

# Optimization of weather index thresholds for improving crop yield insurances

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# Weather-index insurance to cover yield loss risk

Payout if *Weather-index* > *Strike*

$$I > T$$

No payout otherwise

# Two types of errors

**False positive:** payout in the absence of yield loss

à Increase cost for the insurance company

**False negative:** absence of payout in case of yield loss

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Both error types depend on  
the strike value  $T$

# False positive *payout in the absence of yield loss*

False positive rate =  $\Pr( Index > T \mid \text{No yield loss} )$

False positive rate =  $1 - \Pr( Index < T \mid \text{No yield loss} )$

**False positive rate = 1 – Specificity (T)**

# False negative

*absence of payout in case of yield loss*

False negative rate =  $\Pr(\text{Index} < T \mid \text{Yield loss})$

False negative rate =  $1 - \Pr(\text{Index} > T \mid \text{Yield loss})$

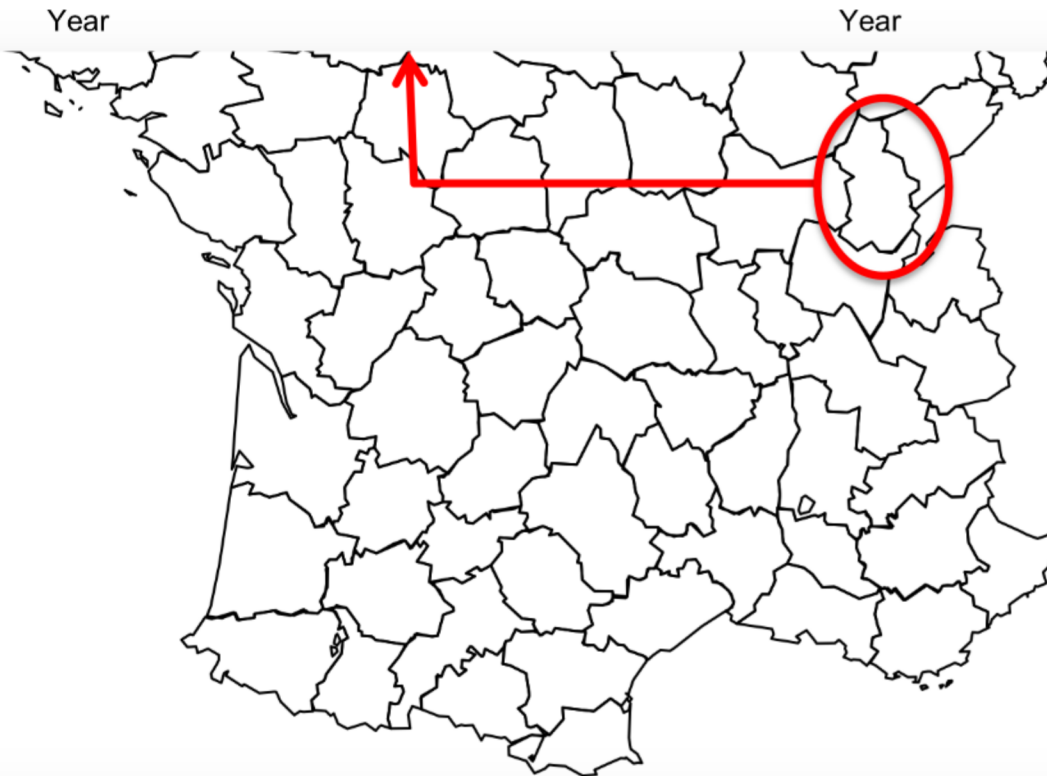
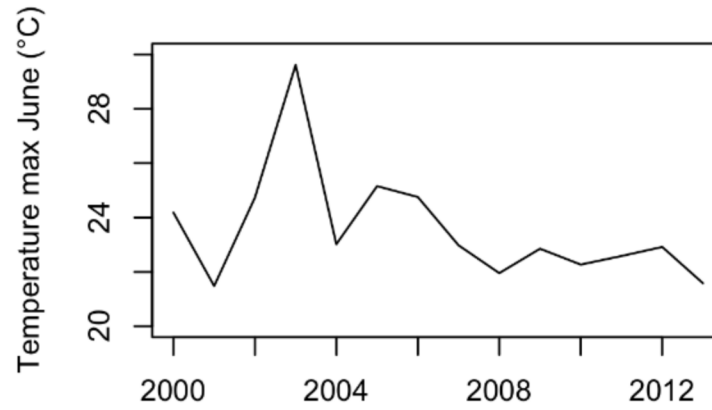
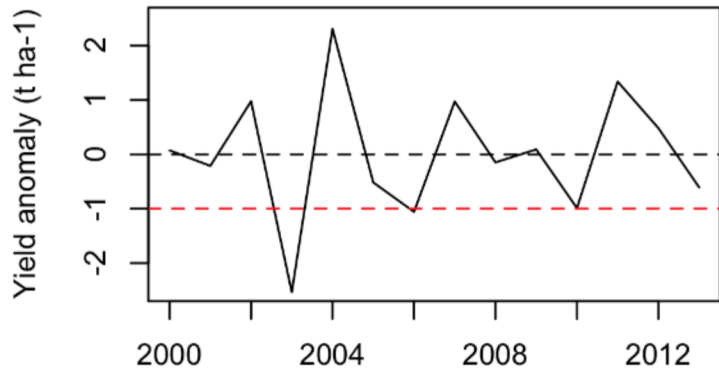
**False negative rate = 1 – Sensitivity (T)**

How to optimize the strike  $T$  ?

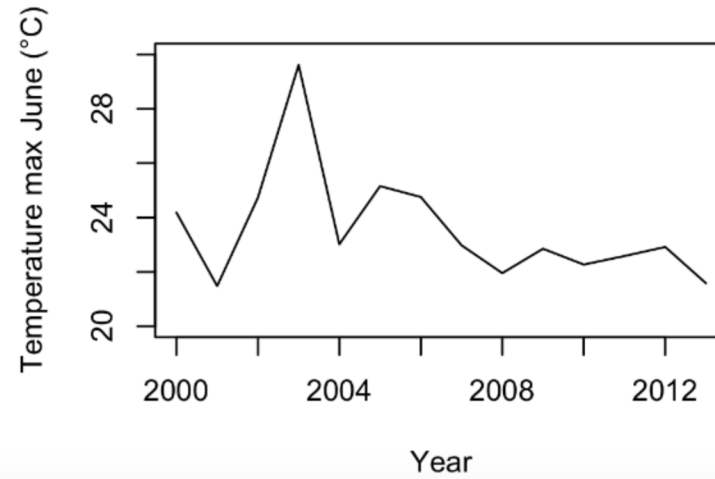
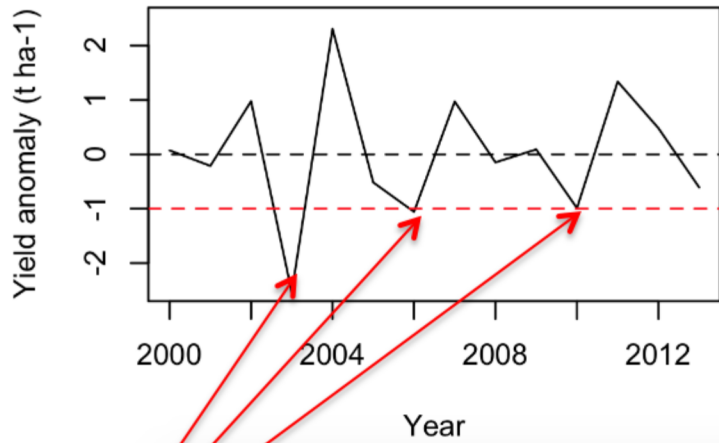




