

2020 MathWorks 中国汽车年会

数值优化技术的工程应用

陈建平, MathWorks 中国



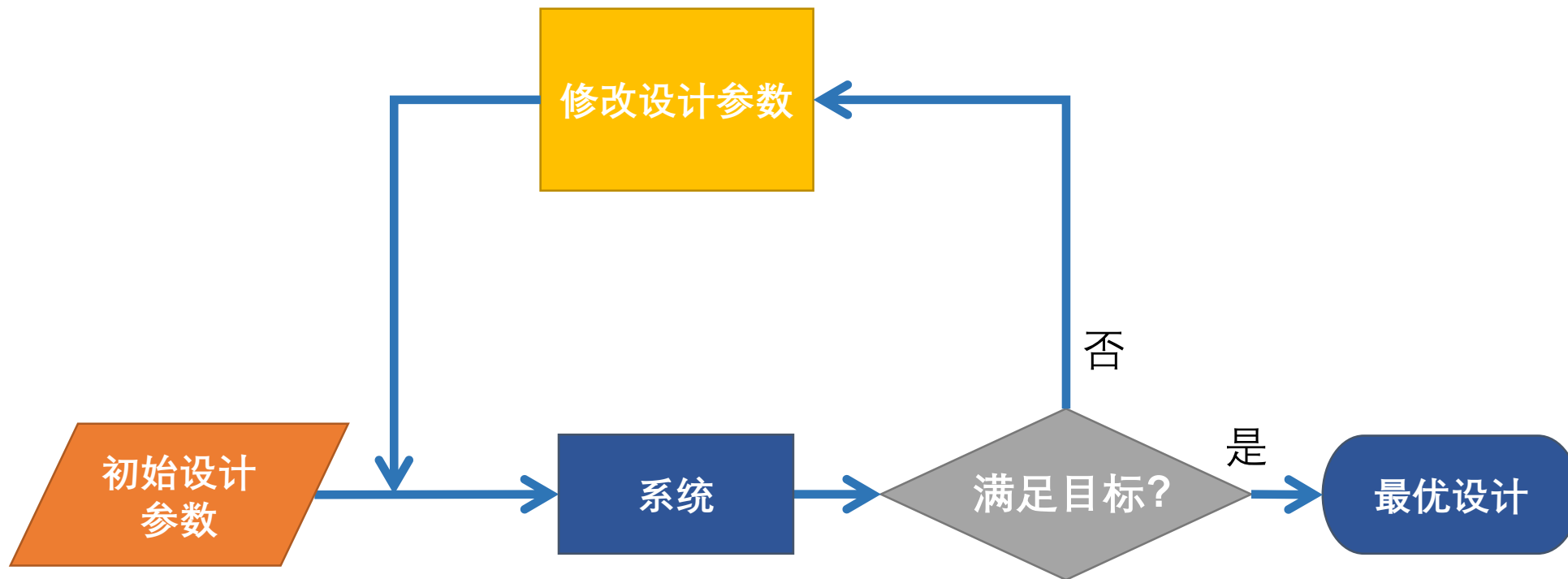
数值优化技术的工程应用

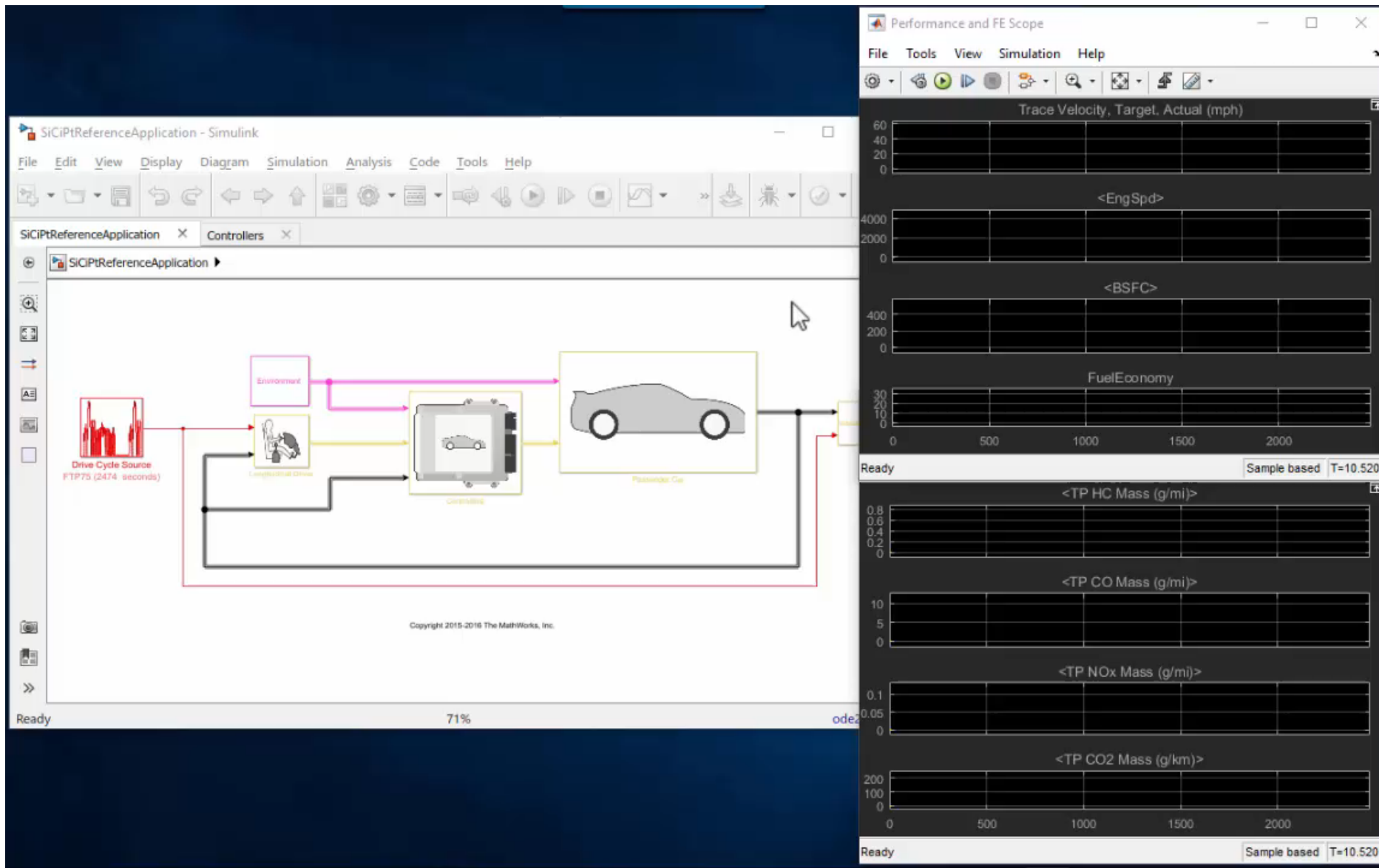
燃油效率最大化
动力最大化



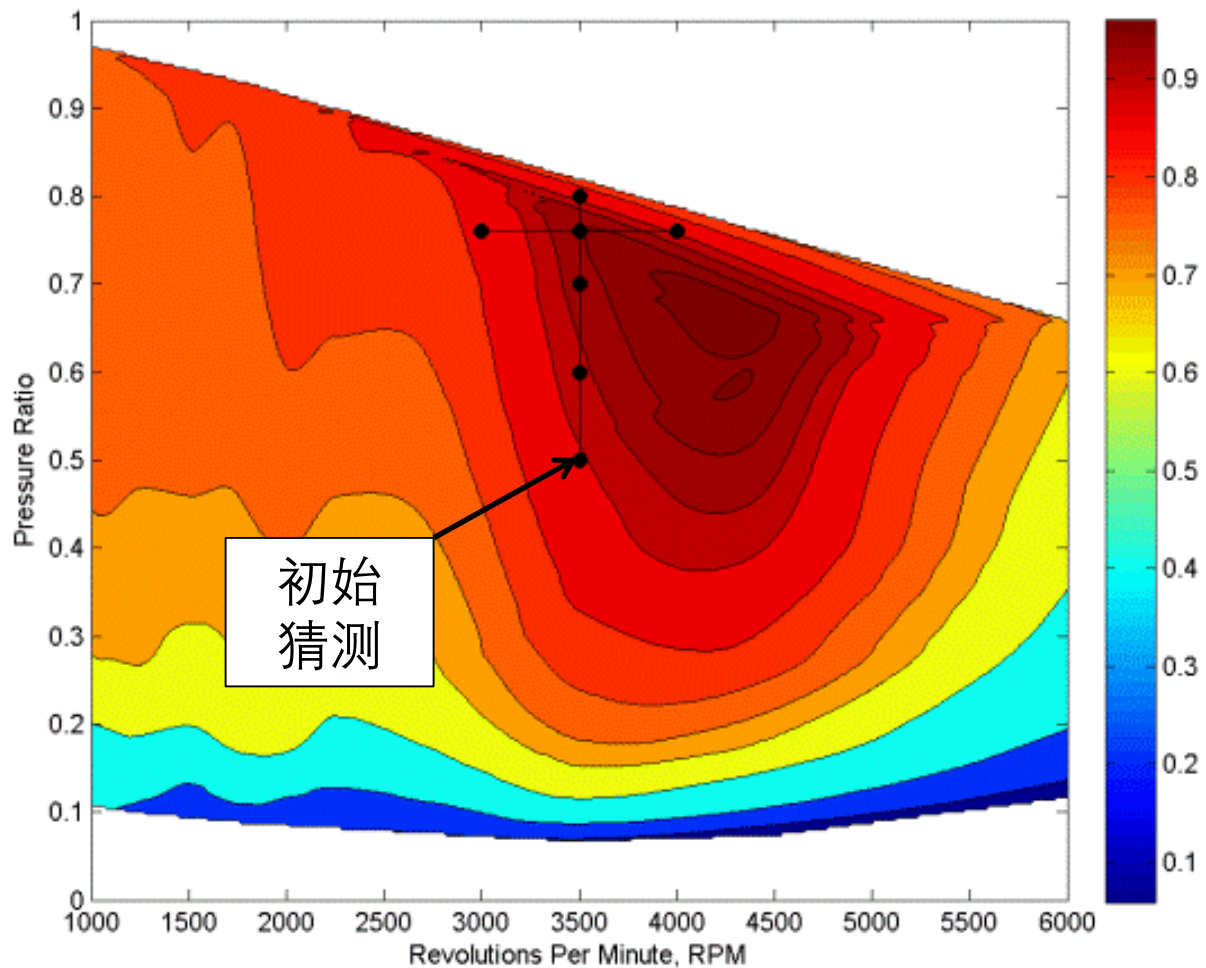
风险最小化
收益最大化



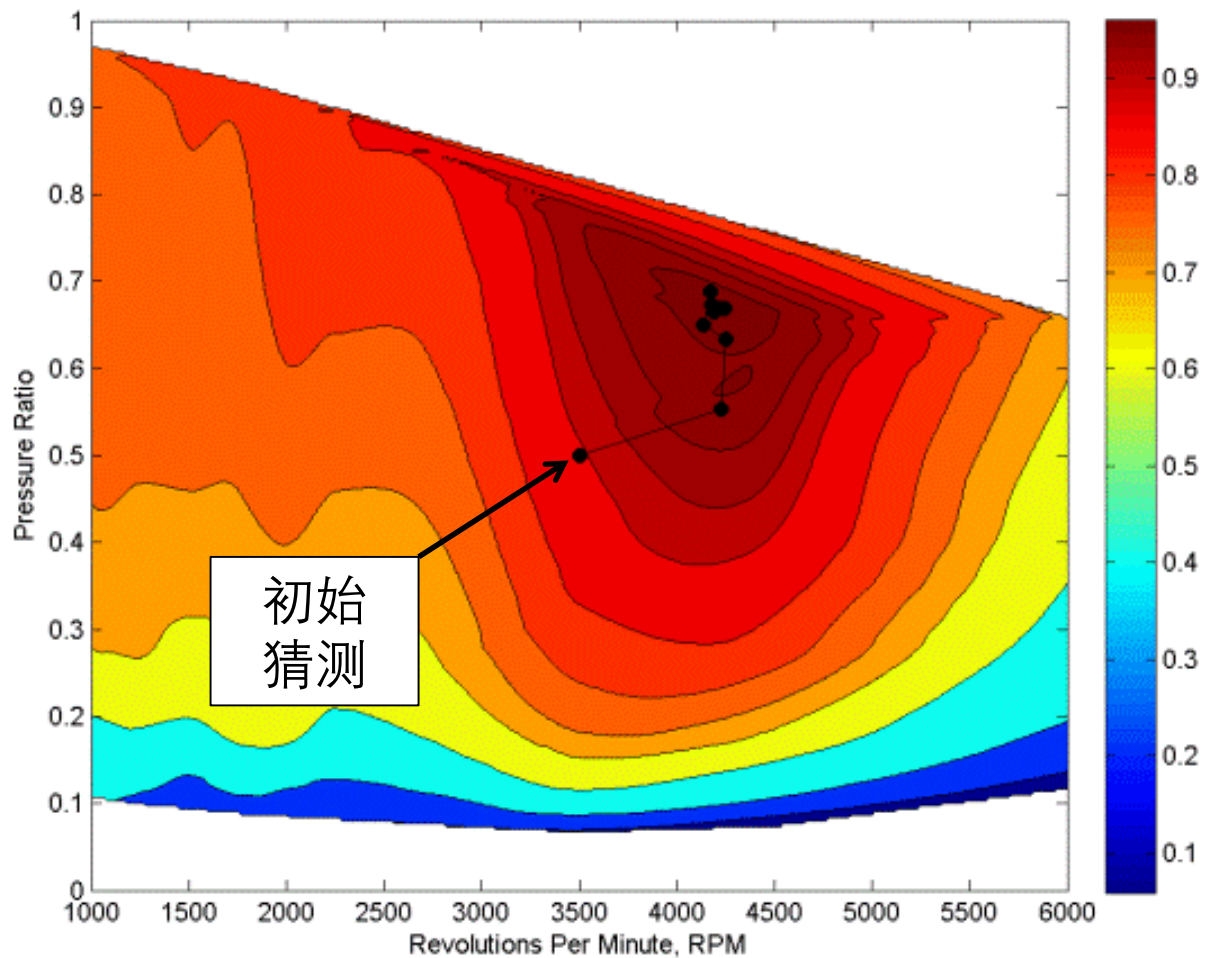




手动优化 (试错/迭代法)



自动优化 (优化法)



