Gradient Boosting

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- Subsequent model focus on reducing the error

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- Models are built sequentially
- Subsequent model focus on reducing the error
- Models are created over the residuals

Gradient Boosting

ID	Age	City	Income
1	32	A	51000
2	30	B	78000
3	21	A	20000
4	27	B	44000
5	36	B	89000
6	25	A	37000
7	47	A	56000
8	54	B	92000

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ID	Age	City	Income
1	32	A	51000
2	30	B	78000
3	21	A	20000
4	27	B	44000
5	36	B	89000
6	25	A	37000
7	47	A	56000
8	54	B	92000

TARGET	PREDICTION	RESIDUAL

Steps to build Gradient Boosting Model

- **Step 1:** Build a model and make predictions on given data

Steps to build Gradient Boosting Model

ID	Age	City	Income
1	32	A	51000
2	30	B	78000
3	21	A	20000
4	27	B	44000
5	36	B	89000
6	25	A	37000
7	47	A	56000
8	54	B	92000

TARGET	PREDICTION	RESIDUAL
Income		
51000		
78000		
20000		
44000		
89000		
37000		
56000		
92000		

Steps to build Gradient Boosting Model

ID	Age	City	Income
1	32	A	51000
2	30	B	78000
3	21	A	20000
4	27	B	44000
5	36	B	89000
6	25	A	37000
7	47	A	56000
8	54	B	92000

TARGET	PREDICTION	RESIDUAL
Income	Predictions	
51000	53500	
78000	61000	
20000	28500	
44000	61000	
89000	90500	
37000	28500	
56000	53500	
92000	90500	

Steps to build Gradient Boosting Model

ID	Age	City	Income	Model 1 Income
1	32	A	51000	53500
2	30	B	78000	61000
3	21	A	20000	28500
4	27	B	44000	61000
5	36	B	89000	90500
6	25	A	37000	28500
7	47	A	56000	53500
8	54	B	92000	90500

TARGET	PREDICTION	RESIDUAL
Income	Predictions	
51000	53500	
78000	61000	
20000	28500	
44000	61000	
89000	90500	
37000	28500	
56000	53500	
92000	90500	

Steps to build Gradient Boosting Model

- **Step 1:** Build a model and make predictions on given data
- **Step 2:** Calculate the error and set this error as target

Steps to build Gradient Boosting Model

ID	Age	City	Income	Model 1 Income
1	32	A	51000	53500
2	30	B	78000	61000
3	21	A	20000	28500
4	27	B	44000	61000
5	36	B	89000	90500
6	25	A	37000	28500
7	47	A	56000	53500
8	54	B	92000	90500

TARGET	PREDICTION	RESIDUAL
Income	Predictions	
51000	53500	
78000	61000	
20000	28500	
44000	61000	
89000	90500	
37000	28500	
56000	53500	
92000	90500	

Steps to build Gradient Boosting Model

ID	Age	City	Income	Model 1 Income
1	32	A	51000	53500
2	30	B	78000	61000
3	21	A	20000	28500
4	27	B	44000	61000
5	36	B	89000	90500
6	25	A	37000	28500
7	47	A	56000	53500
8	54	B	92000	90500

TARGET	PREDICTION	RESIDUAL
Income	Predictions	Error
51000	53500	-2500
78000	61000	17000
20000	28500	-8500
44000	61000	-17000
89000	90500	-1500
37000	28500	8500
56000	53500	2500
92000	90500	1500

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Steps to build Gradient Boosting Model

ID	Age	City	Income	Model 1 Income
1	32	A	51000	53500
2	30	B	78000	61000
3	21	A	20000	28500
4	27	B	44000	61000
5	36	B	89000	90500
6	25	A	37000	28500
7	47	A	56000	53500
8	54	B	92000	90500

TARGET	PREDICTION	RESIDUAL
Income	Predictions	Error
51000	53500	-2500
78000	61000	17000
20000	28500	-8500
44000	61000	-17000
89000	90500	-1500
37000	28500	8500
56000	53500	2500
92000	90500	1500

TARGET
Error
-2500
17000
-8500
-17000
-1500
8500
2500
1500

Steps to build Gradient Boosting Model

- **Step 1:** Build a model and make predictions on given data
- **Step 2:** Calculate the error and set this error as target
- **Step 3:** Build model on the errors and make predictions