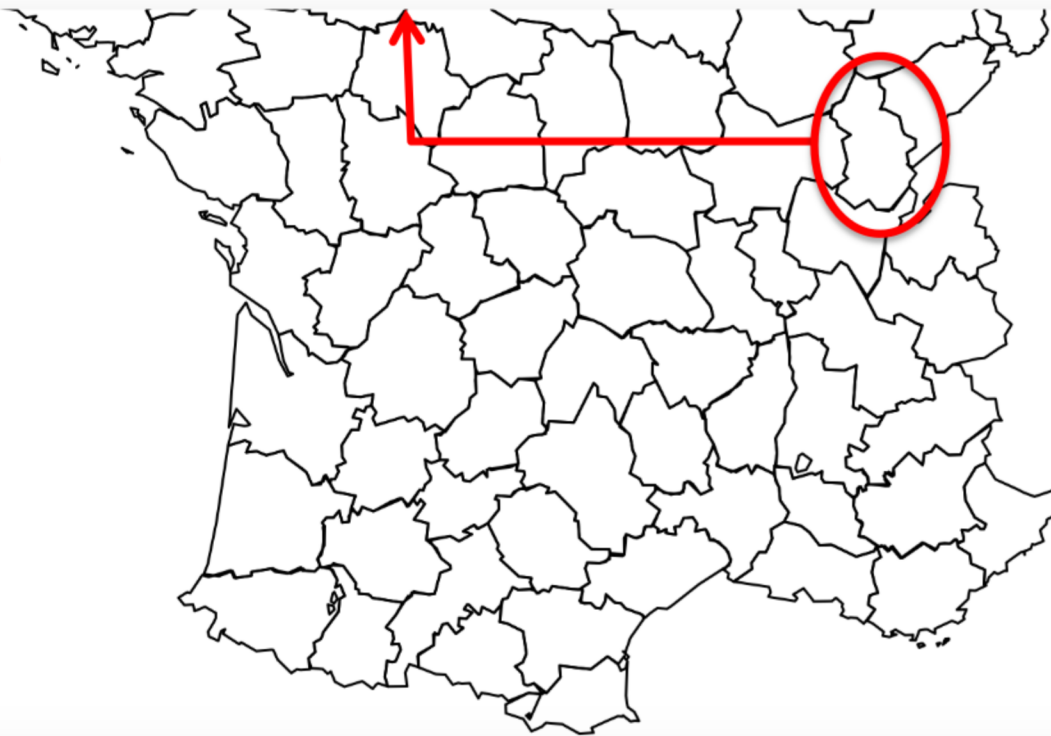
# Jura



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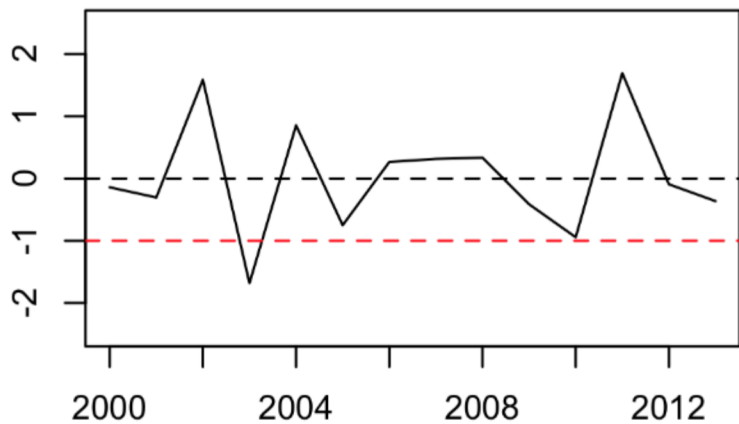
Extreme yield loss



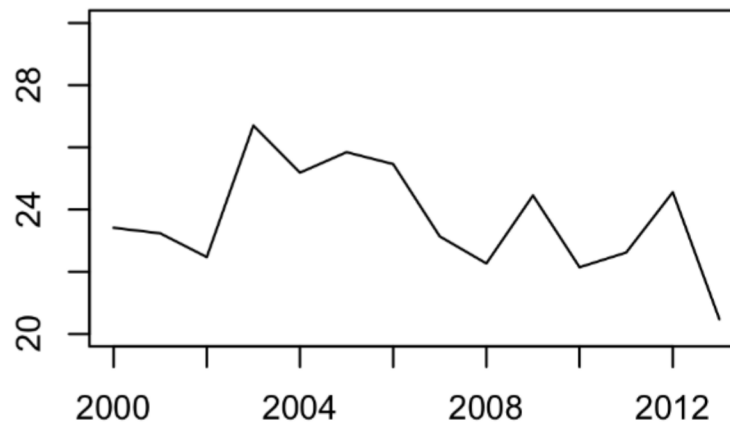


### Pyrenees-Atlantiques

Yield anomaly (t ha<sup>-1</sup>)



Temperature max June (°C)



Year

Year



# Sensitivity and specificity estimation

Location	Climate index (Tmax)	Extreme yield loss
1	28.1	Yes
1	26.5	Yes
...	...	...
2	27.8	Yes
...	...	...



**Rate of true positive (sensitivity)**  
**Prob( Index > T | Extreme yield loss)**

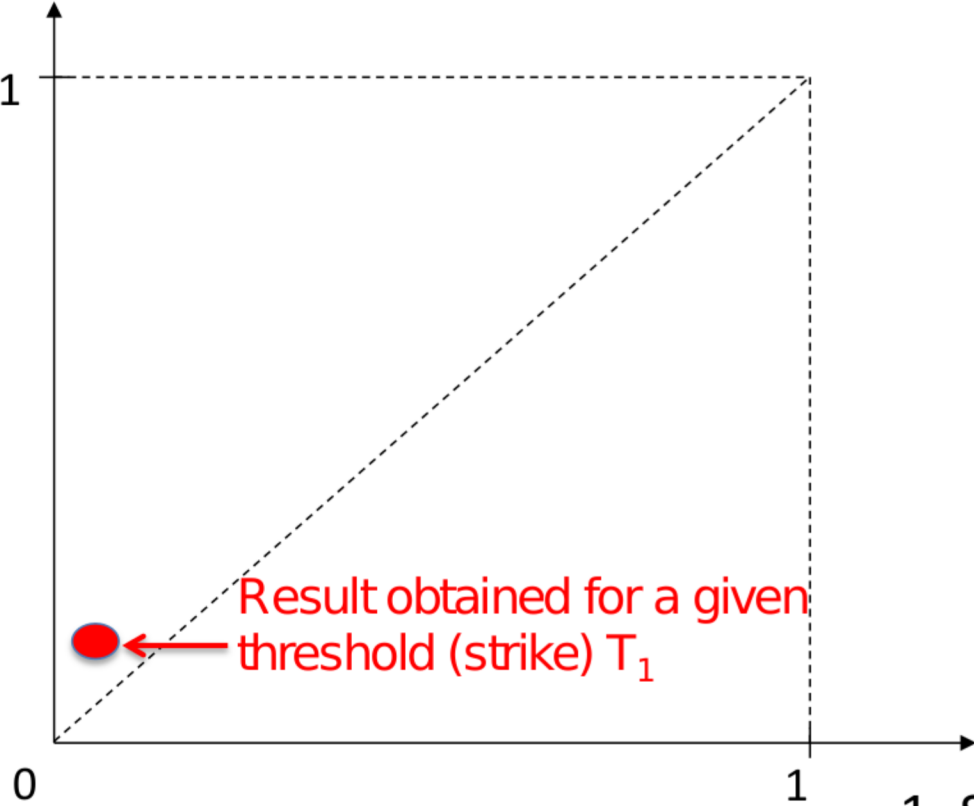
Location	Climate index (Tmax)	Extreme yield loss
1	23.1	No
1	21.5	No
...	...	...
2	22.7	No
...	...	...



