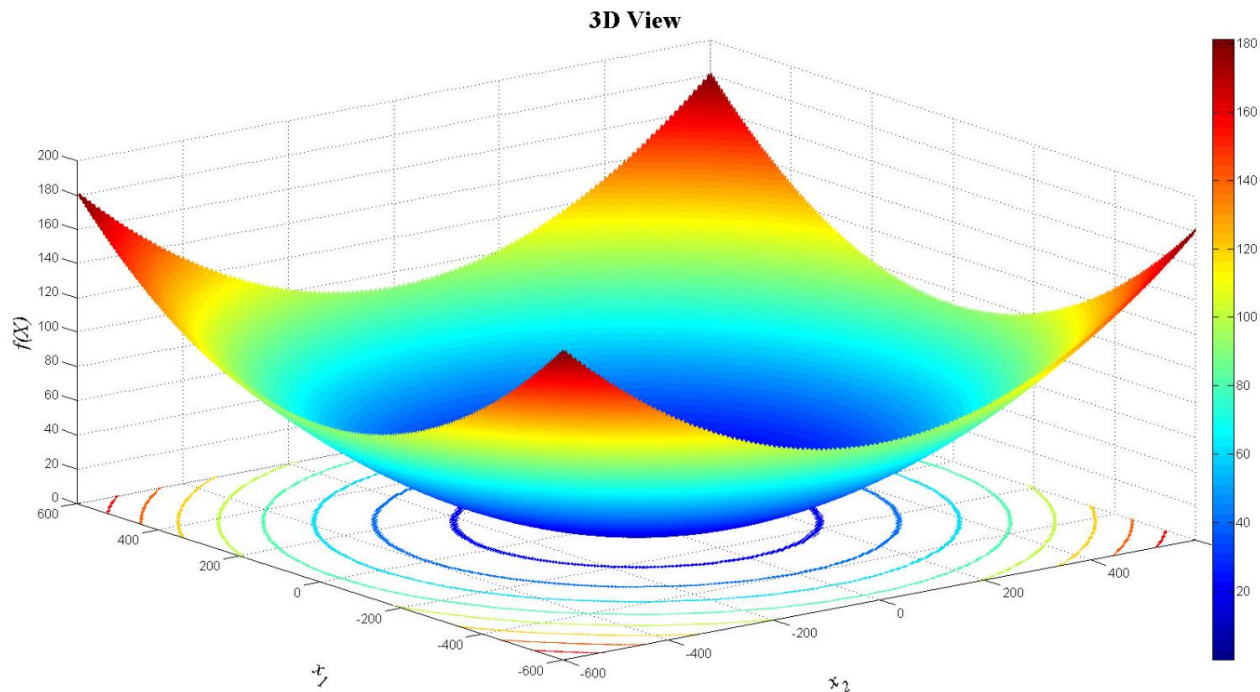


# **Evolution algorithms combined with GMM and CMAES for optimization problems**

Chi-Hsien Chang

# Completely decomposable problem

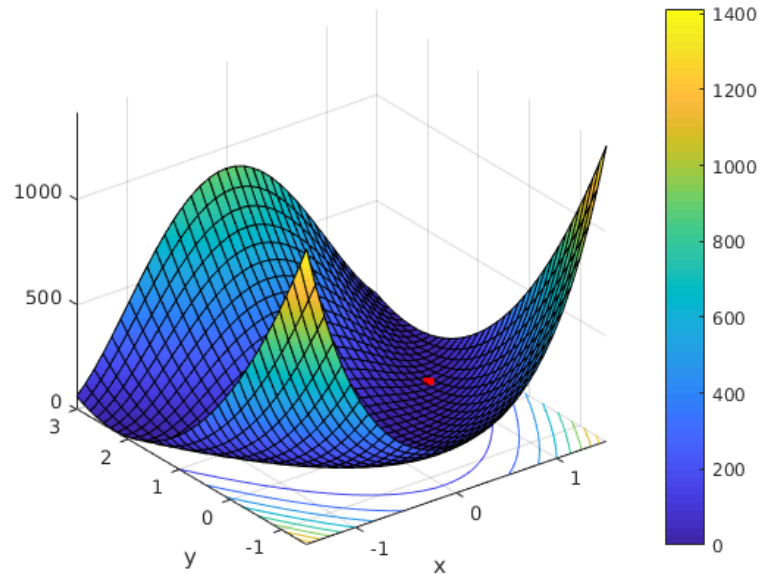
$$f_{\text{sphere}}(\mathbf{x}) = \sum_{i=0}^{\ell-1} x_i^2$$



