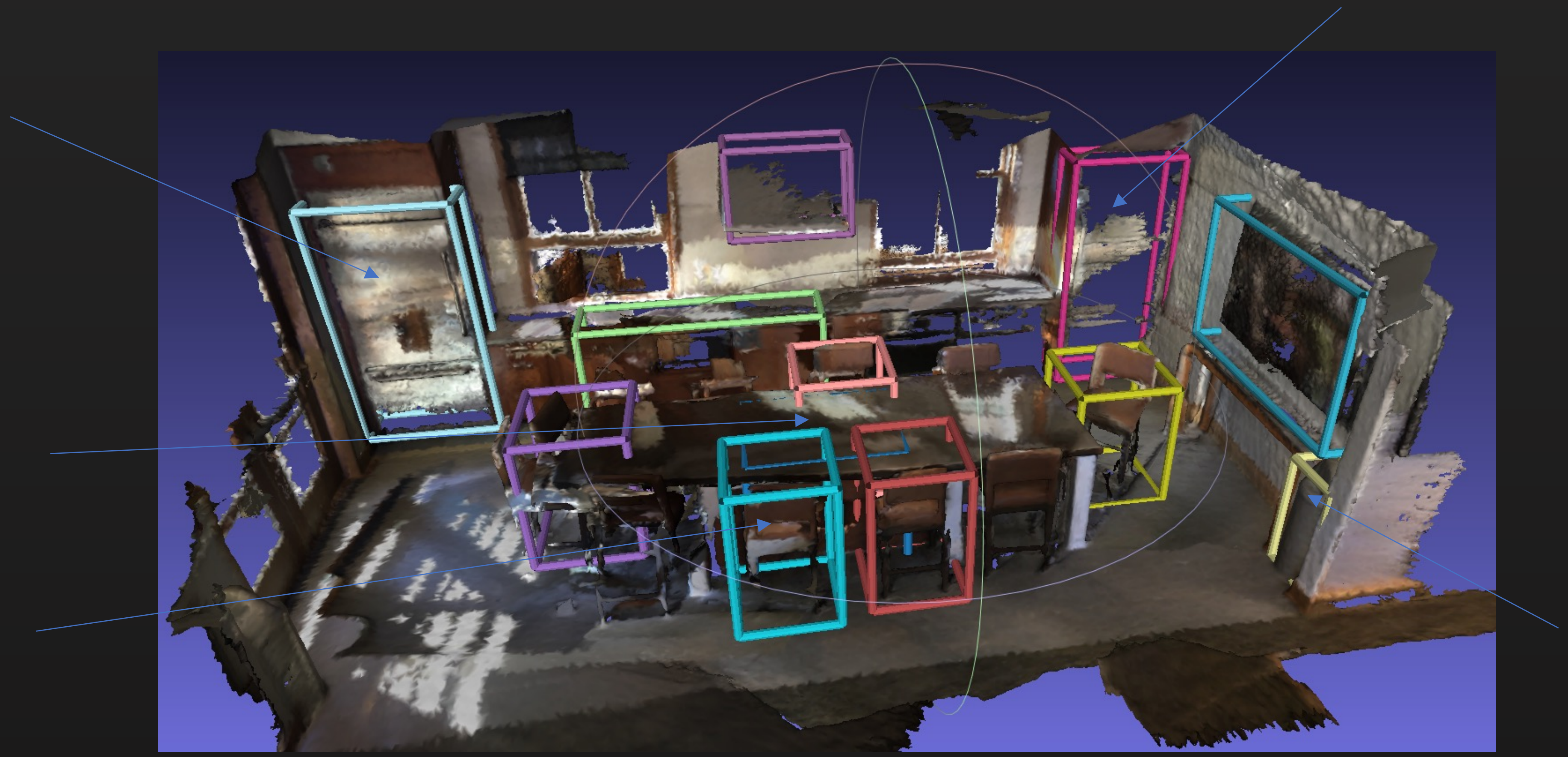
Model	CIDEr	Bleu-4	Meteor	Rouge
VoteNet+RG+CAC *= Scan2Cap*	**39.08**	**23.32**	**21.97**	**44.78**
Scan2CapMMT *= Scan2CapMMT*	32.99	21.92	20.96	44.40

III. Quantitative Results: Reinforcement Learning

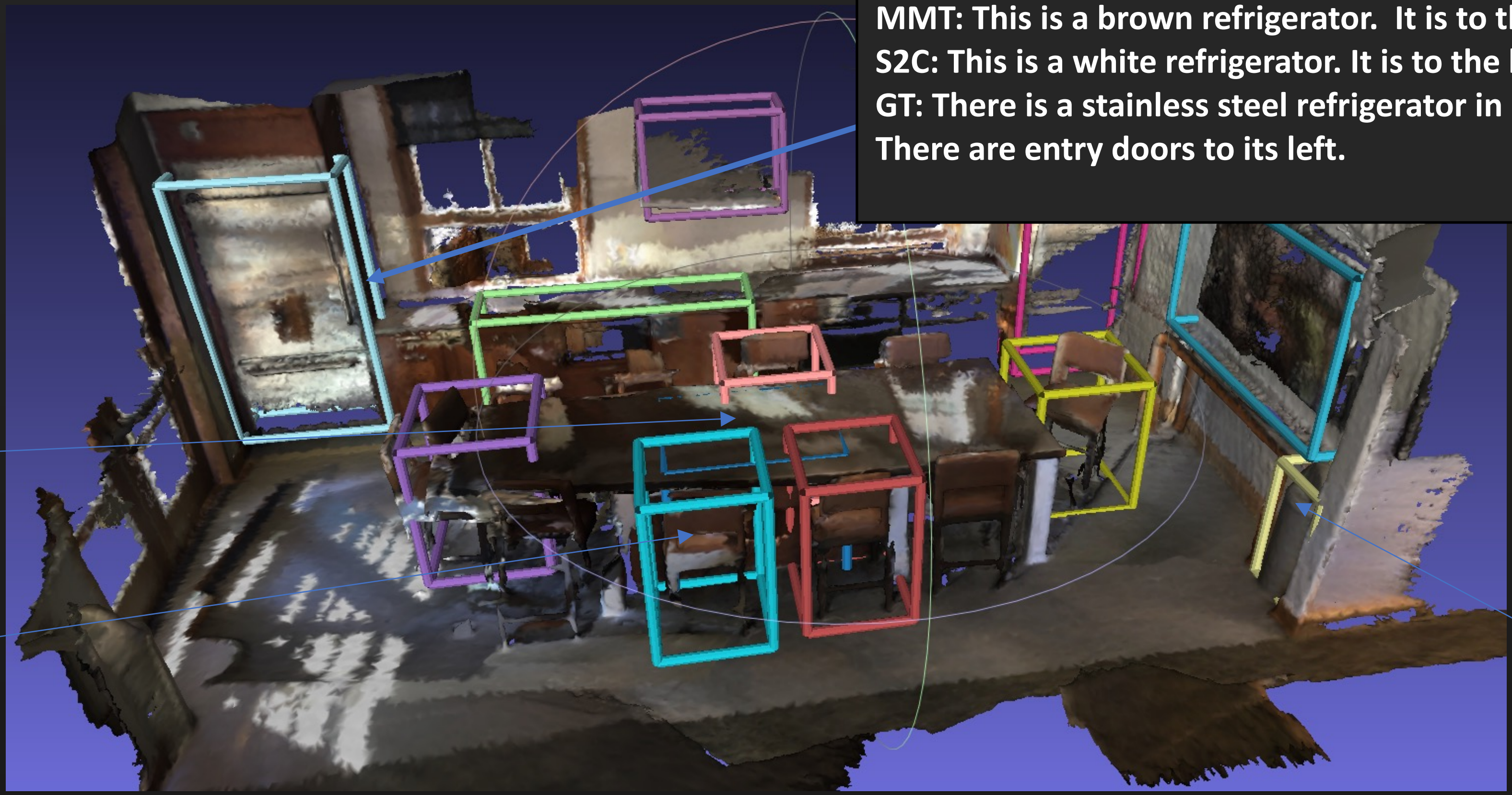
@0.5IoU

Model	CIDEr	Bleu-4	Meteor	Rouge
VoteNet+RG+CAC *= Scan2Cap*	**39.08**	23.32	**21.97**	**44.78**
VoteNet+MMT *= Scan2CapMMT*	32.99	21.92	20.96	44.40
Scan2CapMMT RL	36.18	**23.68**	21.33	44.64

III. Qualitative Results



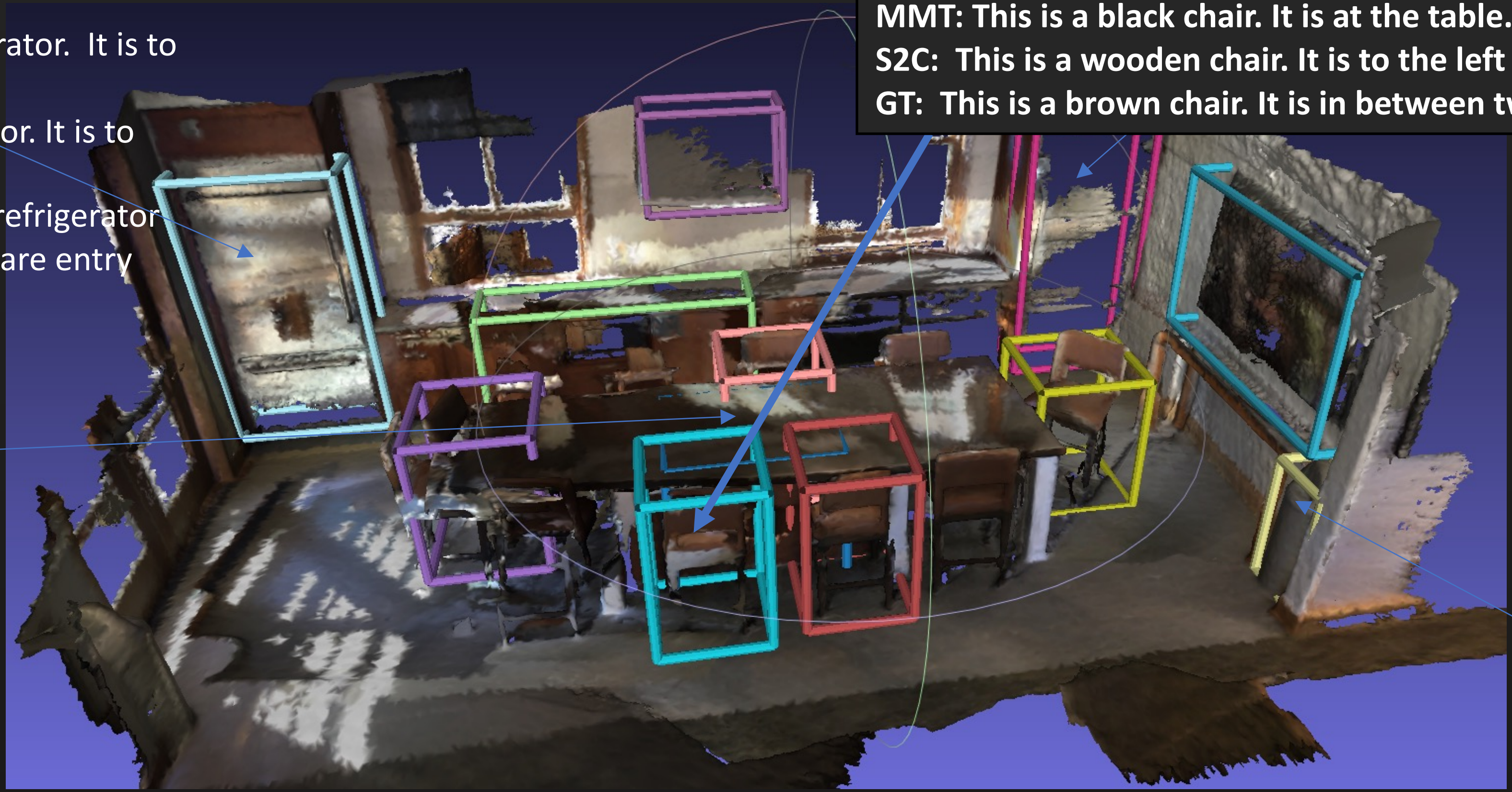
III. Qualitative Results



MMT: This is a brown refrigerator. It is to the left of the door.
S2C: This is a white refrigerator. It is to the left of the door.
GT: There is a stainless steel refrigerator in corner of the room. There are entry doors to its left.