**Rate of true negative (specificity)**  
**Prob( Index < T | No extreme yield loss)**

# ROC curve

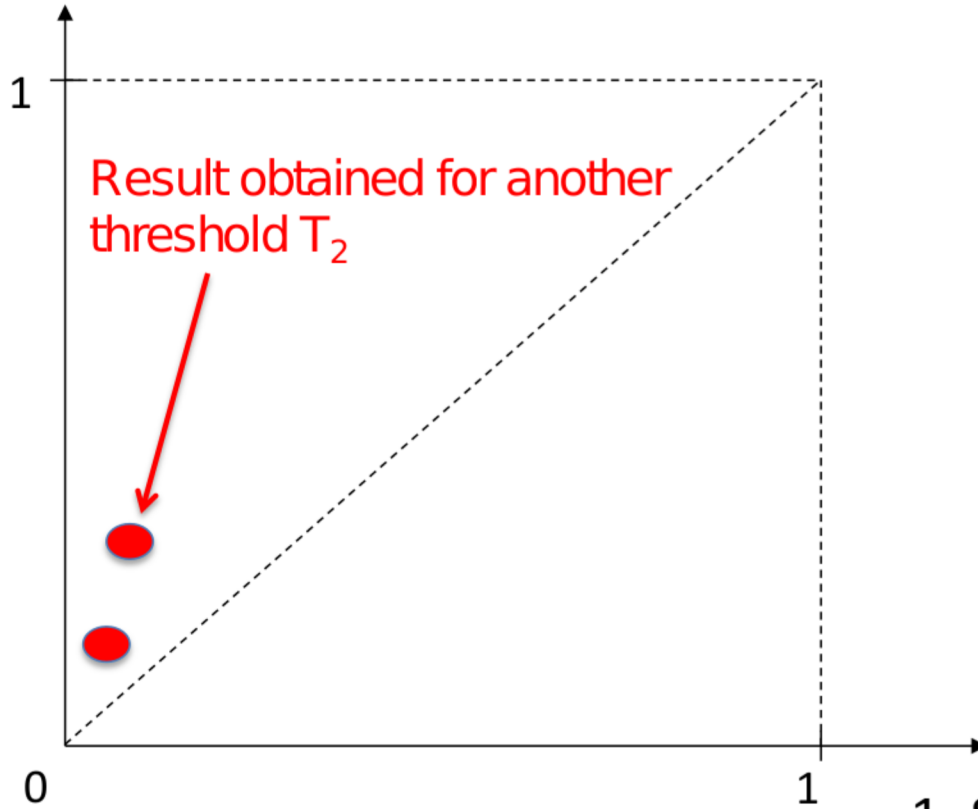
Sensitivity = True positive



1 - Specificity = False positive

# ROC curve

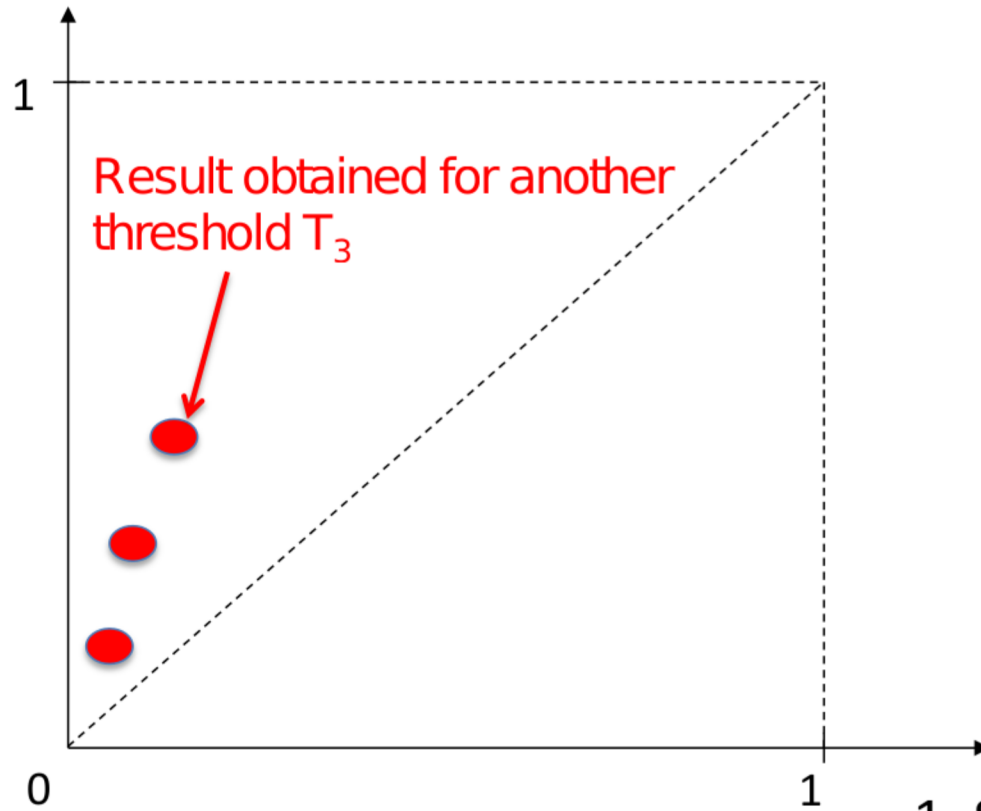
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# ROC curve