响应优化

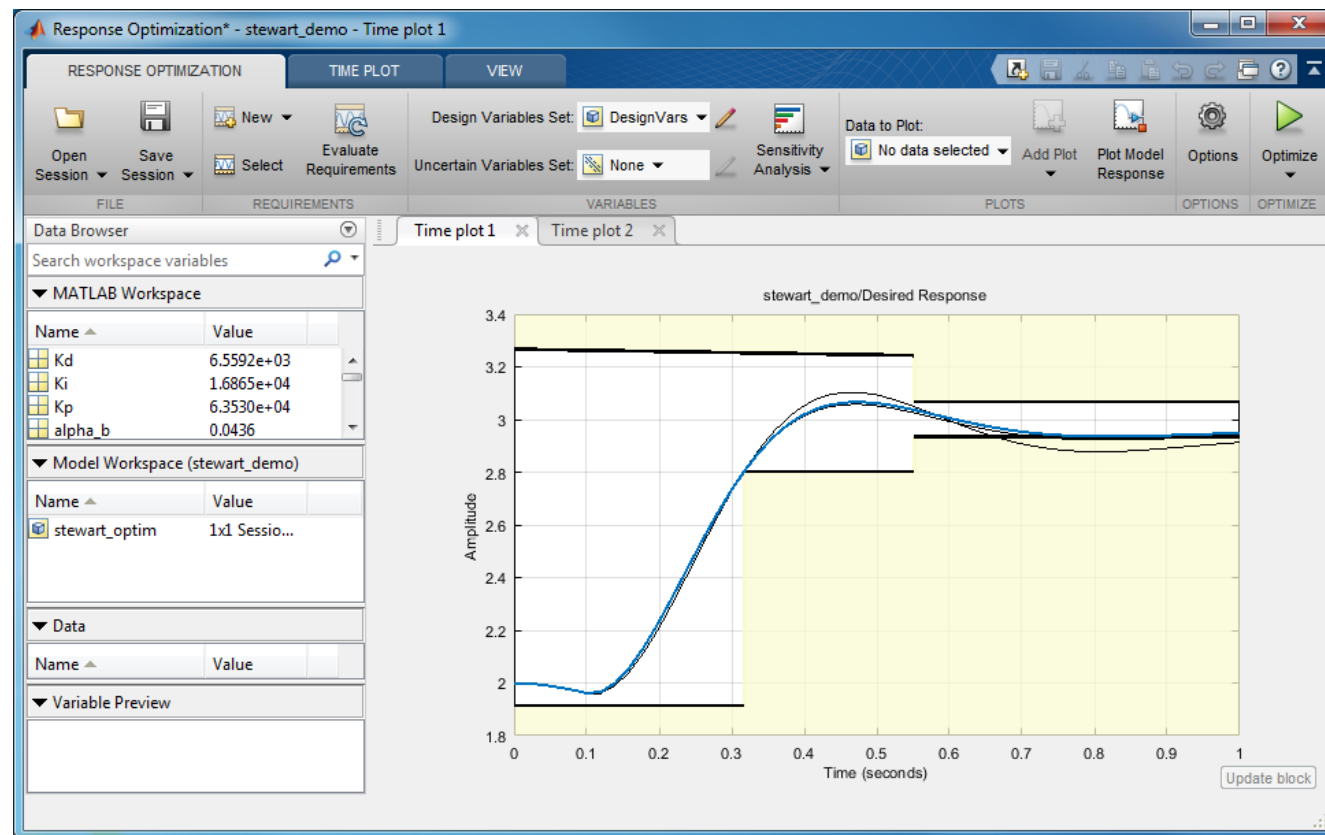
敏感性分析

参数估计和优化

算法和加速

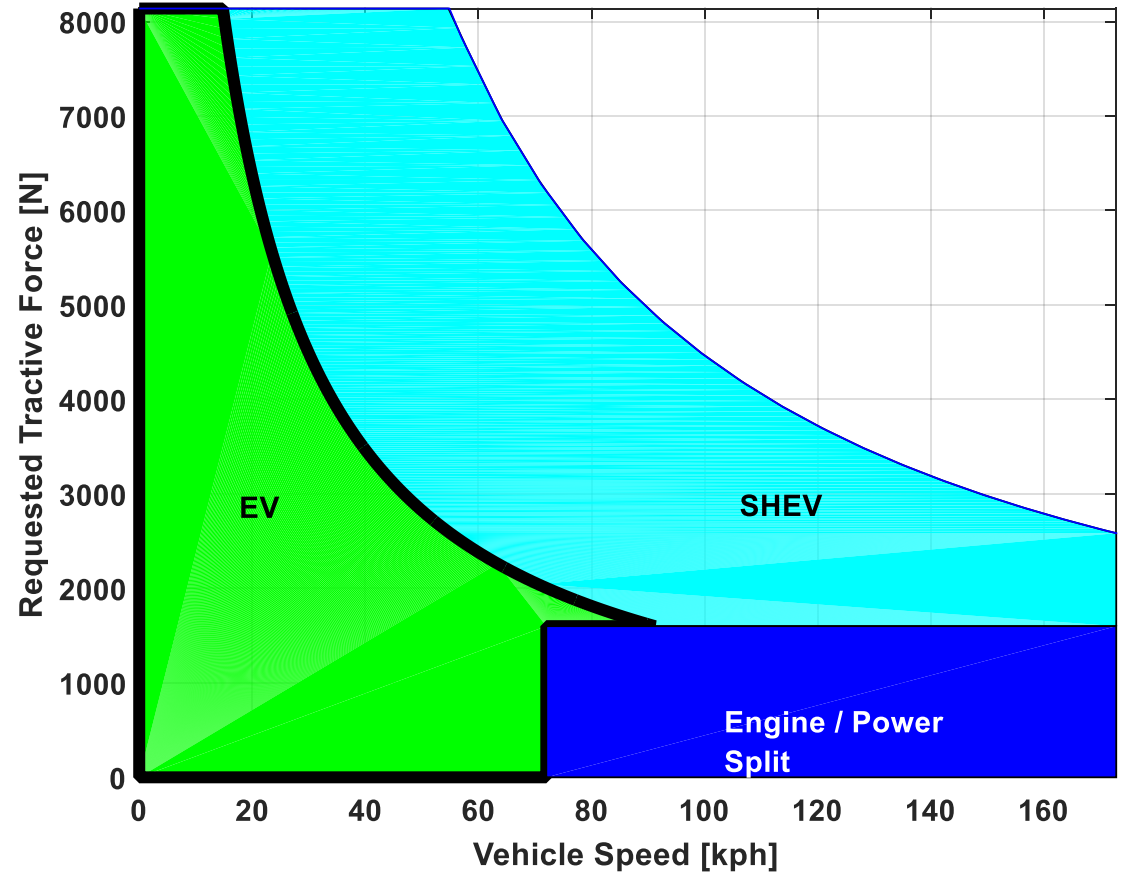
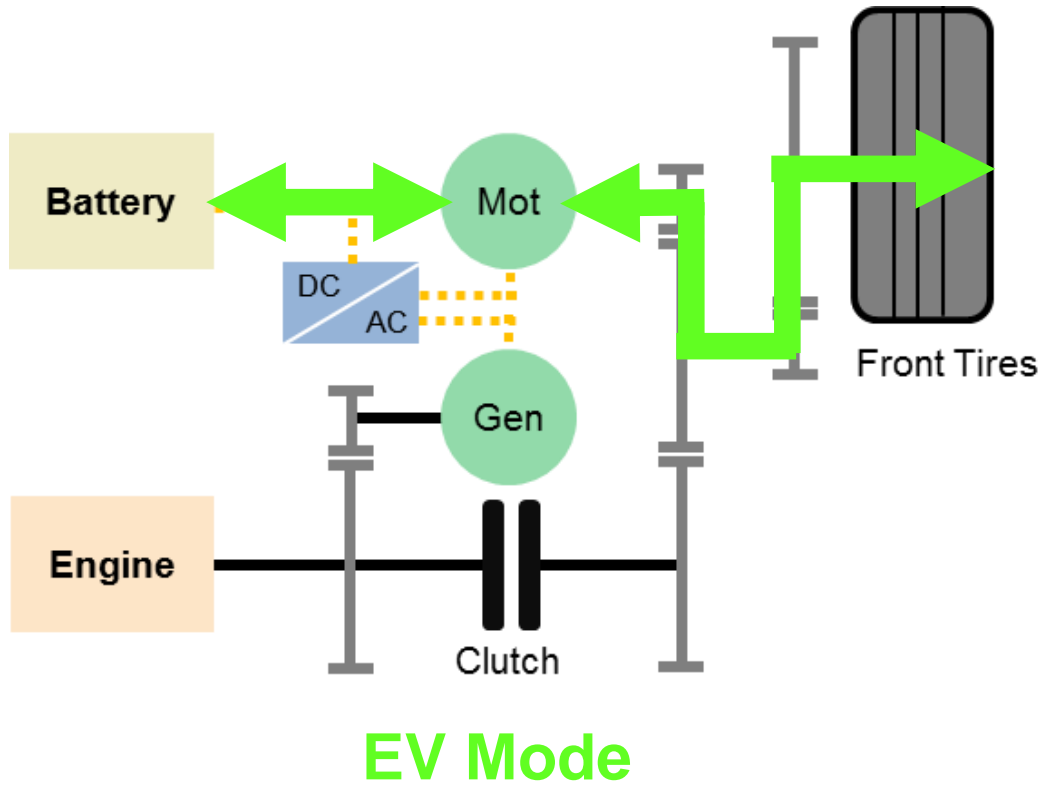
响应优化

调整模型参数直到满足设计需求



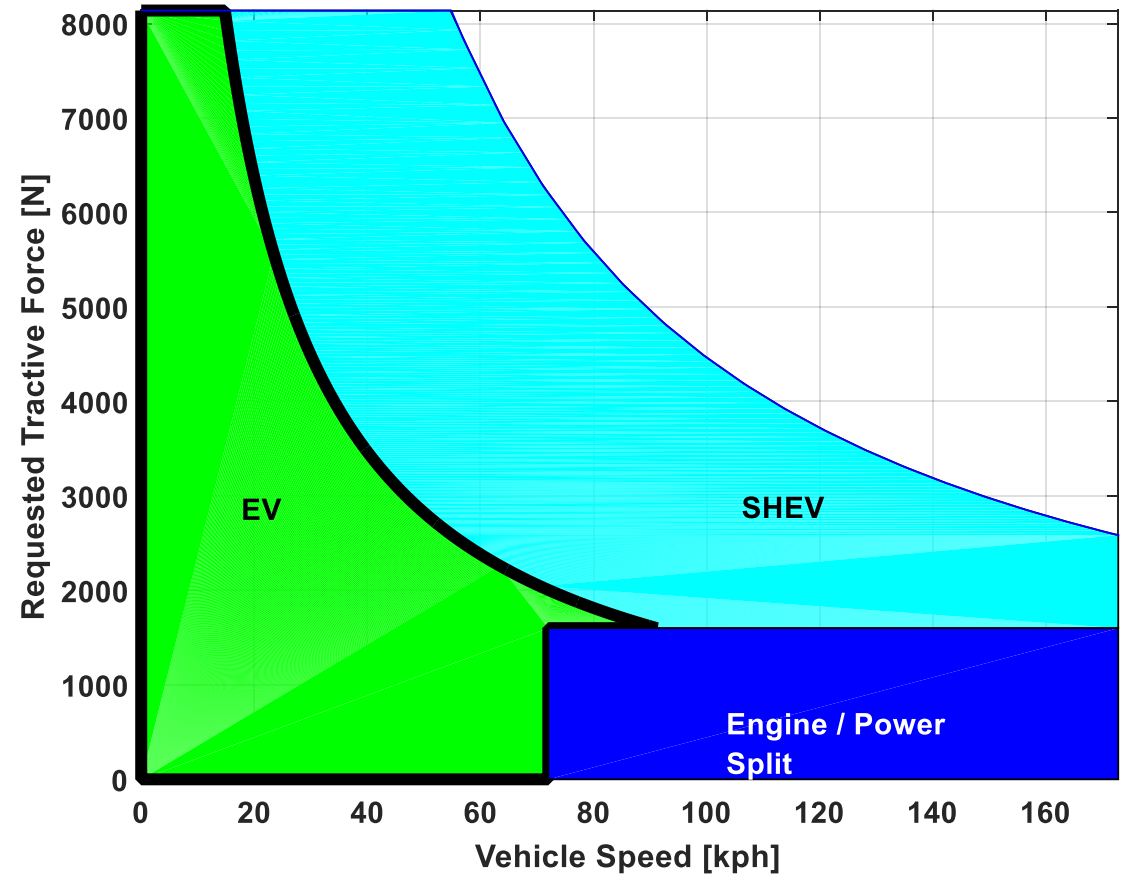
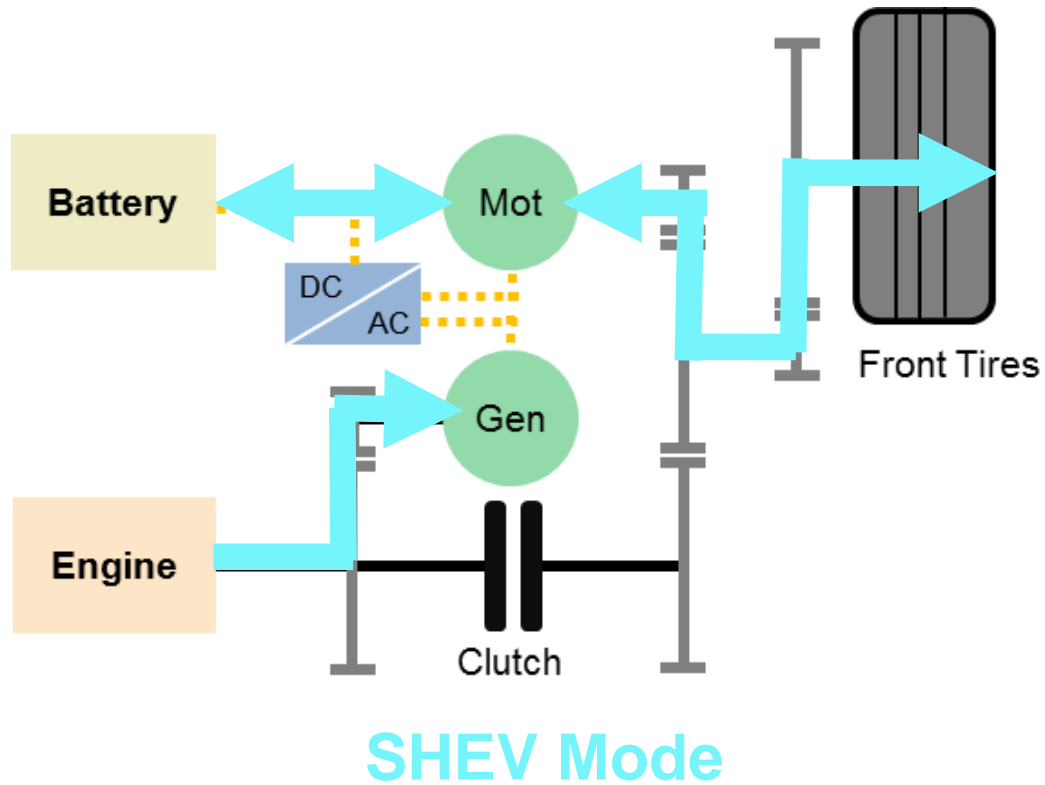
Development of a New Two-Motor Plug-In Hybrid System

Naritomo Higuchi, Yoshihiro Sunaga, Masashi Tanaka and Hiroo Shimada
Honda R&D Co., Ltd.