III. Qualitative Results

MMT: This is a brown refrigerator. It is to the left of the door.
S2C: This is a white refrigerator. It is to the left of the door.
GT: There is a stainless steel refrigerator in corner of the room. There are entry doors to its left.

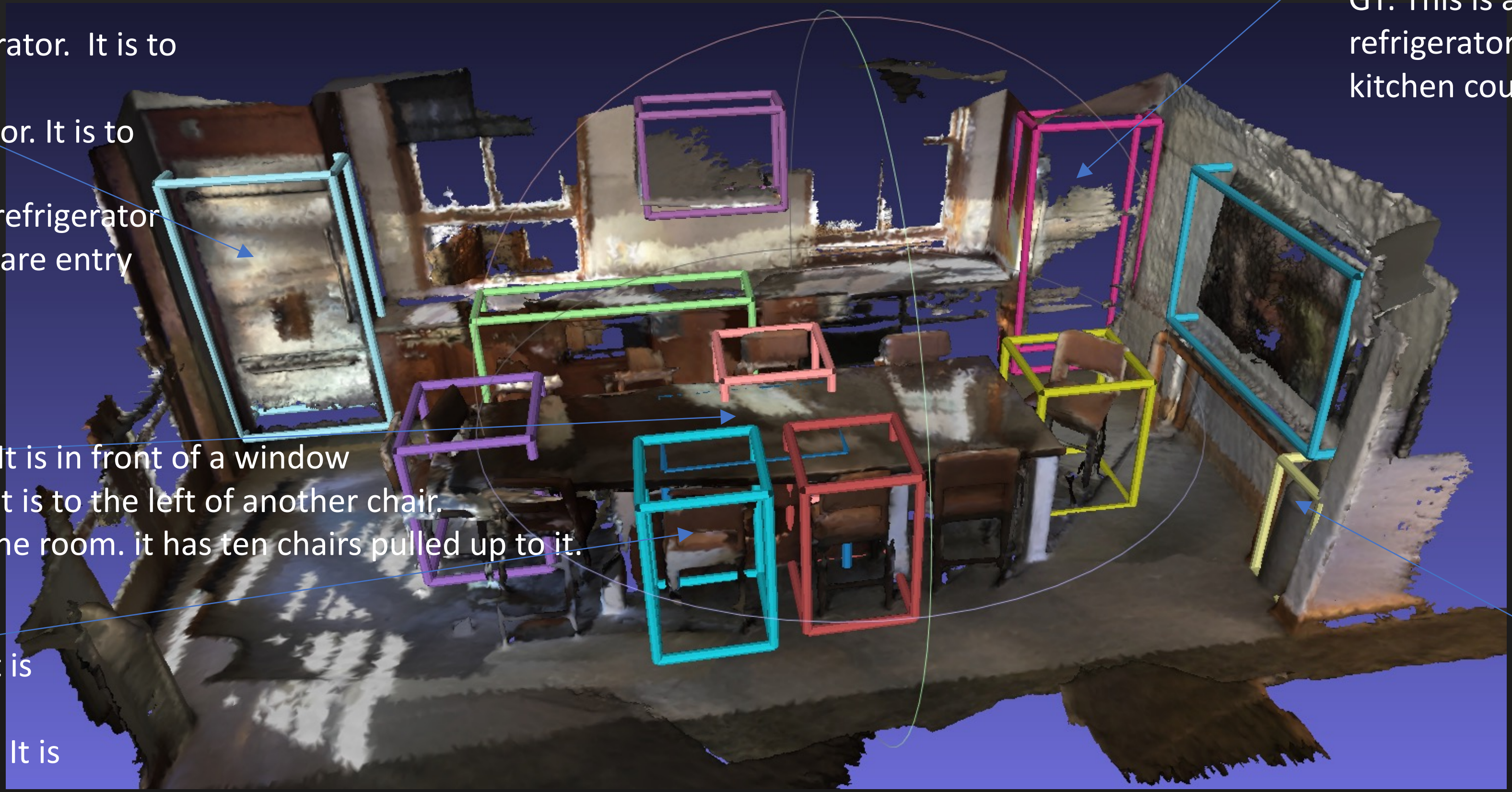


MMT: This is a black chair. It is at the table.
S2C: This is a wooden chair. It is to the left of another chair.
GT: This is a brown chair. It is in between two other chairs.

III. Qualitative Results

MMT: This is a brown refrigerator. It is to the left of the door.
S2C: This is a white refrigerator. It is to the left of the door.
GT: There is a stainless steel refrigerator in corner of the room. There are entry doors to its left.

MMT: This is a brown door. It is to the right of the door.
S2C: This is a white door. It is to the left of the shelf.
GT: This is a stainless steel refrigerator. It is to the right of a kitchen counter.

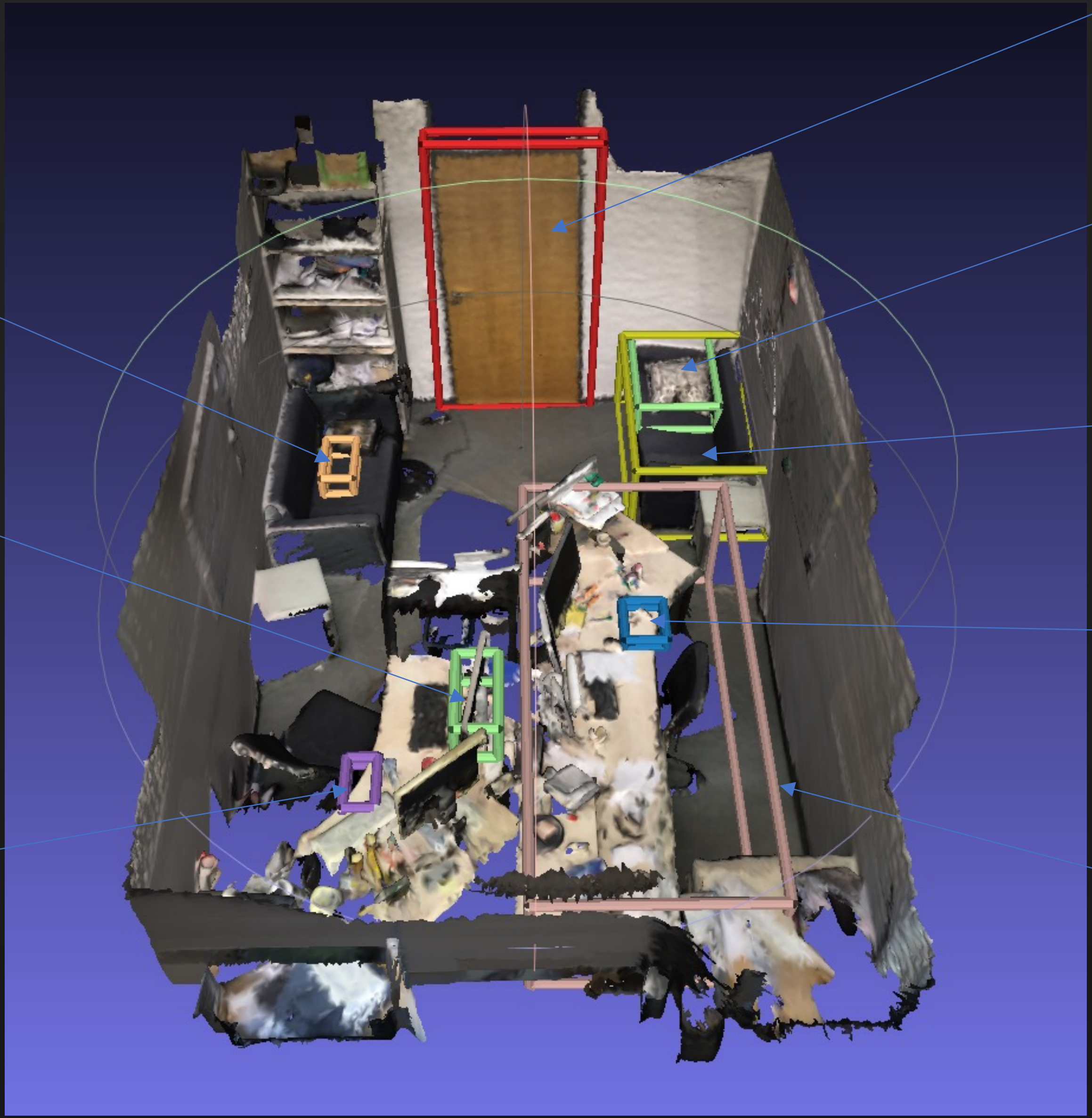


MMT: This is a brown table. It is in front of a window
S2C: This is a wooden chair. It is to the left of another chair.
GT: there is a large table in the room. it has ten chairs pulled up to it.

MMT: This is a black chair. It is at the table.
S2C: This is a wooden chair. It is to the left of another chair.
GT: This is a brown chair. It is in between two other chairs.

MMT: This is a black trash can. It is to the right of the door.
S2C: This is a trash can. It sets against the wall.
GT: This is a gray trash can. It is to the right of a table.