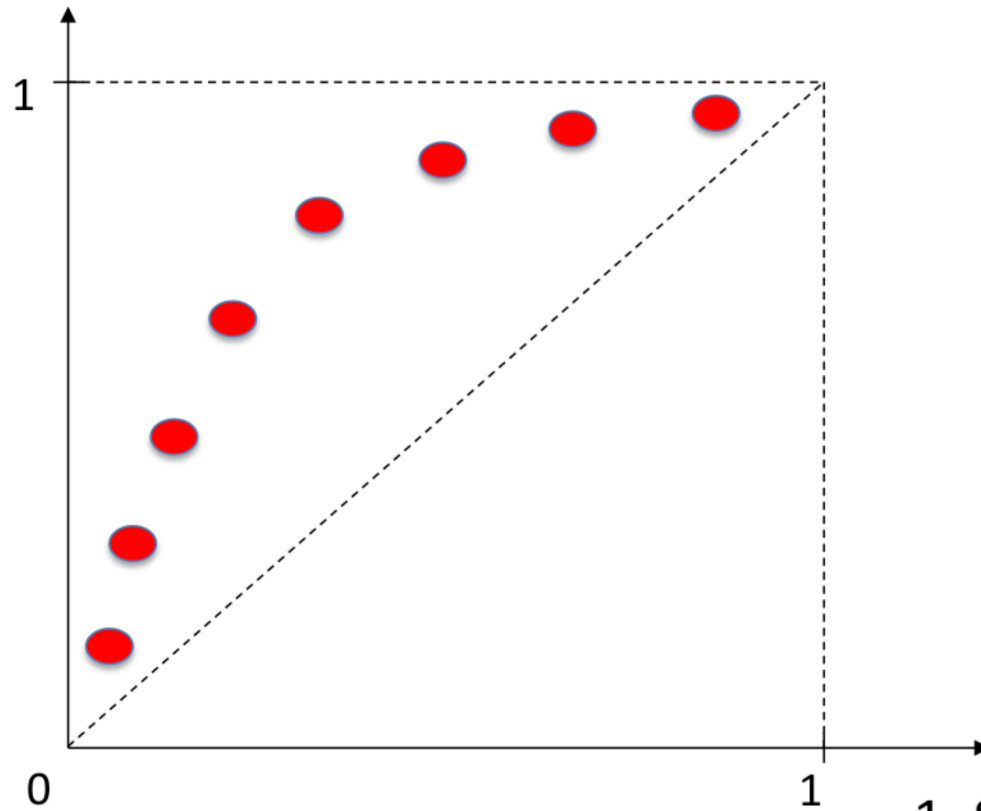
Sensitivity = True positive



1 - Specificity = False positive

# ROC curve

Sensitivity = True positive

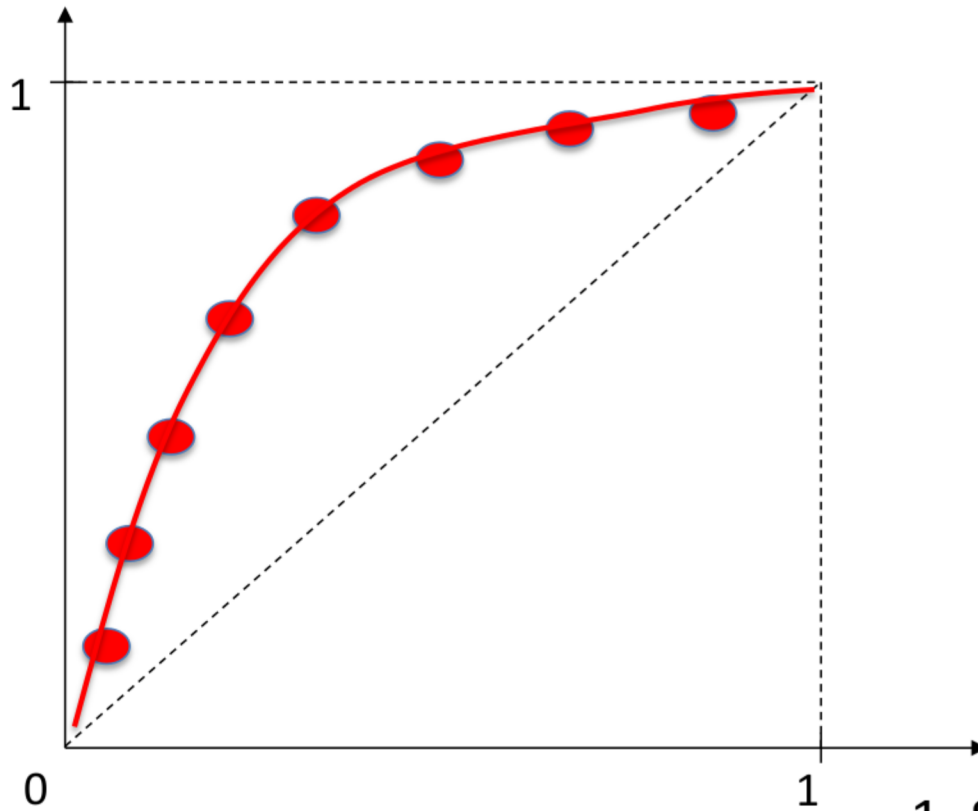


1- Specificity = False positive



# ROC curve

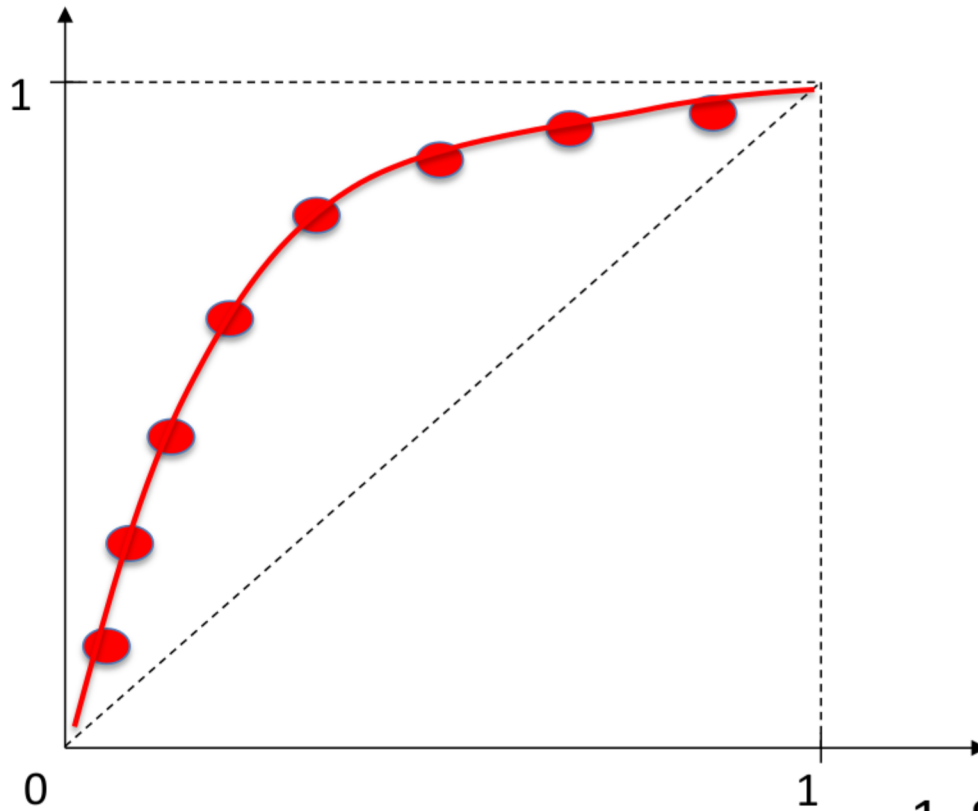
Sensitivity = True positive