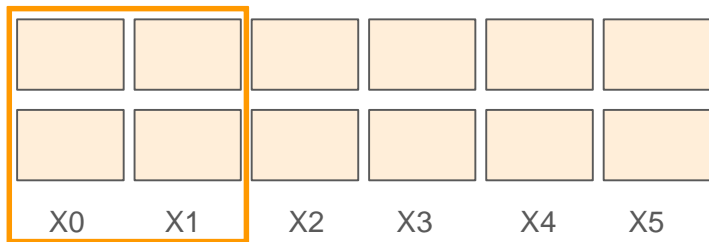
# Overlapping dependencies

- Each pair of consecutive problem variables is dependent on each other

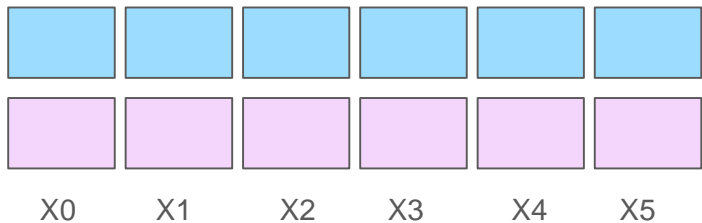
$$f_{\text{Rosenbrock}}(\mathbf{x}) = \sum_{i=0}^{\ell-2} \left[ 100 (\mathbf{x}_{i+1} - \mathbf{x}_i^2)^2 + (1 - \mathbf{x}_i)^2 \right]$$