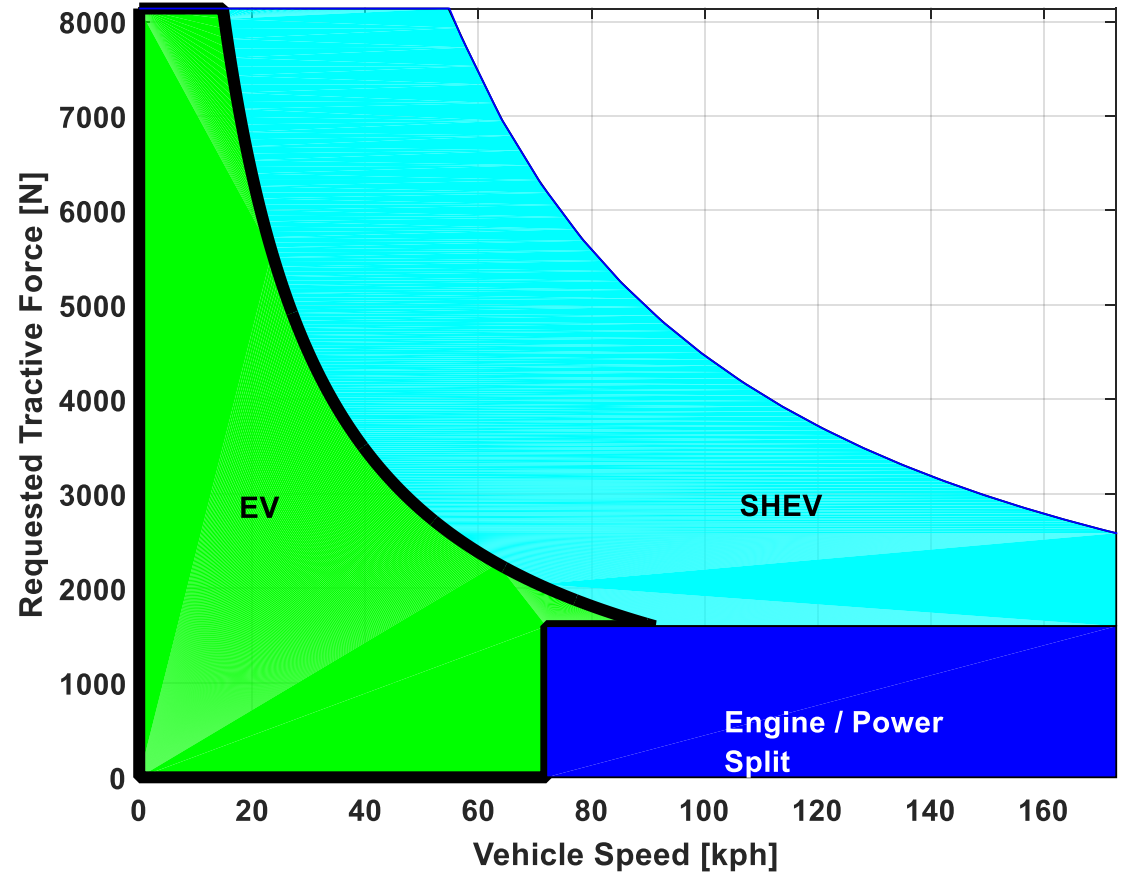
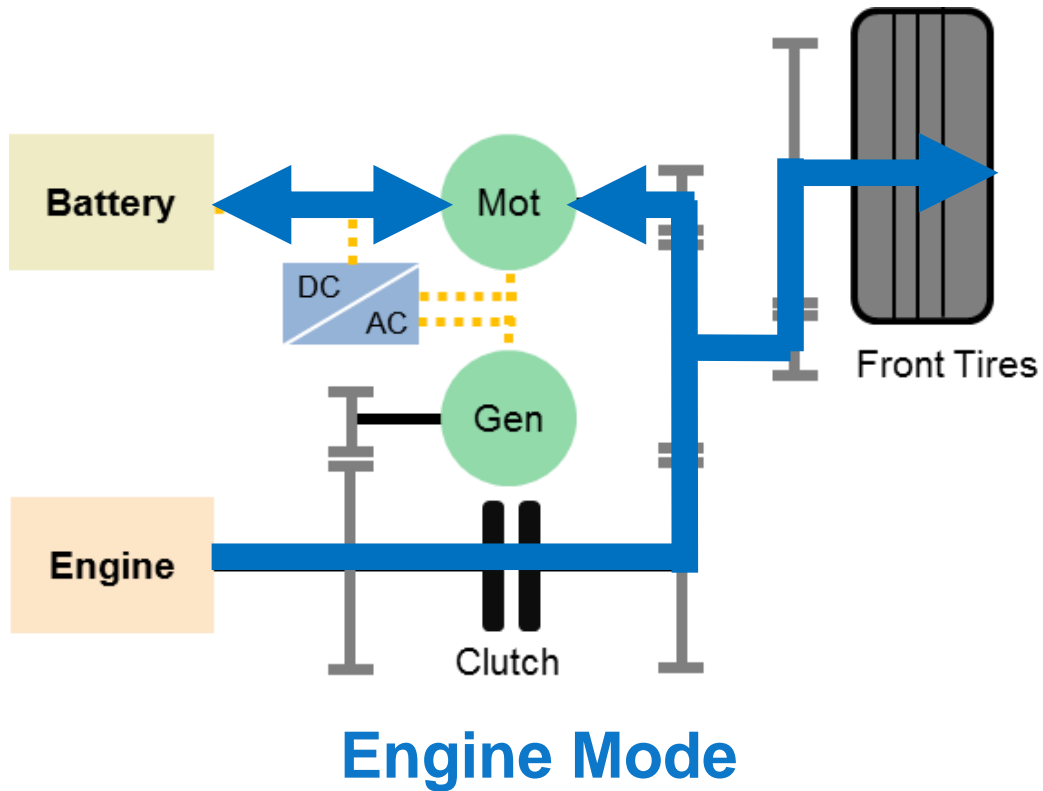
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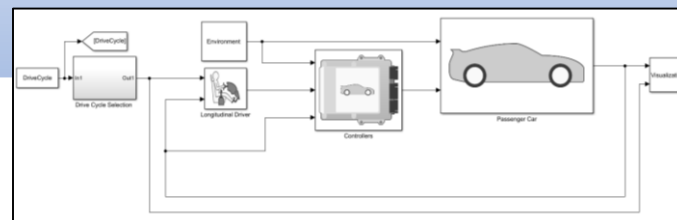
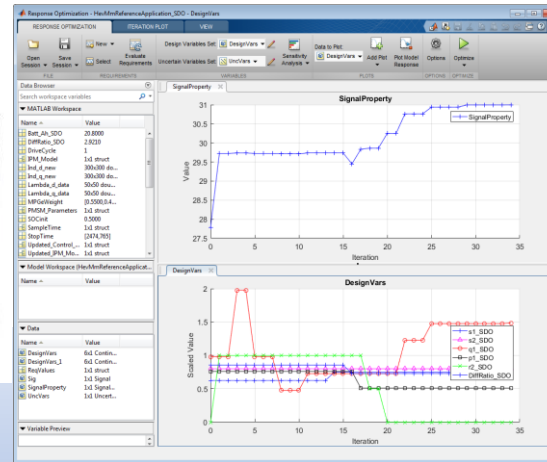
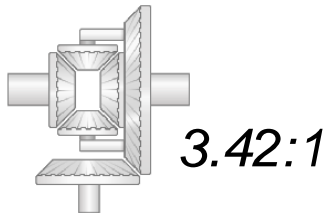
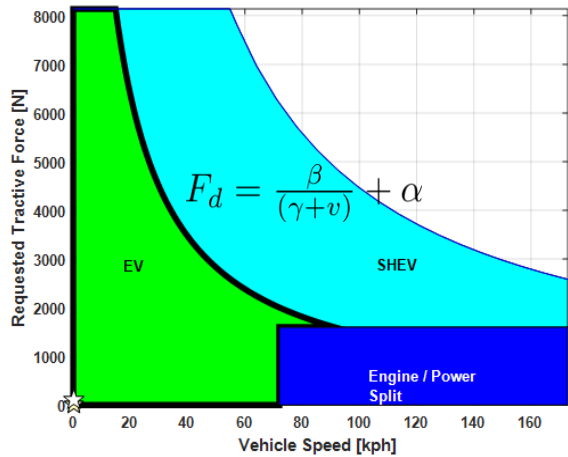
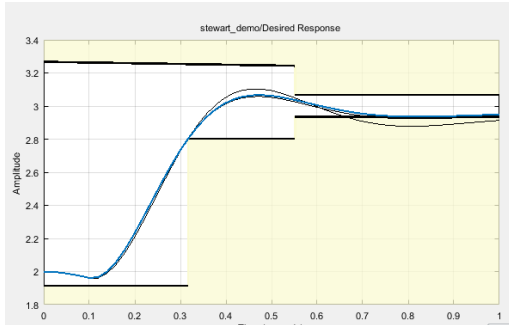


