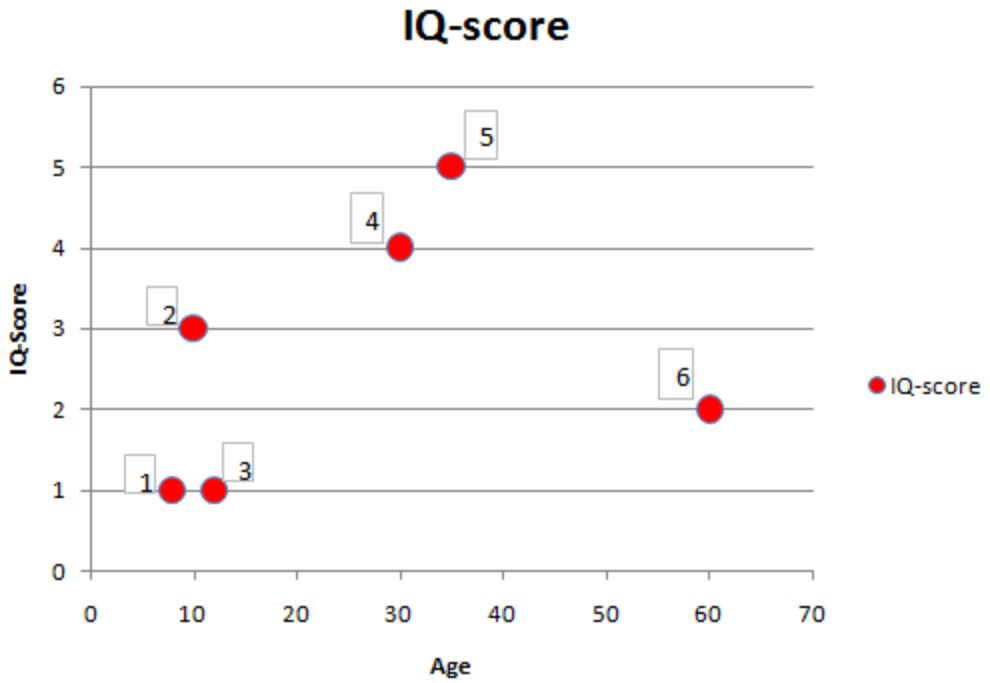
Regression Tree

Dr. Md. Golam Rabiul Alam

Regression Tree Example

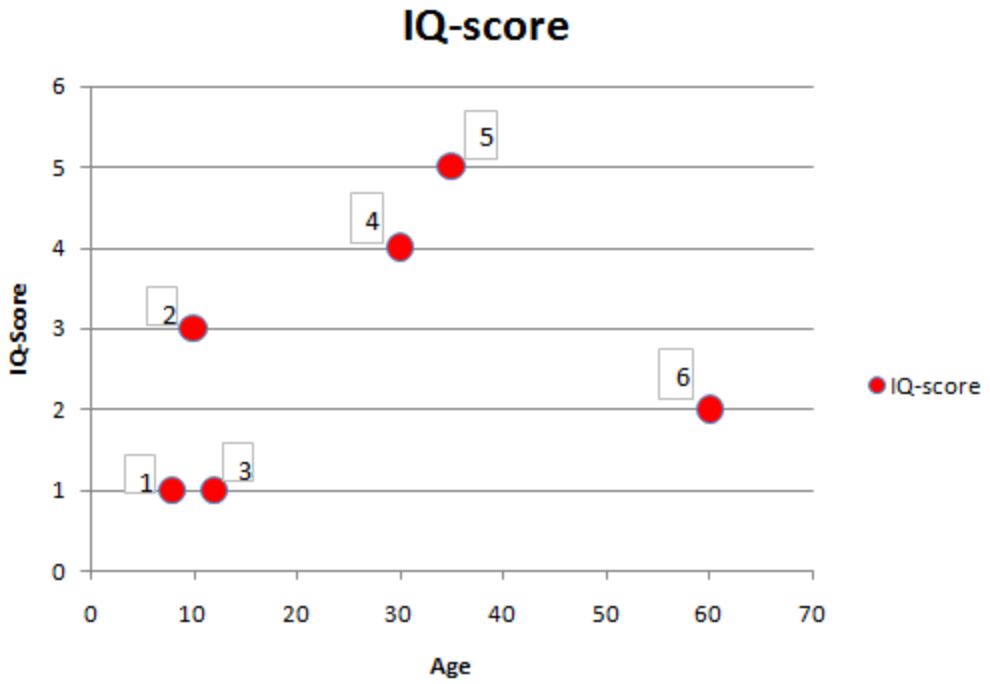
Observations	Age	Place of living	IQ-score
1	8	Village	1
2	10	City	3
3	12	Village	1
4	30	Village	4
5	35	City	5
6	60	City	2



Regression Tree Example

Observations	Age	Place of living	IQ-score
1	8	Village	1
2	10	City	3
3	12	Village	1
4	30	Village	4
5	35	City	5
6	60	City	2

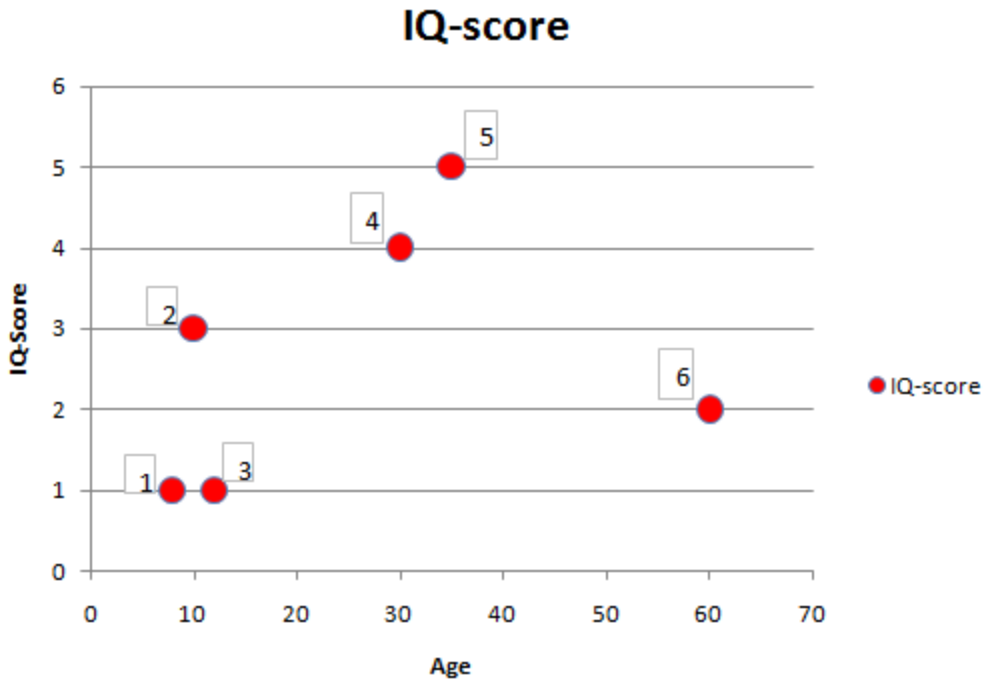
Age	IQ-score
8	1
10	3
12	1
30	4
35	5
60	2



