

# Functional Data Analysis for Organ Transplantation Outcomes

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# Outline

Clinical Transplant Data

Functional Principal Component Analysis of GFR Curves

Jointly Modelling Longitudinal and Time-to-event Clinical Data

Functional Mapping of Multiple Dynamic Traits

Summary

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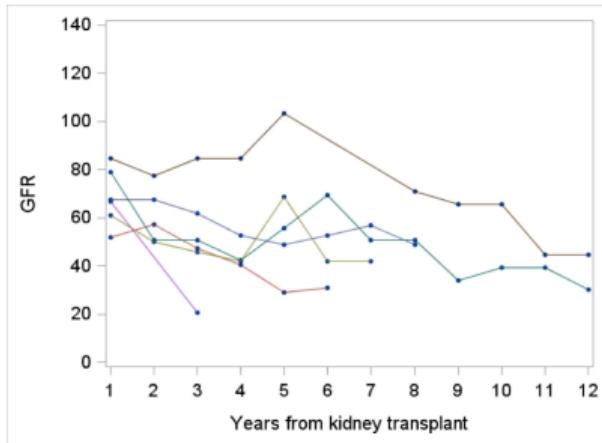
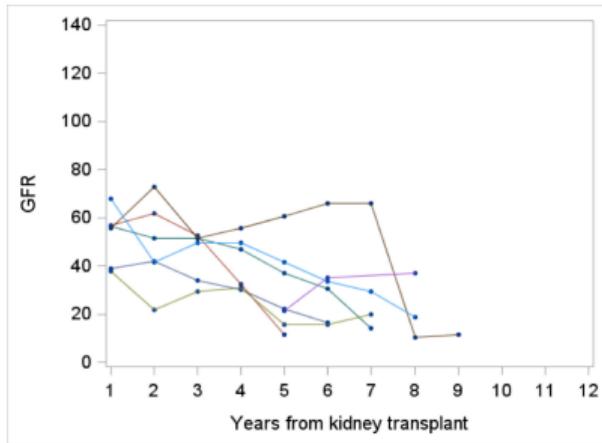
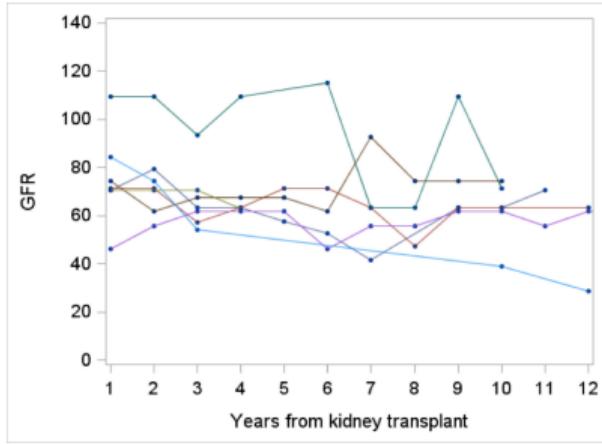
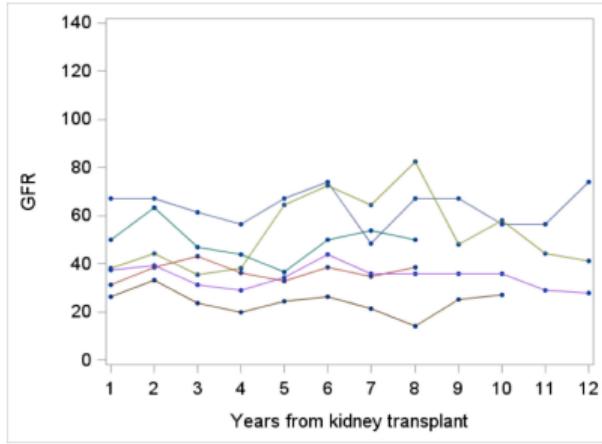
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## Clinical Transplant Data

- United Network for Organ Sharing is the private, non-profit organization that manages the nation's organ transplant system.
- All patients ( $N = 13,635$ ) have both an end-stage renal disease (ESRD) and a diabetic disease;
- All patients already have a kidney transplantation from a living or deceased donor;
- All patients are on the waiting list for the pancreas transplant;
- A part of patients ( $N = 2,776$ ) may have a pancreas transplant at any time during the followed-up period.