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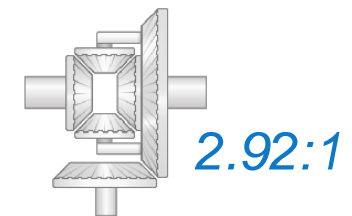
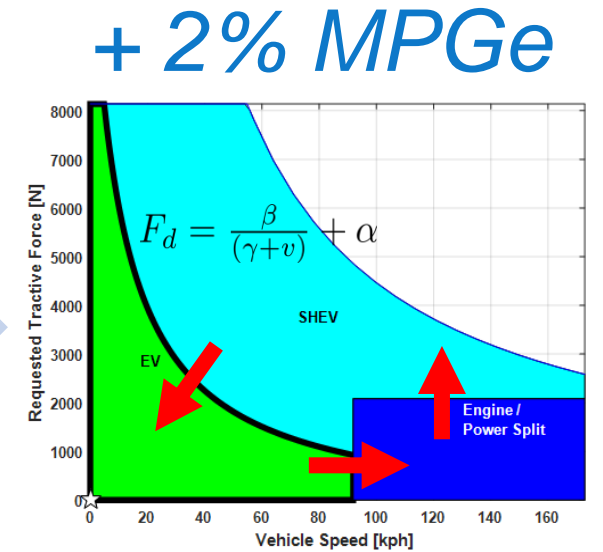
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响应优化