1- Specificity = False positive

# Which threshold (strike) $T$ ?

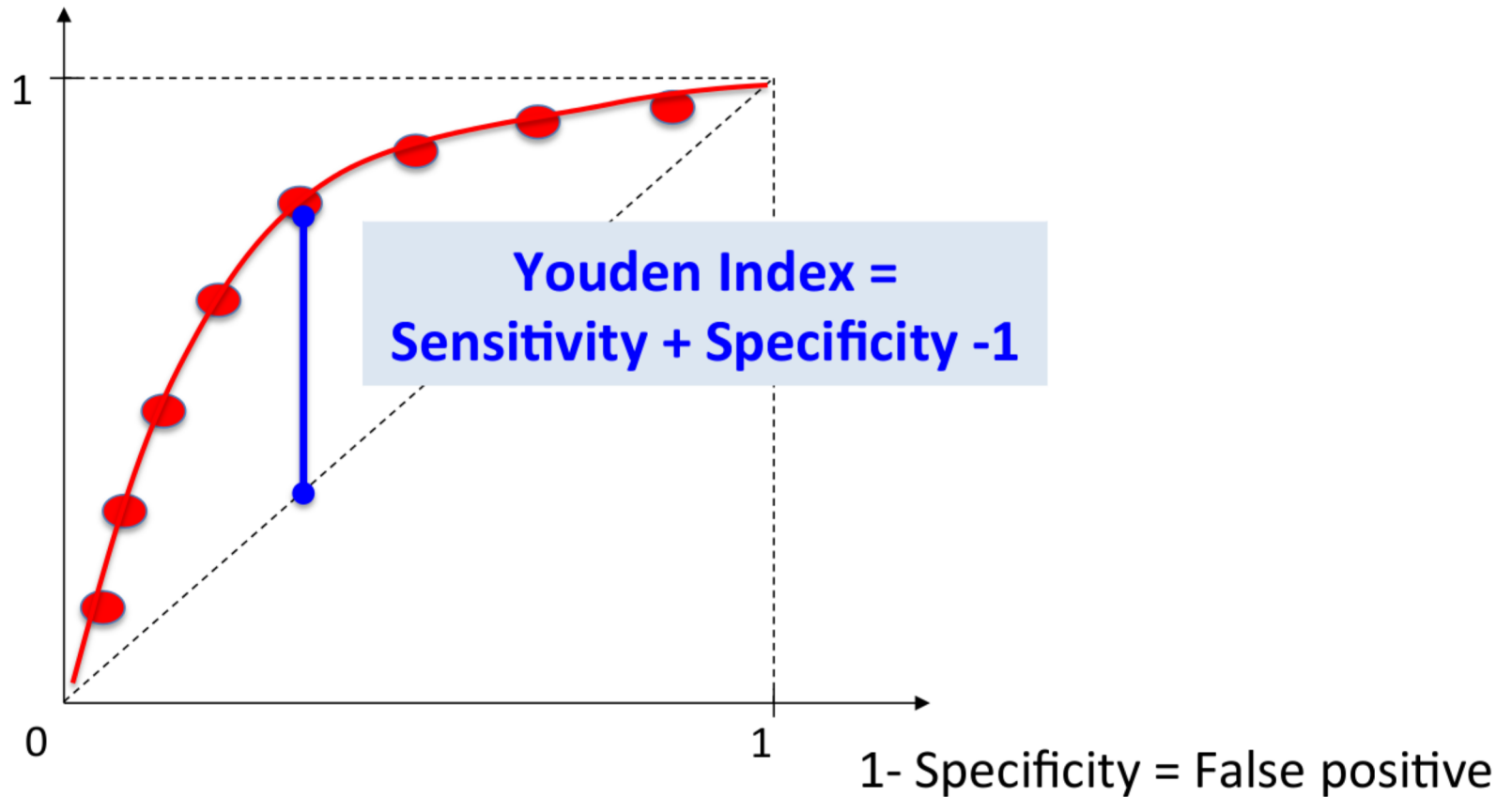
Sensitivity = True positive



1-Specificity = False positive

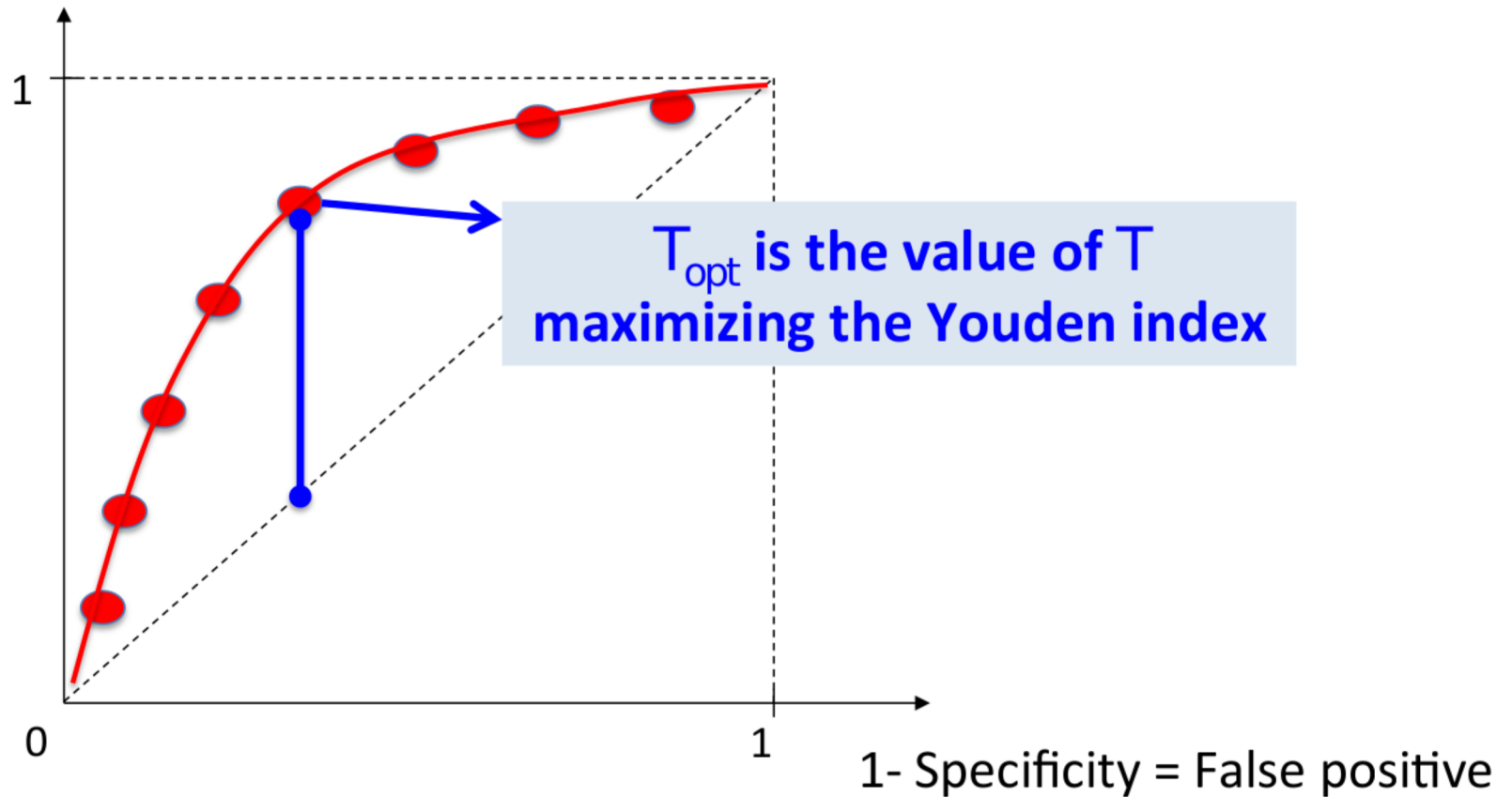
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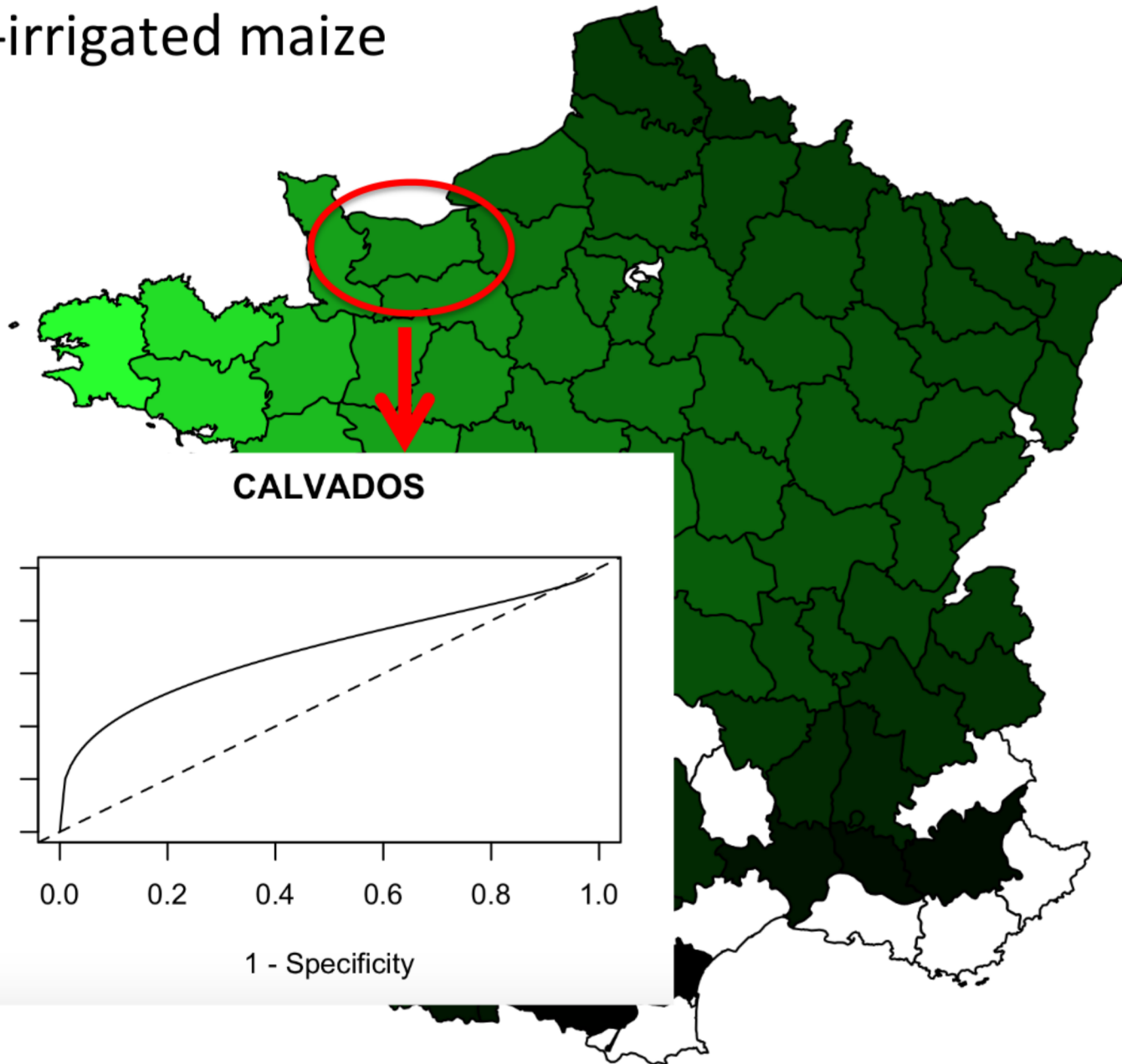