## Glomerular filtration rate (GFR)

- GFR is the best test to measure your level of kidney function and determine your stage of kidney disease.
- Your doctor can calculate it from the results of your blood creatinine test, your age, body size and gender.
- Your GFR tells your doctor your stage of kidney disease and helps the doctor plan your treatment.
- If your GFR number is low, your kidneys are not working as well as they should. The earlier kidney disease is detected, the better the chance of slowing or stopping its progression.



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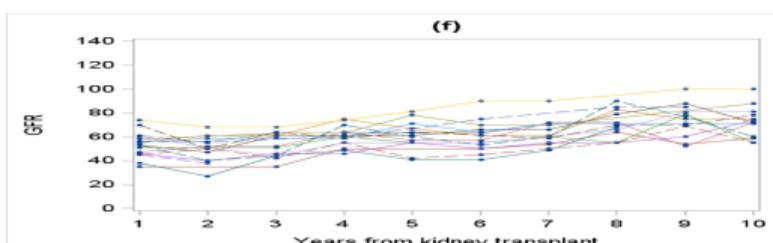
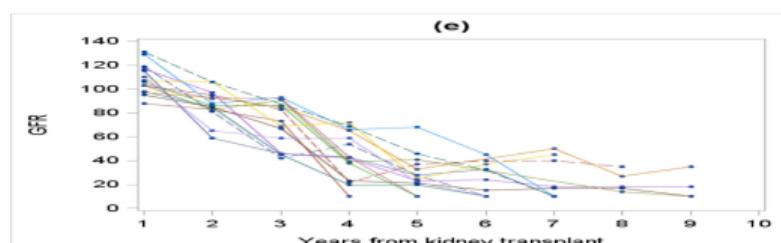
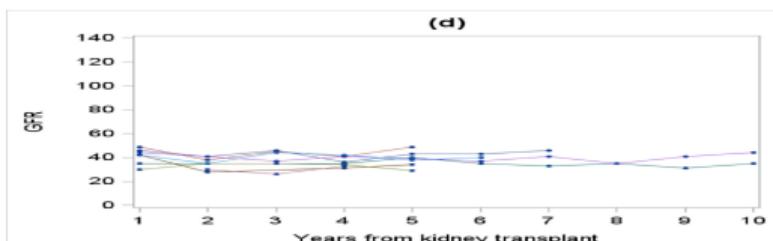
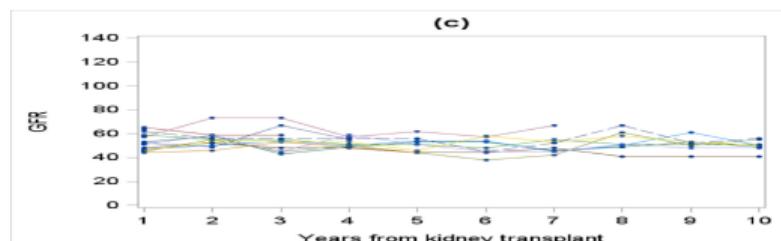
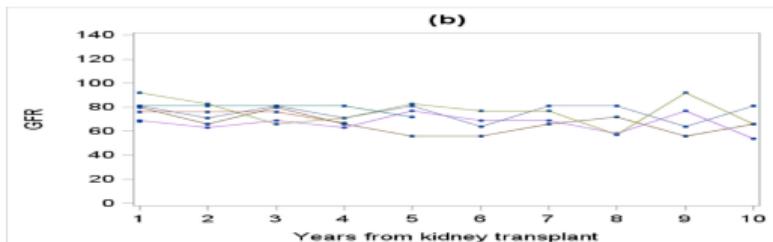
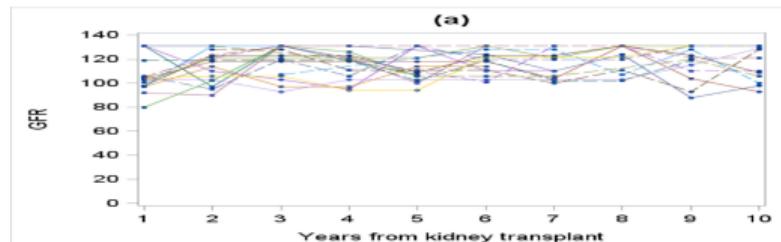
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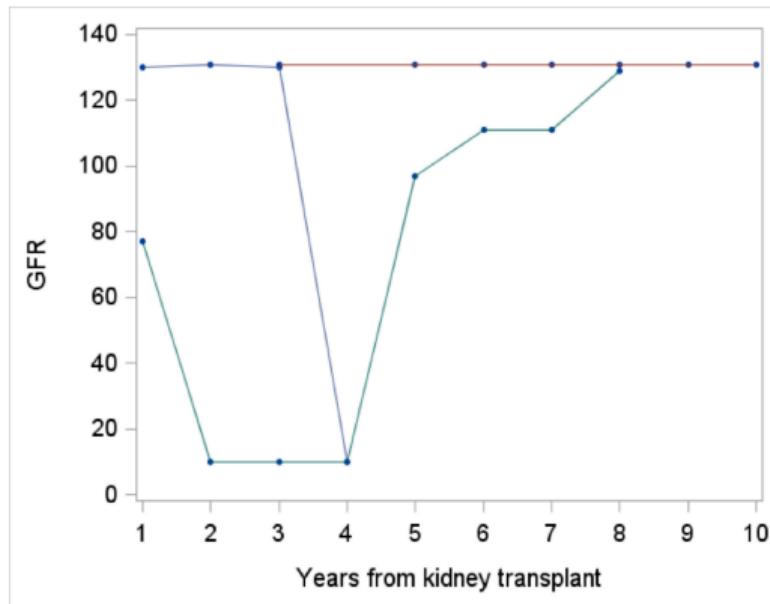
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- Dimension reduction:  $X_i(t) \rightarrow s_{i1}, \dots, s_{iK}$ .

