

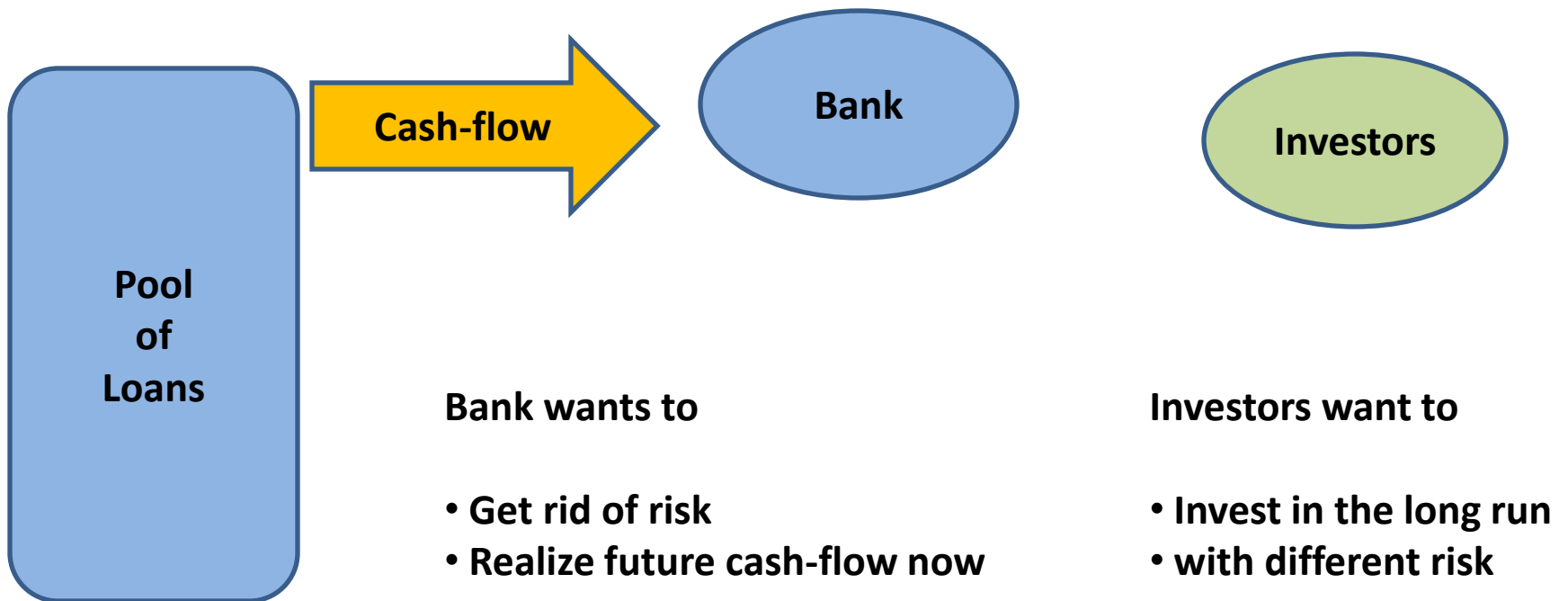
Portfolio Optimization

Artificial Intelligence in Finance

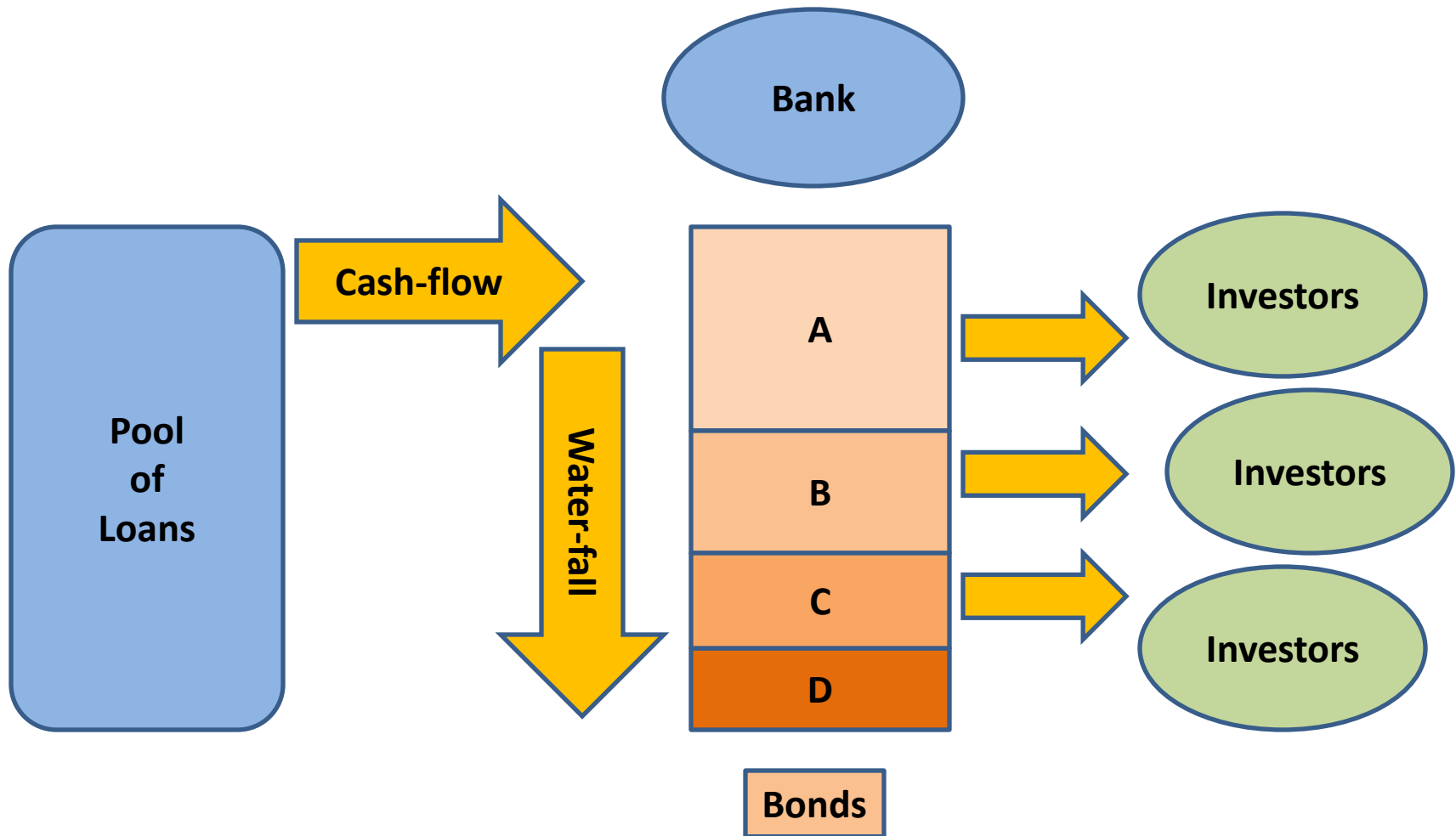
Zsolt Bihary (Morgan Stanley)

2013, Budapest

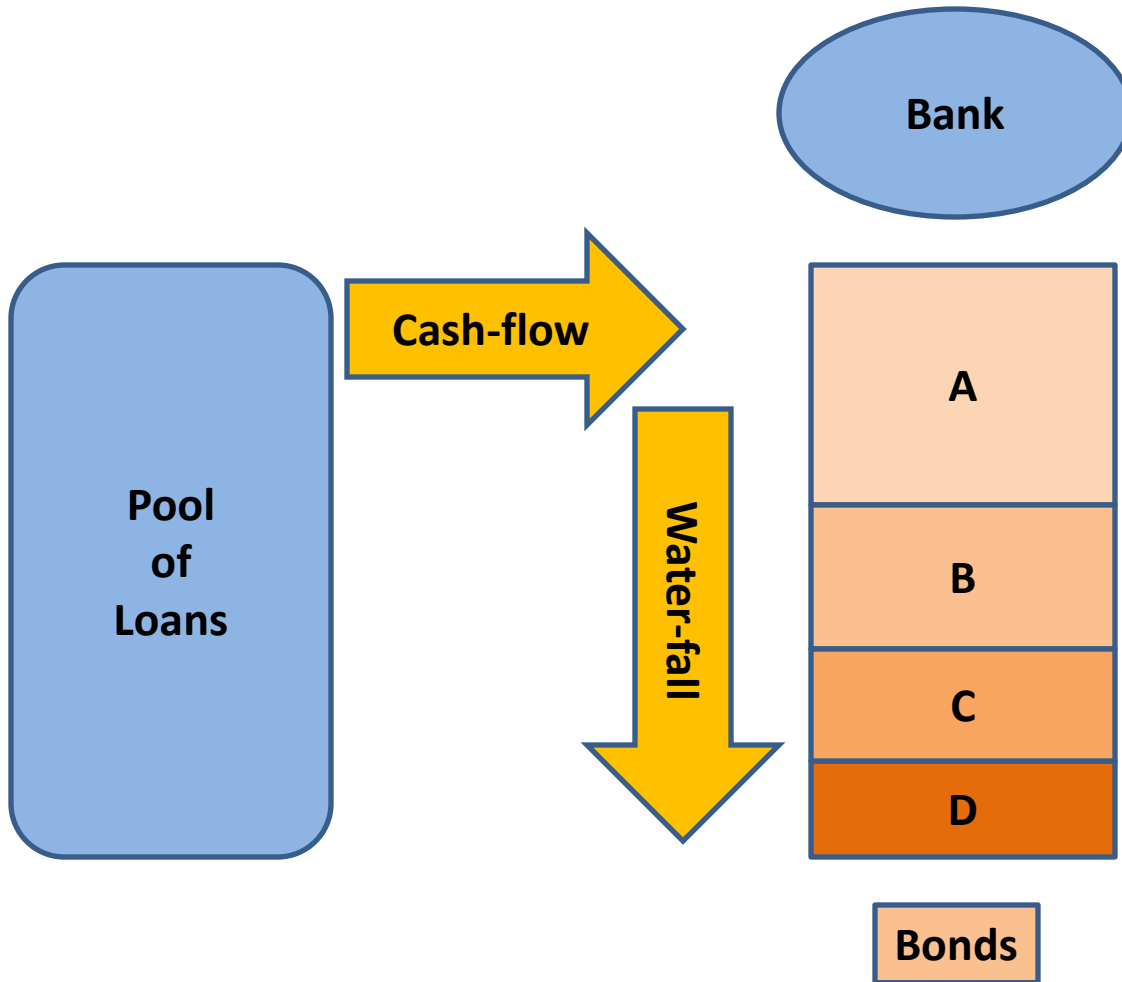
Structuring (Securitization)



