Estimating the Failure Probabilities

How do we evaluate the chance constraint $\mathbb{P}_{\mathbf{x}_r}[f_i(\mathbf{x}_d, \mathbf{x}_r) > 1]$?

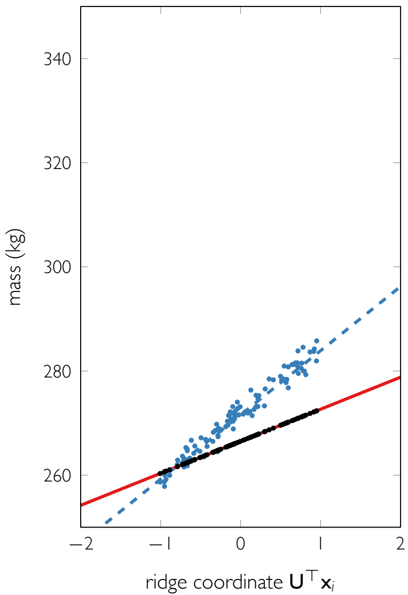
- Sample model at design point $\mathbf{x}_d$ and randomly in $\mathbf{x}_r$
- Build a linear model of $f_i(\mathbf{x}_d, \mathbf{x}_r)$:

$$f_i(\mathbf{x}_d, \mathbf{x}_r) \approx g(\mathbf{x}_r) := \alpha + \mathbf{a}^\top \mathbf{x}_r$$

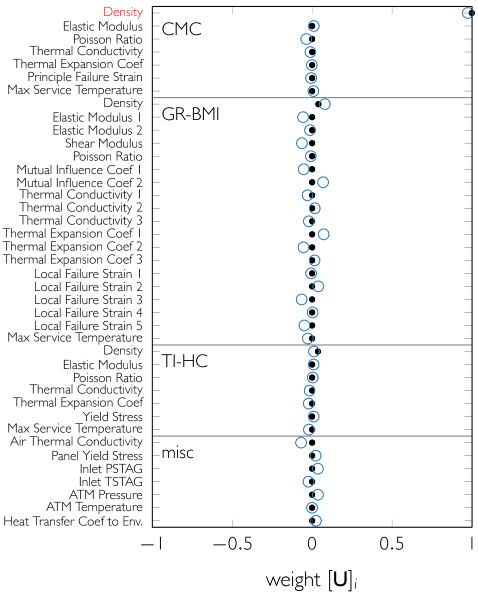
- Estimate failure criteria with surrogate using Monte-Carlo

$$\mathbb{P}_{\mathbf{x}_r}[f_i(\mathbf{x}_d, \mathbf{x}_r) > 1] \approx \mathbb{P}_{\mathbf{x}_r}[g(\mathbf{x}_r) > 1] \approx \sum_{i=1}^{N} [\alpha + \mathbf{a}^\top \mathbf{x}_r^{(i)} > 1]$$

Mass $\tau = 10^{-1}$

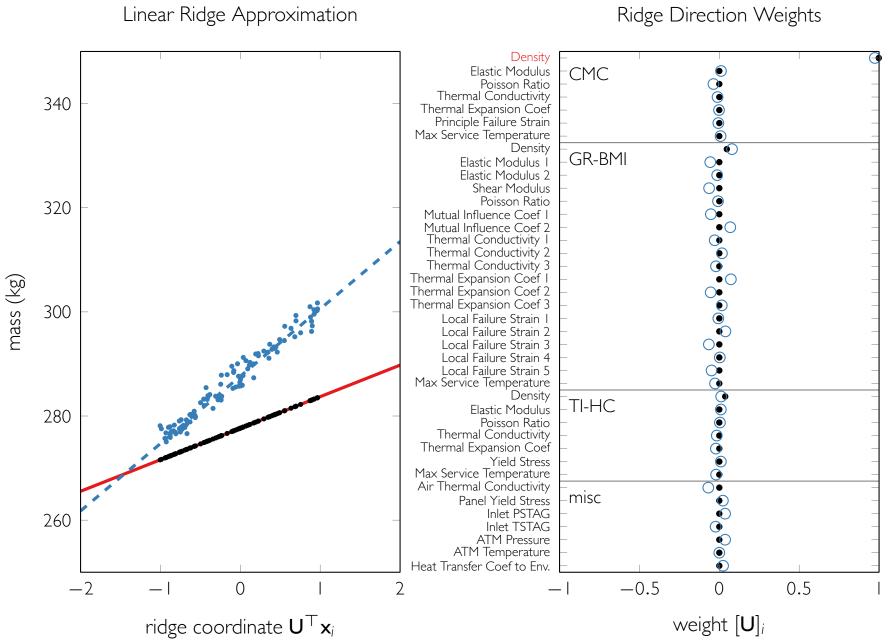


Linear Ridge Approximation
mass (kg)
340
320
300
280
260
−2
−1
0
1
2
ridge coordinate $\mathbf{U}^\top \mathbf{x}_i$