Regression Tree Example

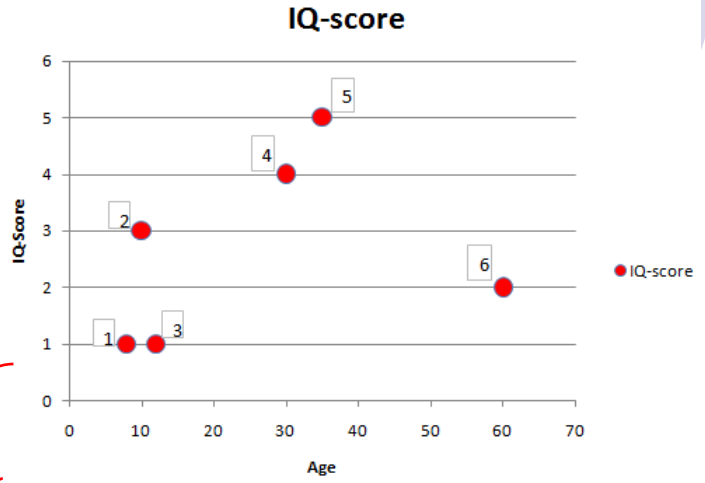
Observations	Age	Place of living	IQ-score
1	8	Village	1
2	10	City	3
3	12	Village	1
4	30	Village	4
5	35	City	5
6	60	City	2

	Age	Average of consecutive two persons age
1	8	
2	10	9
3	12	11
4	30	21
5	35	32.5
6	60	47.5



Regression Tree Example

	Age	Average of consecutive two persons age
1	8	
2	10	9
3	12	11
4	30	21
5	35	32.5
6	60	47.5



$(1-1)^2 + (3-3)^2 + (1-3)^2 + (4-3)^2 + (5-3)^2 + (2-3)^2 = 10$

Age	IQ-score	Considering age 9 as the separator	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
1	8	1	1	3	10
2	10	3	2	3	12
3	12	1	1.666666667	3.666666667	7.333333333
4	30	4	2.25	3.5	11.25
5	35	5	2.8	2	12.8
6	60	2			

Considering age 11 as the separator

Considering age 21 as the separator

Considering age 32.5 as the

Considering age 47.5 as the

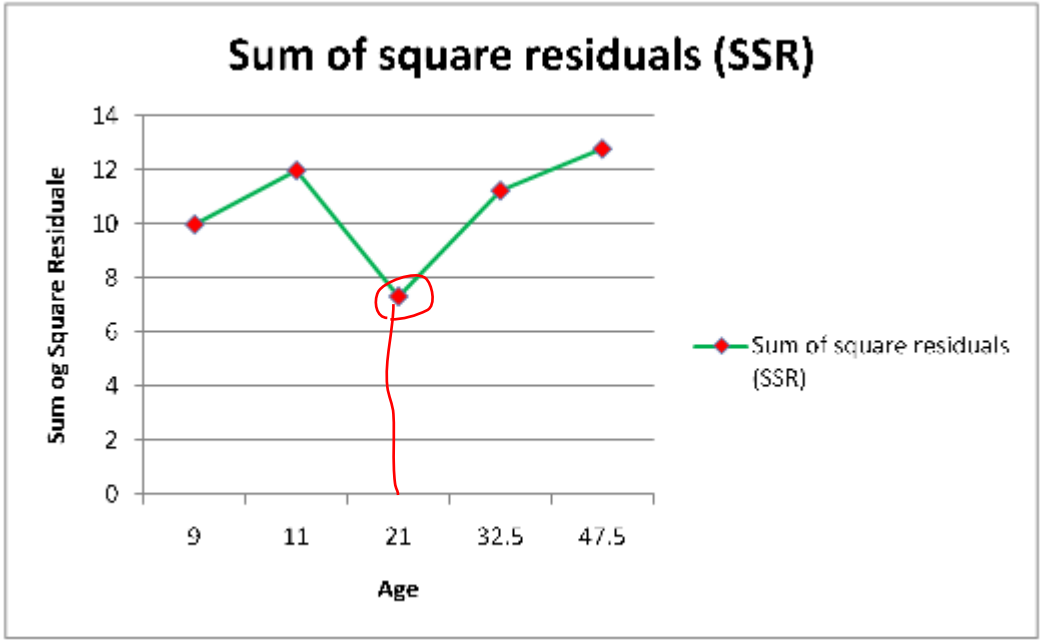
Minimum SSR=7.33

$(1-2)^2 + (3-2)^2 + (1-3)^2 + (4-3)^2 + (5-3)^2 + (2-3)^2 = 12$

Regression Tree Example

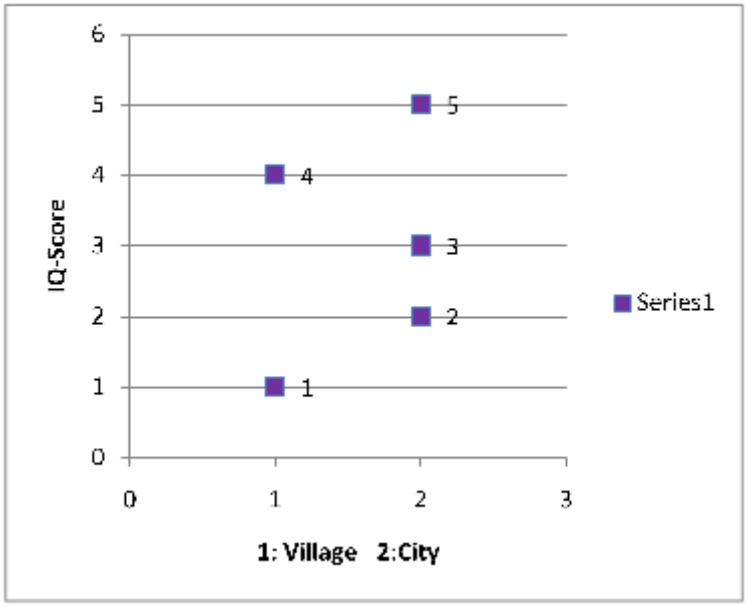
	Age	IQ-score
1	8	1
2	10	3
3	12	1
4	30	4
5	35	5
6	60	2

	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
Considering age 9 as the separator	1	3	10
Considering age 11 as the separator	2	3	12
Considering age 21 as the separator	1.666666667	3.666666667	7.333333333
Considering age 32.5 as the	2.25	3.5	11.25
Considering age 47.5 as the	2.8	2	12.8