Structuring (Securitization)



The Structuring Problem

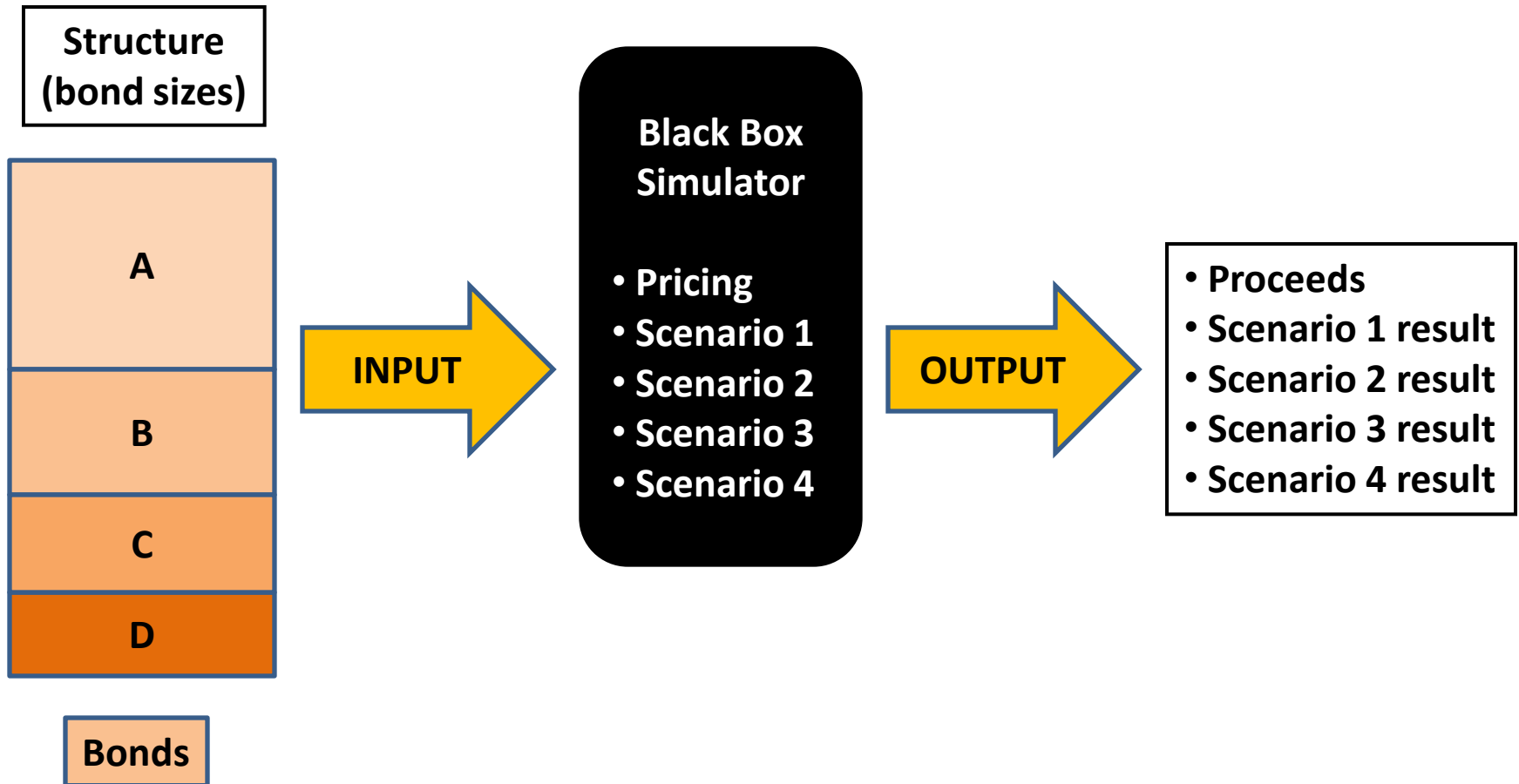


How to choose bond sizes?

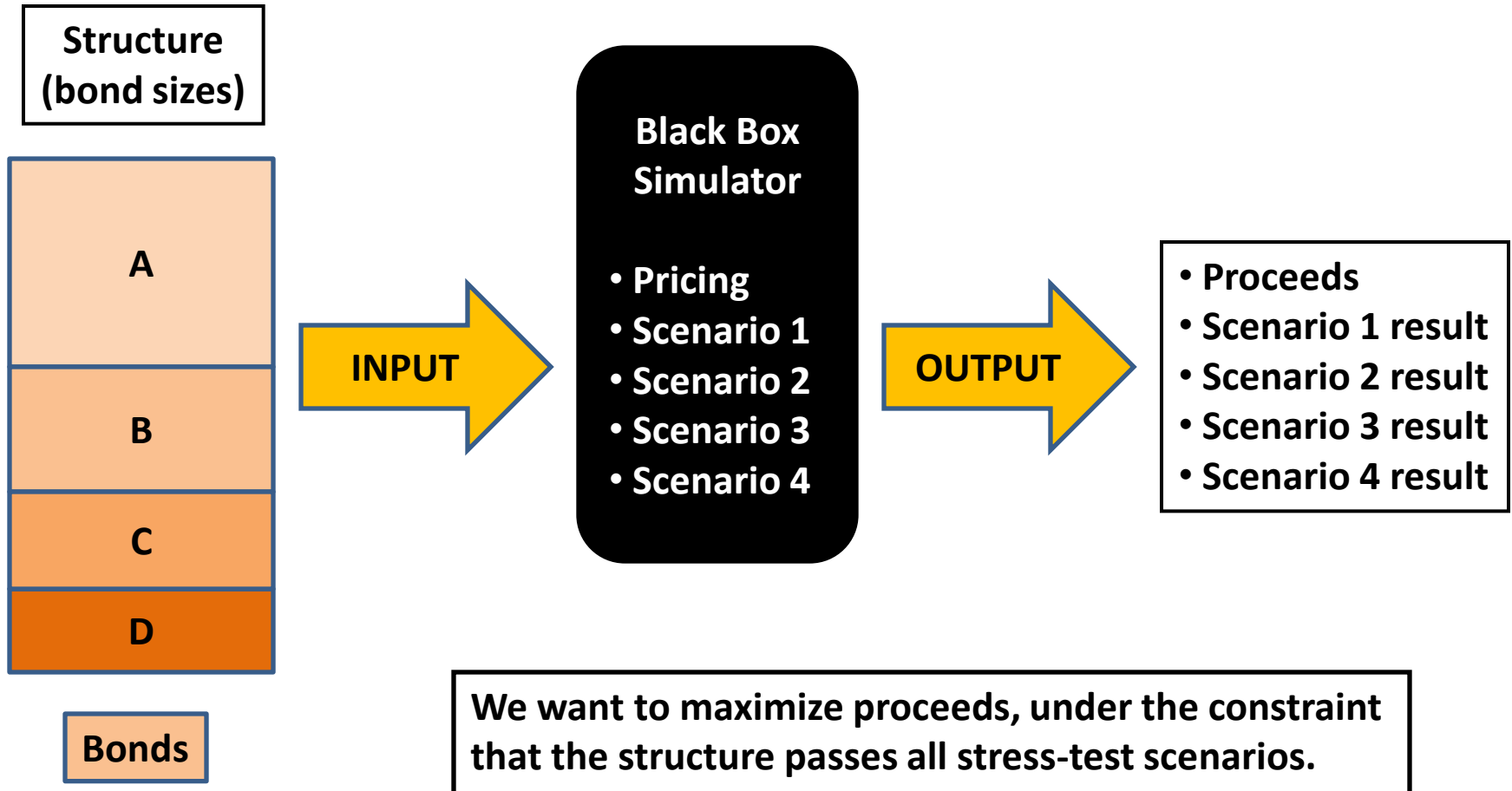
Bank is interested in great bond sizes and high ratings.