~ 12 Hours



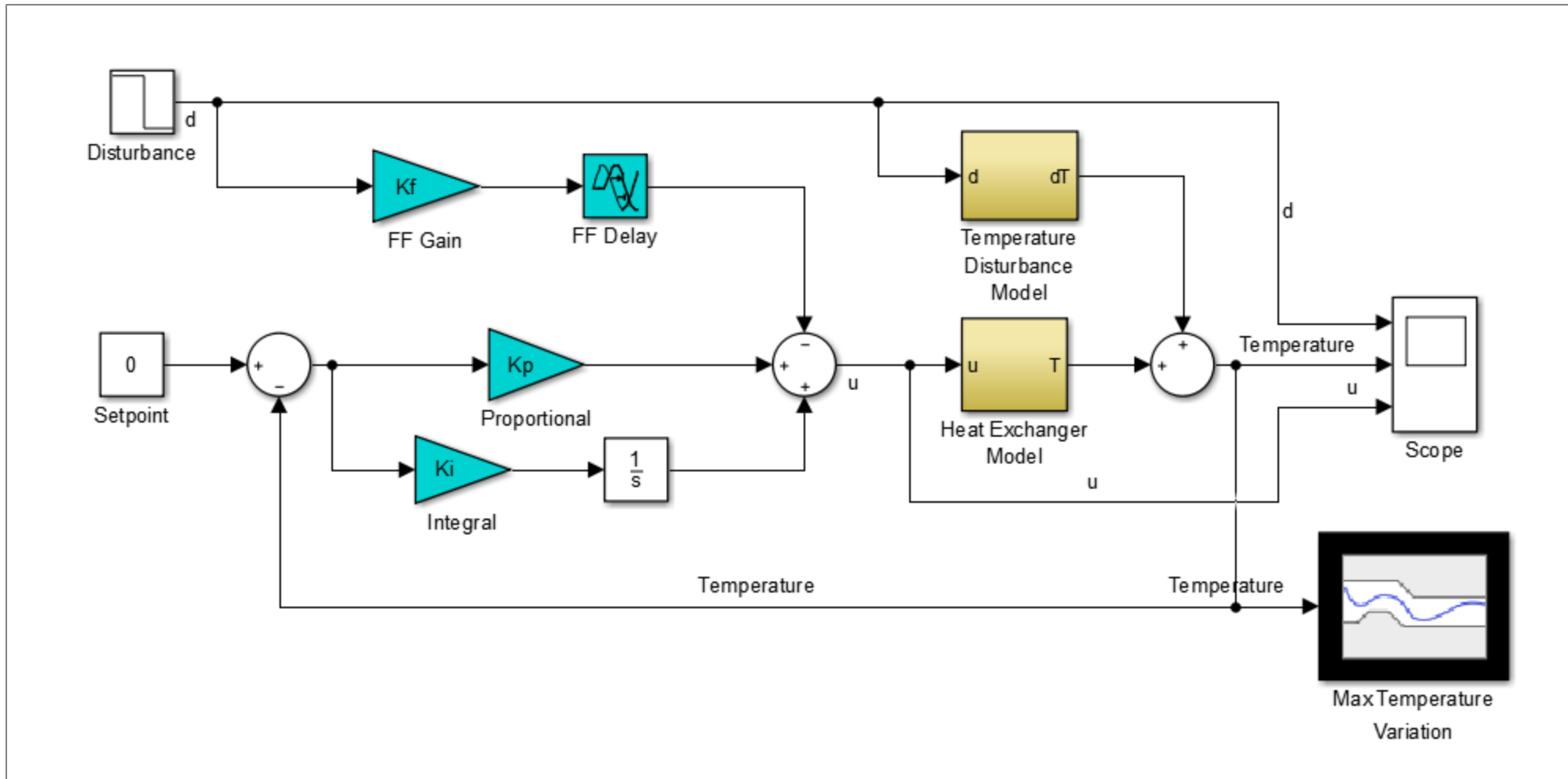
响应优化

敏感性分析

参数估计和优化

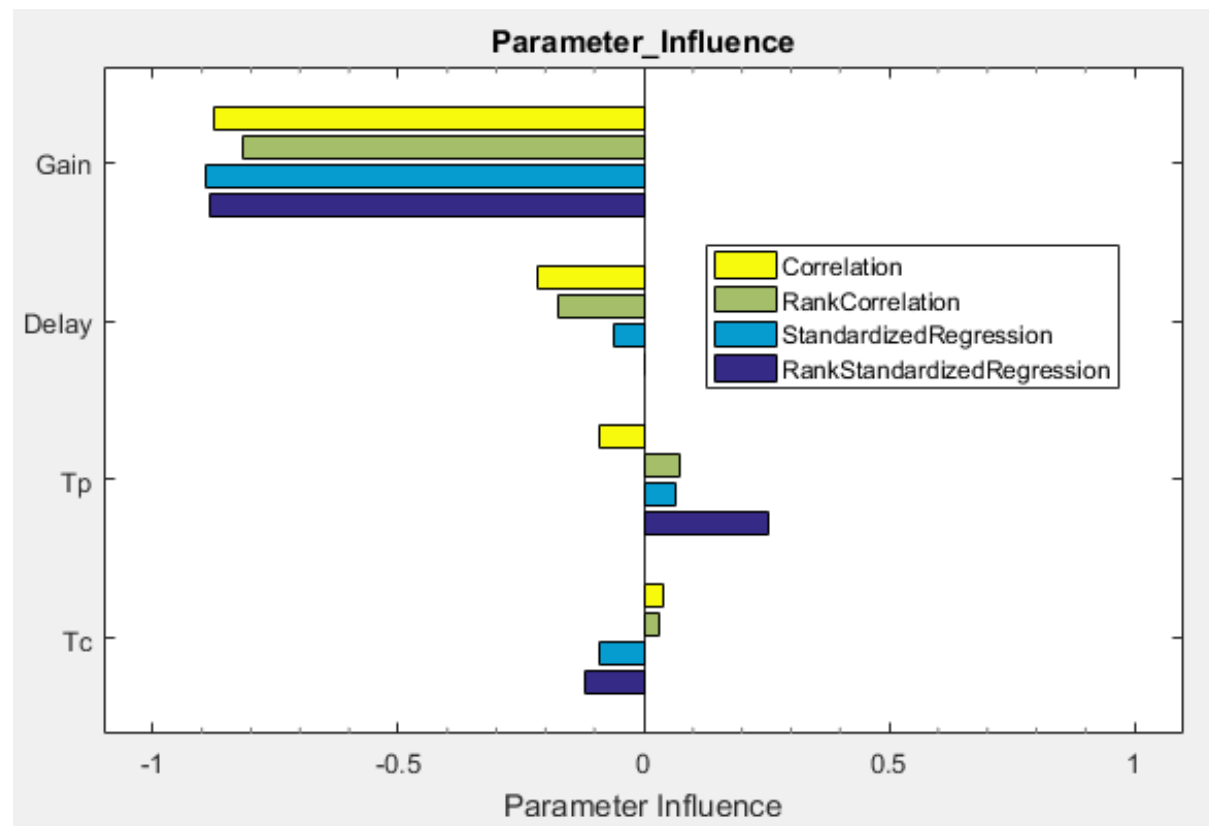
算法和加速

敏感性分析



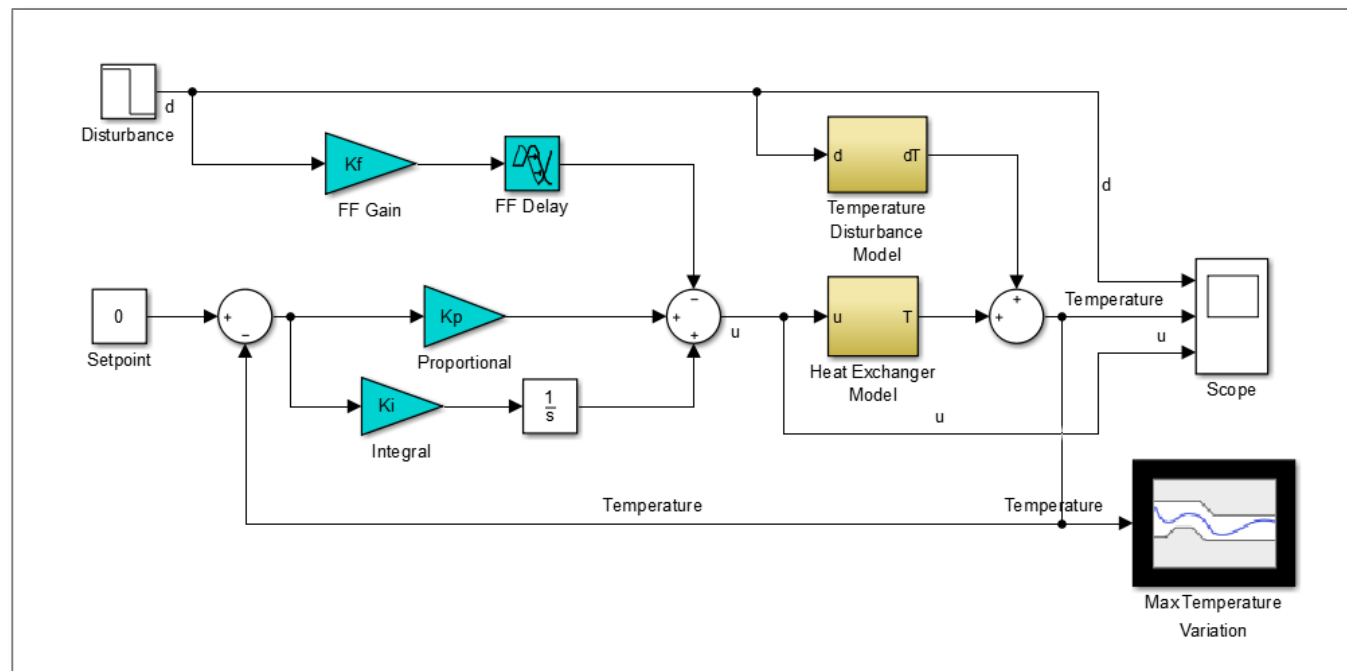
敏感性分析

输出不确定性与输入不确定度的
关系



敏感性分析

- 增加可靠性和鲁棒性
- 减少投入
- 提升性能



丰田开发出更快，更有效的赛车

挑战

访问和分析大量测试数据并快速做出明智的工程决策

解决方案

使用MathWorks工具导入数据，执行分析，可视化数据并处理结果