Regression Tree Example

Place of living	Encoded Place of living	IQ-score
Village	1	1
City	2	3
Village	1	1
Village	1	4
City	2	5
City	2	2



Considering 'Place of living=Village' as the separator

Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
2	3.333333333	10.66666667

$$(1-2)^2+(1-2)^2+(4-2)^2+(3-3.33)^2+(5-3.33)^2+(2-3.33)^2$$

$$= 10.67$$

Minimum SSR=10.67

Minimum SSR for Age=7.33

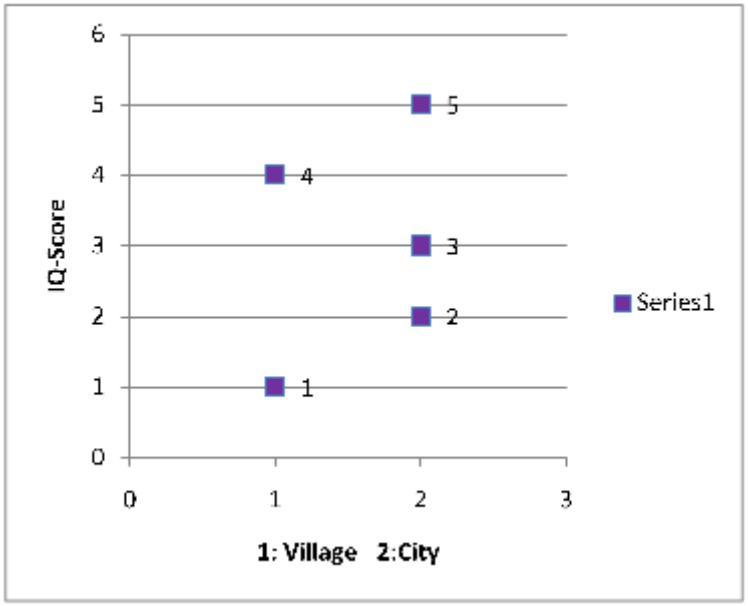
Minimum SSR Place of Living=10.67

Regression Tree Example

Place of living	Encoded Place of living	IQ-score
Village	1	1
City	2	3
Village	1	1
Village	1	4
City	2	5
City	2	2

	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
Considering 'Place of living=Village' as the separator	2	3.333333333	10.66666667

Minimum SSR=10.67



Minimum SSR for Age=7.33

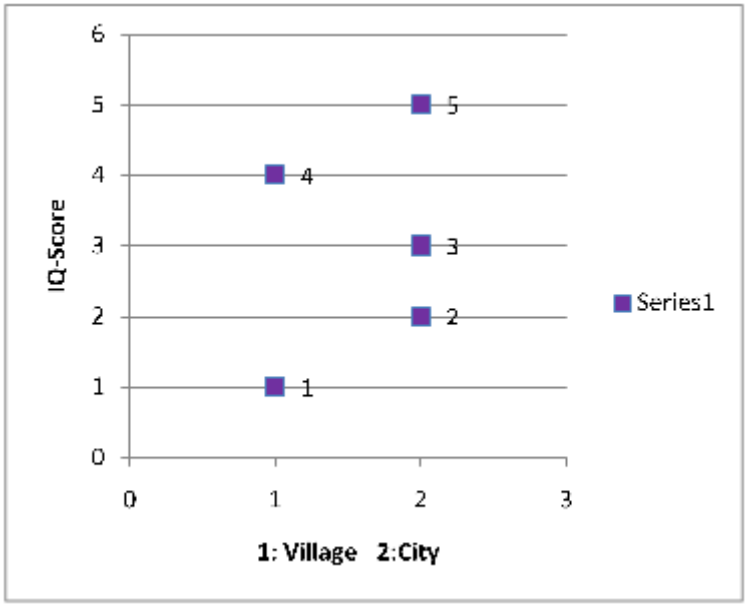
Minimum SSR Place of Living=10.67

Regression Tree Example

Place of living	Encoded Place of living	IQ-score
Village	1	1
City	2	3
Village	1	1
Village	1	4
City	2	5
City	2	2

	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
Considering 'Place of living=Village' as the separator	2	3.333333333	10.66666667

Minimum SSR=10.67



Minimum SSR for Age=7.33

Minimum SSR Place of Living=10.67

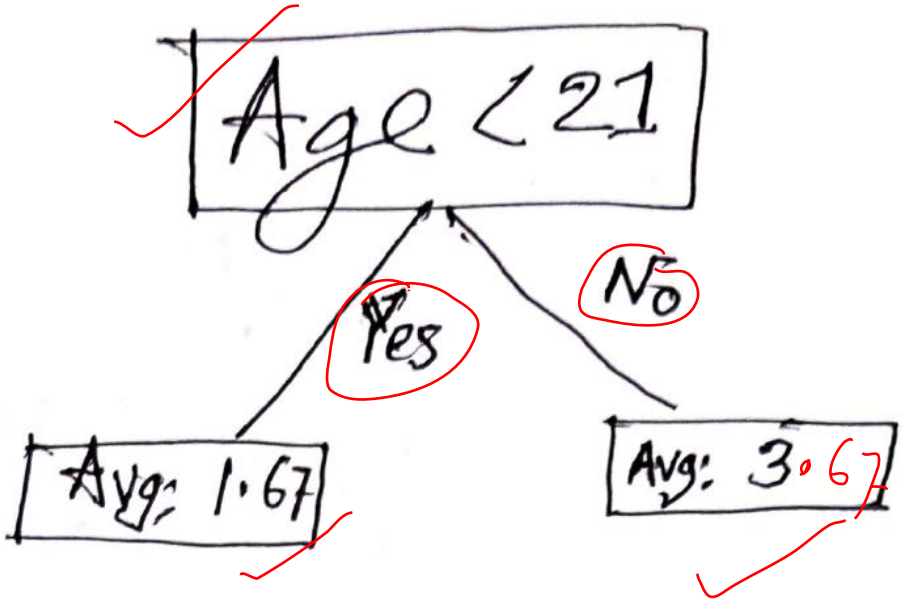
Regression Tree Example

	Age	IQ-score
1	8	1
2	10	3
3	12	1
4	30	4
5	35	5
6	60	2

	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
Considering age 9 as the separator	1	3	10
Considering age 11 as the separator	2	3	12
Considering age 21 as the separator	1.666666667	3.666666667	7.333333333
Considering age 32.5 as the	2.25	3.5	11.25
Considering age 47.5 as the	2.8	2	12.8