Regulators seek to limit bond sizes before giving high ratings.

The Black Box Simulator



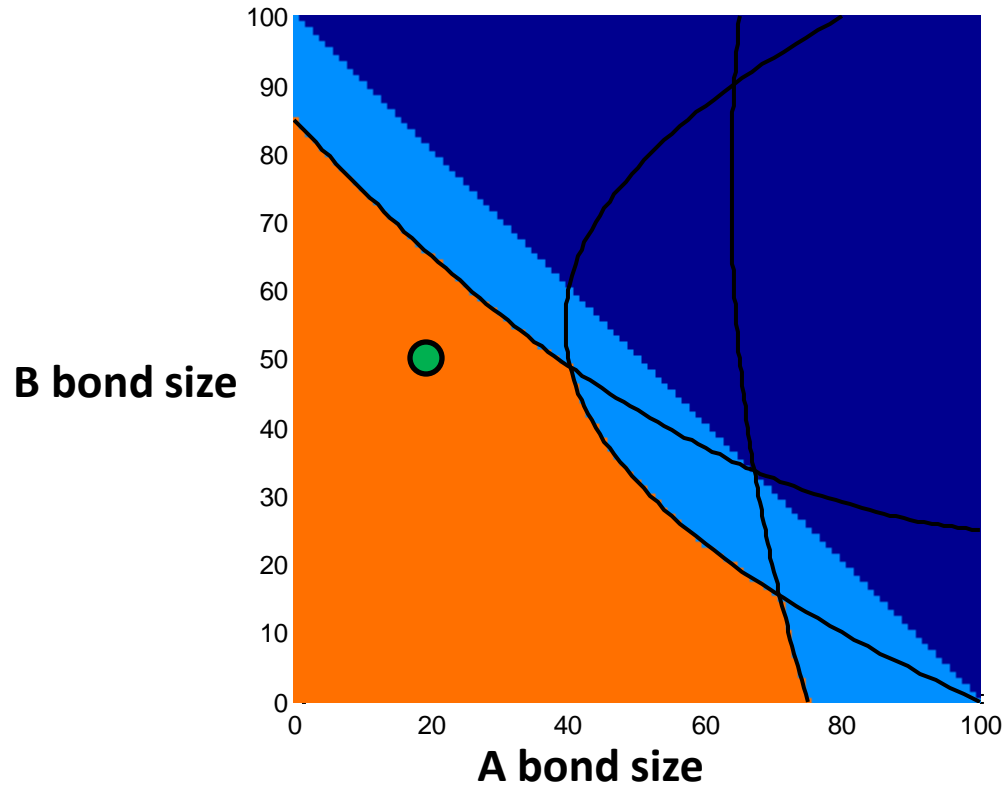
The Black Box Simulator



Nature of the Optimization Problem

- Objective function and constraints evaluated by Black Box (no gradients available)
- Objective function and constraints evaluated simultaneously (unknown constraints)
- Constraints returned as pass/fail Booleans (no differentiable discriminant functions)
- Black Box is very slow (we can afford only 5 iterations)
- We can run Black Box parallel on 20 servers

Synthetic Example



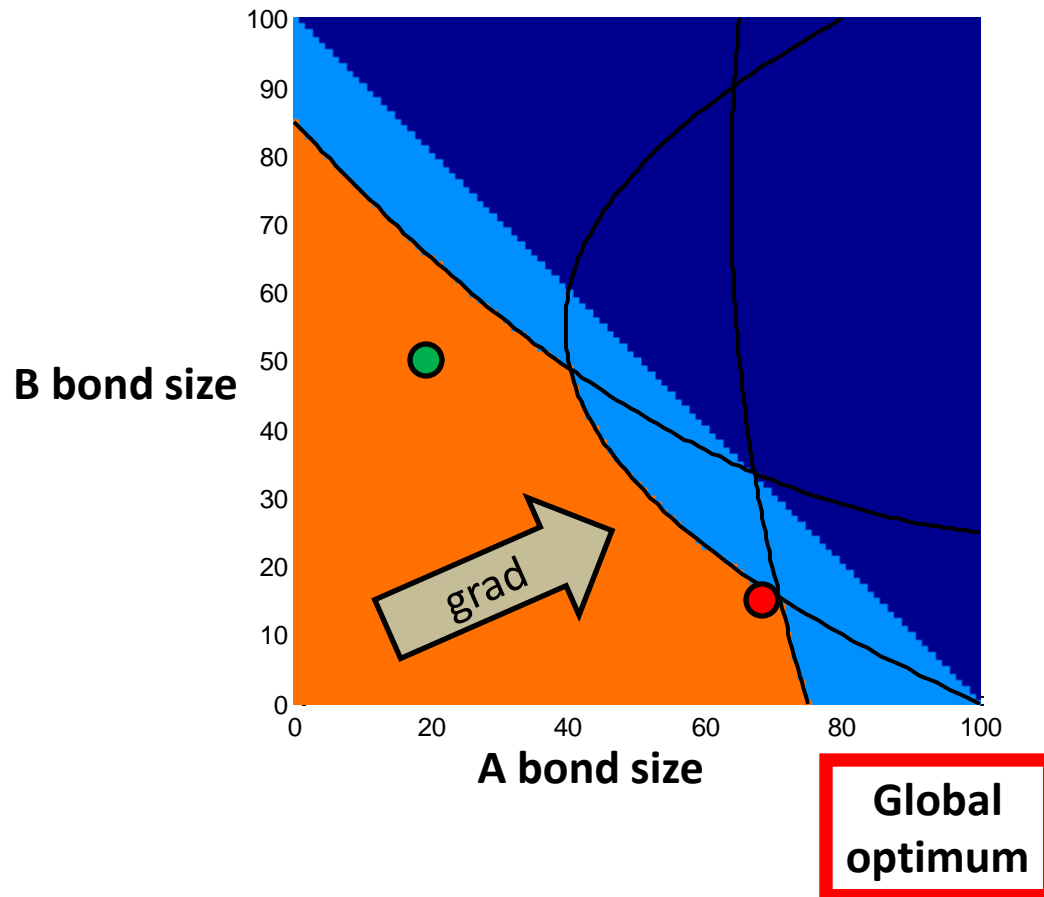
Example structure

A (20%)

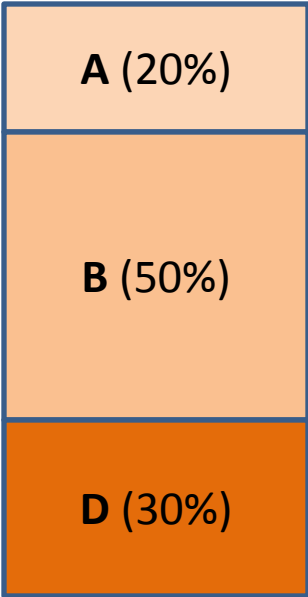
B (50%)

D (30%)