Steps to build Gradient Boosting Model

ID	Age	City	Income	Model 1 Income
1	32	A	51000	53500
2	30	B	78000	61000
3	21	A	20000	28500
4	27	B	44000	61000
5	36	B	89000	90500
6	25	A	37000	28500
7	47	A	56000	53500
8	54	B	92000	90500

TARGET	PREDICTION	RESIDUAL
Error		
-2500		
17000		
-8500		
-17000		
-1500		
8500		
2500		
1500		

Steps to build Gradient Boosting Model

ID	Age	City	Income	Model 1 Income
1	32	A	51000	53500
2	30	B	78000	61000
3	21	A	20000	28500
4	27	B	44000	61000
5	36	B	89000	90500
6	25	A	37000	28500
7	47	A	56000	53500
8	54	B	92000	90500

TARGET	PREDICTION	RESIDUAL
Error	Predictions	
-2500	-5500	
17000	8000	
-8500	-5500	
-17000	-4300	
-1500	8000	
8500	8000	
2500	-4300	
1500	-4300	

Steps to build Gradient Boosting Model

- **Step 1:** Build a model and make predictions on given data
- **Step 2:** Calculate the error and set this error as target
- **Step 3:** Build model on the errors and make predictions
- **Step 4:** Update predictions of model 1

Steps to build Gradient Boosting Model

ID	Age	City	Income	Model 1 Income
1	32	A	51000	53500
2	30	B	78000	61000
3	21	A	20000	28500
4	27	B	44000	61000
5	36	B	89000	90500
6	25	A	37000	28500
7	47	A	56000	53500
8	54	B	92000	90500

TARGET	PREDICTION	RESIDUAL
Error	Predictions	
-2500	-5500	
17000	8000	
-8500	-5500	
-17000	-4300	
-1500	8000	
8500	8000	
2500	-4300	
1500	-4300	

Steps to build Gradient Boosting Model

ID	Age	City	Income	Model 1 Income	Model 2 Income
1	32	A	51000	53500	48000
2	30	B	78000	61000	69000
3	21	A	20000	28500	23000
4	27	B	44000	61000	56700
5	36	B	89000	90500	98500
6	25	A	37000	28500	36500
7	47	A	56000	53500	49200
8	54	B	92000	90500	86200

TARGET	PREDICTION	RESIDUAL
Error	Predictions	
-2500	-5500	
17000	8000	
-8500	-5500	
-17000	-4300	
-1500	8000	
8500	8000	
2500	-4300	
1500	-4300	

Model 2 Income = Model 1 Income + Predicted Errors

Steps to build Gradient Boosting Model

- **Step 1:** Build a model and make predictions on given data
- **Step 2:** Calculate the error and set this error as target
- **Step 3:** Build model on the errors and make predictions
- **Step 4:** Update predictions of model 1
- **Step 5:** Repeat Step 2 to Step 4

Steps to build Gradient Boosting Model

ID	Age	City	Income	Model 1 Income	Model 2 Income
1	32	A	51000	53500	48000
2	30	B	78000	61000	69000
3	21	A	20000	28500	23000
4	27	B	44000	61000	56700
5	36	B	89000	90500	98500
6	25	A	37000	28500	36500
7	47	A	56000	53500	49200
8	54	B	92000	90500	86200

TARGET	PREDICTION	RESIDUAL
Error	Predictions	
-2500	-5500	
17000	8000	
-8500	-5500	
-17000	-4300	
-1500	8000	
8500	8000	
2500	-4300	
1500	-4300	

Steps to build Gradient Boosting Model

ID	Age	City	Income	Model 1 Income	Model 2 Income
1	32	A	51000	53500	48000
2	30	B	78000	61000	69000
3	21	A	20000	28500	23000
4	27	B	44000	61000	56700
5	36	B	89000	90500	98500
6	25	A	37000	28500	36500
7	47	A	56000	53500	49200
8	54	B	92000	90500	86200

TARGET	PREDICTION	RESIDUAL
Error	Predictions	New Error
-2500	-5500	3000
17000	8000	9000
-8500	-5500	-3000
-17000	-4300	-12700
-1500	8000	-9500
8500	8000	500
2500	-4300	6800
1500	-4300	5800