# Optimal Mixing

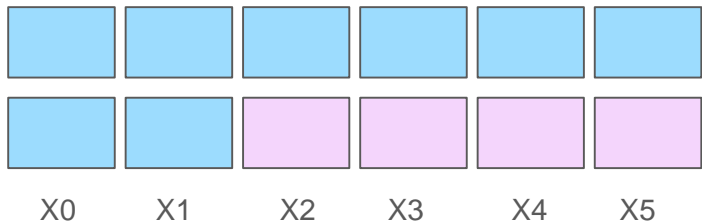


GMM  
→



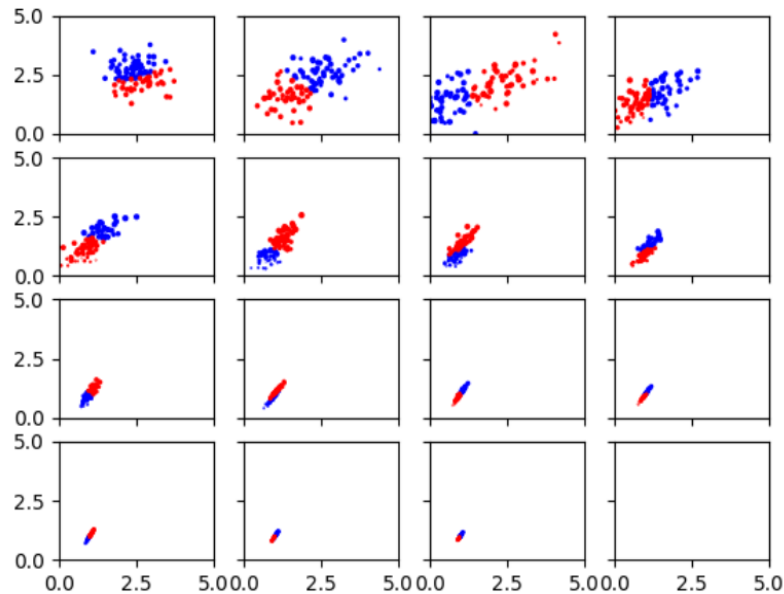
Top k  
←

BM  
↓



CMAES  
→

$$f_{\text{Rosenbrock}}(\mathbf{x}) = \sum_{i=0}^{\ell-2} \left[ 100 (\mathbf{x}_{i+1} - \mathbf{x}_i^2)^2 + (1 - \mathbf{x}_i)^2 \right]$$