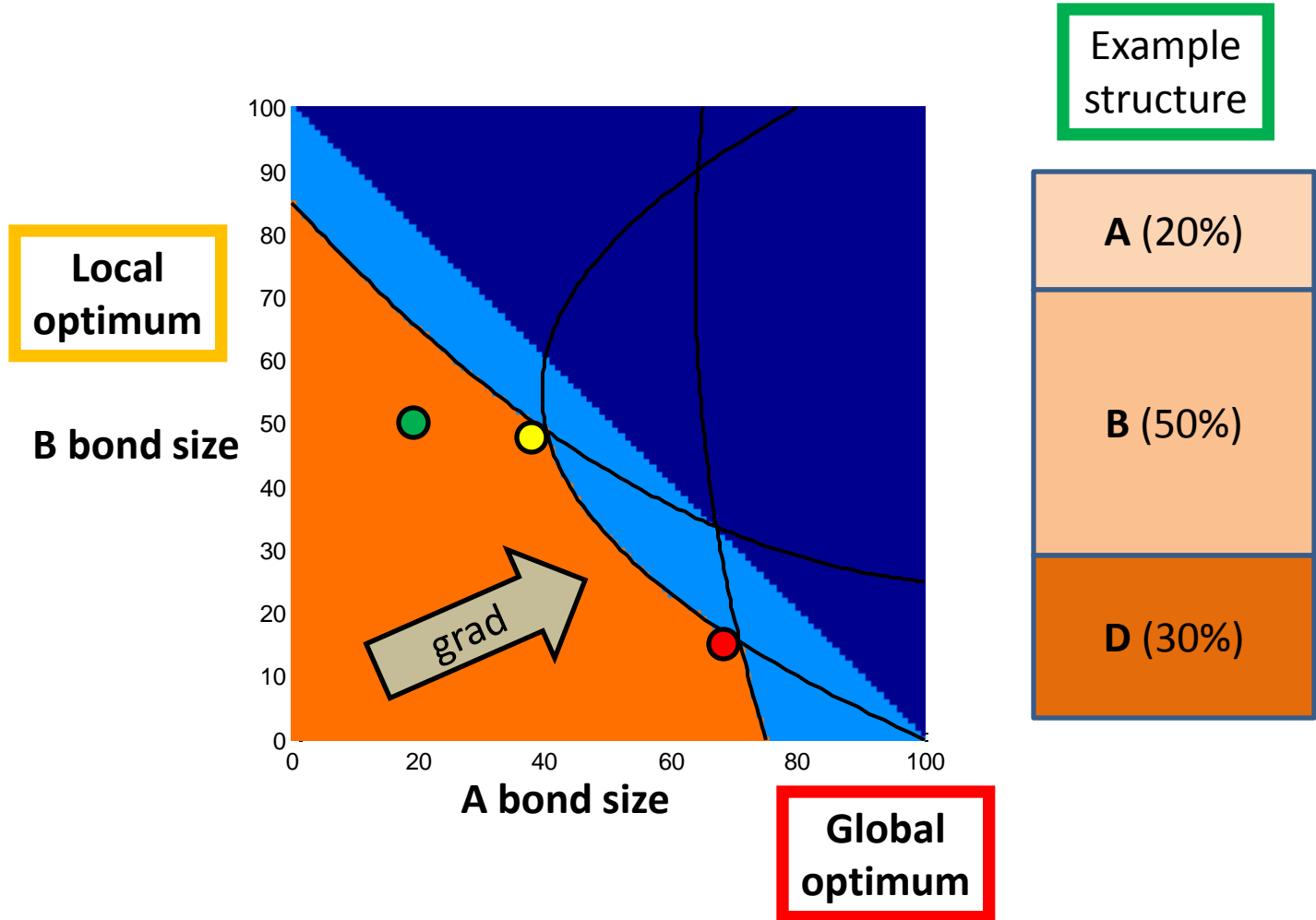
Synthetic Example



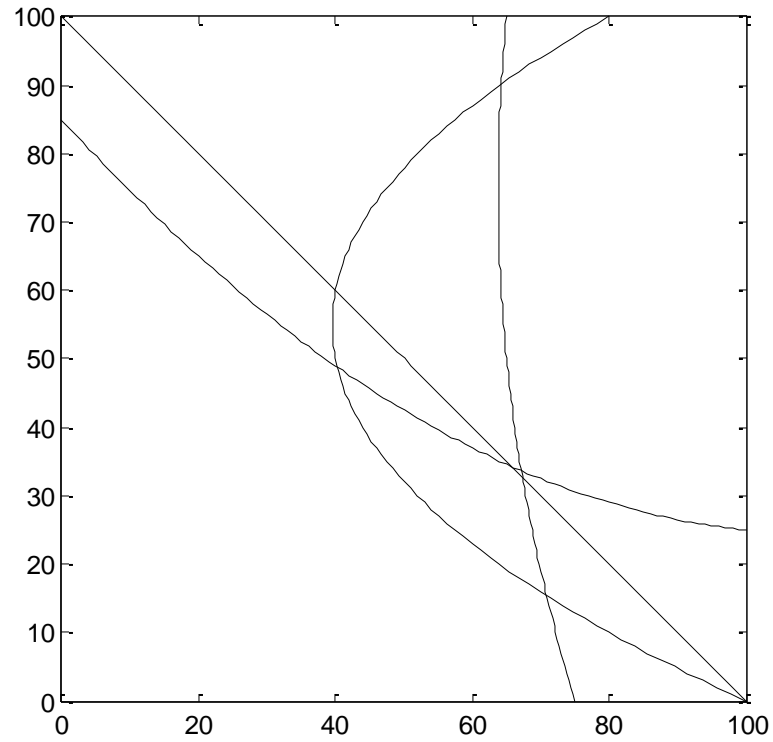
Example structure



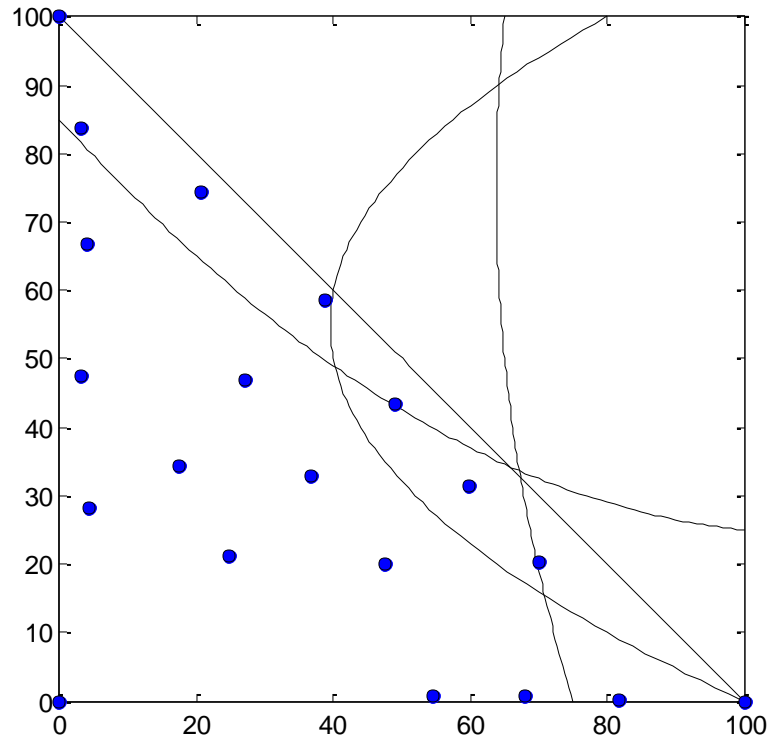
Synthetic Example



Reinforcement Learning

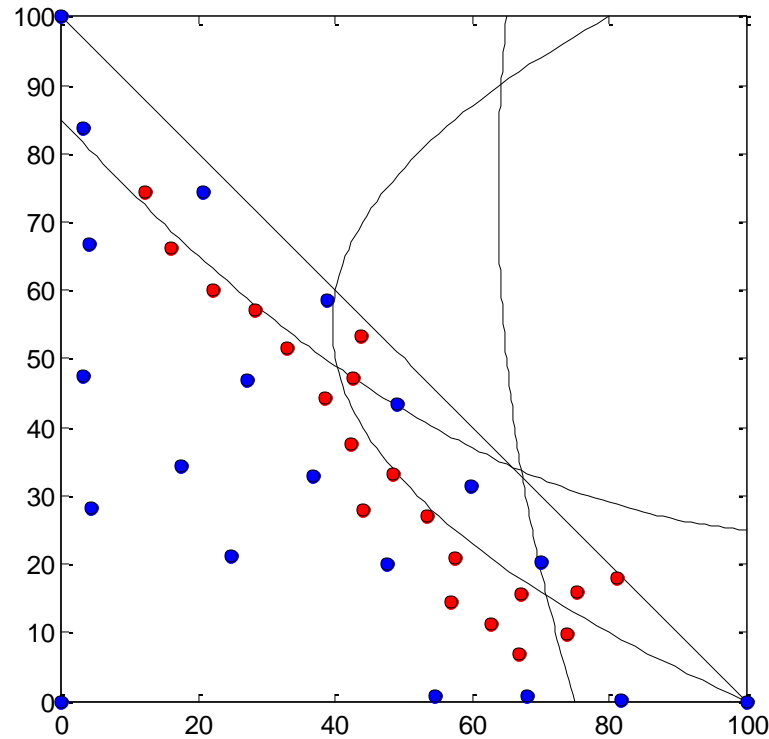


Reinforcement Learning



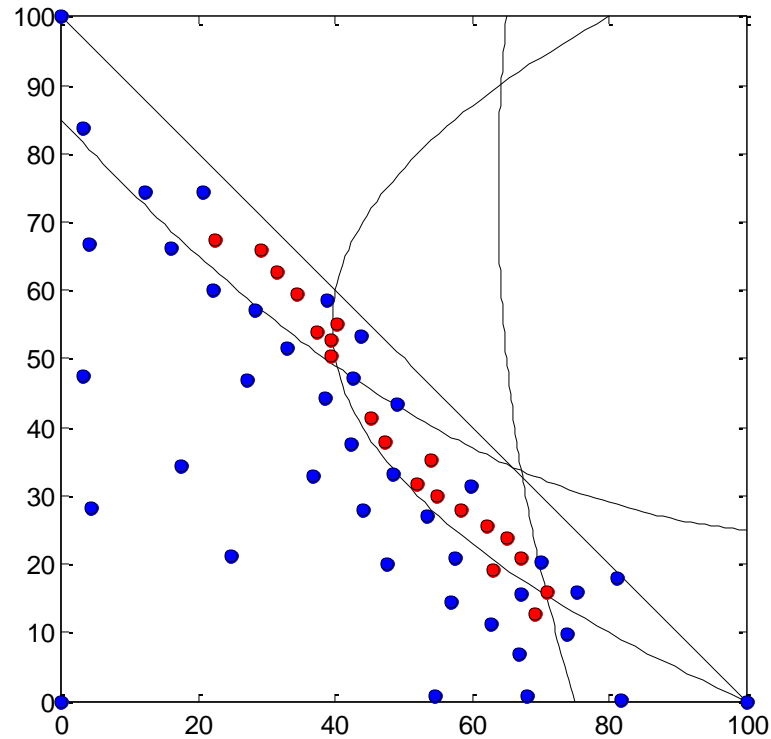
Initially, put down random structures

Reinforcement Learning