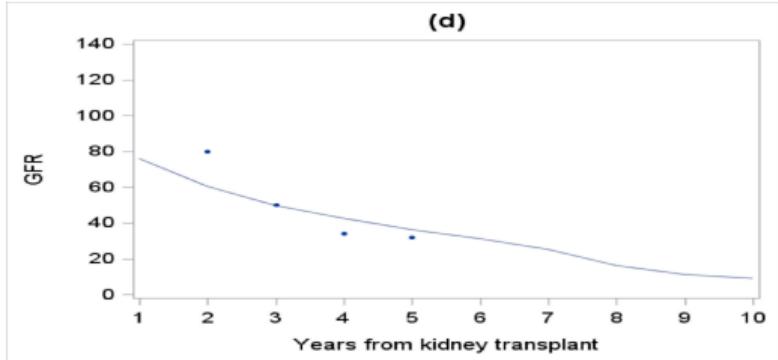
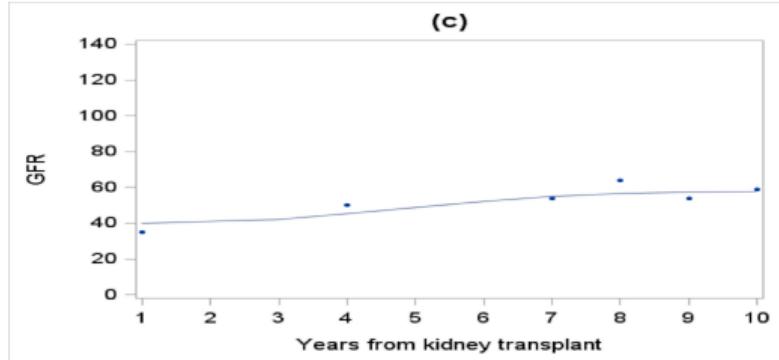
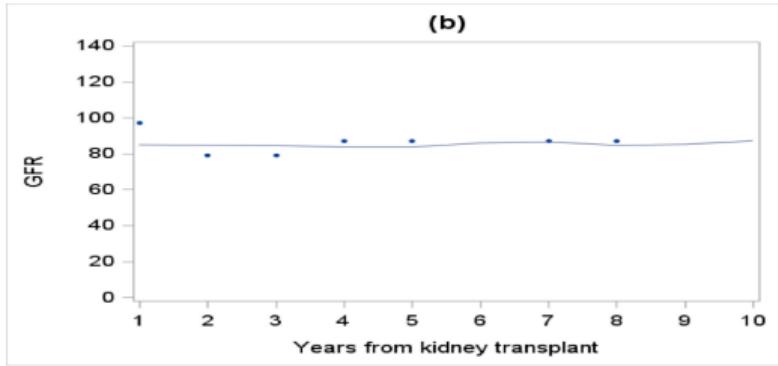
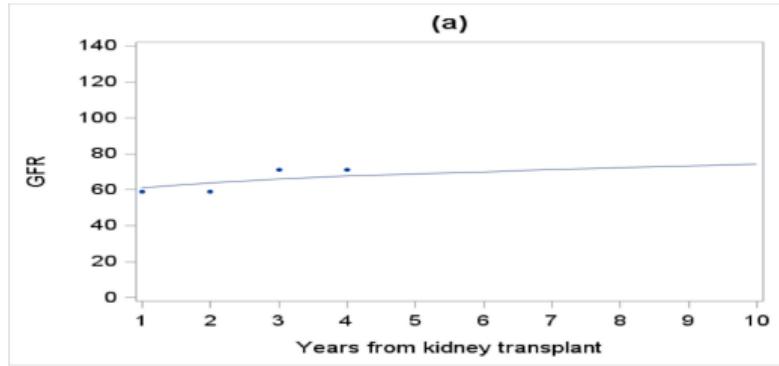
# Cluster patients with homogeneous GFR by FPC score