Next population

# Procedure

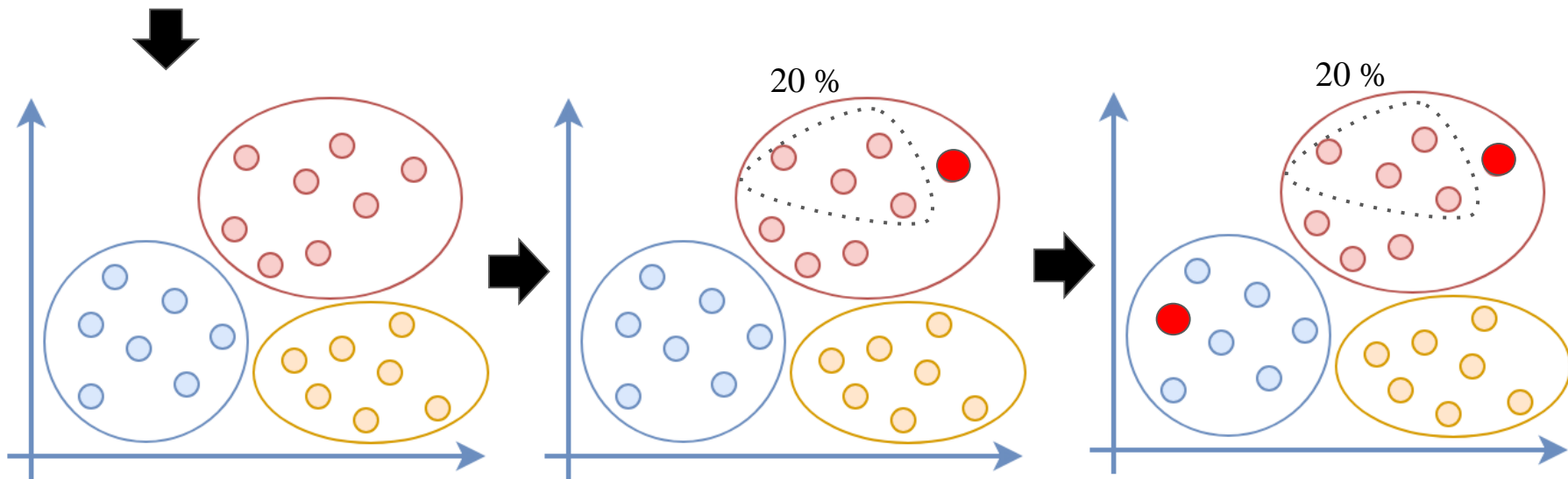
- LT = 

1, 3	0, 2	0, 1, 2, 3
------	------	------------

- ILS = 

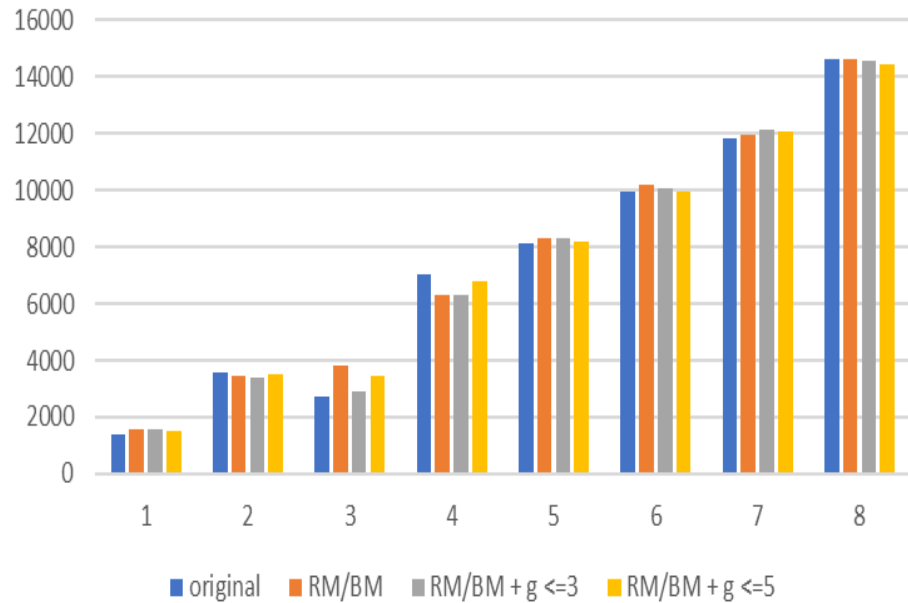
3	3, 0	3, 0, 1	3, 0, 1, 2
---	------	---------	------------

$$MI_{ij} = \log \left( \sqrt{\frac{1}{1 - \left( \frac{\hat{\Sigma}_{ij}}{\hat{\sigma}_i \hat{\sigma}_j} \right)^2}} \right)$$