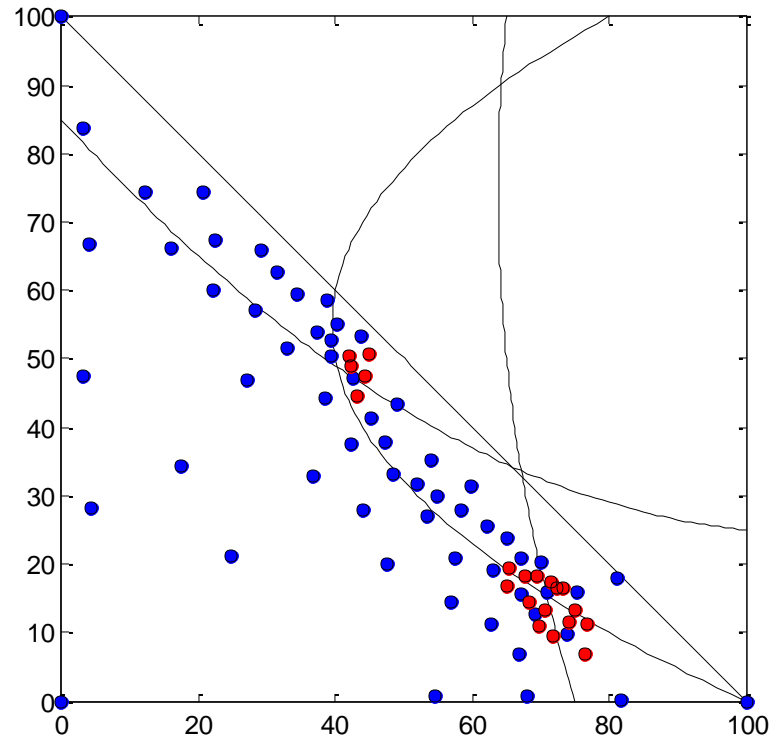
At each iteration, new structures are selected based on information on previous structures

Reinforcement Learning



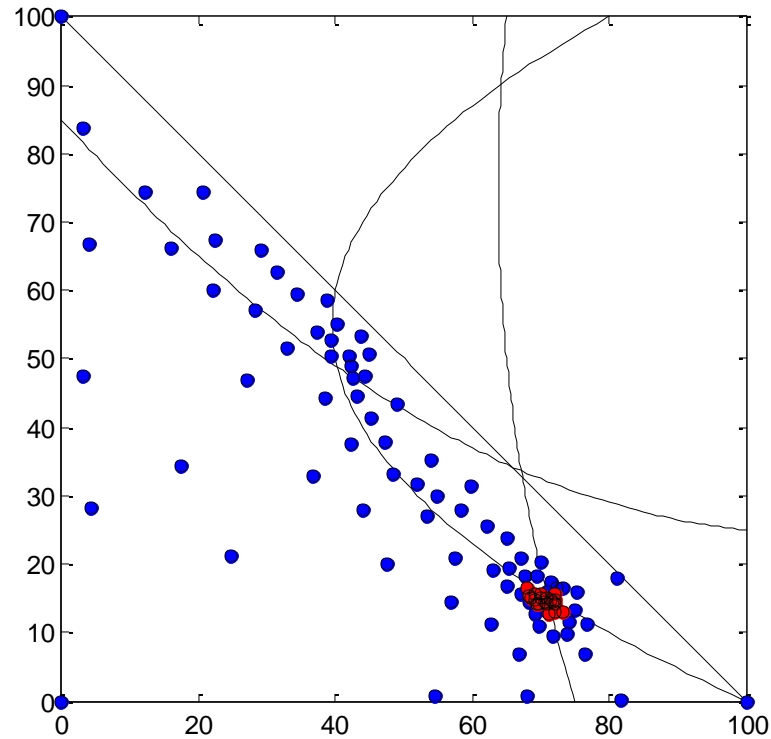
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Reinforcement Learning



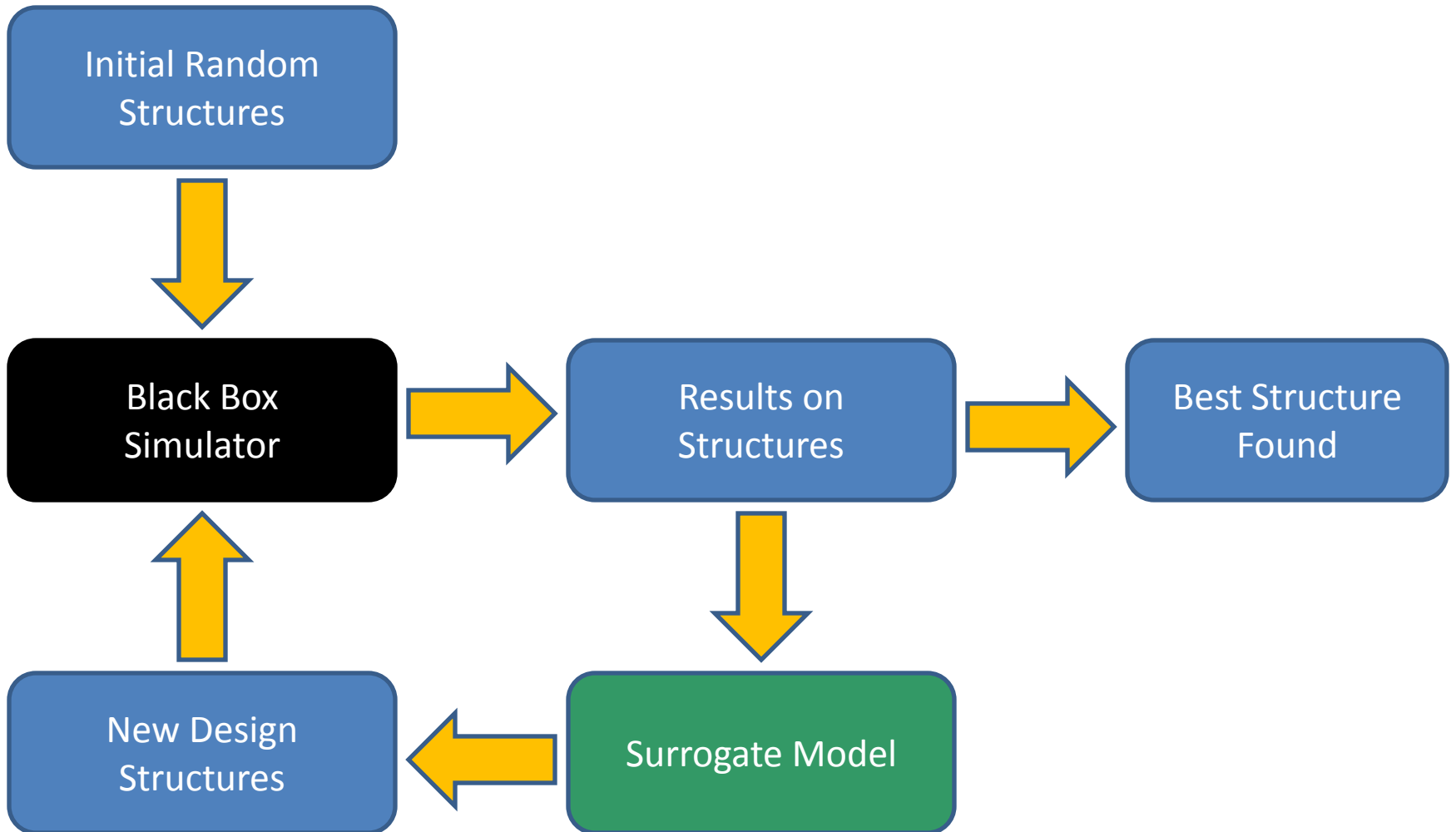
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Reinforcement Learning