Steps to build Gradient Boosting Model

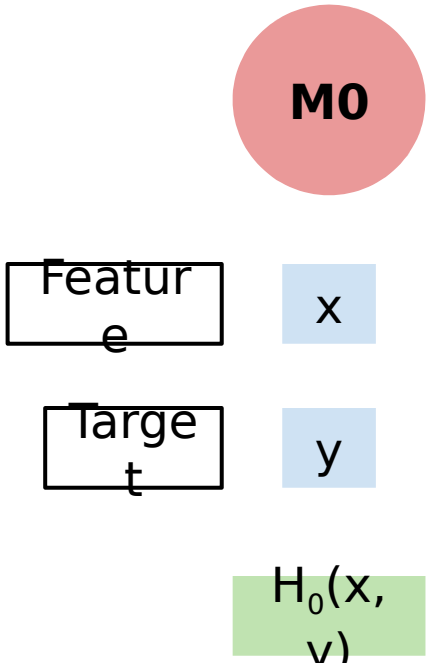
ID	Age	City	Income	Model 1 Income	Model 2 Income
1	32	A	51000	53500	48000
2	30	B	78000	61000	69000
3	21	A	20000	28500	23000
4	27	B	44000	61000	56700
5	36	B	89000	90500	98500
6	25	A	37000	28500	36500
7	47	A	56000	53500	49200
8	54	B	92000	90500	86200

TARGET	PREDICTION	RESIDUAL
New Error		
3000		
9000		
-3000		
-12700		
-9500		
500		
6800		
5800		

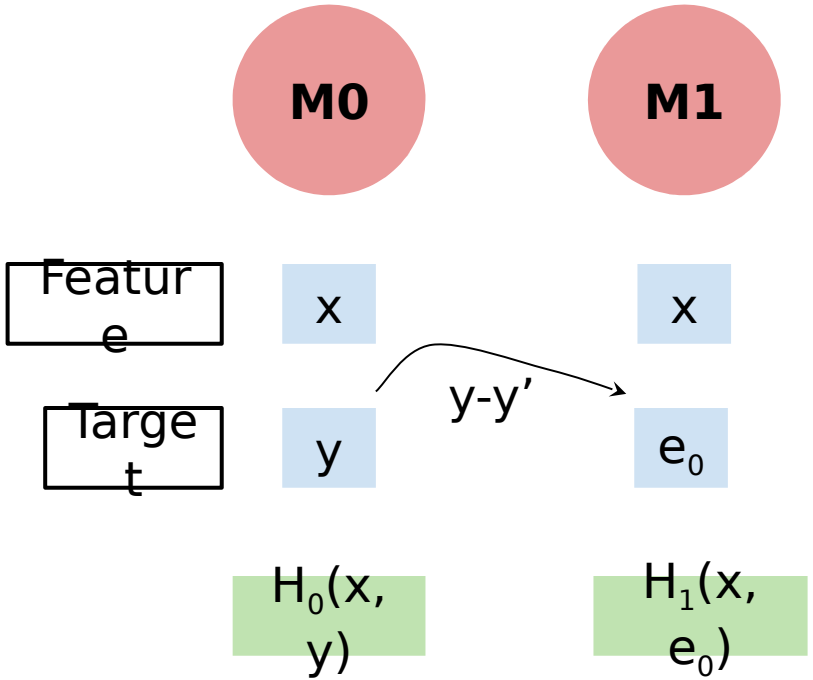
Steps to build Gradient Boosting Model

- **Step 1:** Build a model and make predictions
- **Step 2:** Calculate the error and set this as target
- **Step 3:** Build model on the errors and make predictions
- **Step 4:** Predicted error is added to the predicted age (by model 1)
- **Step 5:** Repeat Step 2 to Step 4