Minimum SSR for Age=7.33

Minimum SSR Place of Living=10.67



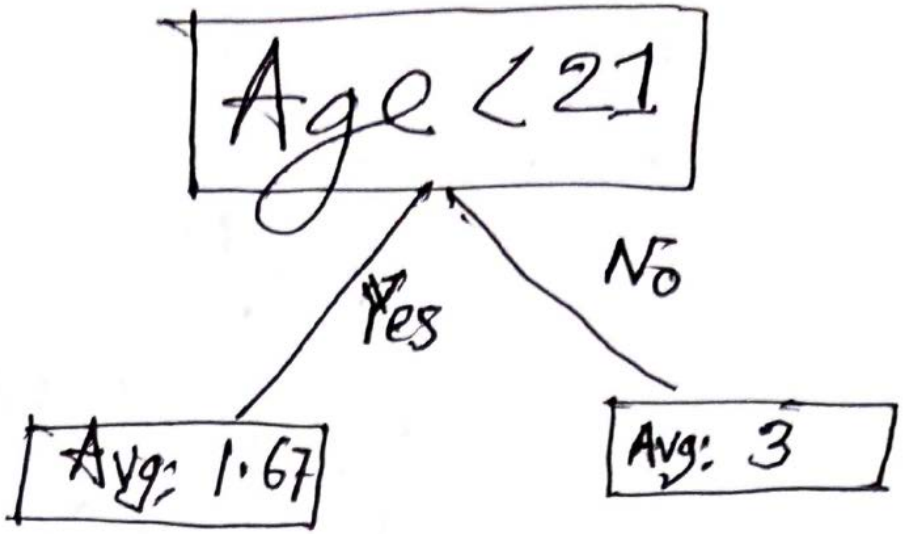
Regression Tree Example

	Age	IQ-score
1	8	1
2	10	3
3	12	1
4	30	4
5	35	5
6	60	2

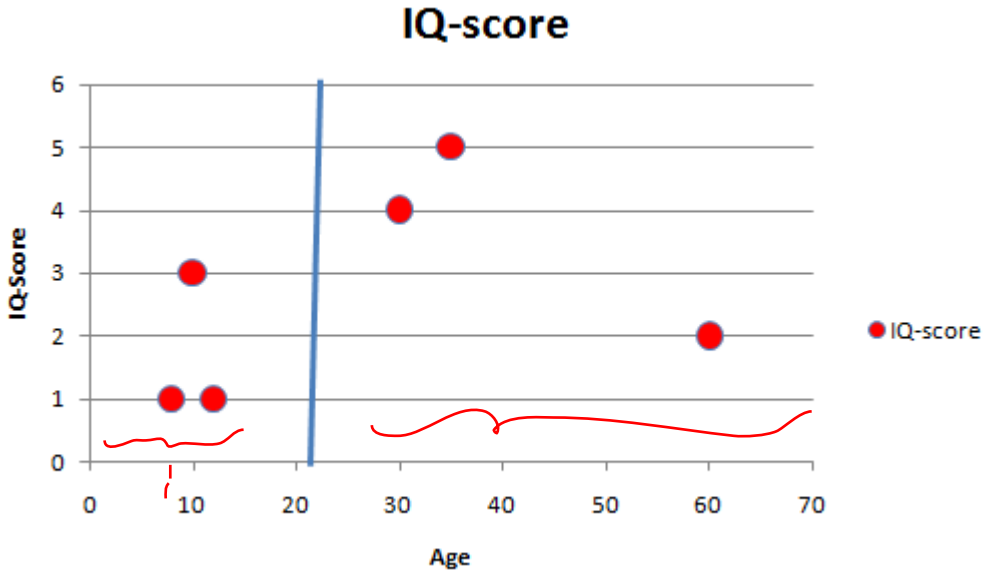
	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
Considering age 9 as the separator	1	3	10
Considering age 11 as the separator	2	3	12
Considering age 21 as the separator	1.666666667	3.666666667	7.333333333
Considering age 32.5 as the	2.25	3.5	11.25
Considering age 47.5 as the	2.8	2	12.8