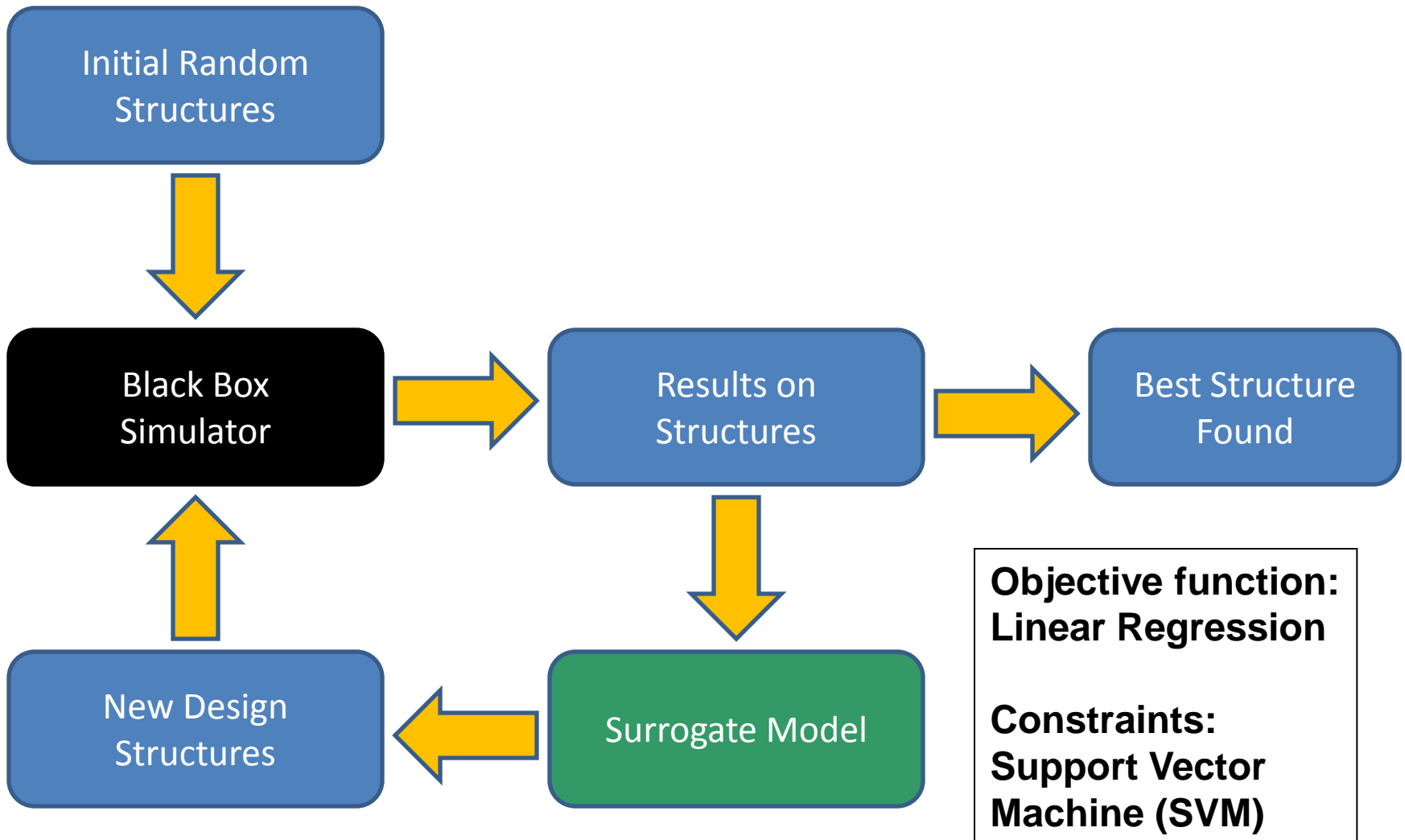


At each iteration, new structures are selected based on information on previous structures

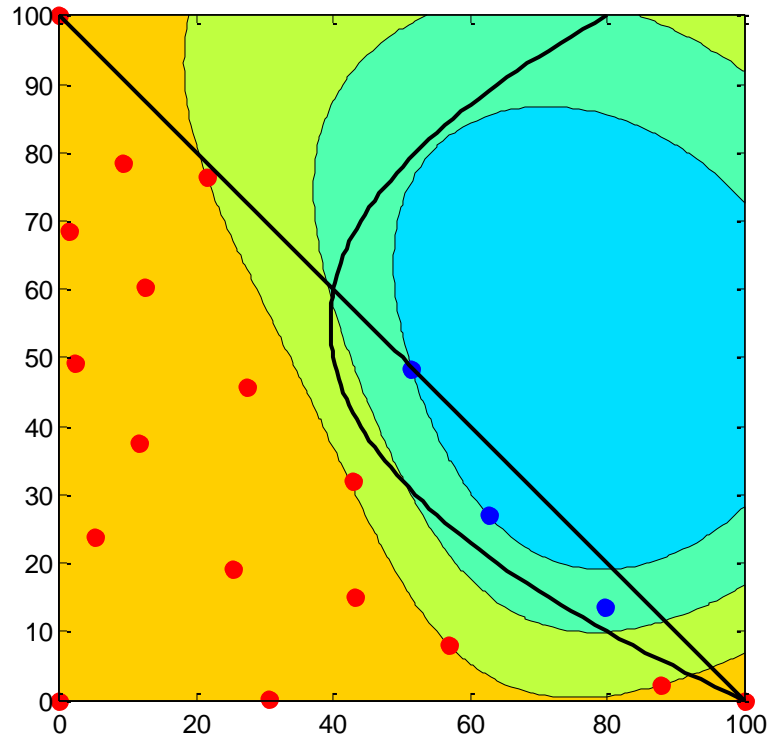
Surrogate Model Approach



Surrogate Model Approach

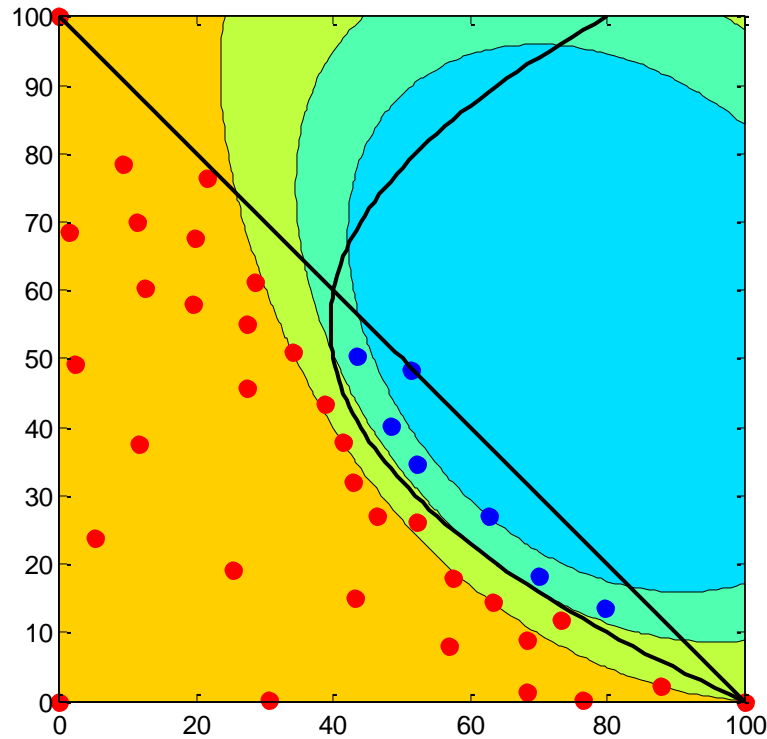


Support Vector Machine (SVM)



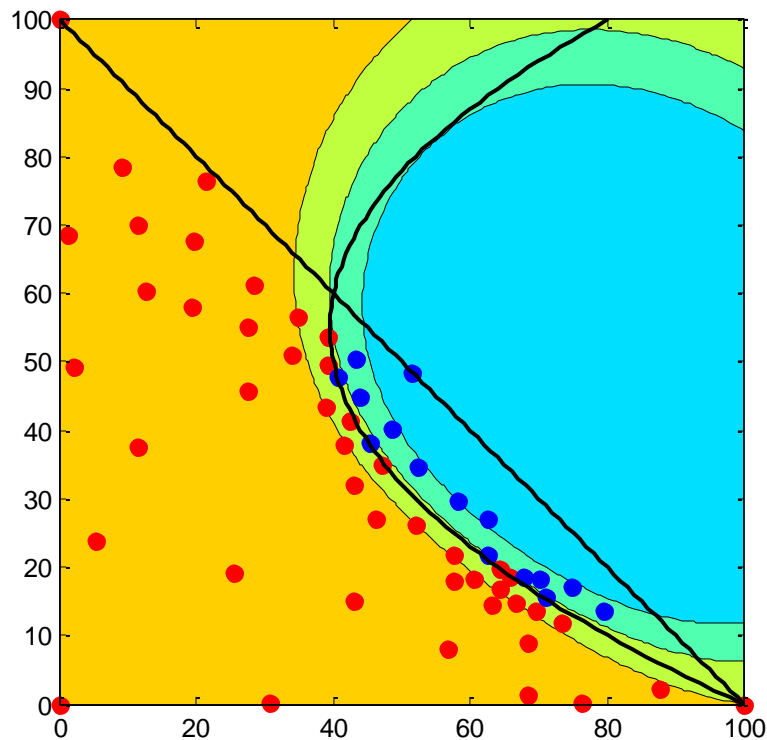
**Gives a surrogate model for the
pass – fail boundary**