结果

- 减少分析的时间
- 复用分析结果
- 在赛道上成功表演



“我们获得的数据超出了我们的筛选范围。 MATLAB 是我们用于查看，共享和处理数据的主力军。”

- Skip Essma, Toyota Racing Development

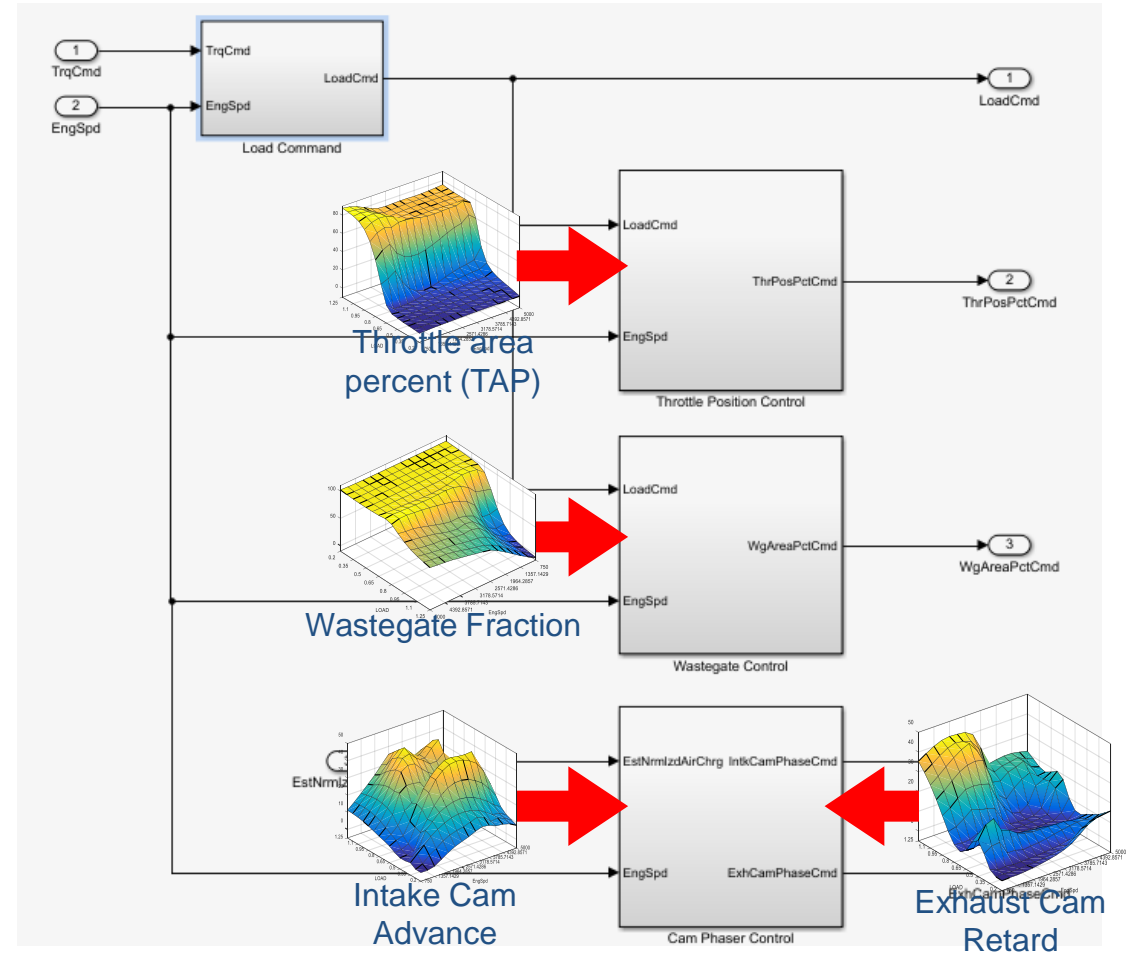
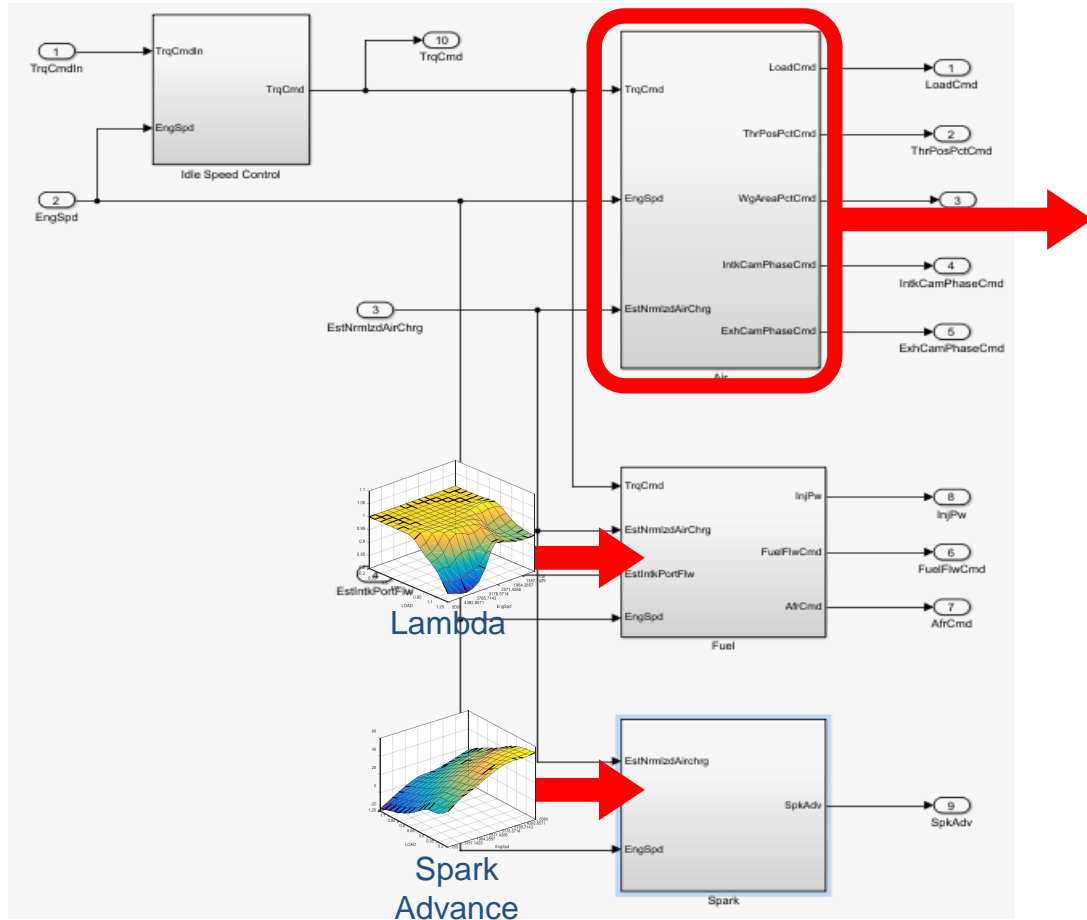
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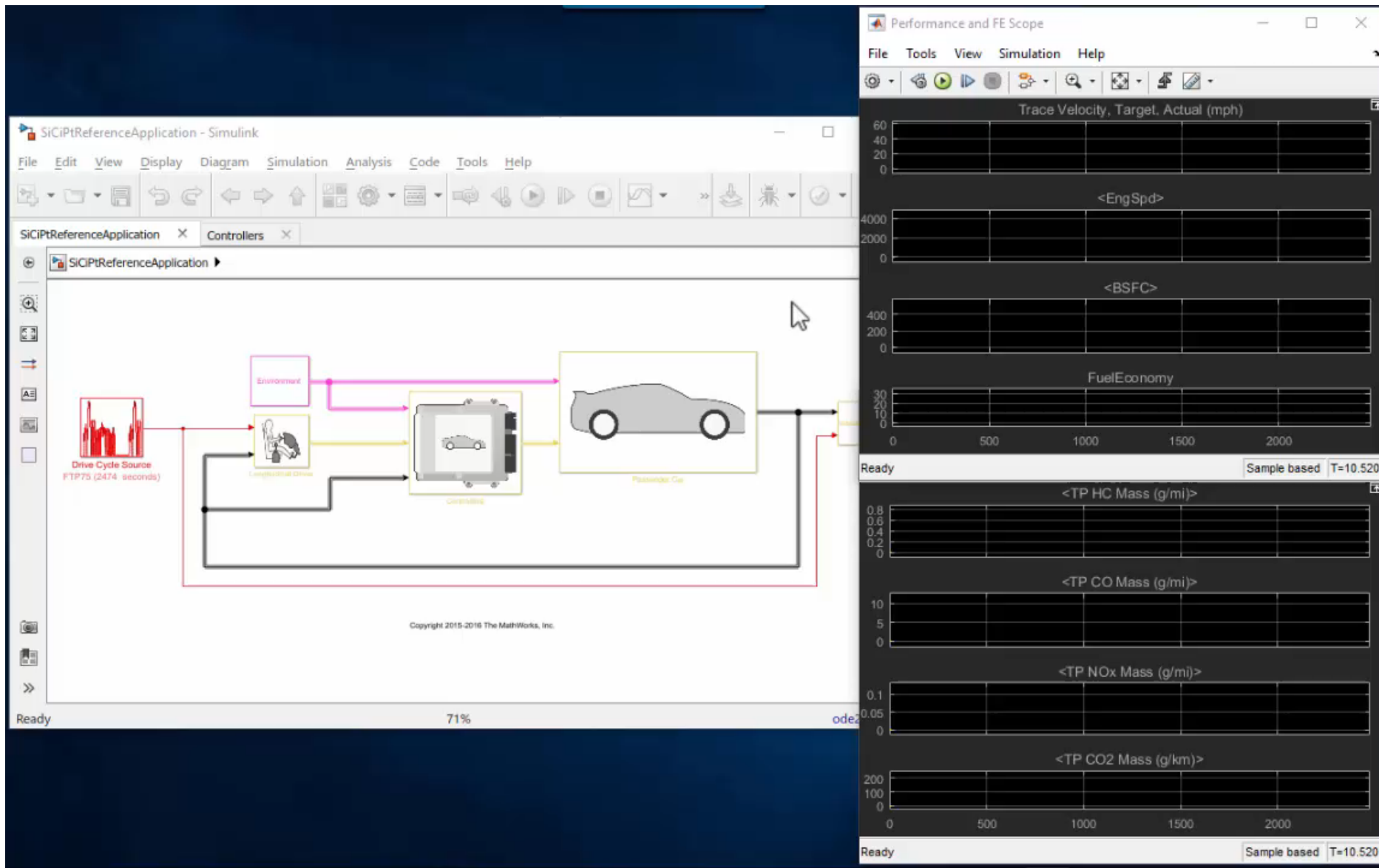
敏感性分析

