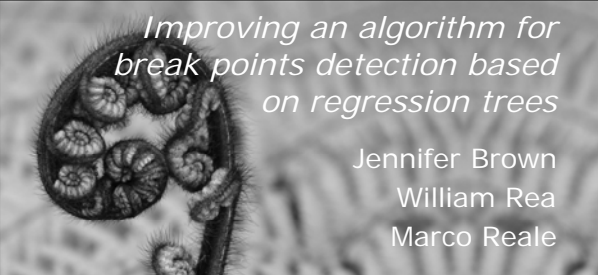



  
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*Improving an algorithm for  
 break points detection based  
 on regression trees*


Jennifer Brown  
 William Rea  
 Marco Reale



  
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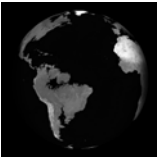
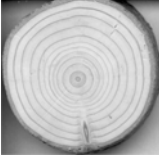
*Outline*

- Structural breaks model
- Atheoretical regression trees
- Spurious breaks
- Enhanced temporal pruning

  
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*Time Series with Long Memory*

- River Flows
- Telecommunications Networks
- Sea Surface Temperatures
- Tree Ring Indices






  
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*Time Series with Structural Breaks*


- Stock market volatility – 1998 Russian Financial Crisis
- Economic output of Europe – WWII
- All Blacks (NZ) loses in the Rugby World Cup



  
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*Detecting Structural Breaks*

- Athereotical Regression Trees (ART)
- Method to identify structural breaks
- Recursive partitioning of the series based in maximum reduction in deviance or minimizing the within-group sums of squares

  
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*ART*

```

    graph TD
      Root["34 56 23 56 78 45 89 42 3 5 7 67 56 8 12 11 3 6 7"]
      Node1["34 56 23 56 78 45 89 42"]
      Node2["3 5 7 67 56 8 12 11 3 6 7"]
      Node3["3 5 7"]
      Node4["67 56"]
      Node5["3 5"]
      Node6["7"]

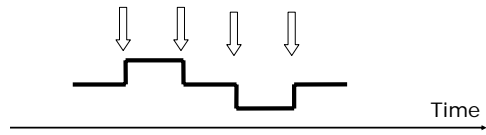
      Root --- Node1
      Root --- Node2
      Node2 --- Node3
      Node2 --- Node4
      Node3 --- Node5
      Node3 --- Node6
  
```

### Structural Breaks Model



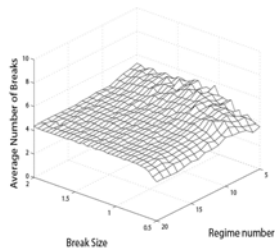
- Spurious breaks
- Especially with short series length and small break sizes
- Too much ART?

### Structural Breaks Model

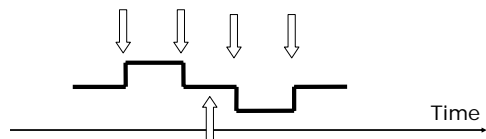


4 breaks  
5 regimes

### Structural Breaks Model



### Structural Breaks Model



### Too Much ART?



- Simulated series with structural breaks
- Broke series into "regimes" using ART
- Assessed the number of breaks reported by ART against the true number of breaks

### Too Much ART?

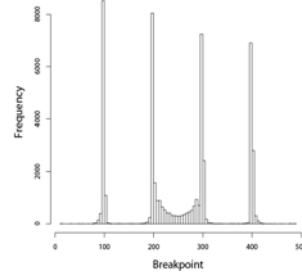


- Excess breaks occurred either at root node or at terminal node
- Excess breaks at root node are more serious because they can not be "repaired".
- Terminal node excess breaks can be repaired by pruning

### Too Much ART?

- Excess breaks occurred either at root node or at terminal node
- Five regime series where the middle regime was equal to the mean
  - Spurious root node breaks tended to happen in the middle of the series

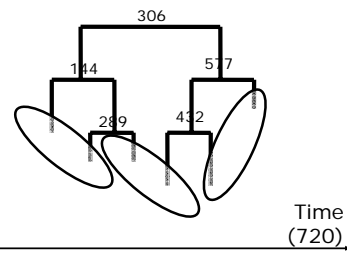
### Too Much ART?



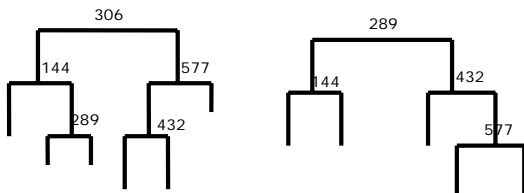
### Proposed Improved Method

- Enhanced temporal pruning:
  1. Grow and prune regression tree
  2. For each pair of adjacent terminal nodes that do not have the same parent node test if they should be combined (e.g., BIC)
  3. If so, combine at the first common ancestor node
  4. Computationally inexpensive

### Proposed Improved Method



### Proposed Improved Method



### Enhanced Temporal Pruning

- 1000 simulated series all with incorrect root node splits, for different regimes lengths
- Use ART to detect breaks
- With Enhanced Temporal Pruning 85% of the simulated series were repaired

## *Conclusions*



- ART can be used to detect structural breaks
- Recommend using Enhanced Temporal Pruning to remove spurious breaks
- Computationally inexpensive