# Which threshold (strike) $T$ ?

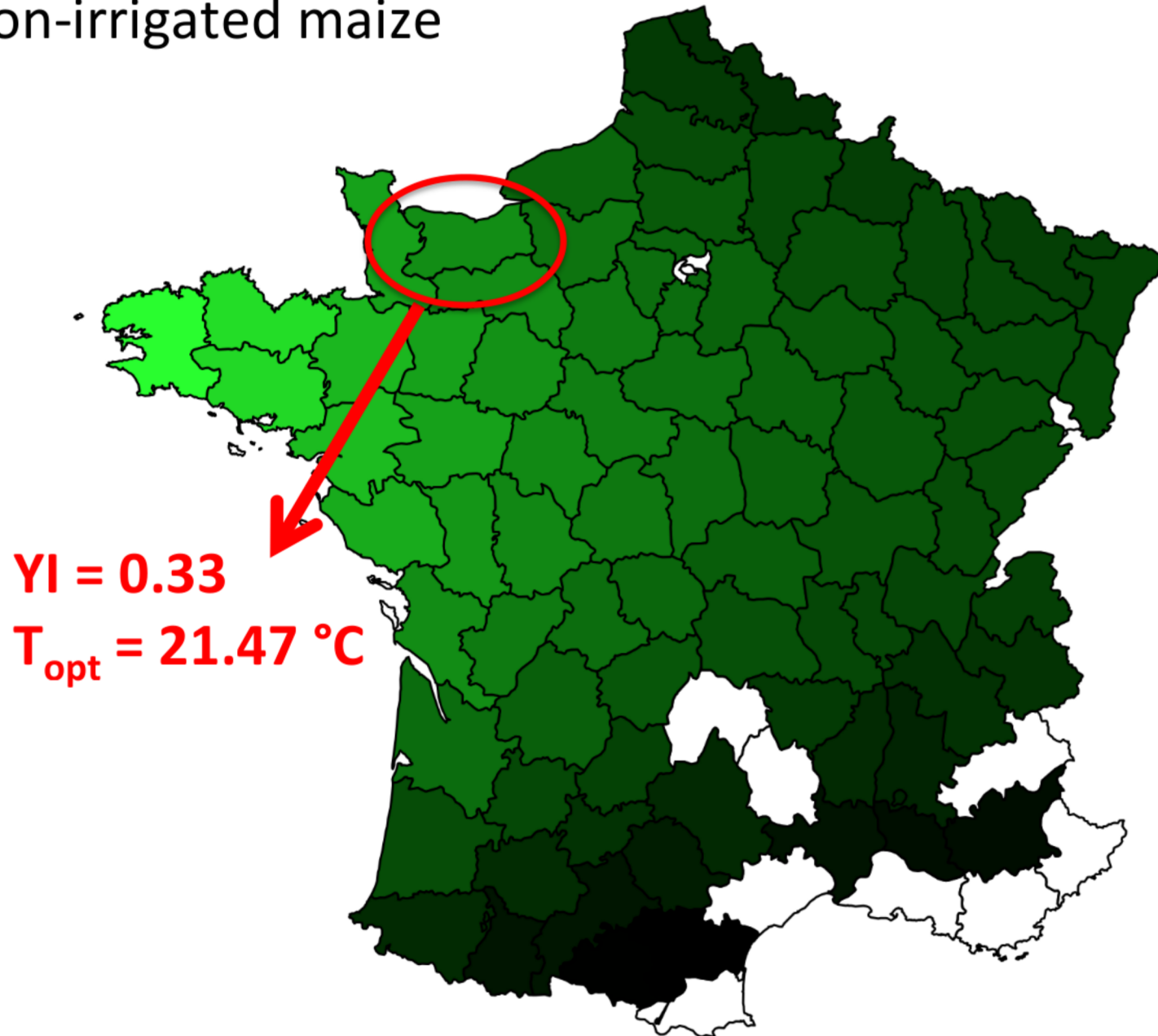
Sensitivity = True positive



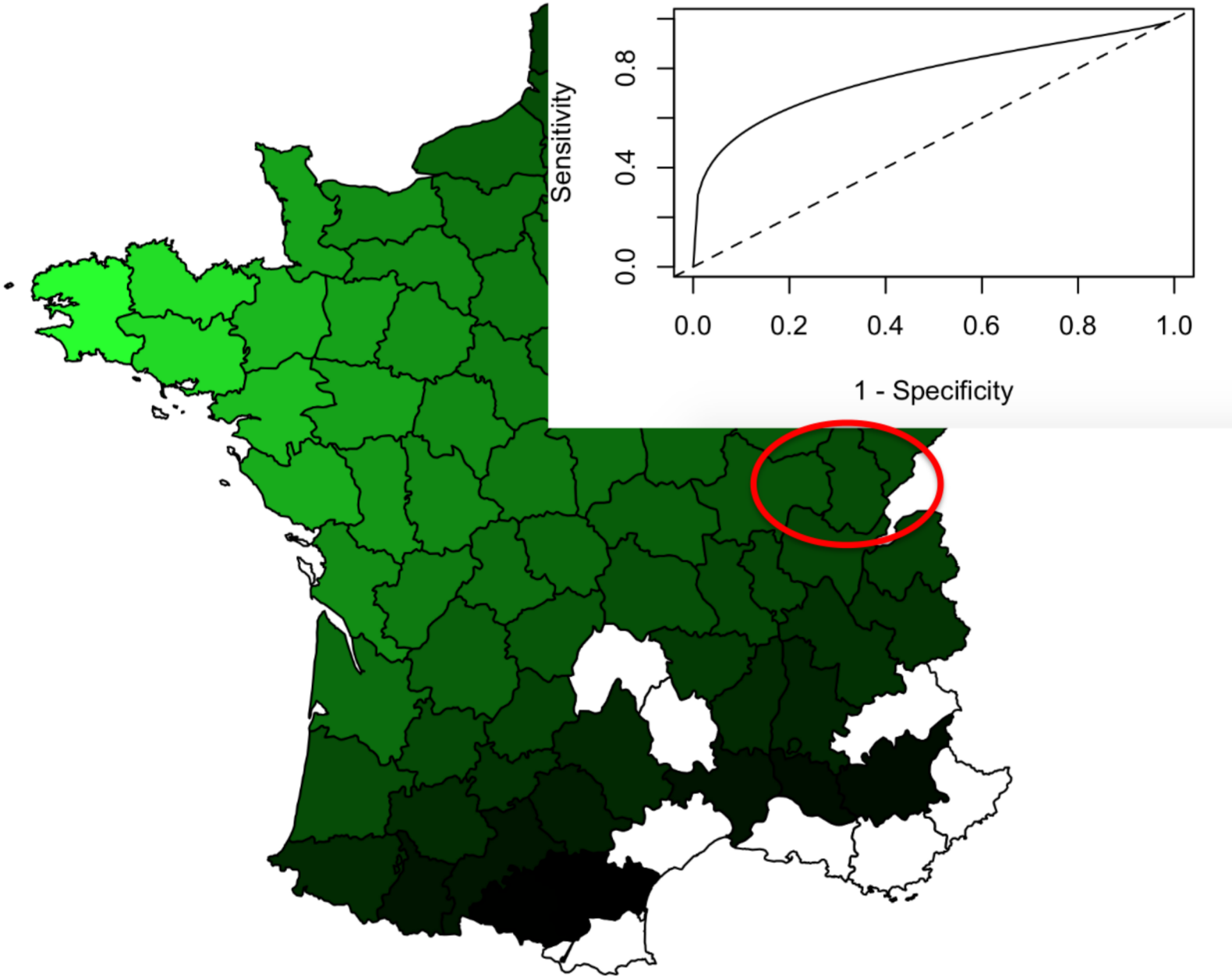
« Extreme yield loss if  $T_{max}$  in June  $> T$  »  
Non-irrigated maize



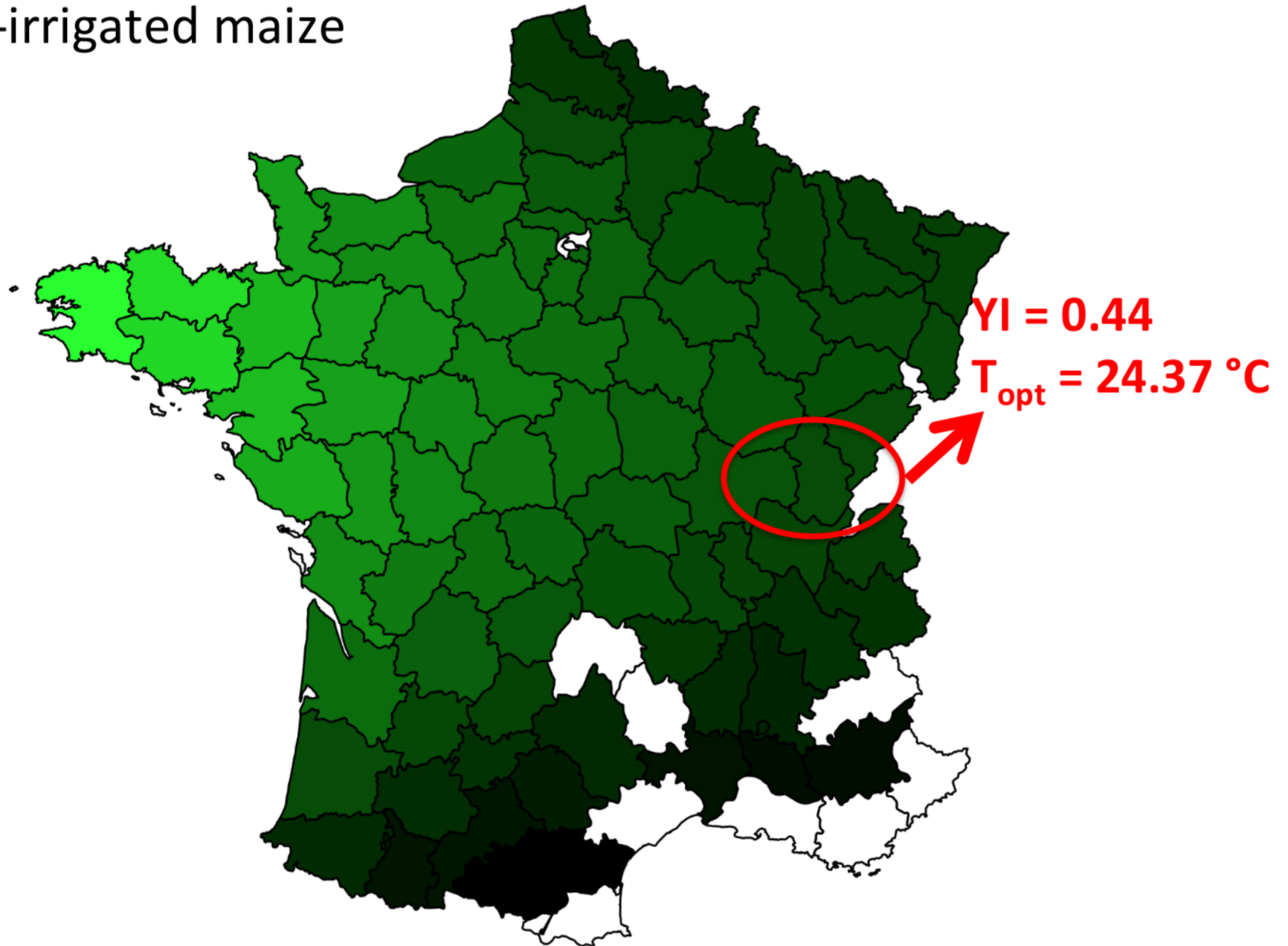
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# JURA