Support Vector Machine (SVM)



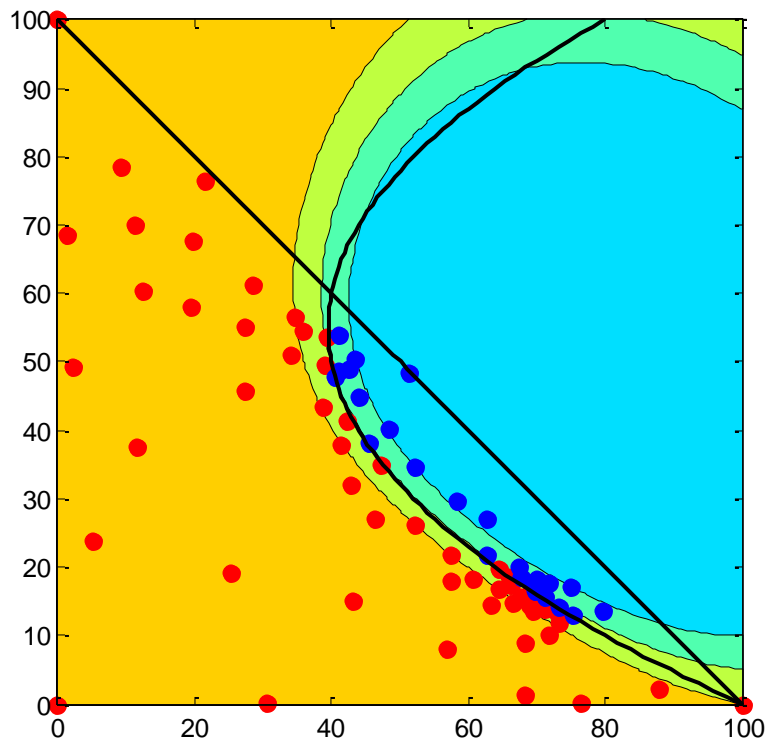
With more points, SVM gives more and more accurate boundary

Support Vector Machine (SVM)



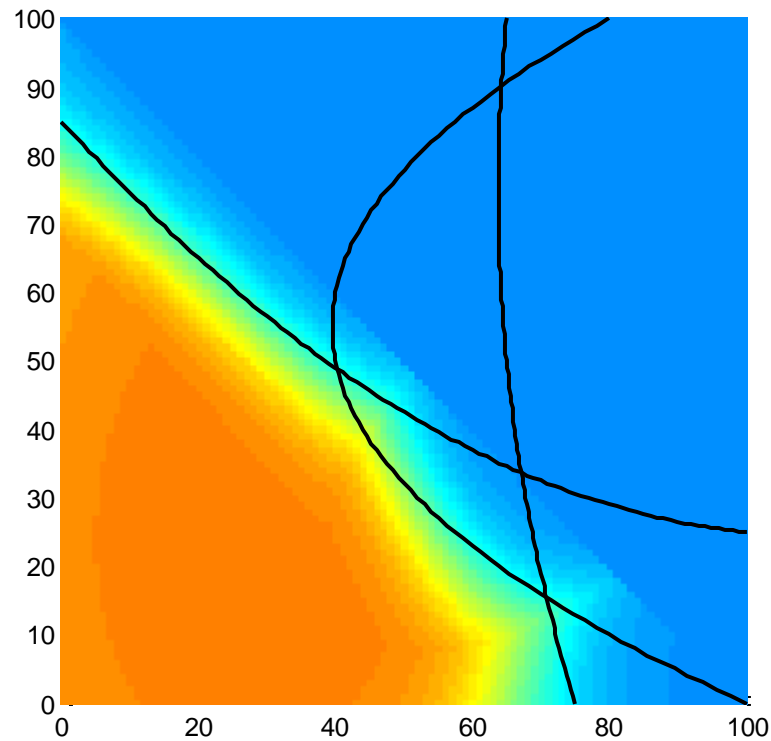
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Support Vector Machine (SVM)



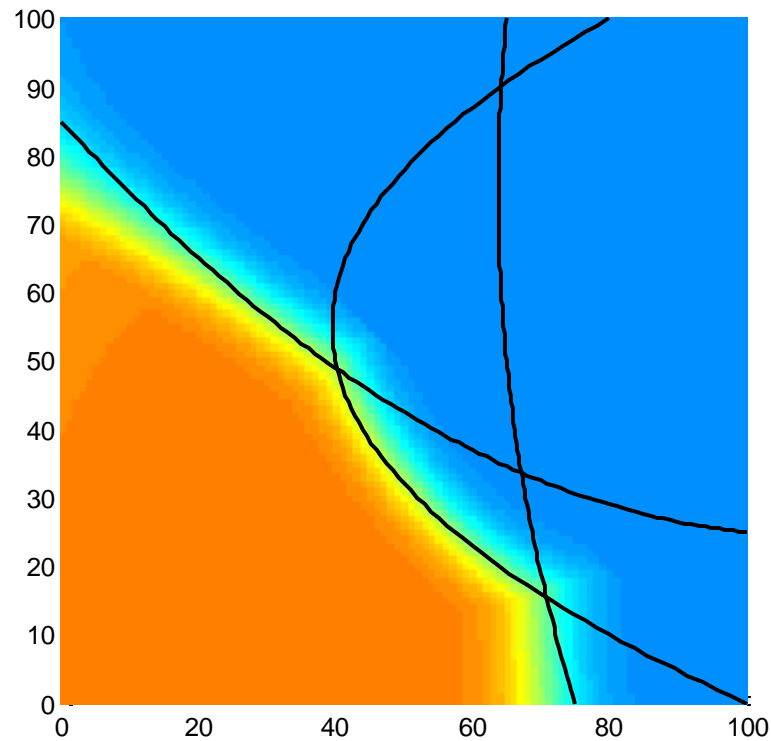
With more points, SVM gives more and more accurate boundary

Pass Probability



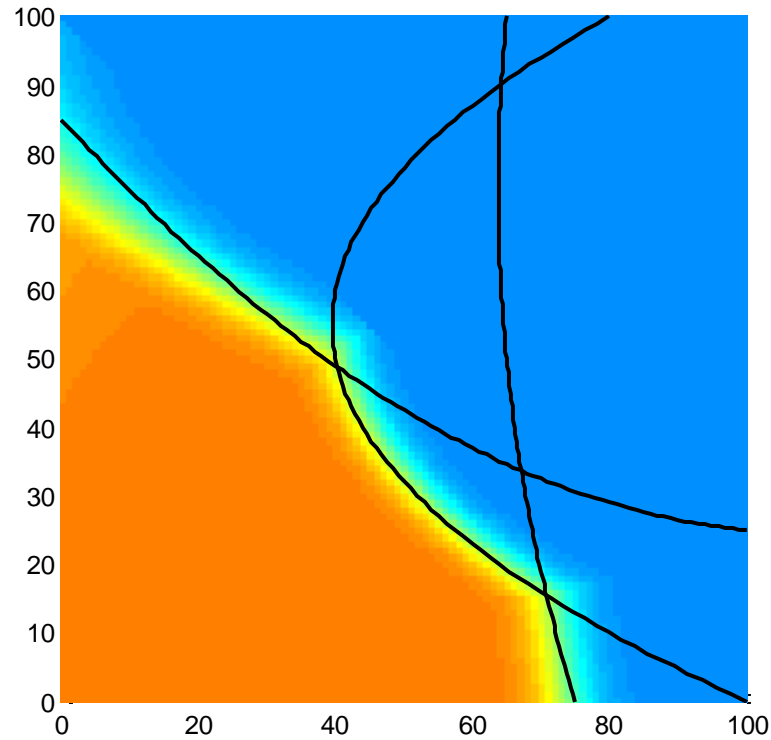
**SVM maps out the pass probability
in structure space**

Pass Probability



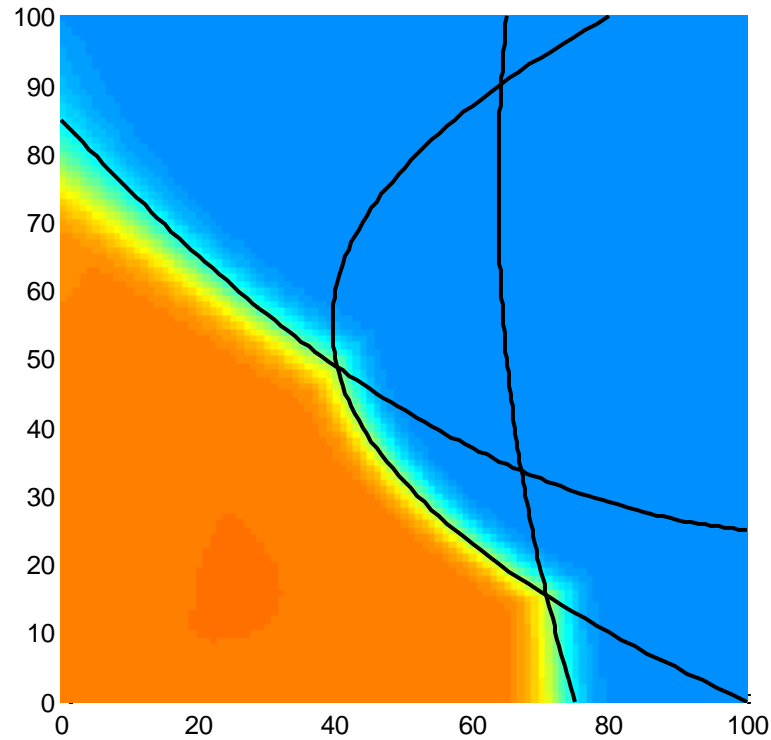
With more points, pass probability map becomes more and more accurate