## Detect outliers (abnormal GFR curves) by FPC score



# The predicted GFR curves



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# Jointly Modelling Longitudinal and Time-to-event Clinical Data

- Longitudinal continuous outcome of glomerular filtration rate (GFR)
- Time-to-event outcome of all-cause graft loss (ACGL)

## Advantages of Joint Modelling

- Estimate parameters in the survival component by incorporating the longitudinal data information;
- Increase the power and decrease the Type I error.

## Joint model to predict the long-term kidney function

Parameters	The longitudinal submodel		The survival submodel	
	Coef.(SE)	P value	Coef.(SE)	P value
$\beta_1$	48.94(2.34)	< 0.001		
$\beta_2$	-1.36(0.12)	< 0.001		
$\gamma_1$			-0.07(0.01)	< 0.001
$\gamma_2$			-0.21(0.04)	< 0.001

## Effect of Pancreas Transplant on Allograft

- The pancreas transplant has a significantly statistical benefit effect on ACGL because the hazard ratio is  $\exp(\gamma_{31}) = \exp(-0.13) = 0.88$  with the p-value 0.045.
- The pancreas transplant can reduce the risk of the time-to-event outcome ACGL.

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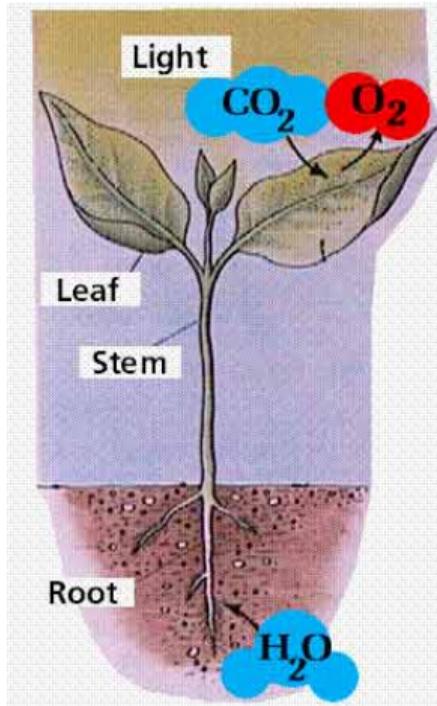
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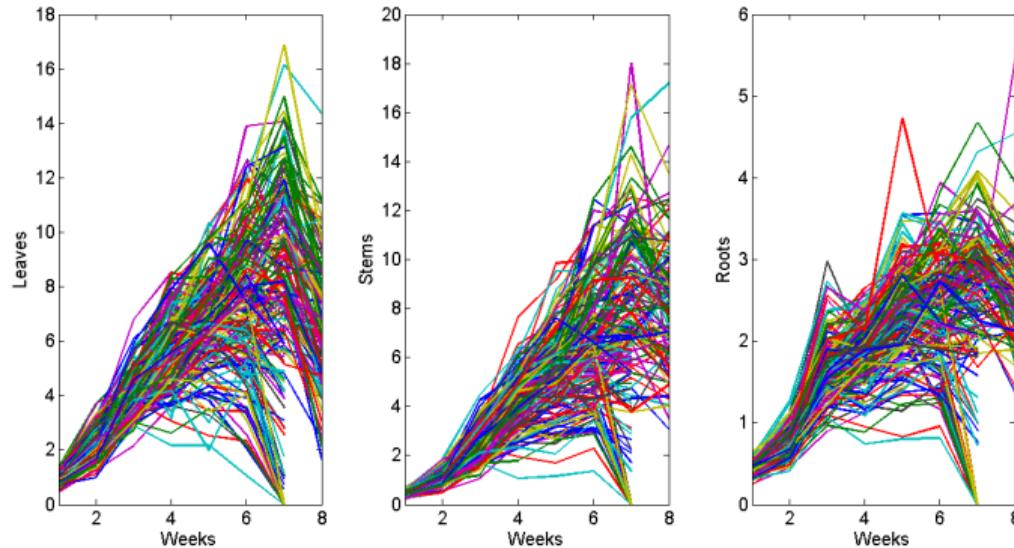
## A Soybean