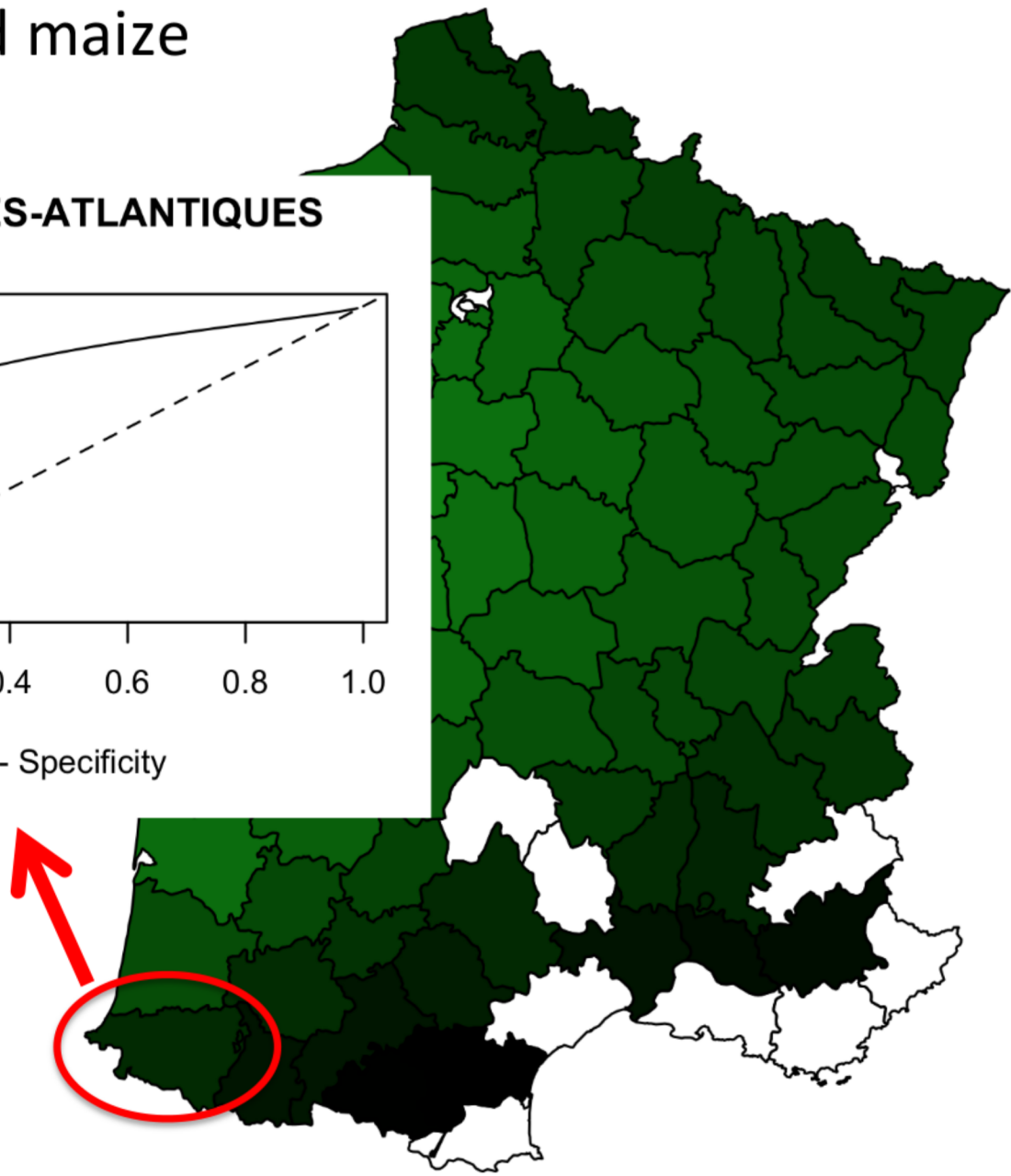
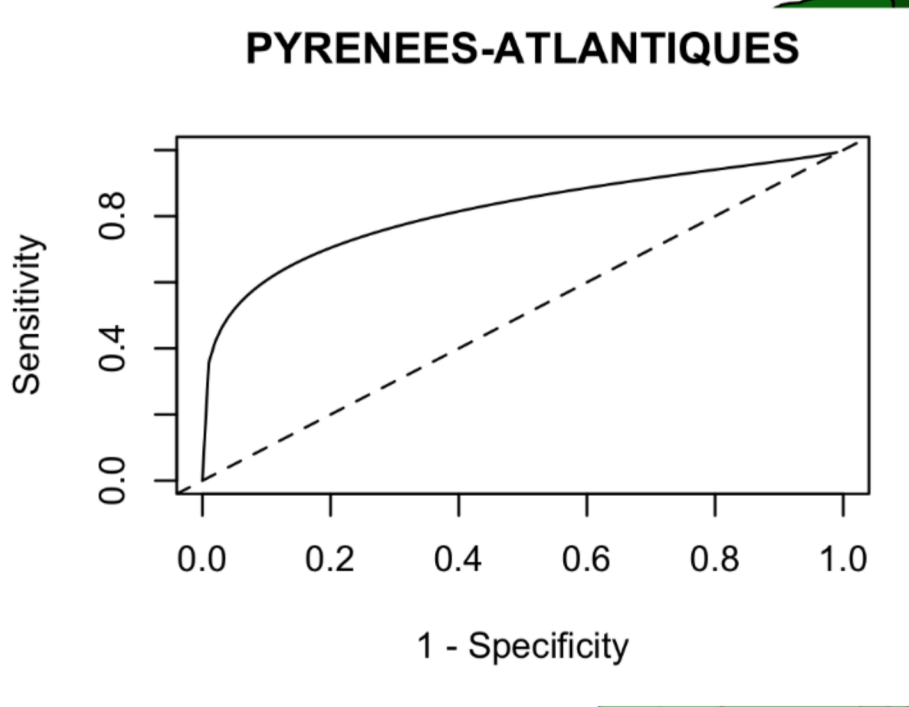


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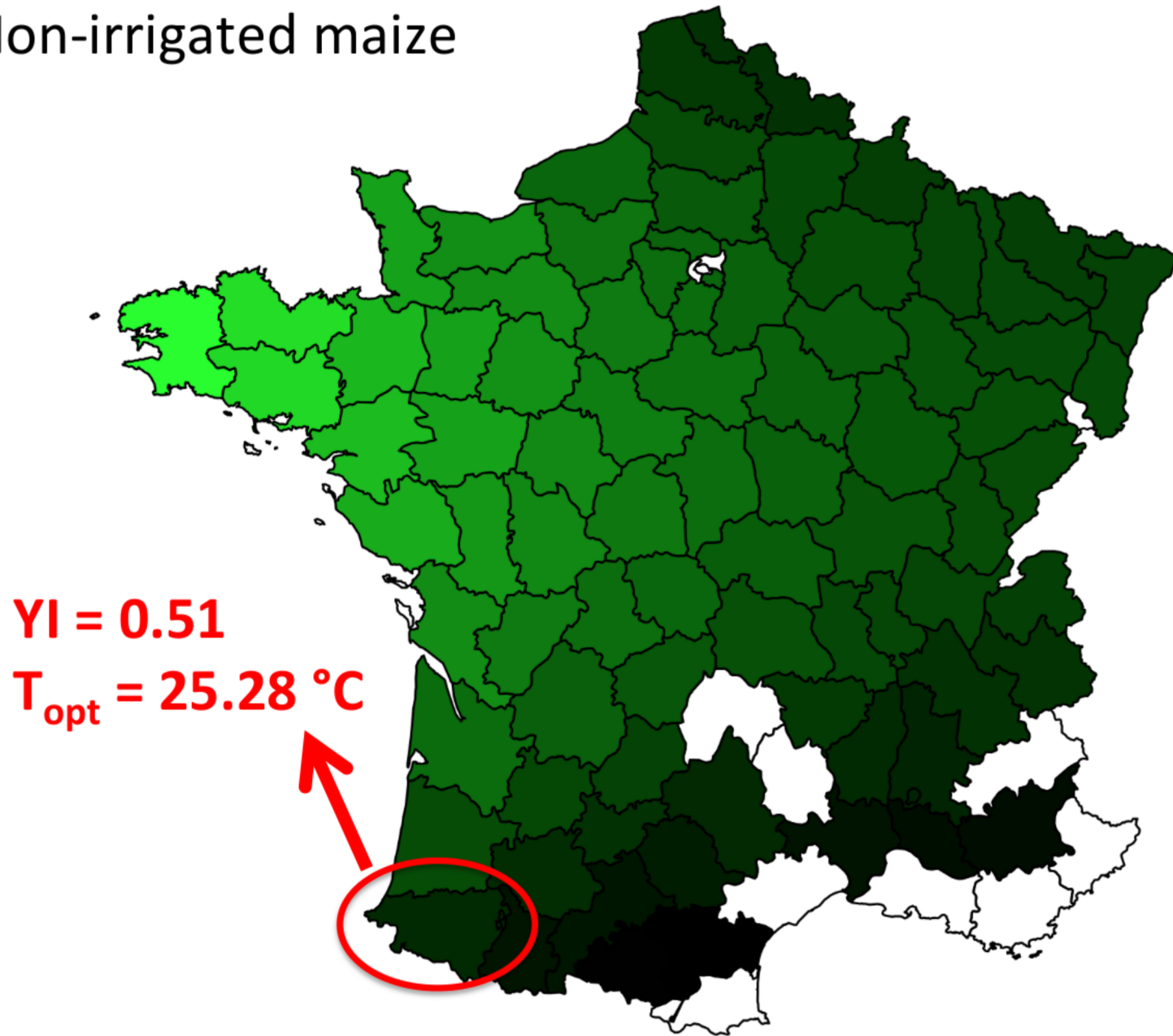