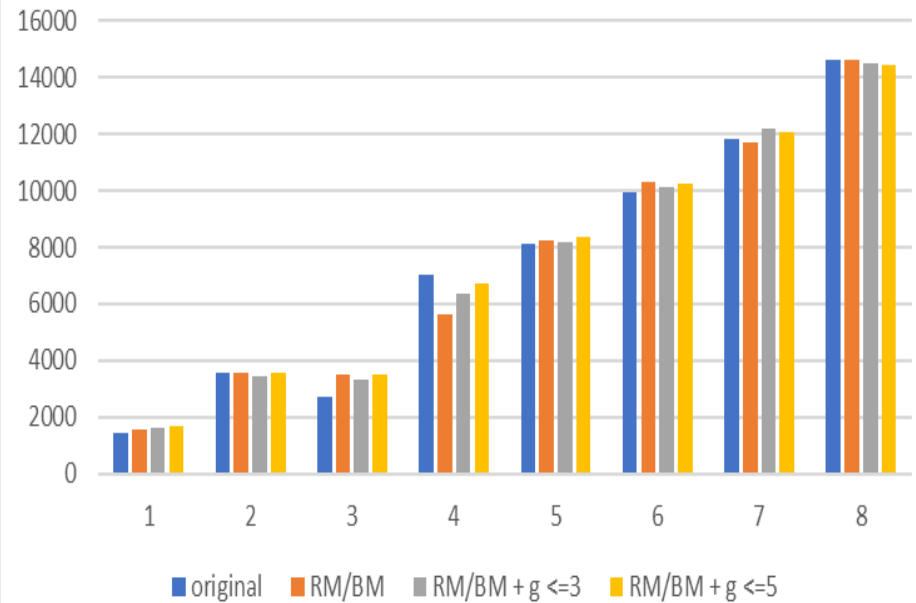


# Rosenbrock ( 10 times / Dimension: 3 ~ 10)

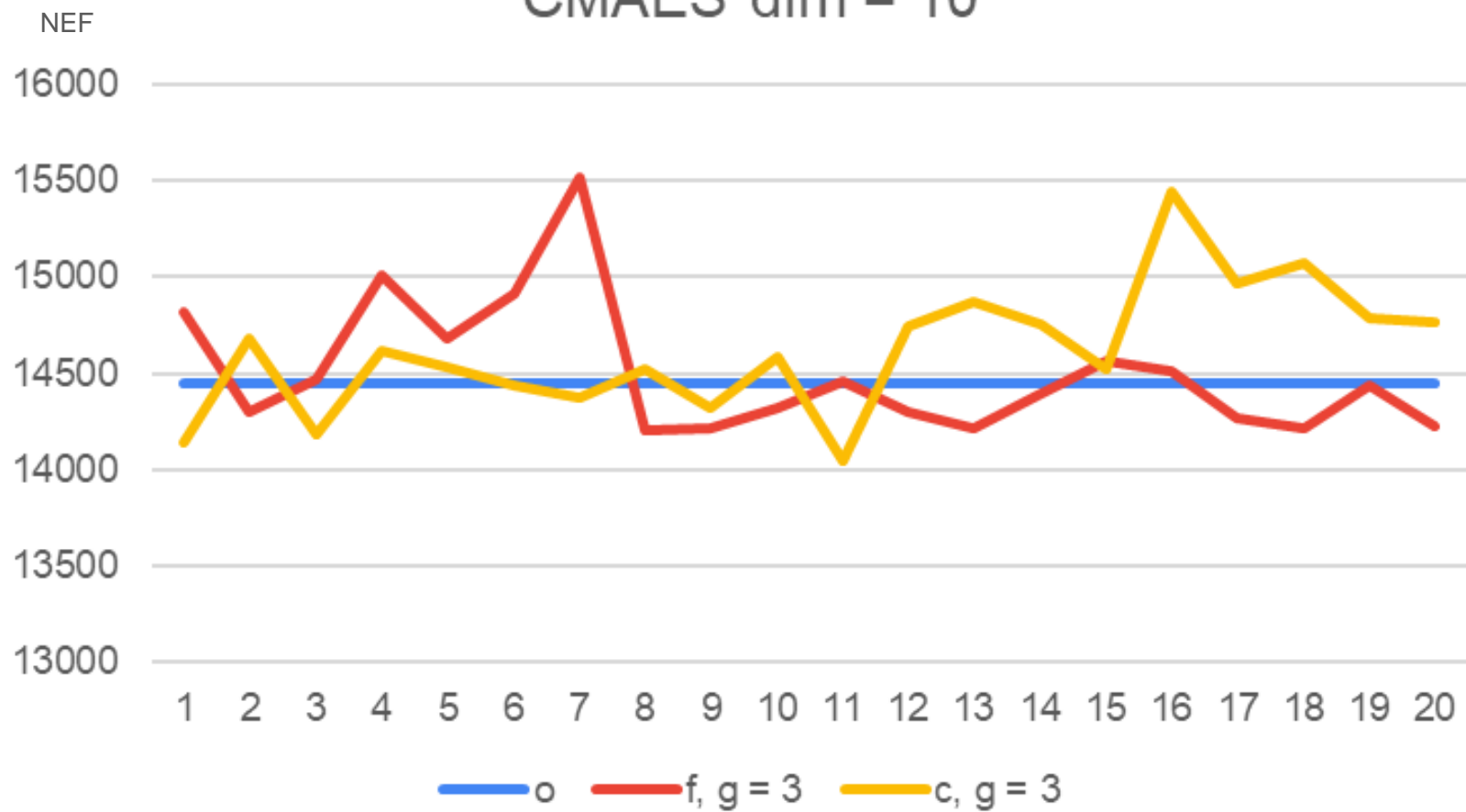