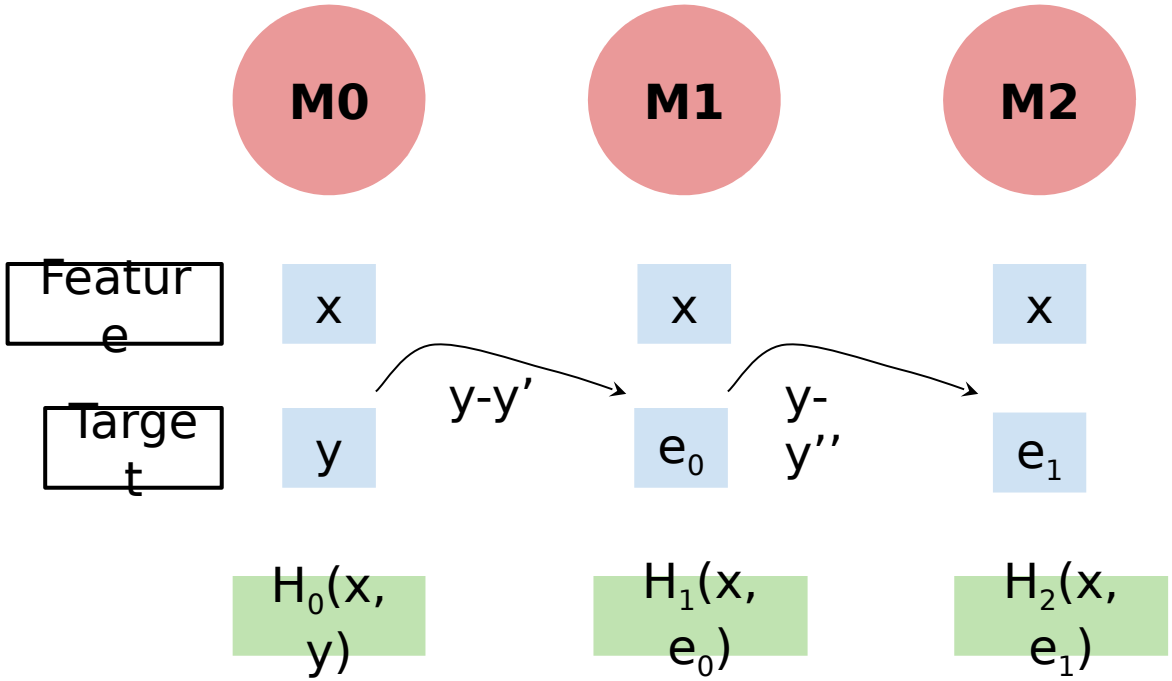
Gradient Boosting Model



Gradient Boosting Model



Gradient Boosting Model



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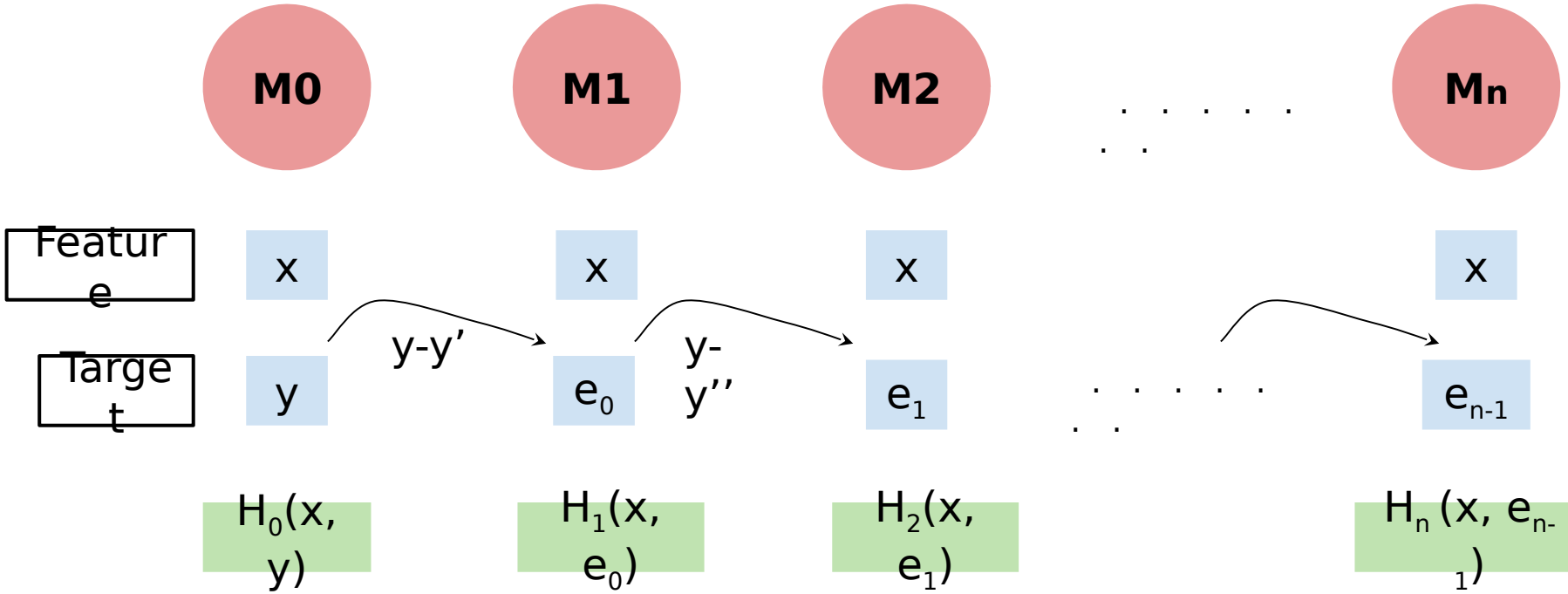
Gradient Boosting Model