III. Qualitative Results

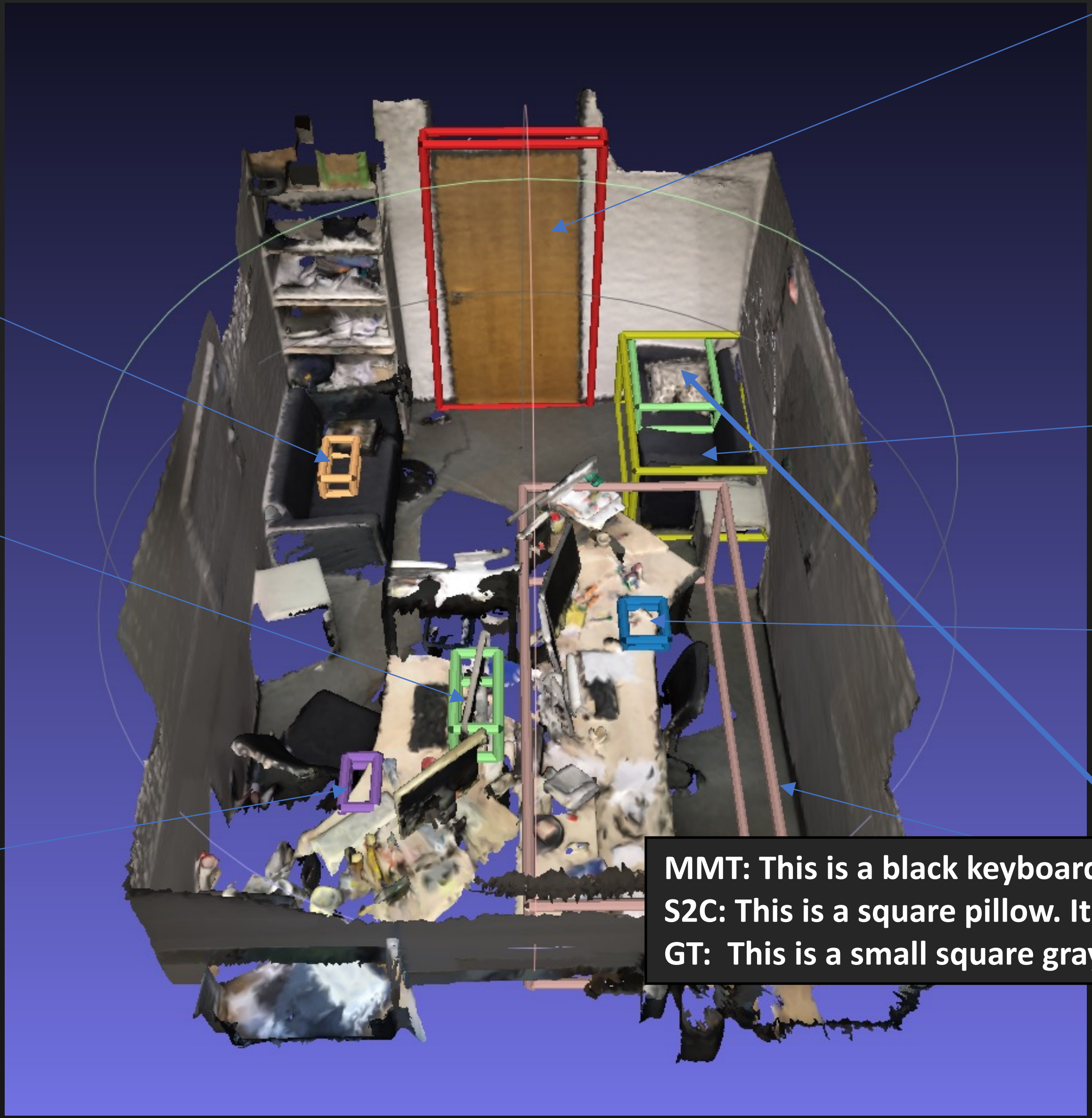


III. Qualitative Results

MMT: This is a brown door. It is to the right of a bookshelf.
S2C: This is a white door. It is to the left of a couch.
GT: A light brown door beside a tall shelf. A black couch is to the right of it .

III. Qualitative Results

MMT: This is a brown door. It is to the right of a bookshelf.
S2C: This is a white door. It is to the left of a couch.
GT: A light brown door beside a tall shelf. A black couch is to the right of it .



MMT: This is a black keyboard. It is on the desk.
S2C: This is a square pillow. It is on the couch.
GT: This is a small square gray pillow. It is located on a black couch.

III. Qualitative Results

MMT: This is a brown door. It is to the right of a bookshelf.
S2C: This is a white door. It is to the left of a couch.
GT: A light brown door beside a tall shelf. A black couch is to the right of it .

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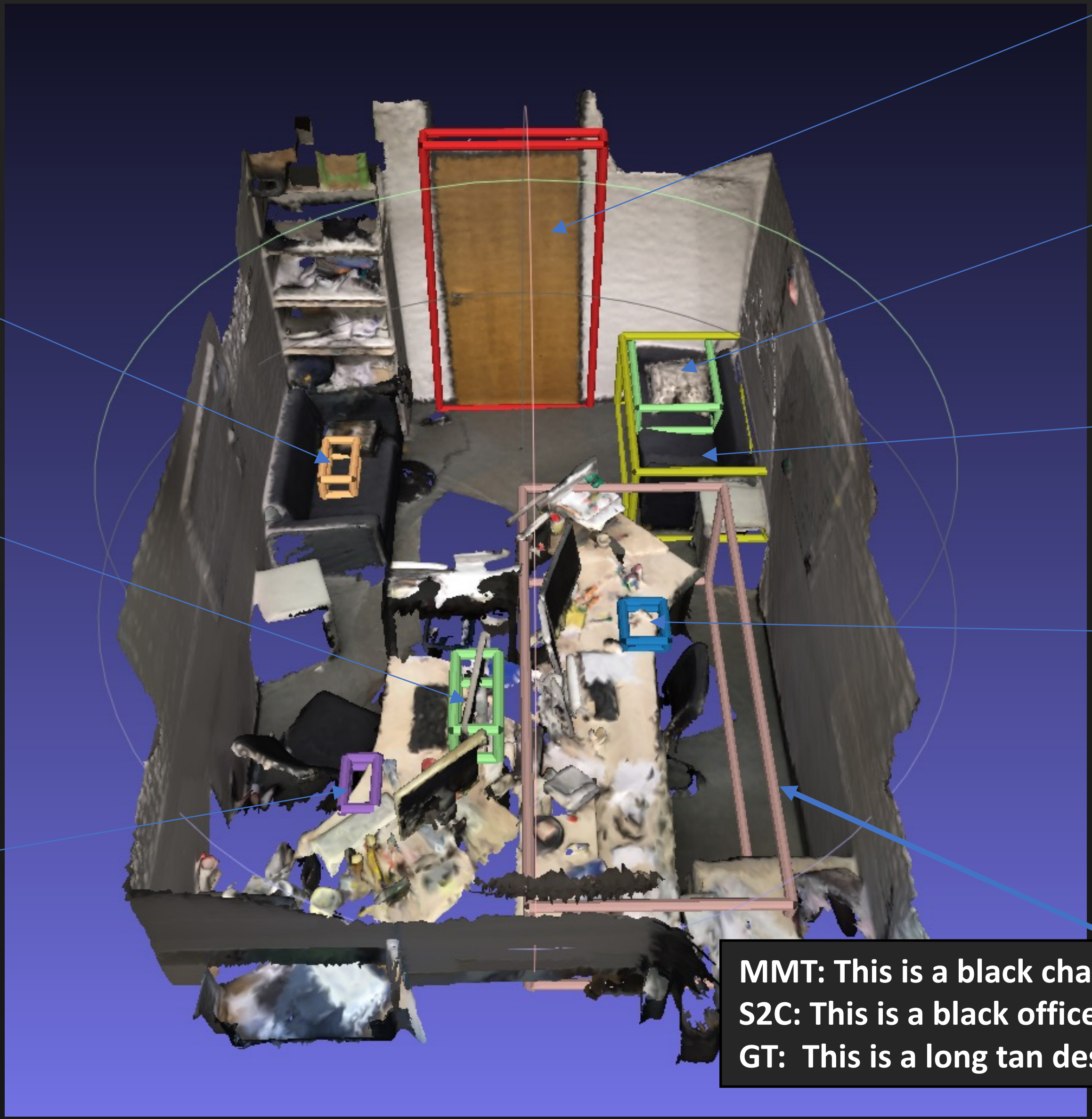


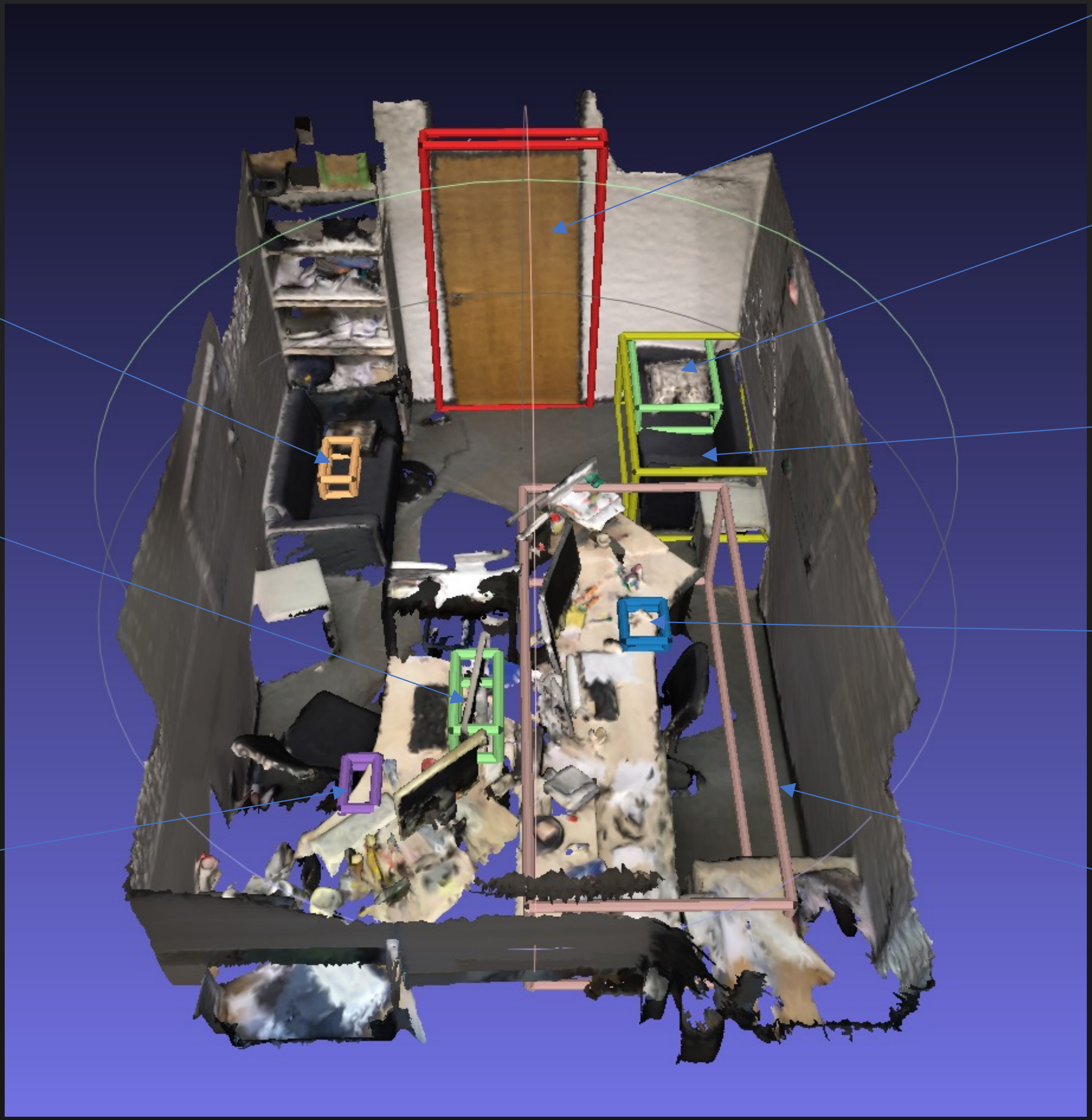
MMT: This is a black chair. It is to the right of the desk.
S2C: This is a black office chair. It is in front of a desk.
GT: This is a long tan desk. It is located near a wall and a small cabinet.