参数估计和优化

算法和加速

发动机的标定





日产为空燃比控制器提高排放性能并减少标定时间

挑战

通过缩短标定时间，减少发动机排放并加速 AFR 控制器的产品开发。

解决方案

结合使用优化工具箱和 Simulink Design Optimization 优化控制器性能并自动执行参数标定。

结果

- NO_x 和 CO 排放减半
- 标定时间减少了 90%
- 确保一致的标定质量



“在日产，多年来，我们一直在寻找通过基于模型的设计来加快开发和改进产品的新方法。最近，随着 MATLAB 和 Simulink 优化产品的推出，通过改善现有 AFR 控制器设计的性能来减少排放。”

- Hiroshi Katoh, Nissan Motor Corporation

[Link to user story](#)

响应优化

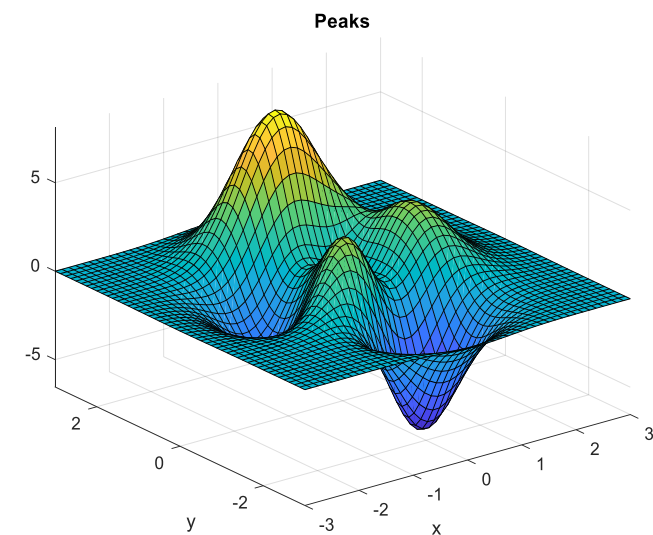
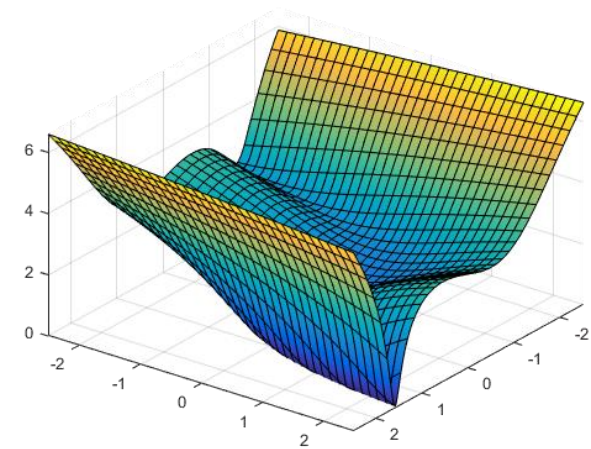
敏感性分析

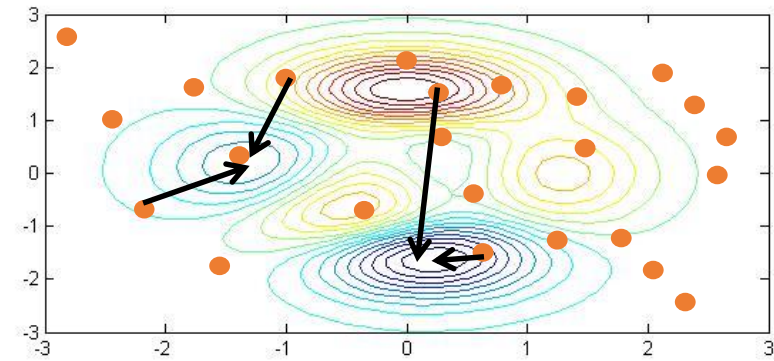
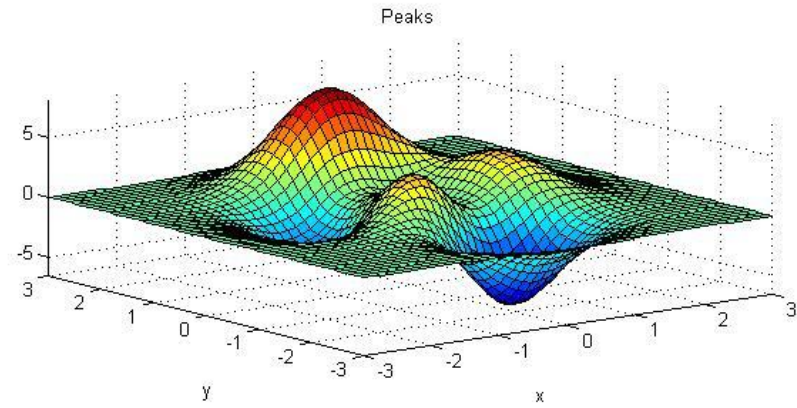
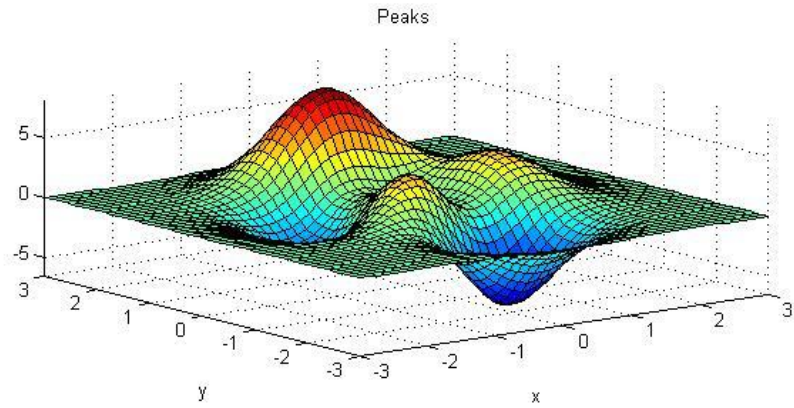
参数估计和优化