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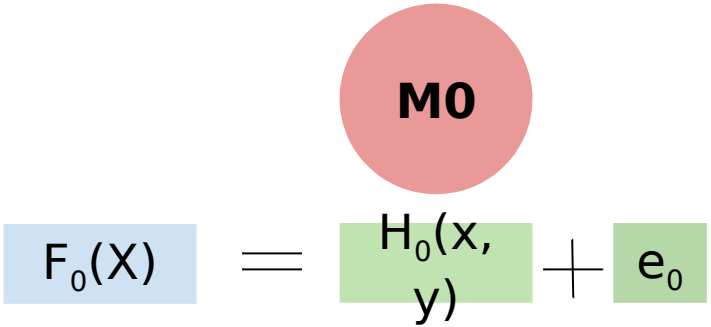
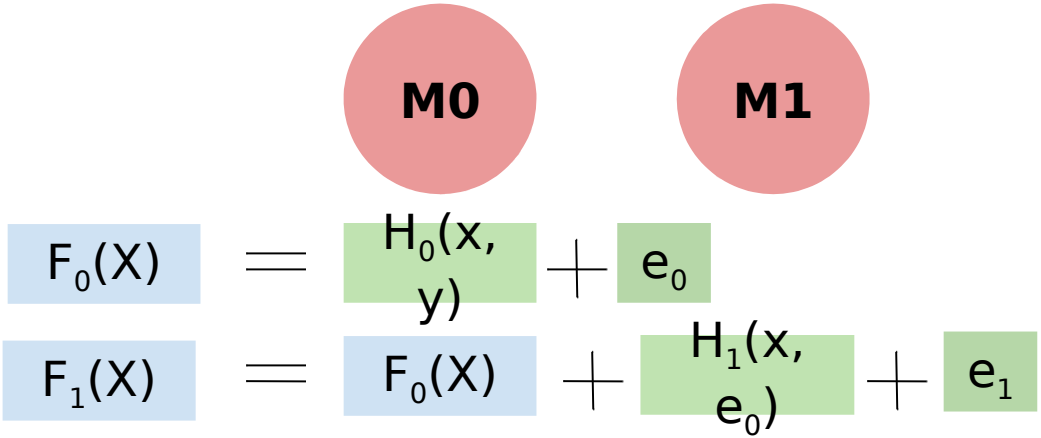
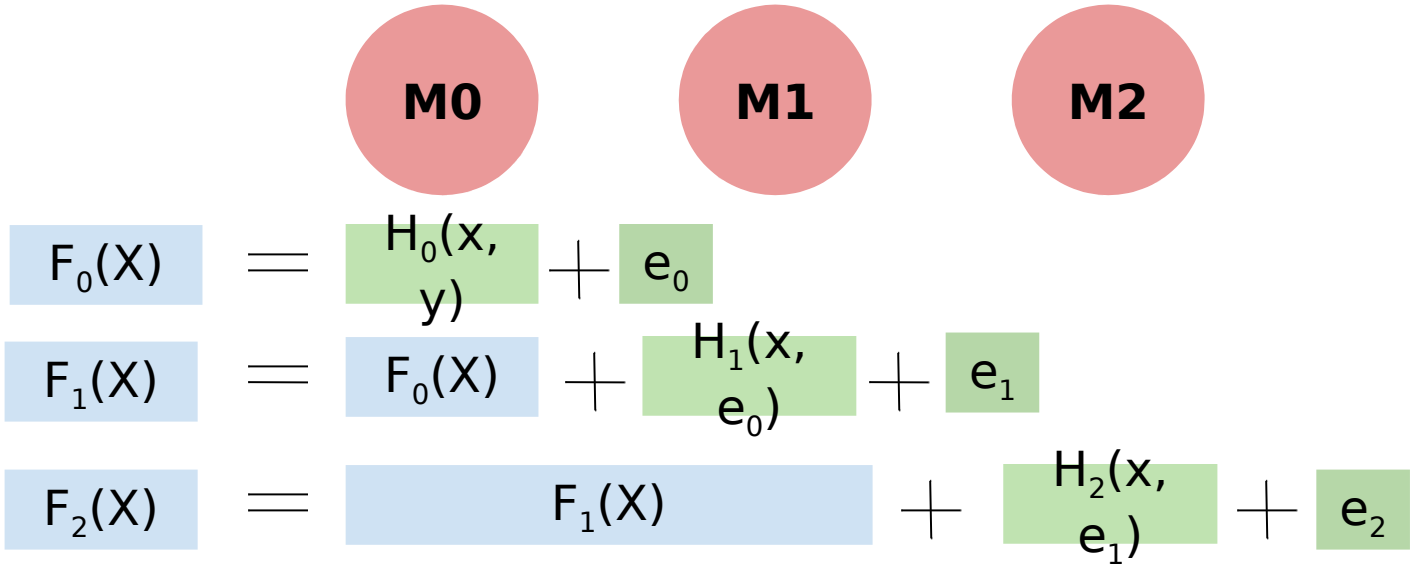
Gradient Boosting Model