III. Qualitative Results

MMT: This is a black chair. It is to the right of the desk.
S2C: This is a brown couch. It is to the left of a brown table.
GT: It is a black sofa. It is located to the wall behind the fan.

MMT: This is a black monitor. It is on the desk.
S2C: N/A
GT: The monitor is located on top of the desk, and to the left of the other monitor facing the chair.

MMT: This is a black keyboard. It is on the desk.
S2C: N/A
GT: This is a long tan desk. It is located next to a black office chair.



MMT: This is a brown door. It is to the right of a bookshelf.
S2C: This is a white door. It is to the left of a couch.
GT: A light brown door beside a tall shelf. A black couch is to the right of it .

MMT: This is a black keyboard. It is on the desk.
S2C: This is a square pillow. It is on the couch.
GT: This is a small square gray pillow. It is located on a black couch.

MMT: This is a brown couch. It is to the right of the desk.
S2C: This is a brown couch. It is to the left of a table.
GT: The couch is located in the corner of the room. It is to the right side of the door.

2.MMT: This is a black keyboard. It is on a desk.
S2C: This is a black monitor. It is on a desk.
GT: A black computer screen is sitting on the desk. It is next to a black framed computer screen and to the left of it.

MMT: This is a black chair. It is to the right of the desk.
S2C: This is a black office chair. It is in front of a desk.
GT: This is a long tan desk. It is located near a wall and a small cabinet.

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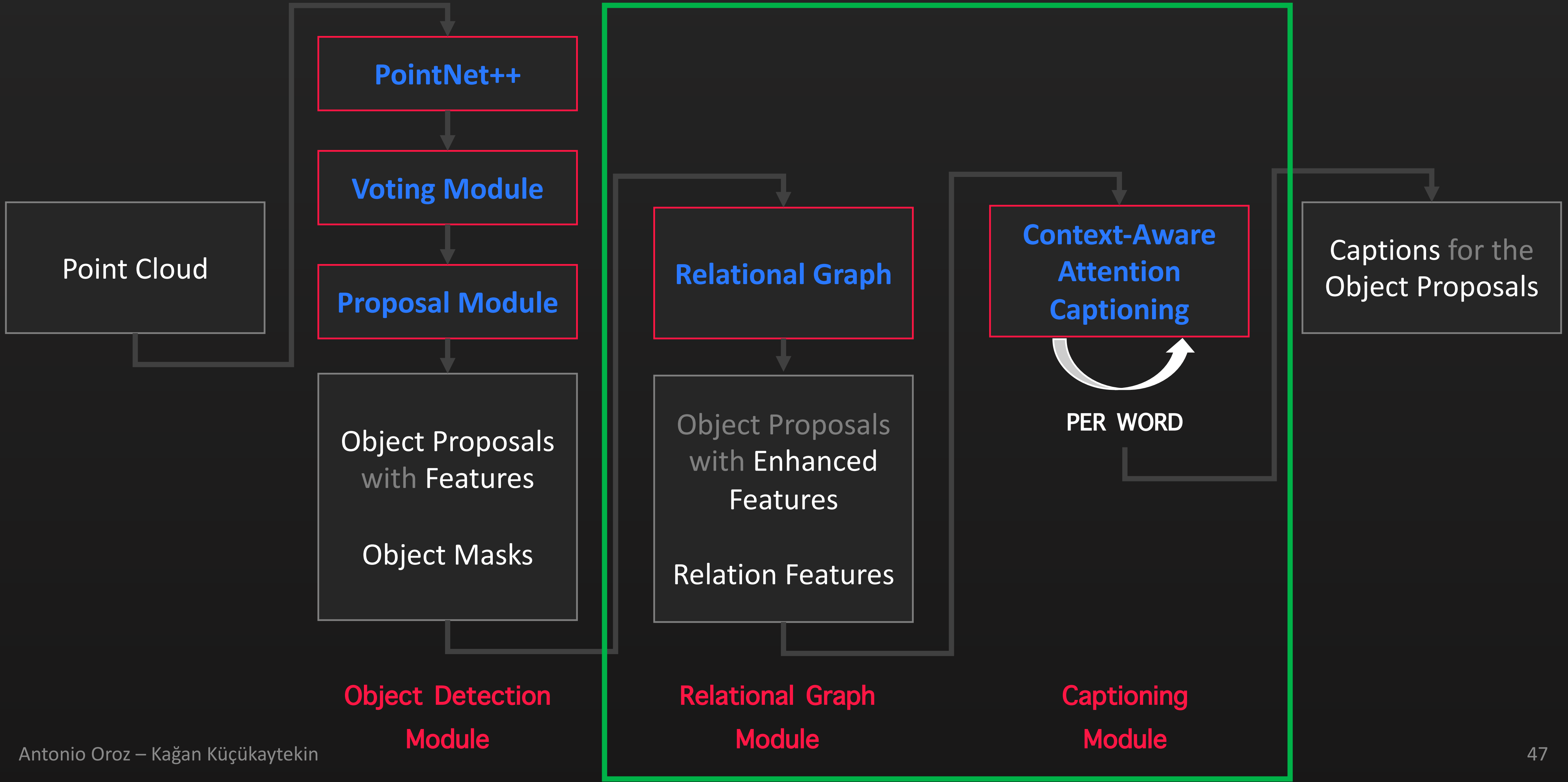
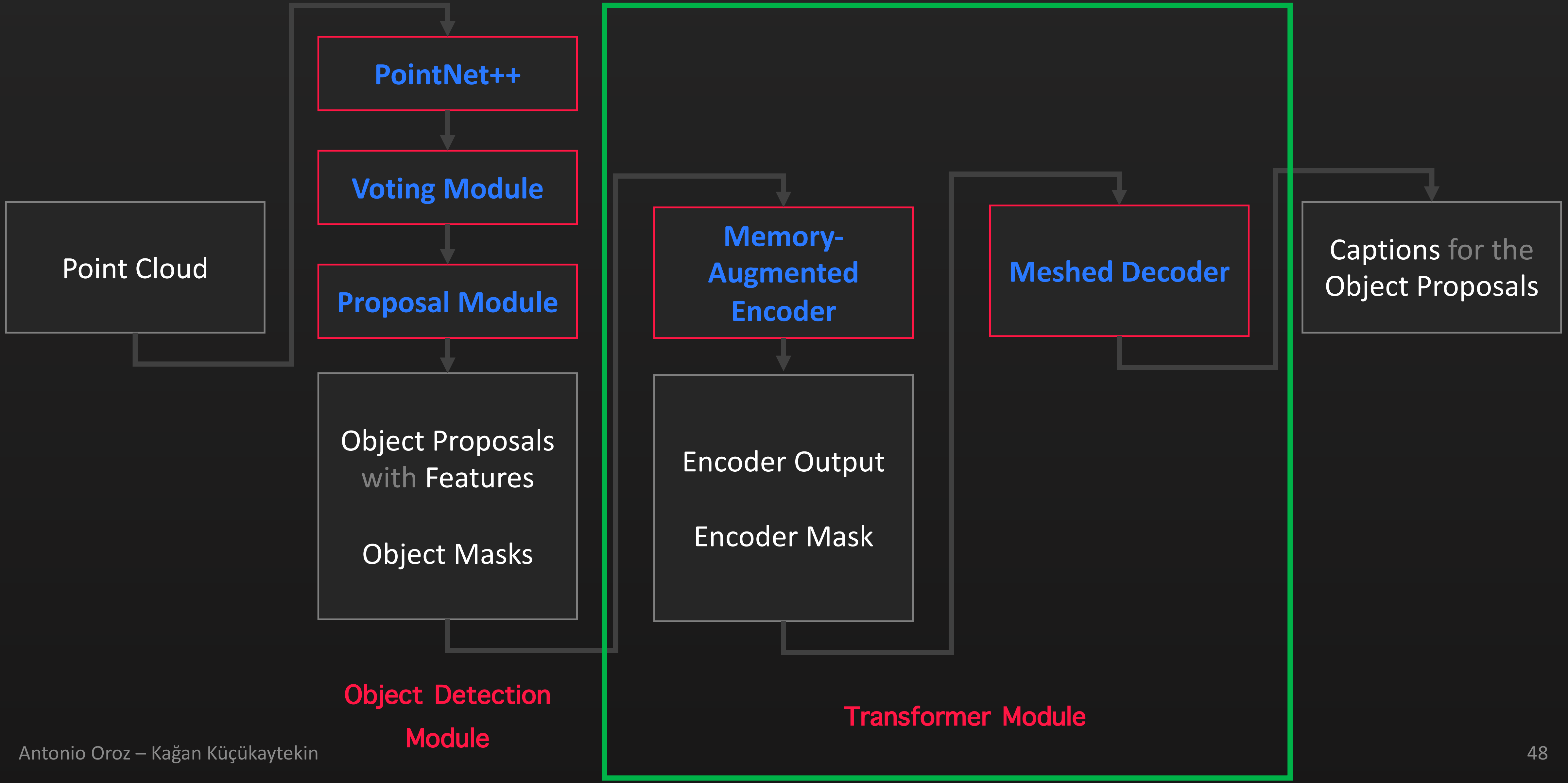
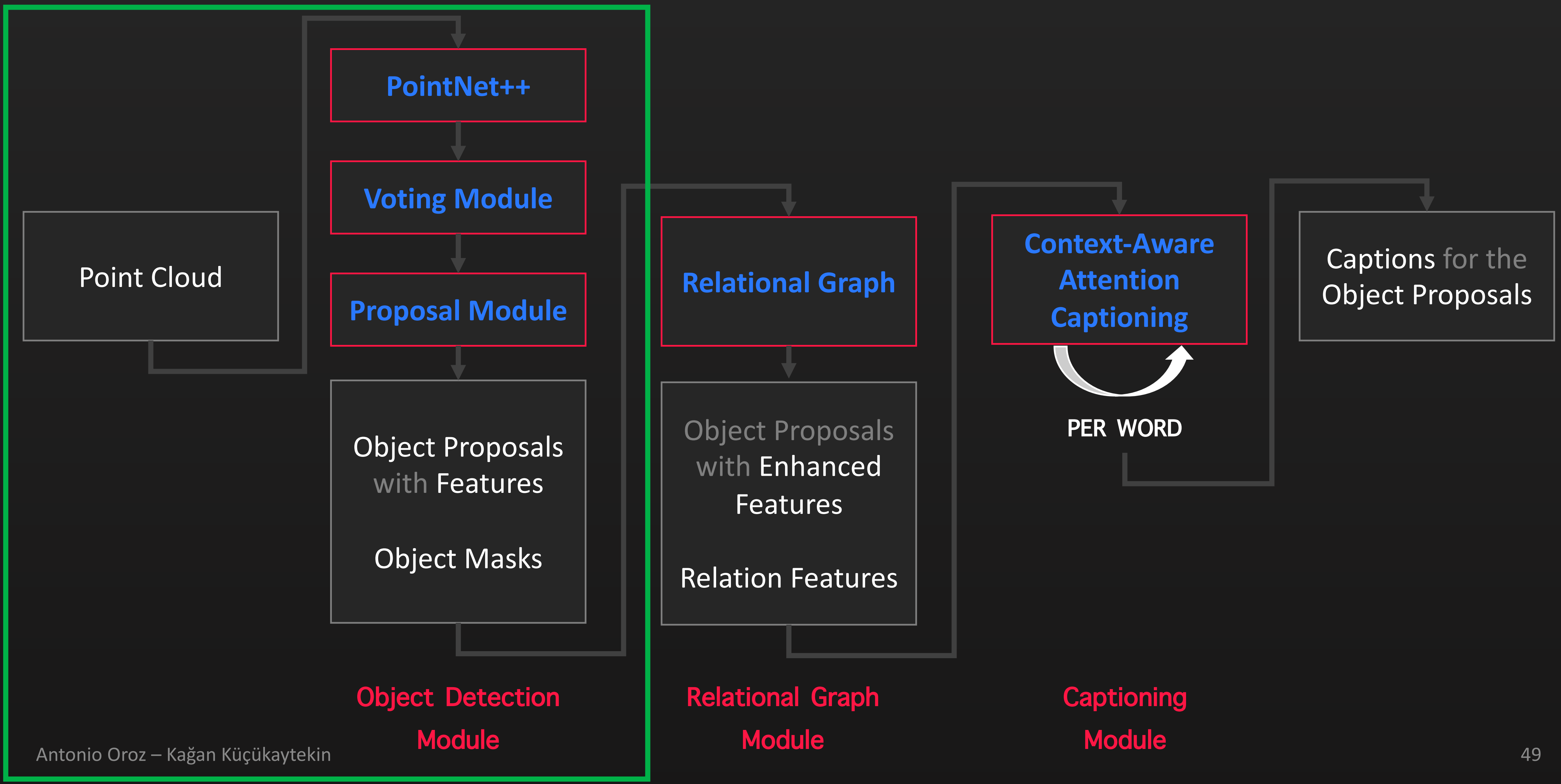
IV. Our Contribution