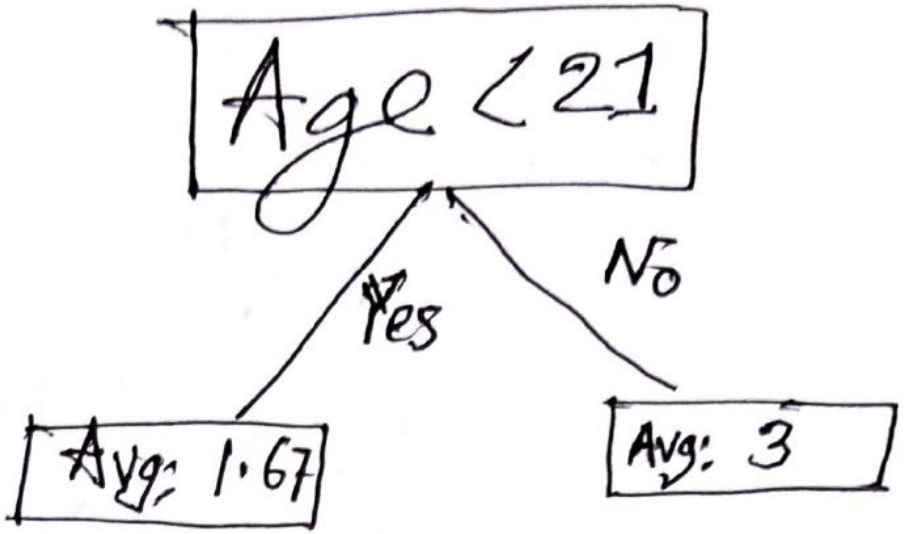
Minimum SSR for Age=7.33

Minimum SSR Place of Living=10.67

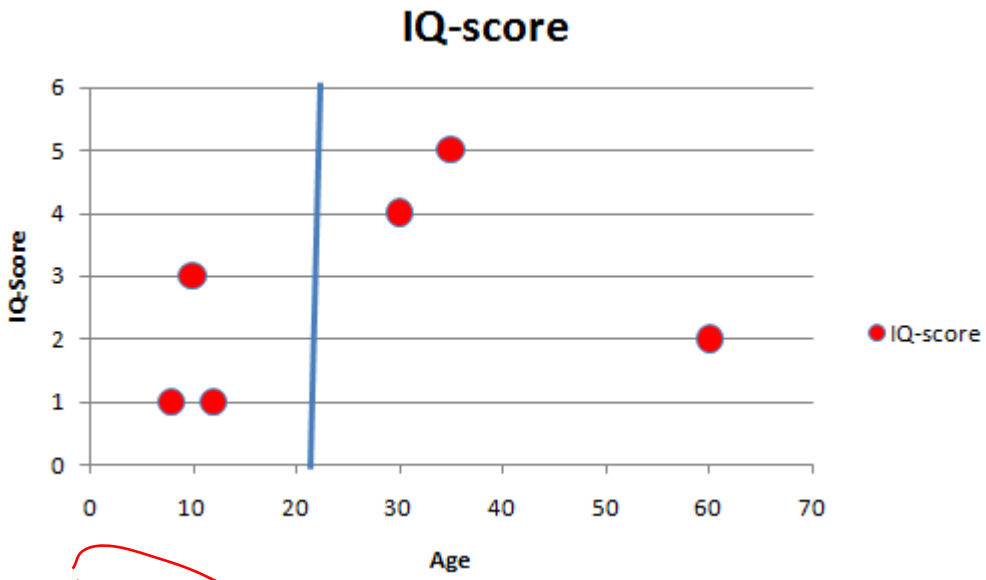


Regression Tree Example



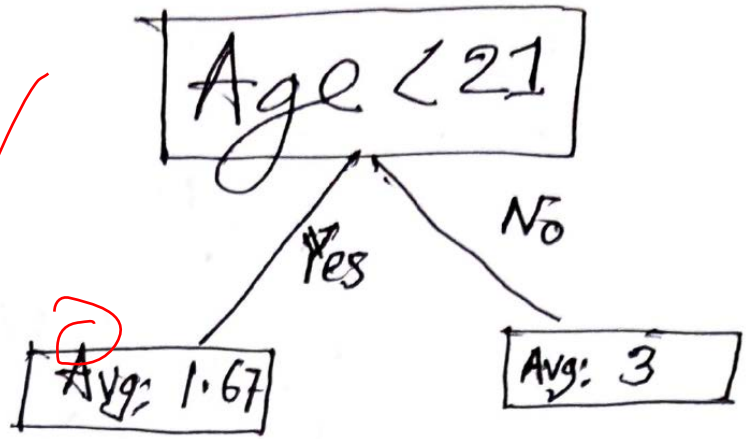


Regression Tree Example



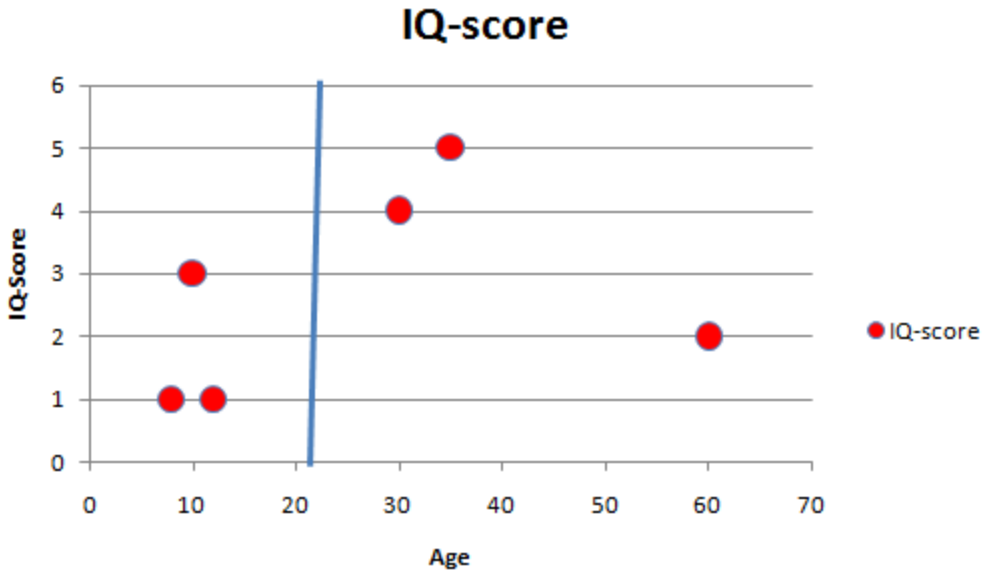
Observations	Age	Place of living	IQ-score
1	8	Village	1
2	10	City	3
3	12	Village	1

Observations	Age	Place of living	IQ-score
4	30	Village	4
5	35	City	5
6	60	City	2



Regression Tree Example

Observations	Age	Place of living	IQ-score
1	8	Village	1
2	10	City	3
3	12	Village	1



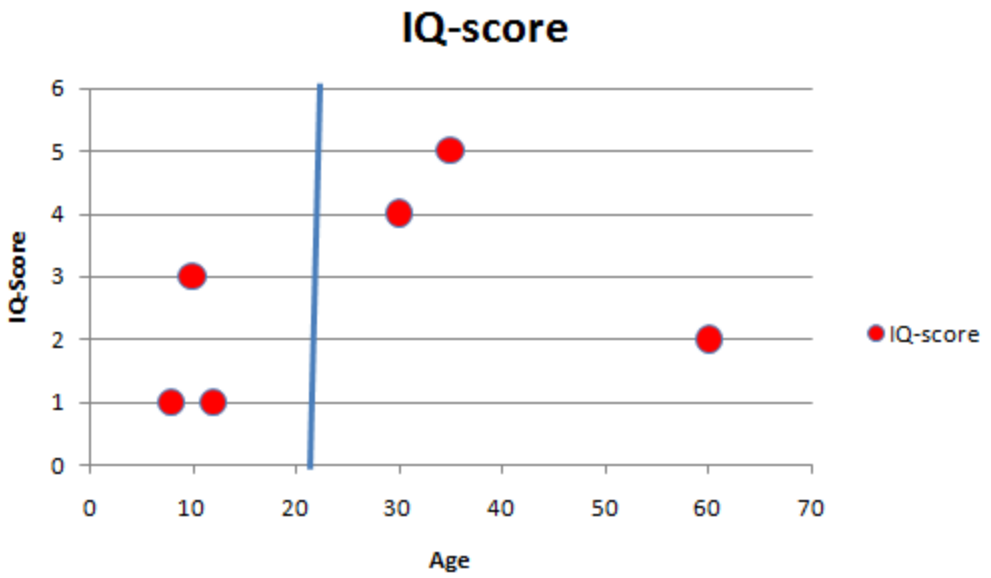
Age	IQ-score
8	1
10	3
12	1

	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
Considering age 9 as the separator	1	2	2
Considering age 11 as the separator	2	1	2

Minimum SSR=2

Regression Tree Example

Observations	Age	Place of living	IQ-score
1	8	Village	1
2	10	City	3
3	12	Village	1