Ridge Direction Weights
Density
Elastic Modulus
Poisson Ratio
Thermal Conductivity
Thermal Expansion Coef
Principle Failure Strain
Max Service Temperature
Density
Elastic Modulus 1
Elastic Modulus 2
Shear Modulus
Poisson Ratio
Mutual Influence Coef 1
Mutual Influence Coef 2
Thermal Conductivity 1
Thermal Conductivity 2
Thermal Conductivity 3
Thermal Expansion Coef 1
Thermal Expansion Coef 2
Thermal Expansion Coef 3
Local Failure Strain 1
Local Failure Strain 2
Local Failure Strain 3
Local Failure Strain 4
Local Failure Strain 5
Max Service Temperature
Density
Elastic Modulus
Poisson Ratio
Thermal Conductivity
Thermal Expansion Coef
Yield Stress
Max Service Temperature
Air Thermal Conductivity
Panel Yield Stress
Inlet PSTAG
Inlet TSTAG
ATM Pressure
ATM Temperature
Heat Transfer Coef to Env.
CMC
GR-BMI
TI-HC
misc
−1
−0.5
0
0.5
1
weight $[\mathbf{U}]_i$

Mass $\tau = 10^{-6}$



Linear Ridge Approximation
Ridge Direction Weights
mass (kg)
340
320
300
280
260
−2
−1
0
1
2
ridge coordinate $\mathbf{U}^\top \mathbf{x}_i$
Density
Elastic Modulus
Poisson Ratio
Thermal Conductivity
Thermal Expansion Coef
Principle Failure Strain
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Density
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Thermal Conductivity 3
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Thermal Expansion Coef 3
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Local Failure Strain 2
Local Failure Strain 3
Local Failure Strain 4
Local Failure Strain 5
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Density
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Thermal Expansion Coef
Yield Stress
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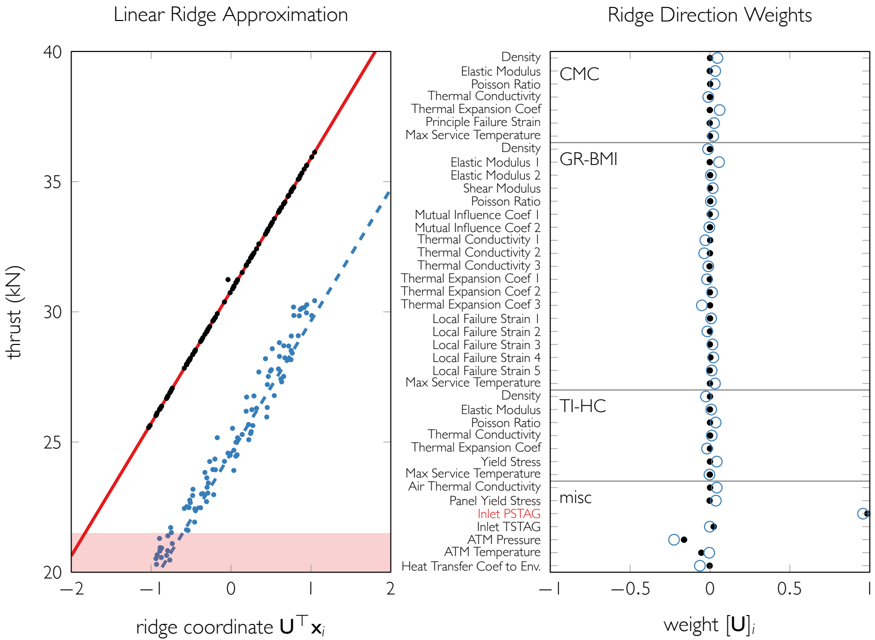
Air Thermal Conductivity
Panel Yield Stress
Inlet PSTAG
Inlet TSTAG
ATM Pressure
ATM Temperature
Heat Transfer Coef to Env.
CMC
GR-BMI
TI-HC
misc
−1
−0.5
0
0.5
1
weight $[\mathbf{U}]_i$

Thrust $\tau = 10^{-1}$



Thrust $\tau = 10^{-6}$