IV. Our Contribution



IV. Exploring Transformers for Detection Module



IV. Detection with Transformers

VoteNet

Point Cloud

↓

PointNet++

↓

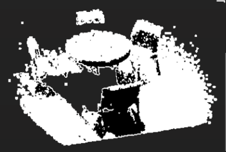
Voting Module

↓

Proposal Module

IV. Detection with Transformers

VoteNet



Point Cloud

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PointNet++

↓

Voting Module

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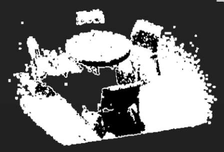
Proposal Module

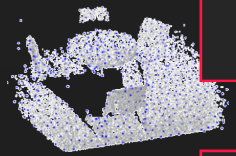
IV. Detection with Transformers

VoteNet



Point Cloud

↓



PointNet++

↓

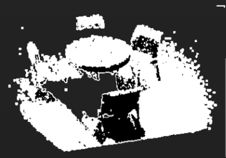
Voting Module

↓

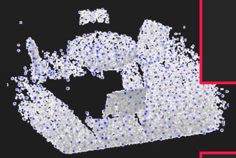
Proposal Module

IV. Detection with Transformers

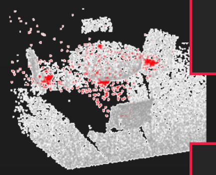
VoteNet



Point Cloud



PointNet++

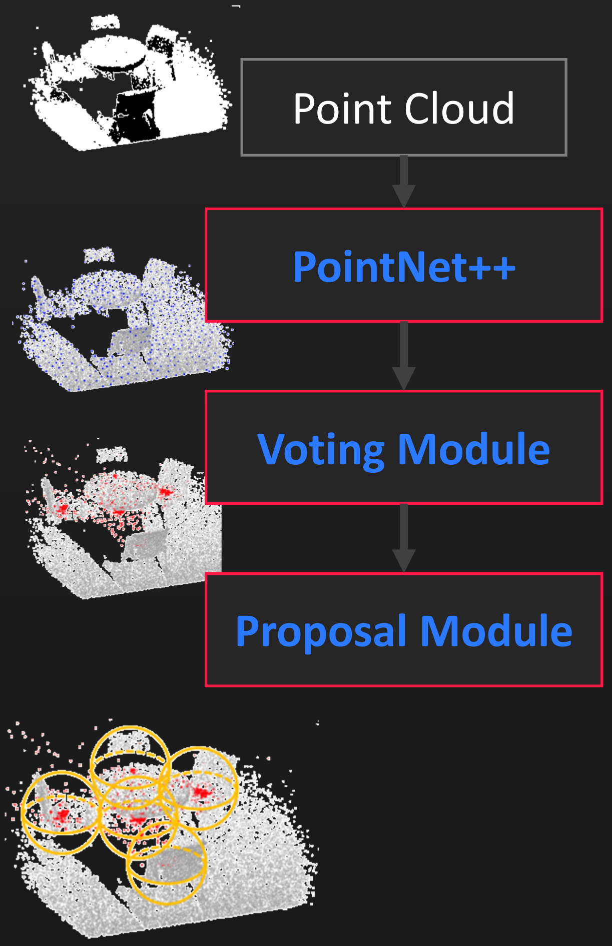


Voting Module

Proposal Module

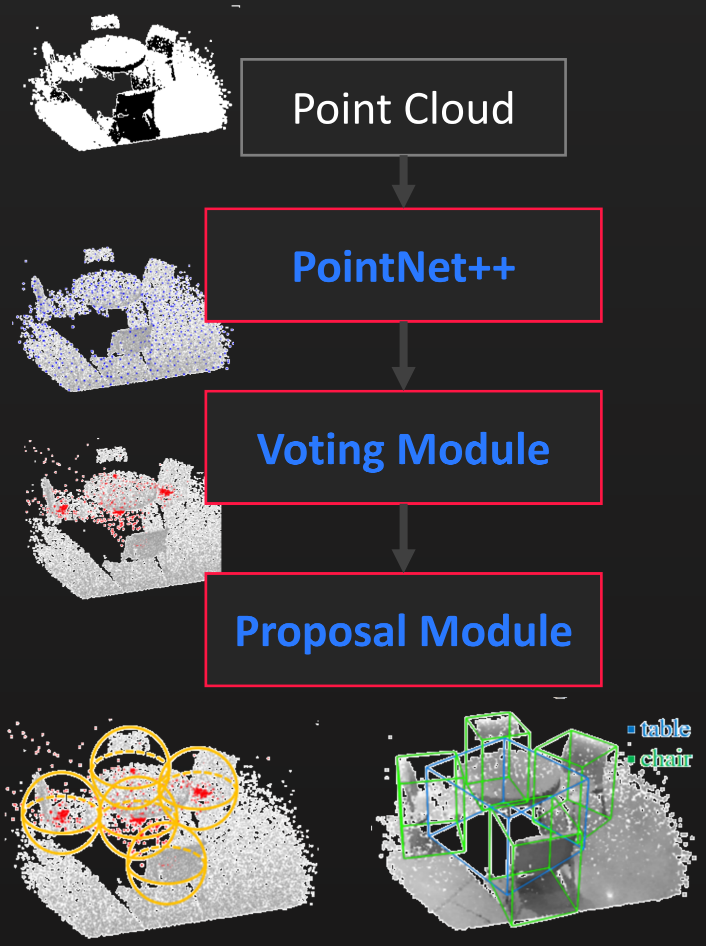
IV. Detection with Transformers

VoteNet



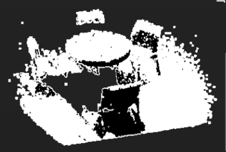
IV. Detection with Transformers

VoteNet

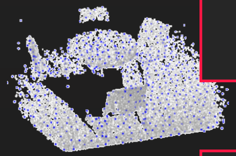


IV. Detection with Transformers

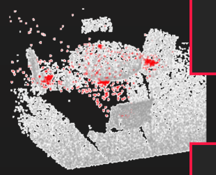
VoteNet



Point Cloud

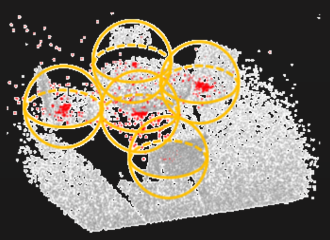


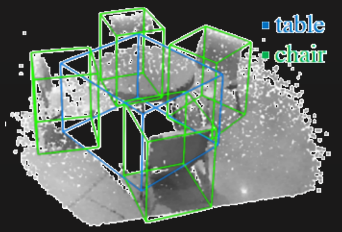
PointNet++



Voting Module

Proposal Module

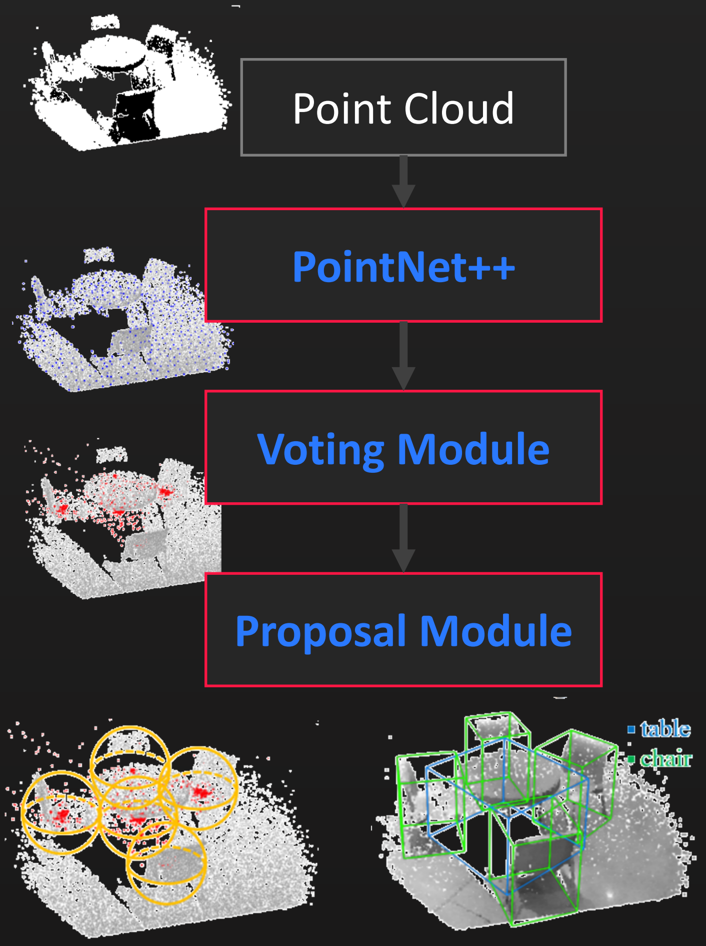




*Vote grouping is an issue! Especially when objects are overlapping.