Place of living	Place of living	IQ-score
		1
Village	1	
City	2	3
Village	1	1

Considering 'Place of living=Village' as the separator

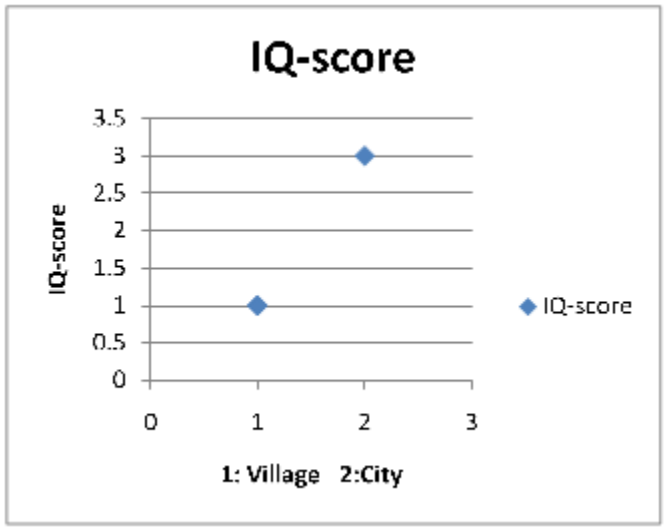
Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
1	3	0

Minimum SSR=0

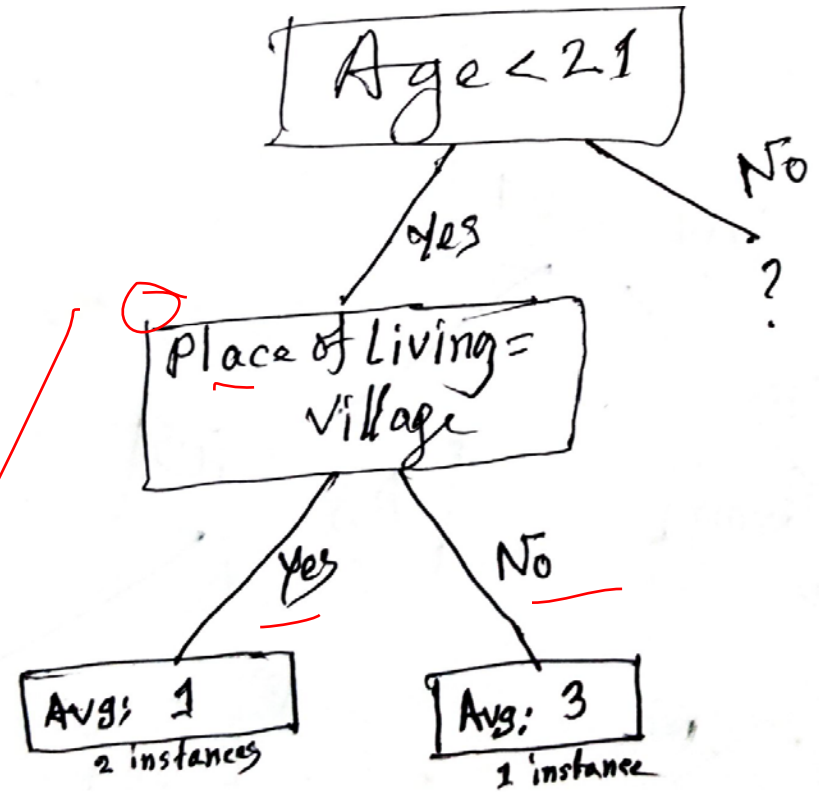
Regression Tree Example

Place of living	Place of living	IQ-score
Village	1	1
City	2	3
Village	1	1

	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
Considering 'Place of living=Village' as the separator	1	3	0