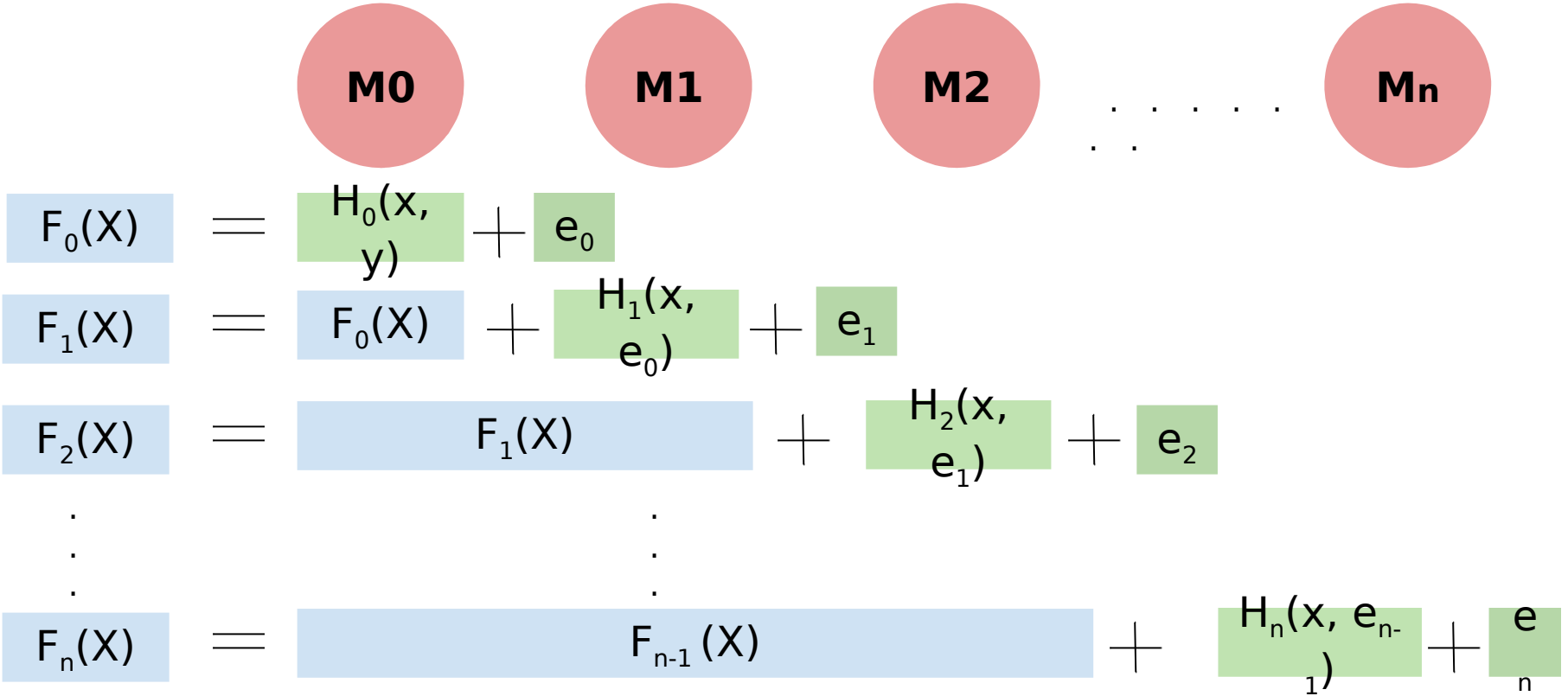
Gradient Boosting Model



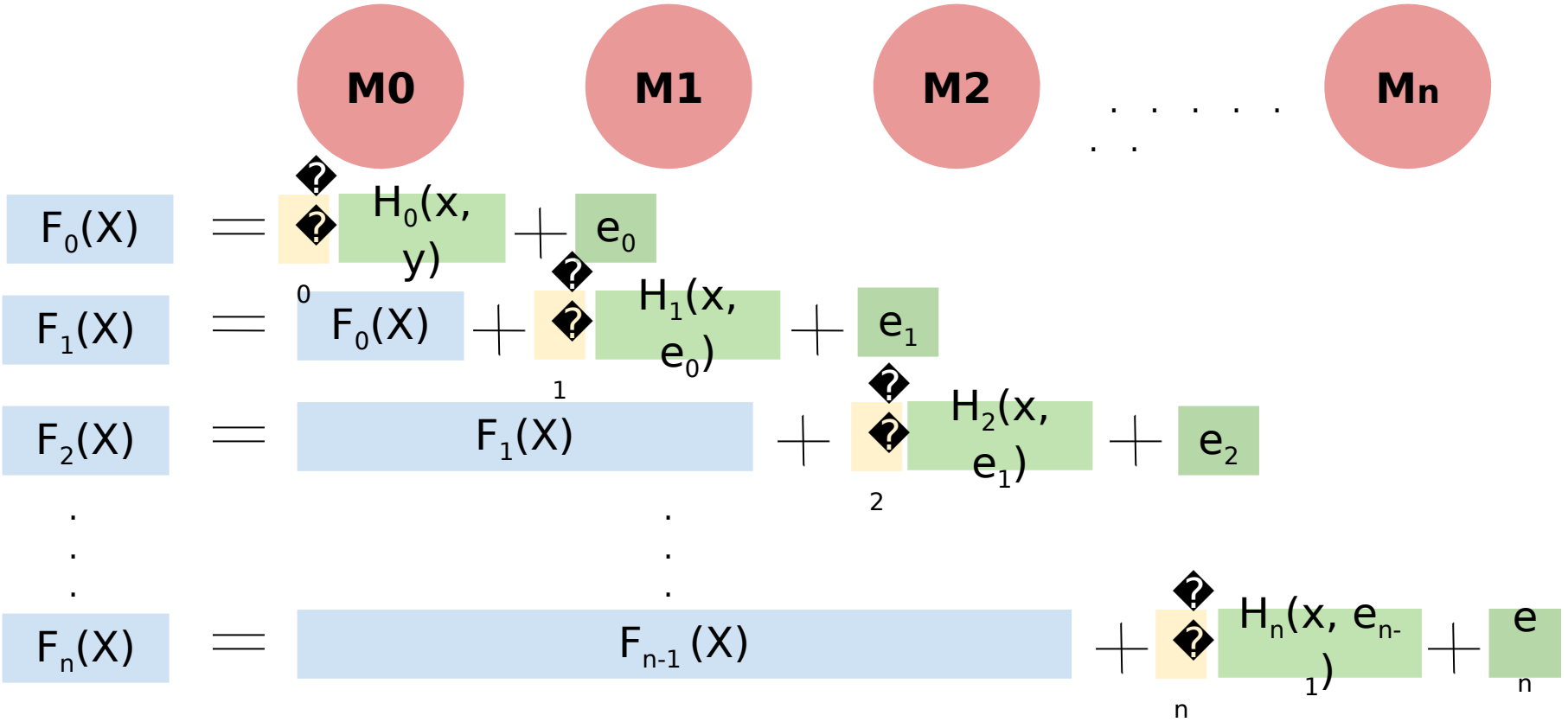
Gradient Boosting Model



Gradient Boosting Model



Gradient Boosting Model



Gradient Boosting Model