## LT / Component = 4



## ILS / Component = 4

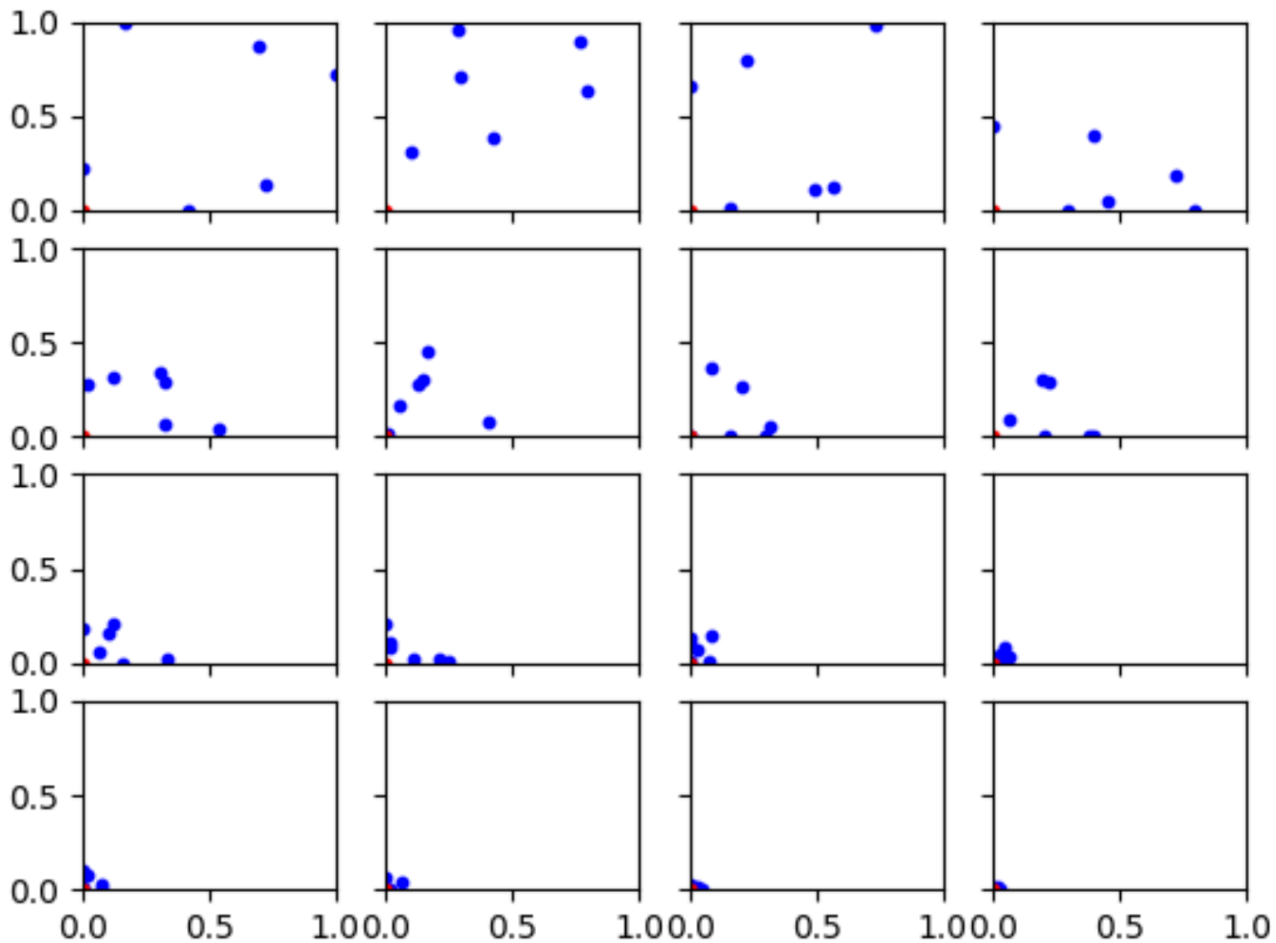


# CMAES dim = 10



TOP

# CMA-ES (sphere)





# CMA-ES (Rosenbrock)