IV. Detection with Transformers

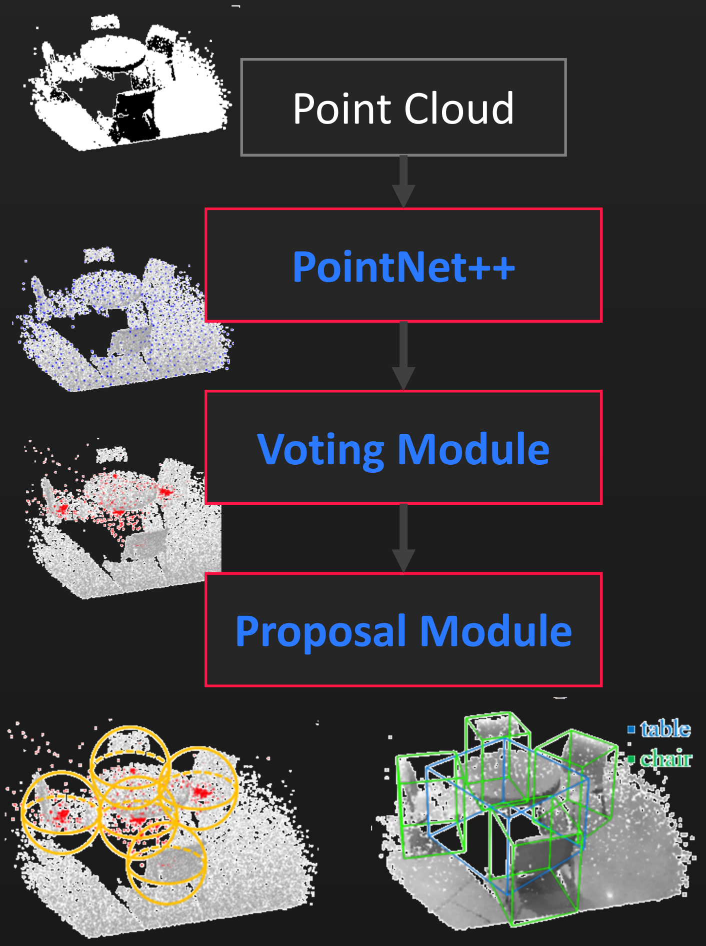
VoteNet



*Vote grouping is an issue! Especially when objects are overlapping.
*Radius for grouping is an important hyperparameter

IV. Detection with Transformers

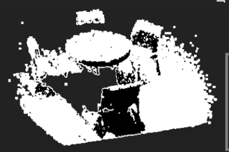
VoteNet



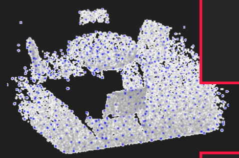
*Vote grouping is an issue! Especially when objects are overlapping.
*Radius for grouping is an important hyperparameter
*NMS only for eval