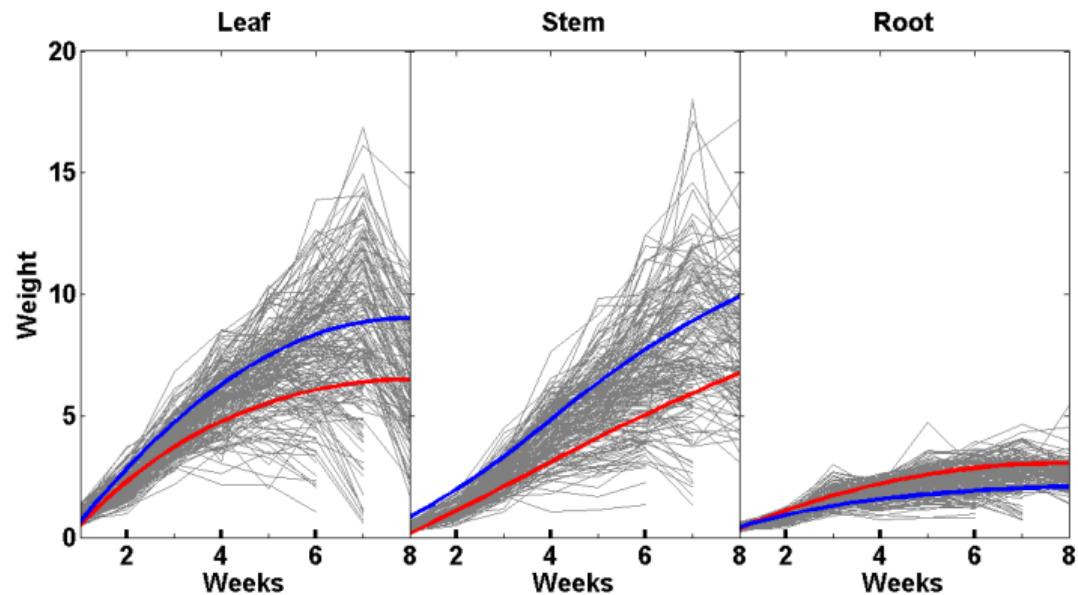
# Weights of Leaves, Stems, and Roots

184 Soybeans are measured once every week for 8 weeks.

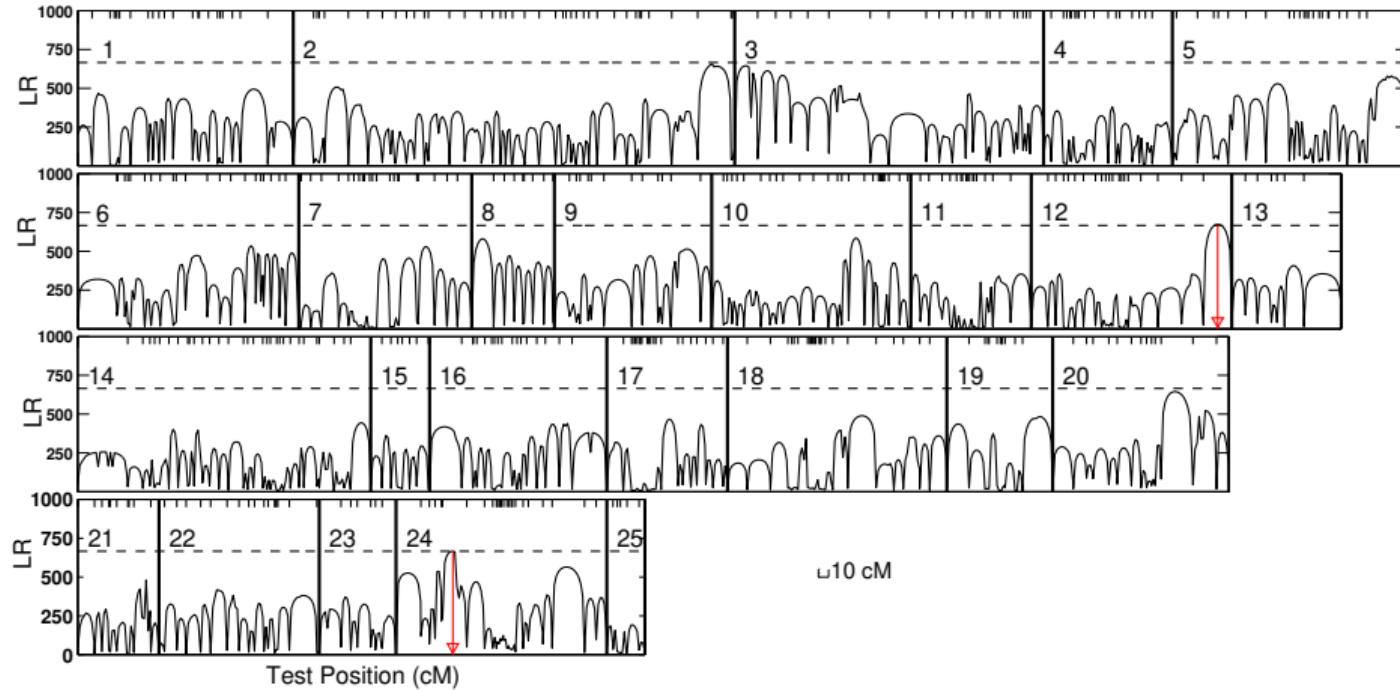
Goal: Detect genes that determine the growth of soybean.



# Mixture Distribution of Data



## Grid search for QTL every 2 cM



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- Functional principal component analysis is a good tool to analyze GFR curves and other longitudinal trajectories.
- Jointly modelling longitudinal and time-to-event clinical data.
- Functional mapping of multiple dynamic traits.

tusind tak  
謝謝 dakujem vám  
ありがとう  
dziekuję  
merci  
baie dankie  
ଧନ୍ୟବାଦ molte grazie  
gracias  
obrigada  
obrigado  
teşekkür ederim  
شكراً  
tack så mycket

455359502

suksema  
danke  
**thank you**  
gracias  
obrigada  
obrigado  
teşekkür ederim  
tack så mycket

tusind tak  
謝謝 dakujem vám  
ありがとう  
nugiyapqonq  
dziekuje  
merci  
baie dankie  
ধন্যবাদ molte grazie  
dank u  
dire m halo  
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