Minimum SSR=0

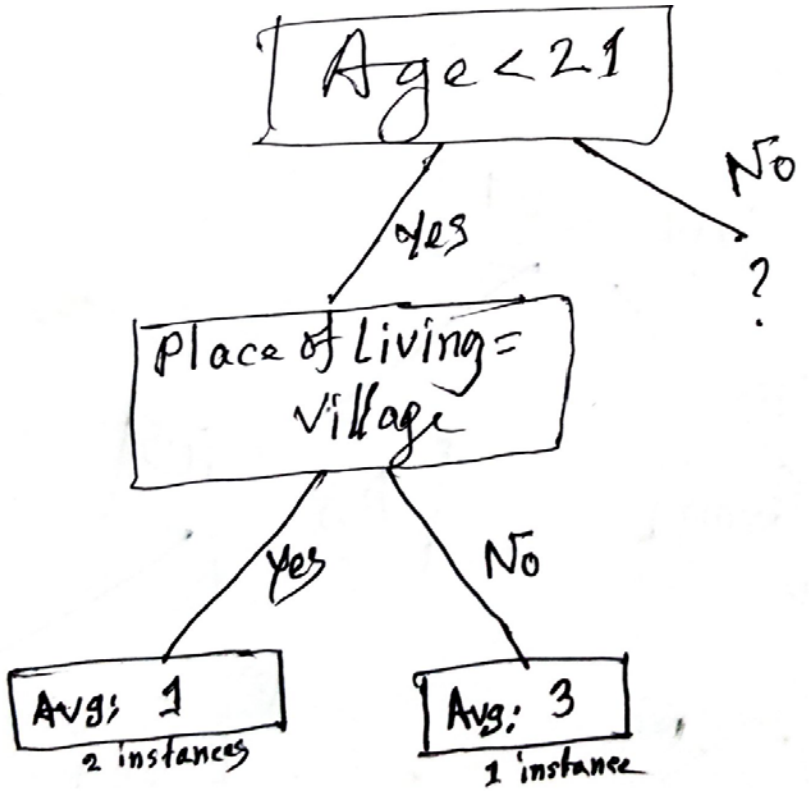


Minimum SSR for Age=2

Minimum SSR Place of Living=0

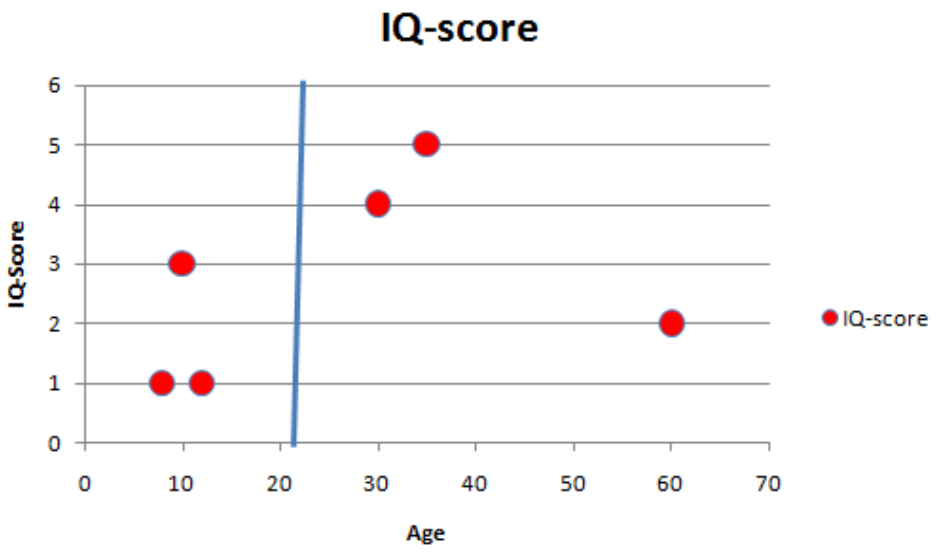
Regression Tree Example

Observations	Age	Place of living	IQ-score
4	30	Village	4
5	35	City	5
6	60	City	2



Regression Tree Example

Observations	Age	Place of living	IQ-score
4	30	Village	4
5	35	City	5
6	60	City	2



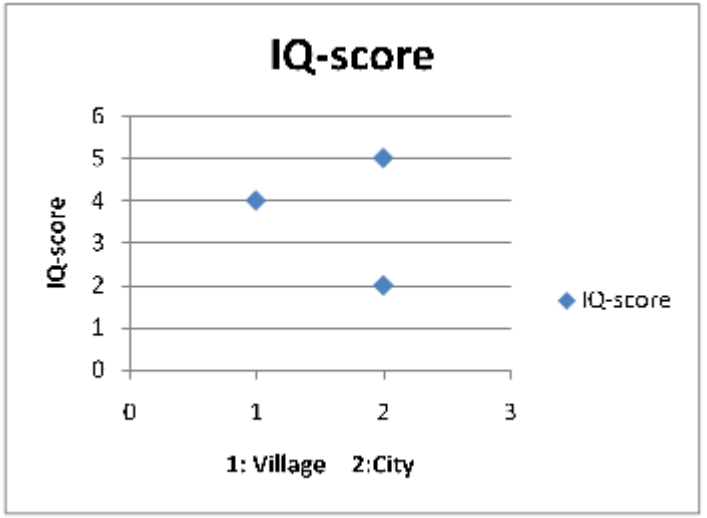
Age	IQ-score
30	4
35	5
60	2

	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
Considering age 32.5 as the	4	3.5	4.5
Considering age 47.5 as the	4.5	2	0.5

Minimum SSR=0.5

Regression Tree Example

Observations	Age	Place of living	IQ-score
4	30	Village	4
5	35	City	5
6	60	City	2



Place of living	Encoded Place of living	IQ-score
		4
Village	1	
City	2	5
City	2	2

	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
Considering 'Place of living=Village' as the separator	4	3.5	4.5

Minimum SSR=4.5

Regression Tree Example

Age	IQ-score
30	4
35	5
60	2

	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
Considering age 32.5 as the	4	3.5	4.5
Considering age 47.5 as the	4.5	2	0.5

Minimum SSR=0.5

Place of living	Encoded Place of living	IQ-score
Village	1	4
City	2	5
City	2	2

	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
Considering 'Place of living=Village' as the separator	4	3.5	4.5