IV. Detection with Transformers

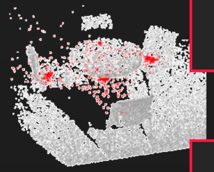
VoteNet



Point Cloud

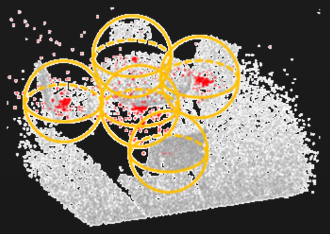


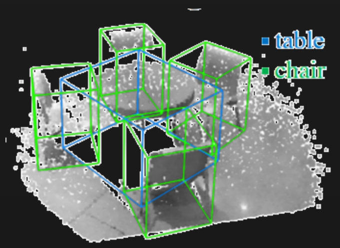
PointNet++



Voting

Proposal





3DETR

Point Cloud

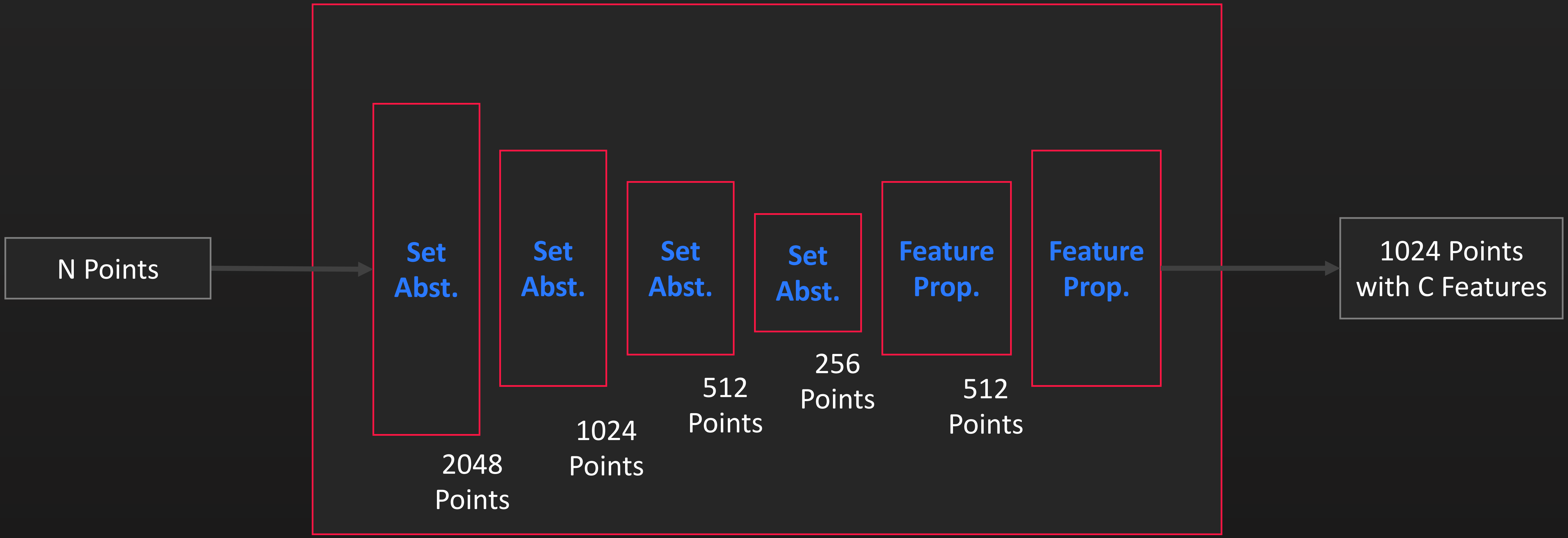
Group-Free-3D

Point Cloud

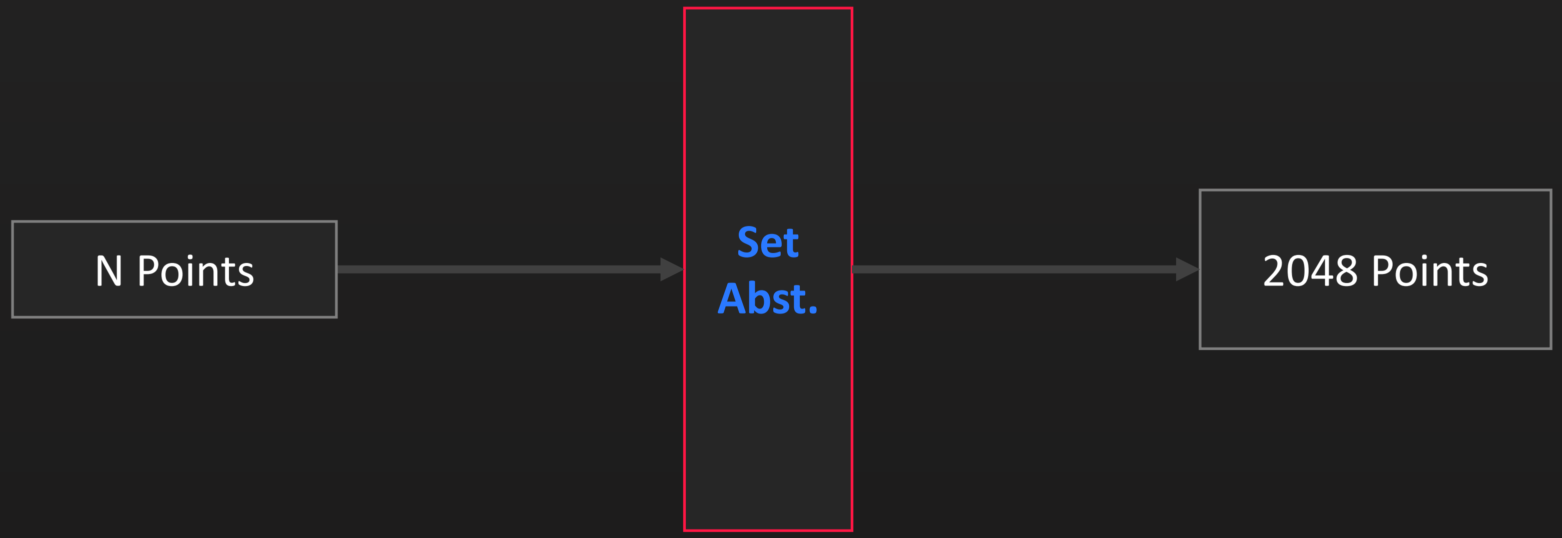
IV. Detection with Transformers

PointNet++

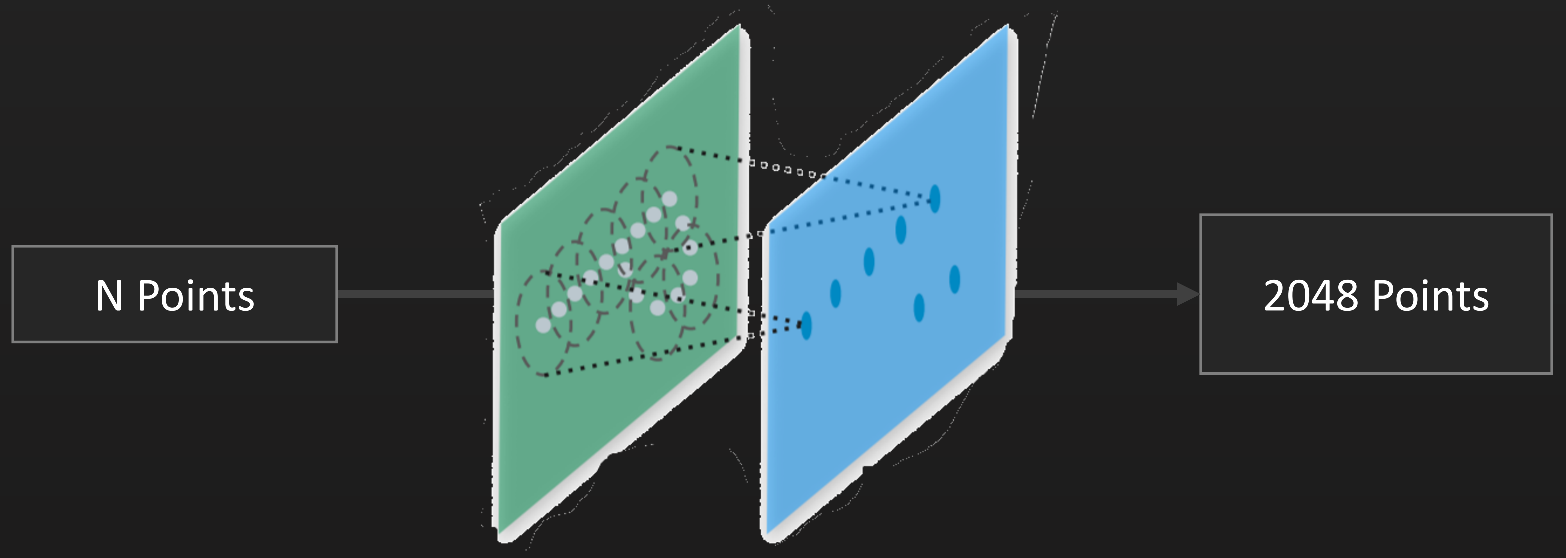
IV. Detection with Transformers



IV. Detection with Transformers

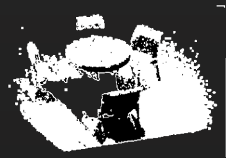


IV. Detection with Transformers

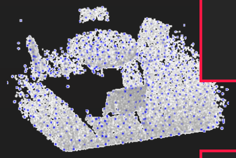


IV. Detection with Transformers

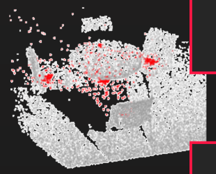
VoteNet



Point Cloud

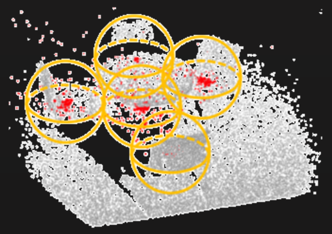


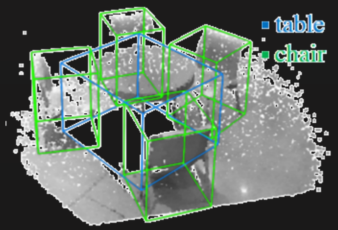
PointNet++



Voting

Proposal





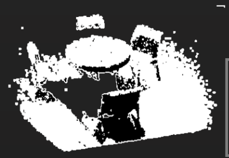
3DETR

Point Cloud

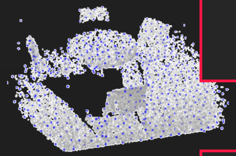
Set Abstraction

IV. Detection with Transformers

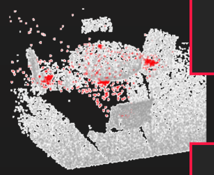
VoteNet



Point Cloud



PointNet++



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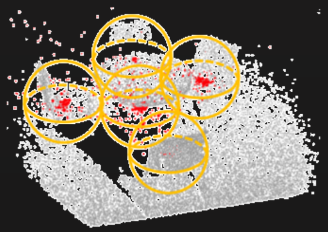
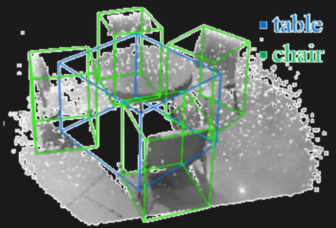
Proposal





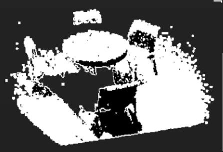
3DETR

Point Cloud

Set Abstraction

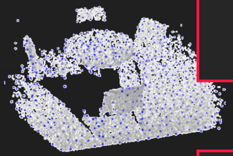
IV. Detection with Transformers

VoteNet



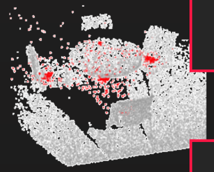
Point Cloud

↓



PointNet++

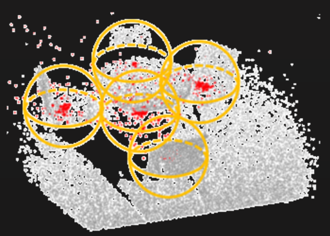
↓

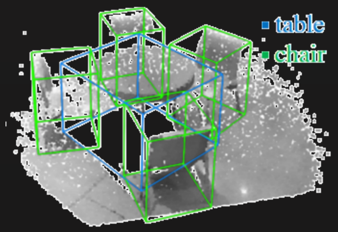


Voting

↓

Proposal





3DETR

Point Cloud

↓

Set Abstraction

Group-Free-3D

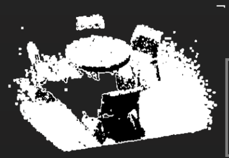
Point Cloud

↓

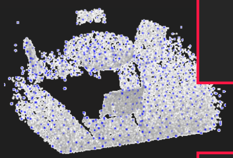
Pointnet++

IV. Detection with Transformers

VoteNet



Point Cloud



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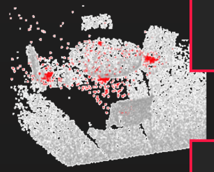

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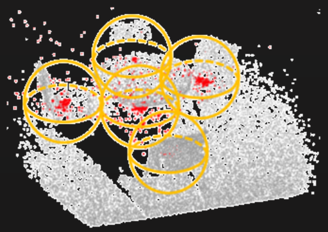
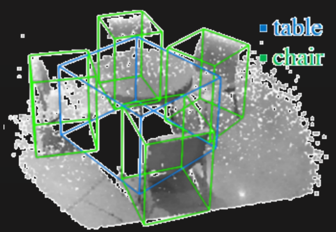
Proposal





3DETR

Point Cloud

Set Abstraction

Transformer

Proposal

Group-Free-3D

Point Cloud

Pointnet++

Transformer

Proposal

IV. Detection with Transformers

VoteNet

3DETR

Group-Free-3D

- Vote grouping is an issue!
- Cluster radius
- NMS reliance

IV. Detection with Transformers

VoteNet

- Vote grouping is an issue!
- Cluster radius
- NMS reliance

3DETR

+No NMS

Group-Free-3D

+No NMS

IV. Detection with Transformers

VoteNet

- Vote grouping is an issue!
- Cluster radius
- NMS reliance

3DETR

+No NMS
+Predict with every decoder output

Group-Free-3D

+No NMS
+Predict with every decoder output

IV. Detection with Transformers

VoteNet

- Vote grouping is an issue!
- Cluster radius
- NMS reliance

3DETR

+No NMS
+Predict with every decoder output

Group-Free-3D

+No NMS
+Predict with every decoder output
+Use learnable pos. embeddings

IV. Detection with Transformers

VoteNet

- Vote grouping is an issue!
- Cluster radius
- NMS reliance

3DETR

+No NMS
+Predict with every decoder output

Group-Free-3D

+No NMS
+Predict with every decoder output
+Use learnable pos. embeddings
+More efficient point sampling strategy

IV. Detection with Transformers

VoteNet

- Vote grouping is an issue!
- Cluster radius
- NMS reliance

3DETR

+No NMS
+Predict with every decoder output
+Simplest, flexible

Group-Free-3D

+No NMS
+Predict with every decoder output
+Use learnable pos. embeddings
+More efficient point sampling strategy

IV. Detection with Transformers

VoteNet	3DETR	Group-Free-3D
mAP@0.5: 39.9	mAP@0.5: 47	mAP@0.5: 49

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VoteNet	3DETR	Group-Free-3D
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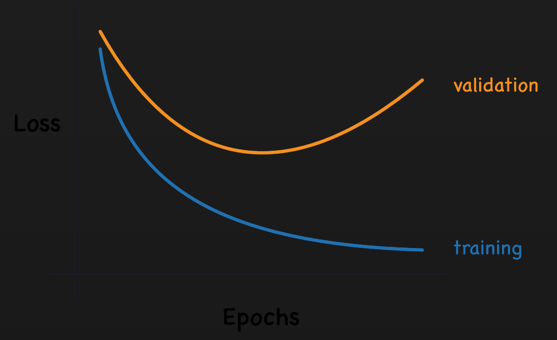
1M Parameters	7.3M Parameters	14.5M Parameters

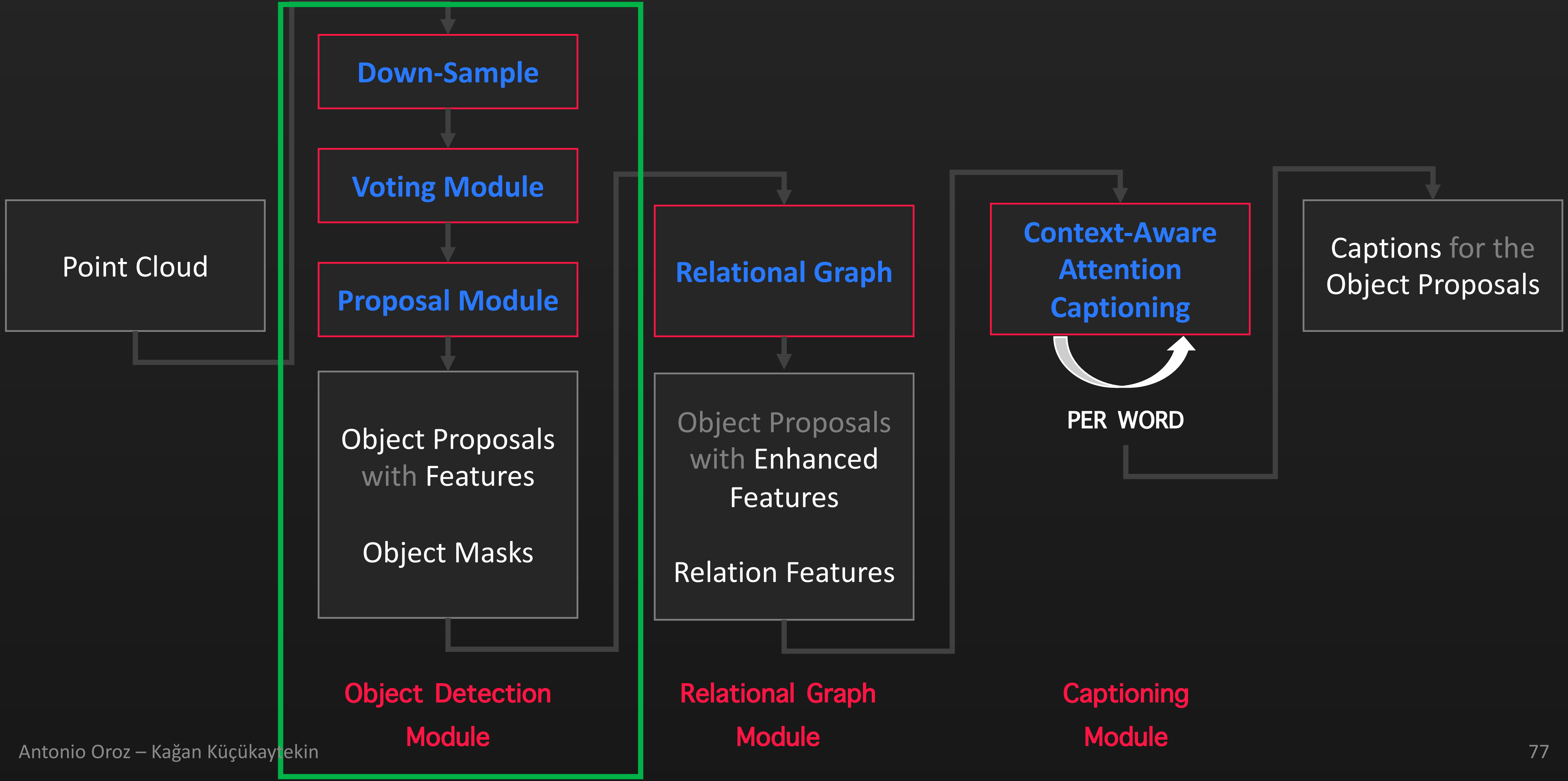
IV. Detection with Transformers

VoteNet	3DETR	Group-Free-3D
mAP@0.5: 39.9	mAP@0.5: 47	mAP@0.5: 49
1M Parameters	7.3M Parameters	14.5M Parameters