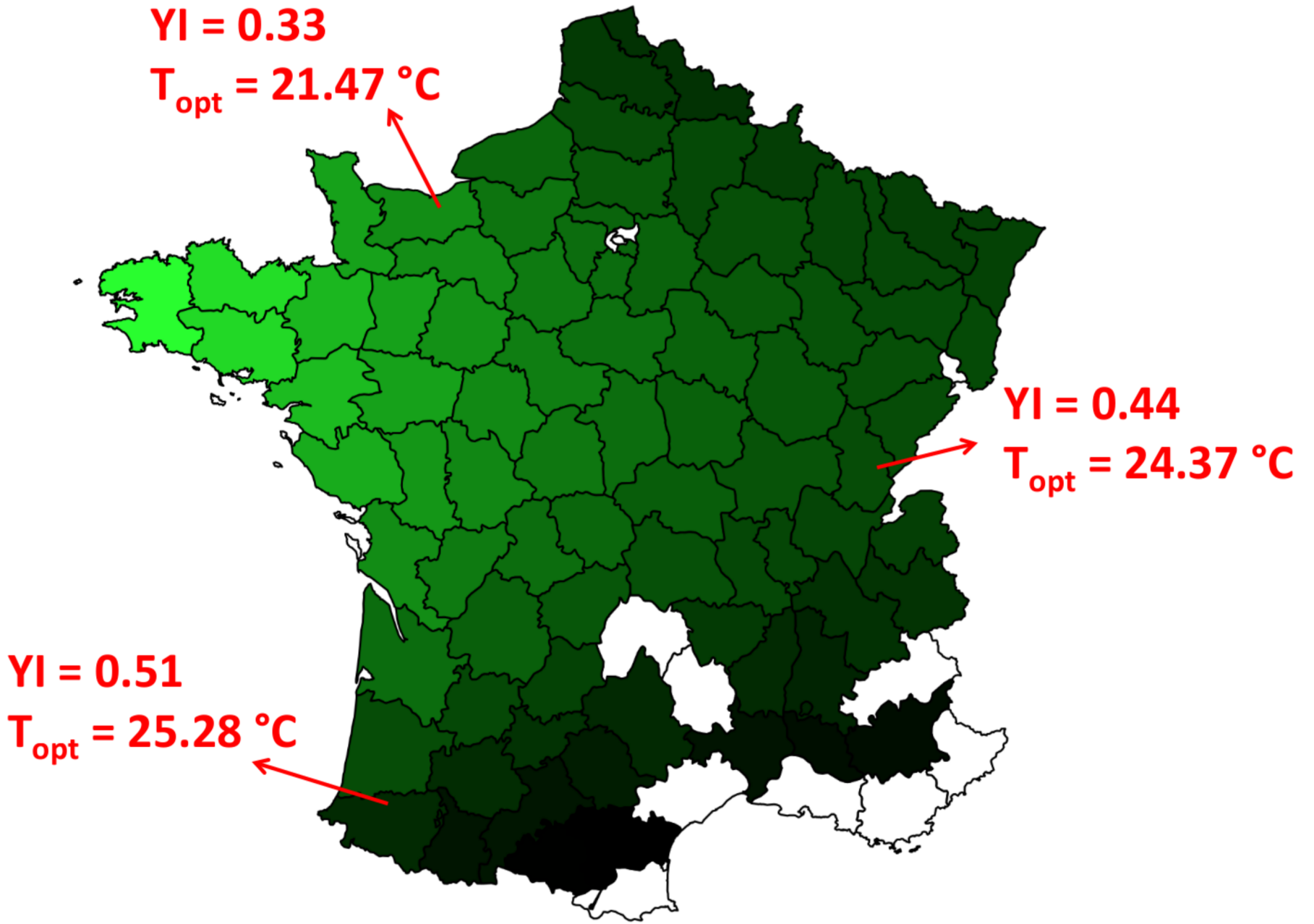


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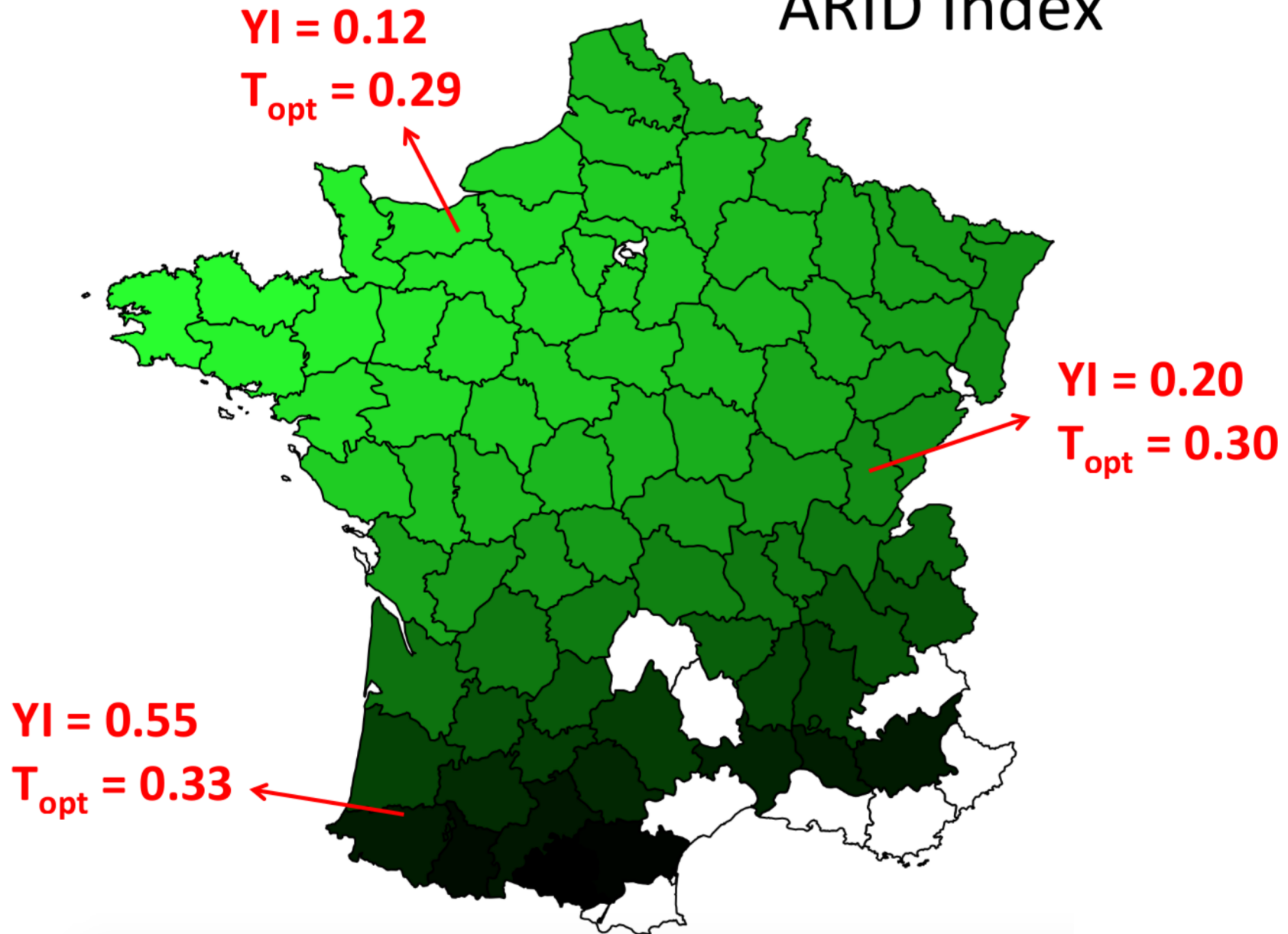


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Non-irrigated maize





# ARID Index



# Perspectives

- Evaluate a large range of weather-indices
- Consider major crop species
- Estimate optimal strike values and basis risk levels
- Conclude on the interest of weather-index insurance