Minimum SSR=4.5

Minimum SSR for Age=0.5
Minimum SSR Place of Living=4.5

Regression Tree Example

Age	IQ-score
30	4
35	5
60	2

Considering age 32.5 as the

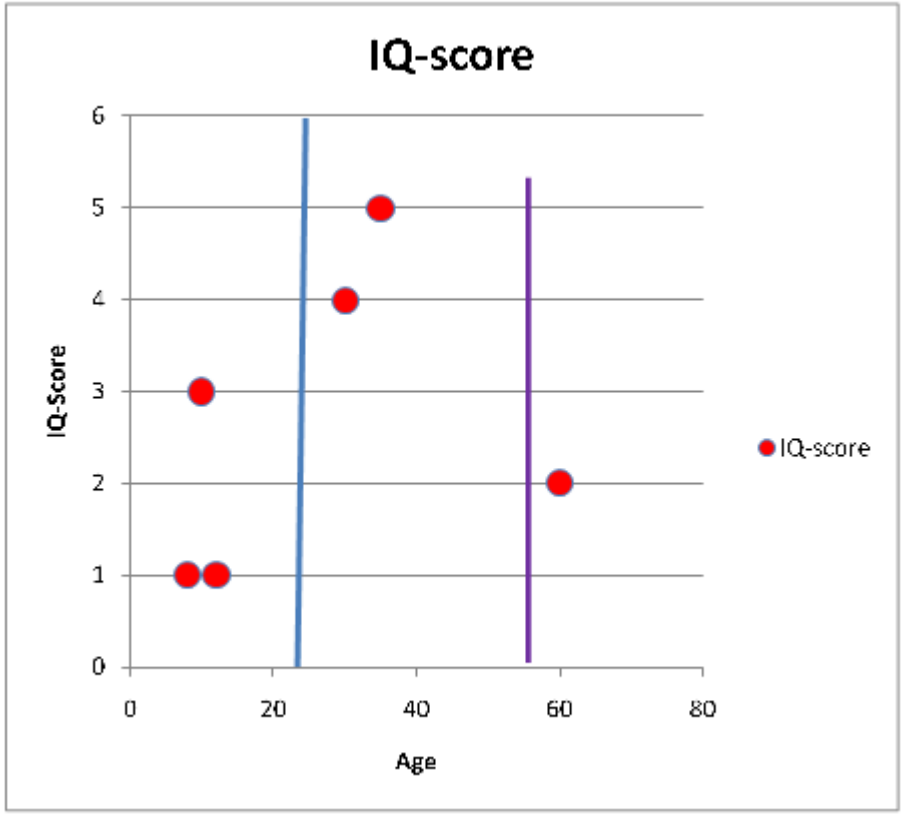
Considering age 47.5 as the

Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
4	3.5	4.5
4.5	2	0.5

Minimum SSR=0.5

Minimum SSR for Age=0.5

Minimum SSR Place of Living=4.5



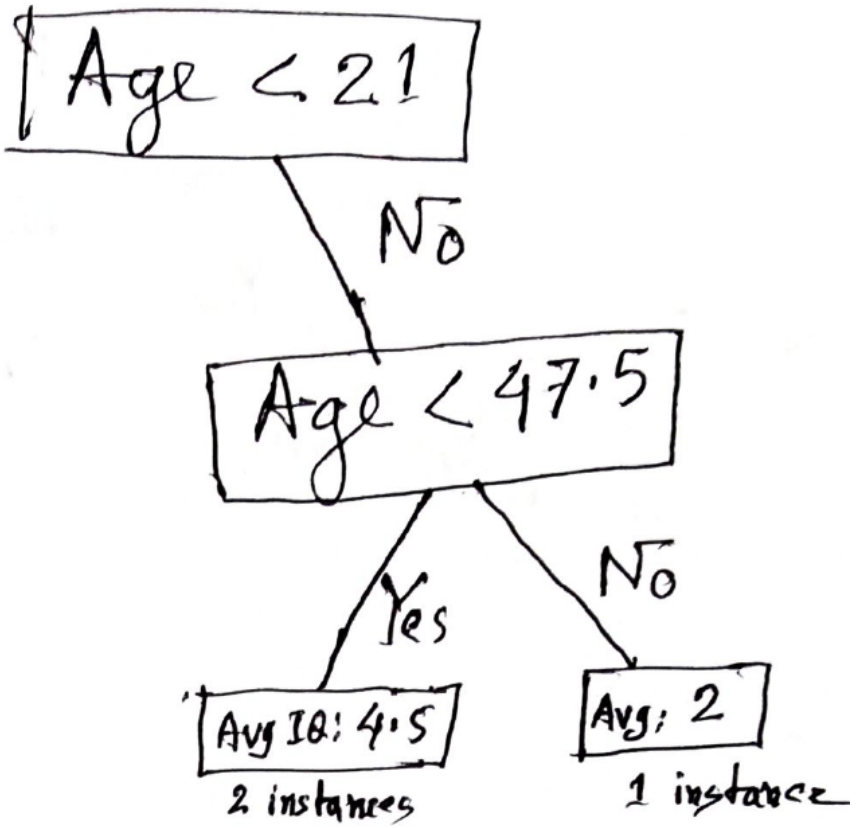
Regression Tree Example

Age	IQ-score
30	4
35	5
60	2

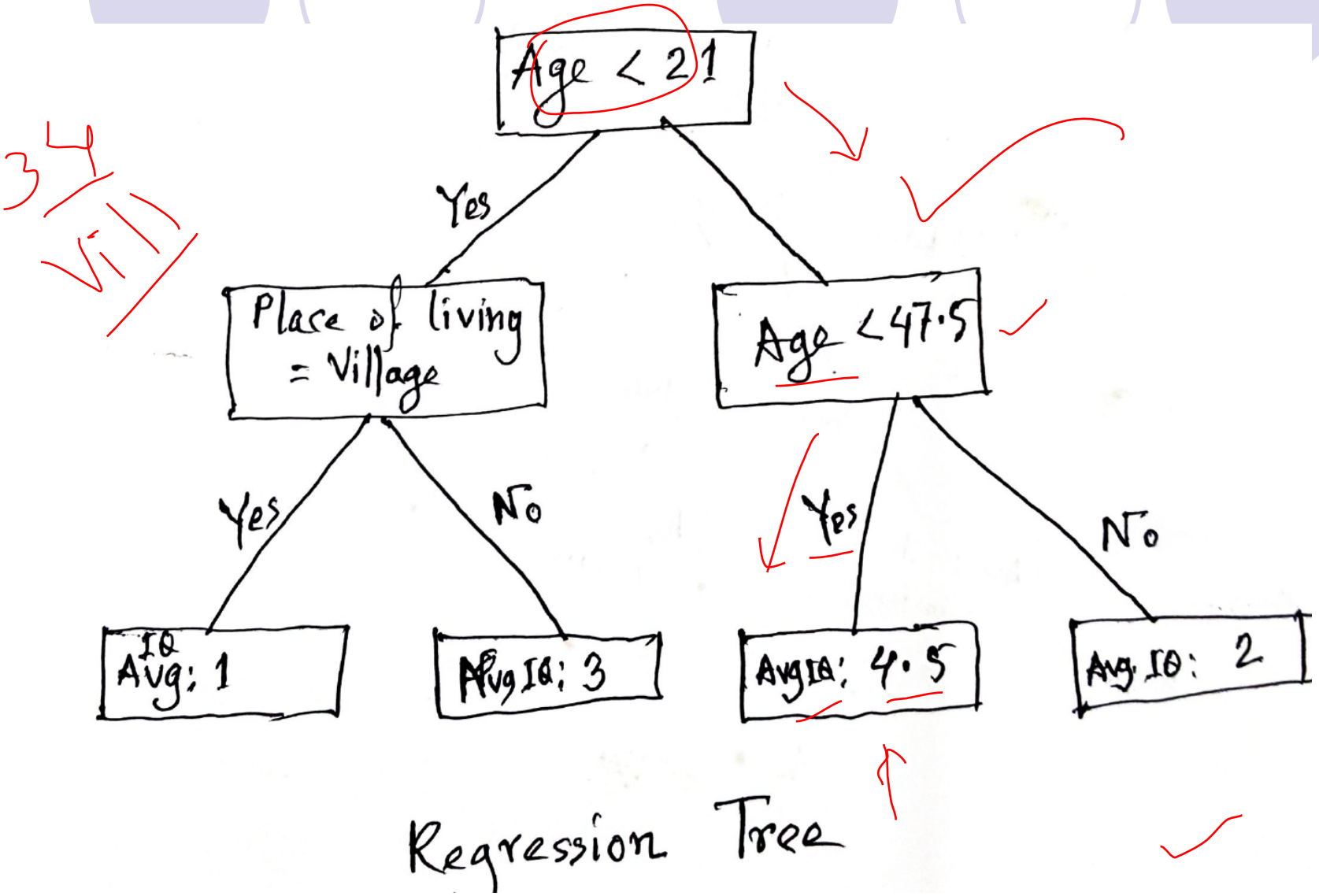
	Average IQ score of Left side instances	Average IQ score of Right side instances	Sum of square residuals (SSR)
Considering age 32.5 as the	4	3.5	4.5
Considering age 47.5 as the	4.5	2	0.5

Minimum SSR=0.5

Minimum SSR for Age=0.5
Minimum SSR Place of Living=4.5



Regression Tree Example



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- https://mitpress.mit.edu/sites/default/files/titles/content/boosting_foundations_algorithms/toc.html#indx-1

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- https://machinelearningmastery.com/boosting-and-adaboost-for-machine-learning/

- **3. Quick Introduction to Boosting Algorithms in Machine Learning**
- https://www.analyticsvidhya.com/blog/2015/11/quick-introduction-boosting-algorithms-machine-learning/

- **4. My github repo and kaggle kernel link for GBM from scratch:**
  https://www.kaggle.com/grroverpr/gradient-boosting-simplified/
  https://nbviewer.jupyter.org/github/groverpr/Machine-Learning/blob/master/notebooks/01_Gradient_Boosting_Scratch.ipynb
- 5. A detailed and intuitive explanation of gradient boosting: **How to explain gradient boosting** by Terence Parr and Jeremy Howard
- **6. Fast.ai github repo link** for DecisionTree from scratch **(Massive ML/DL related resources)**:
  https://github.com/fastai/fastai
- 7. Lecture by **Alexander Ihler** **in UCA**

  https://www.youtube.com/watch?v=sRktKszFmSk&t=311s

8. Machine Learning With Boosting: A Beginner's Guide by Scott Hartshorn, Kindle Edition

9. Machine Learning With Random Forests And Decision Trees: A Visual Guide For Beginners by Scott Hartshorn, Kindle Edition

10. MIT open courseware (Lecture 17: Boosting)

https://www.youtube.com/watch?v=UHBmv7qCey4

11. Hands-On Machine Learning with R by *Bradley Boehmke & Brandon Greenwell*

https://bradleyboehmke.github.io/HOML/