Because of data constraints, Group-Free-3D is more likely to overfit, so examine 3DETR



IV. Exploring Transformers for Detection Module



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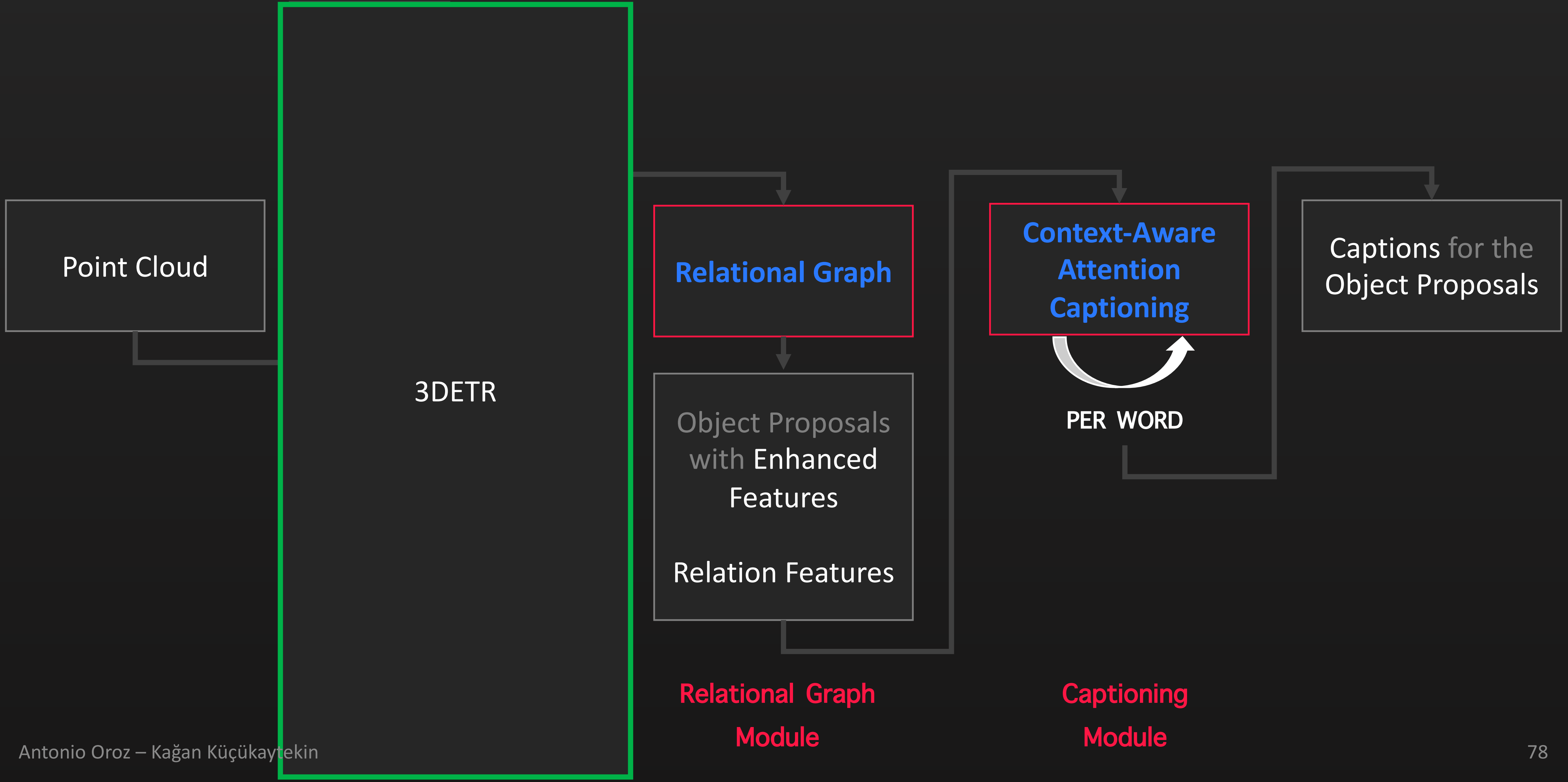

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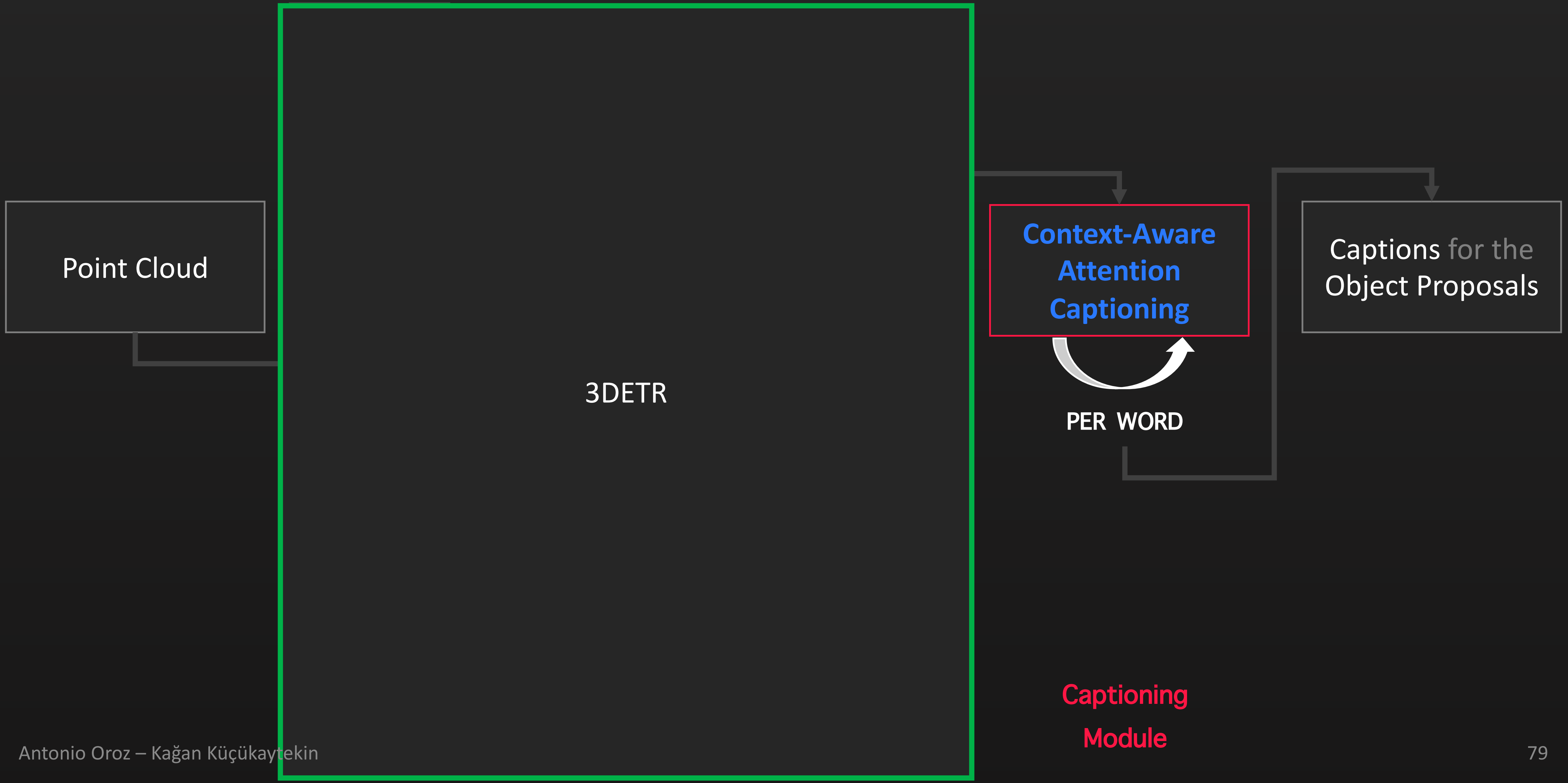

IV. Status

What we have done?

IV. Status

What we have done:

- Integrate 3DETR into the architecture

IV. Status

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- Test end-to-end pipeline by overfitting to single sample without caption

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Possible next steps?

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Possible next steps:

- End-to-end overfit to small sample for whole task

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What we have done:

- Integrate 3DETR into the architecture
- Test end-to-end pipeline by overfitting to single sample without caption

Possible next steps:

- End-to-end overfit to small sample for whole task
- Try transfer Learning with pre-trained 3DETR-m

IV. Status

What we have done:

- Integrate 3DETR into the architecture
- Test end-to-end pipeline by overfitting to single sample without caption

Possible next steps:

- End-to-end overfit to small sample for whole task
- Try transfer Learning with pre-trained 3DETR-m
- No promise! Ablation studies on our model is our Prio 1.

Scan2CapMMT

I. Scan2CapMMT Recap

II. Improving Scan2CapMMT

III. Quantitative & Qualitative Results

IV. Detection with Transformers

V. Timeline until the Final Presentation

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V. Timeline until the Final Presentation

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- Reproduced Scan2Cap
- Started MMT Implemtation

1. Presentation

V. Timeline until Final Presentation

- Reproduced Scan2Cap
- Started MMT Implemtation

1. Presentation

- Finalized MMT Implementation
- Implemented Beam Search and RL
- Looked into Detection Module alternatives
- Prototype 3DETR Implementation into Scan2Cap pipeline

2. Presentation

V. Timeline until Final Presentation

- Reproduced Scan2Cap
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1. Presentation

- Finalized MMT Implementation
- Implemented Beam Search and RL
- Looked into Detection Module alternatives
- Prototype 3DETR Implementation into Scan2Cap pipeline

2. Presentation

- Trying 3DETR with MMT
- Figuring out why Reinforcement Learning is unstable
- Qualitative and Quantitative Analysis
- Ablation Study

Final Presentation

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THANK YOU FOR YOUR ATTENTION :D