Pass Probability



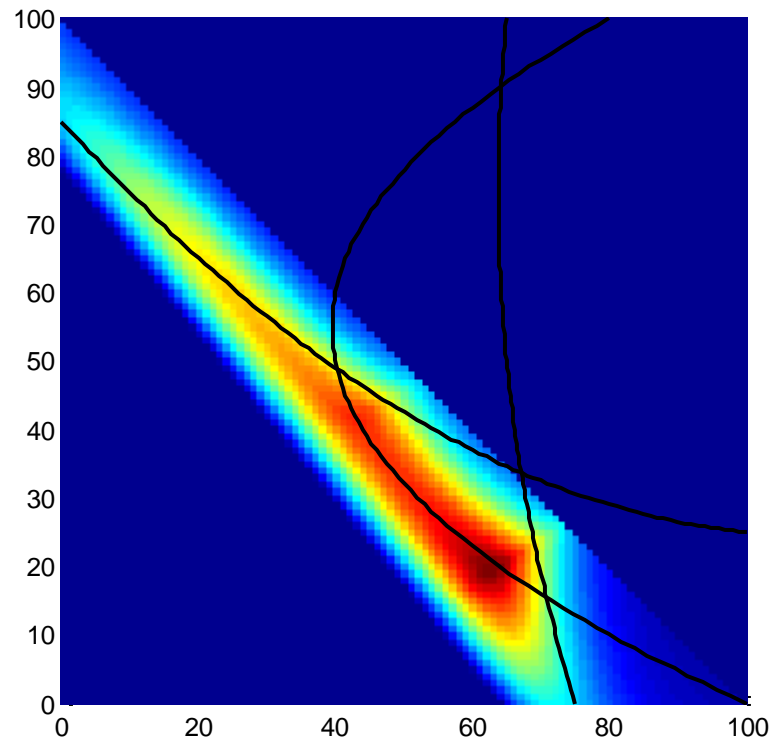
With more points, pass probability map becomes more and more accurate

Pass Probability



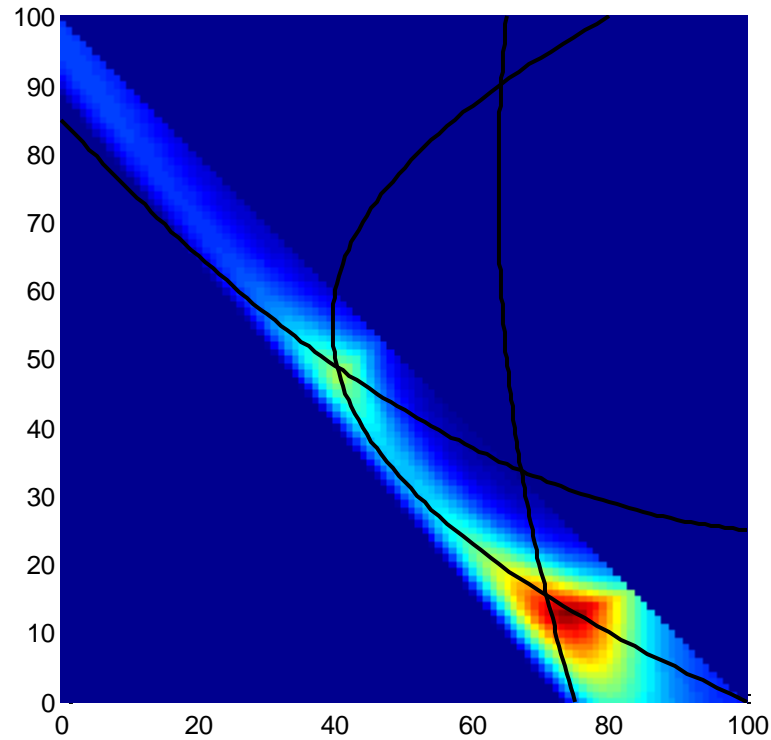
With more points, pass probability map becomes more and more accurate

Expected Improvement



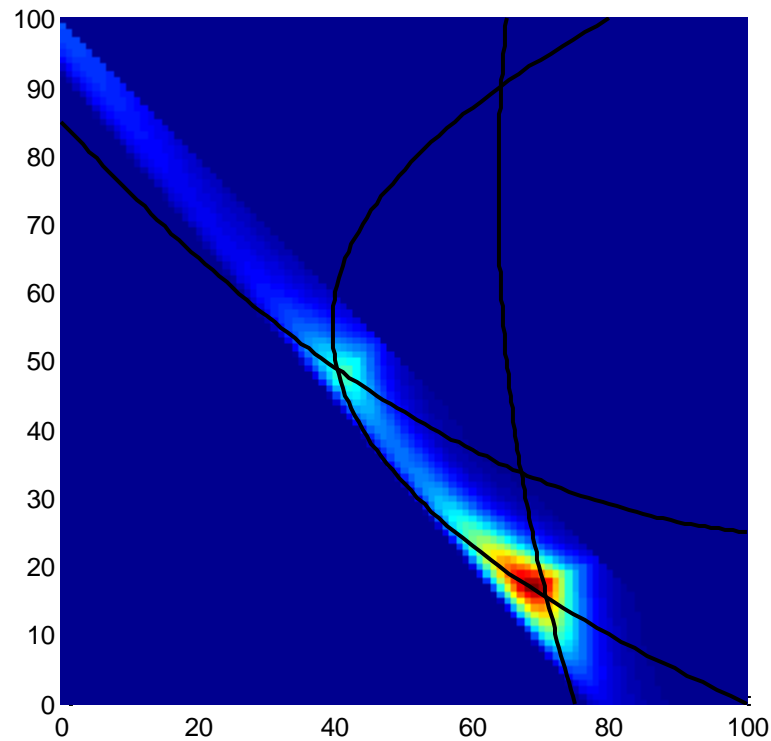
Surrogate model maps out the most promising regions of structure space

Expected Improvement



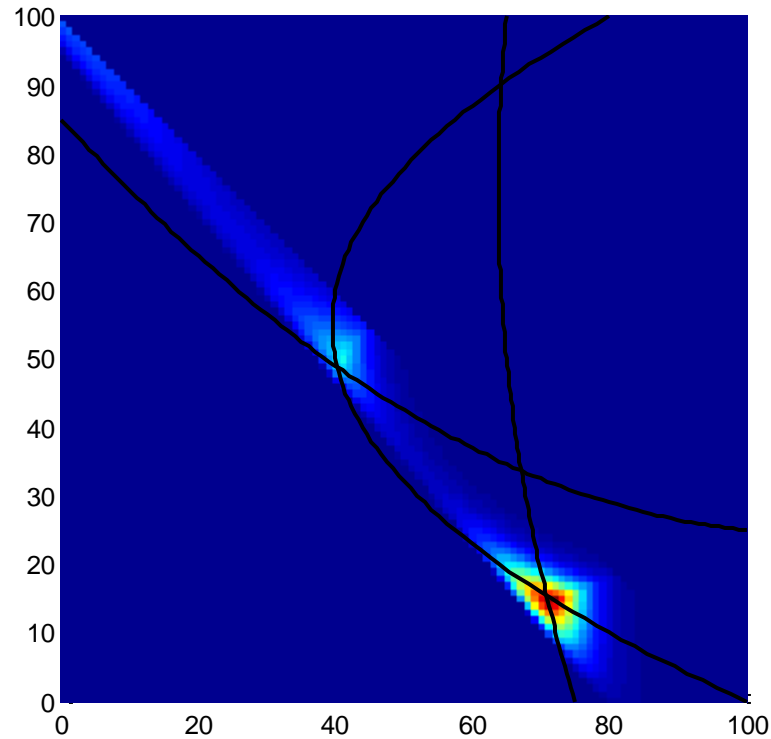
With more and more points, surrogate model zeros in to the optimal region

Expected Improvement



With more and more points, surrogate model zeros in to the optimal region

Expected Improvement



With more and more points, surrogate model zeros in to the optimal region

Conclusion

**Using Machine Learning techniques
on the Portfolio Structuring Problem,
we could provide a useful tool
for our structuring business**

Thank you for your attention