算法和加速

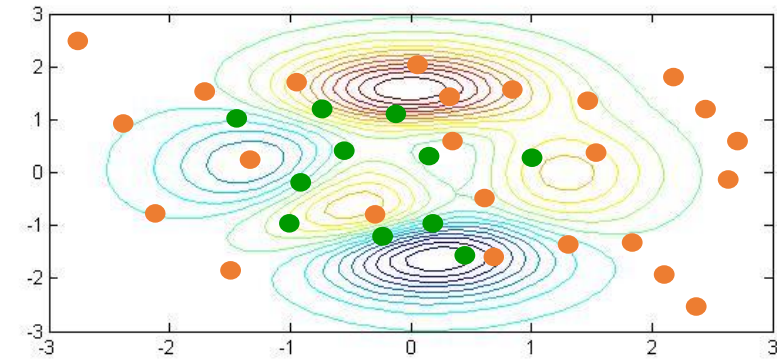
优化算法的选择

	凸优化	全局优化
运算量最小	✓	
问题规模 (更高维度)	✓	
局部最优	✓	
全局最优 (大概率)		✓
<ul style="list-style-type: none">• 非平滑曲面• 随机• 非连续• 未知梯度		✓ ✓ ✓ ✓
自定义数据类型 (GA 或 SA)		✓

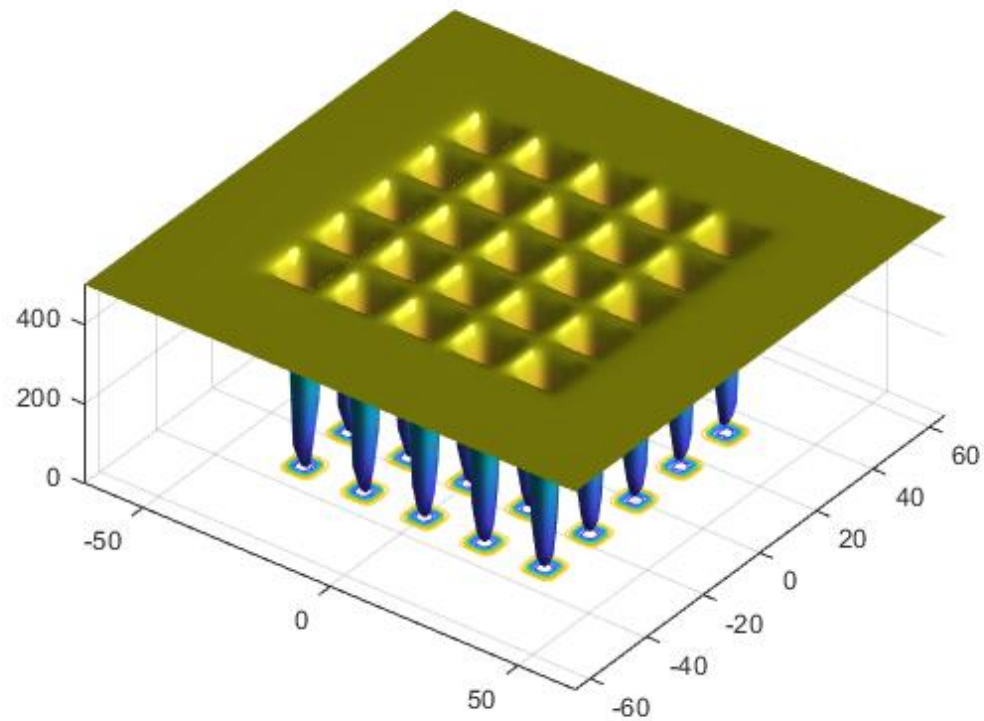




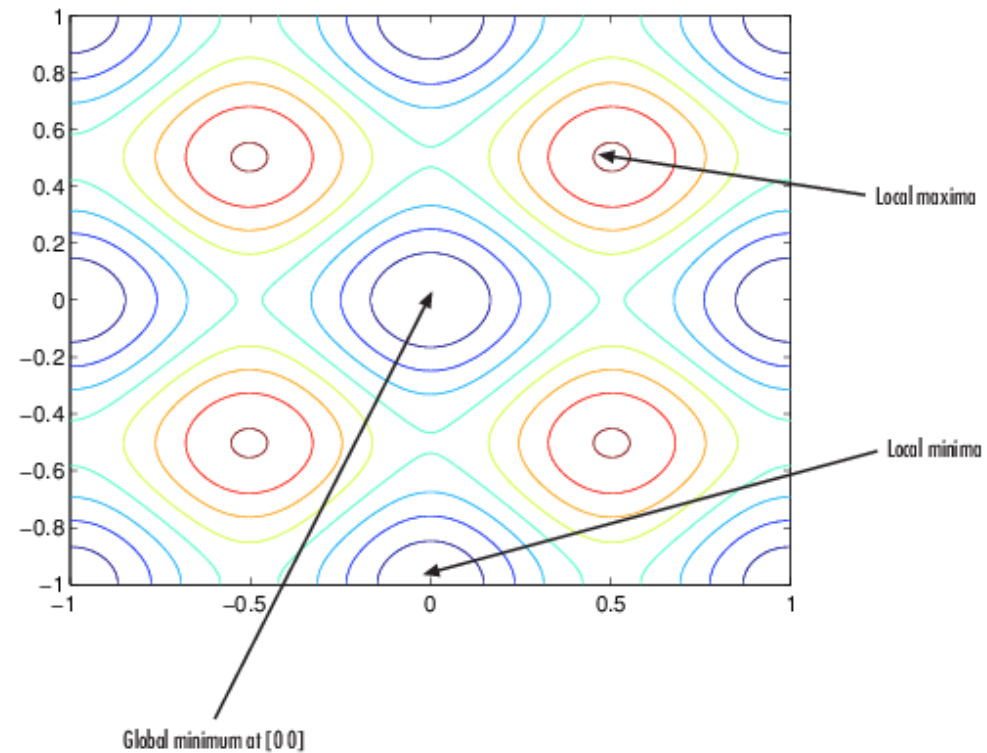
MultiStart



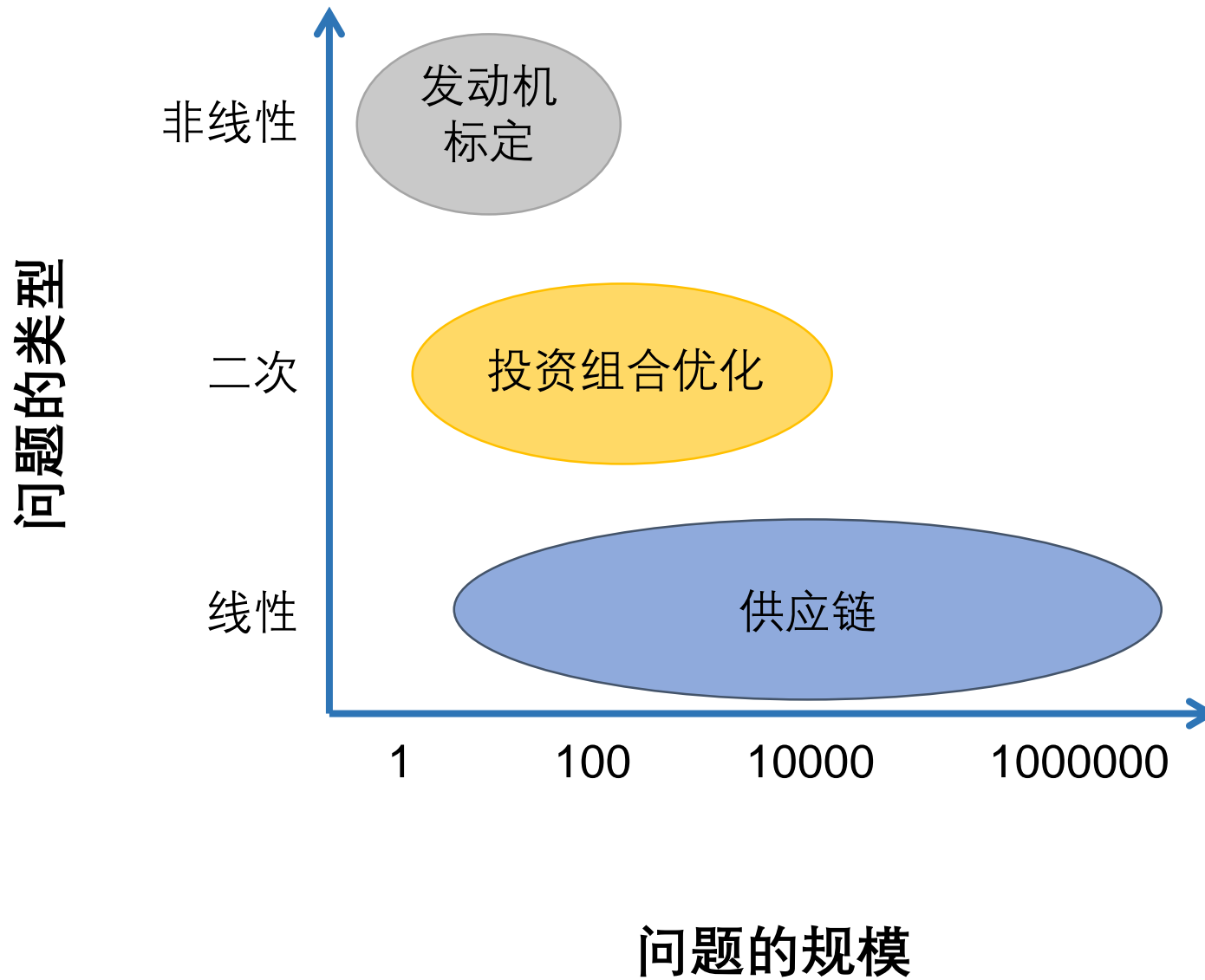
GlobalSearch



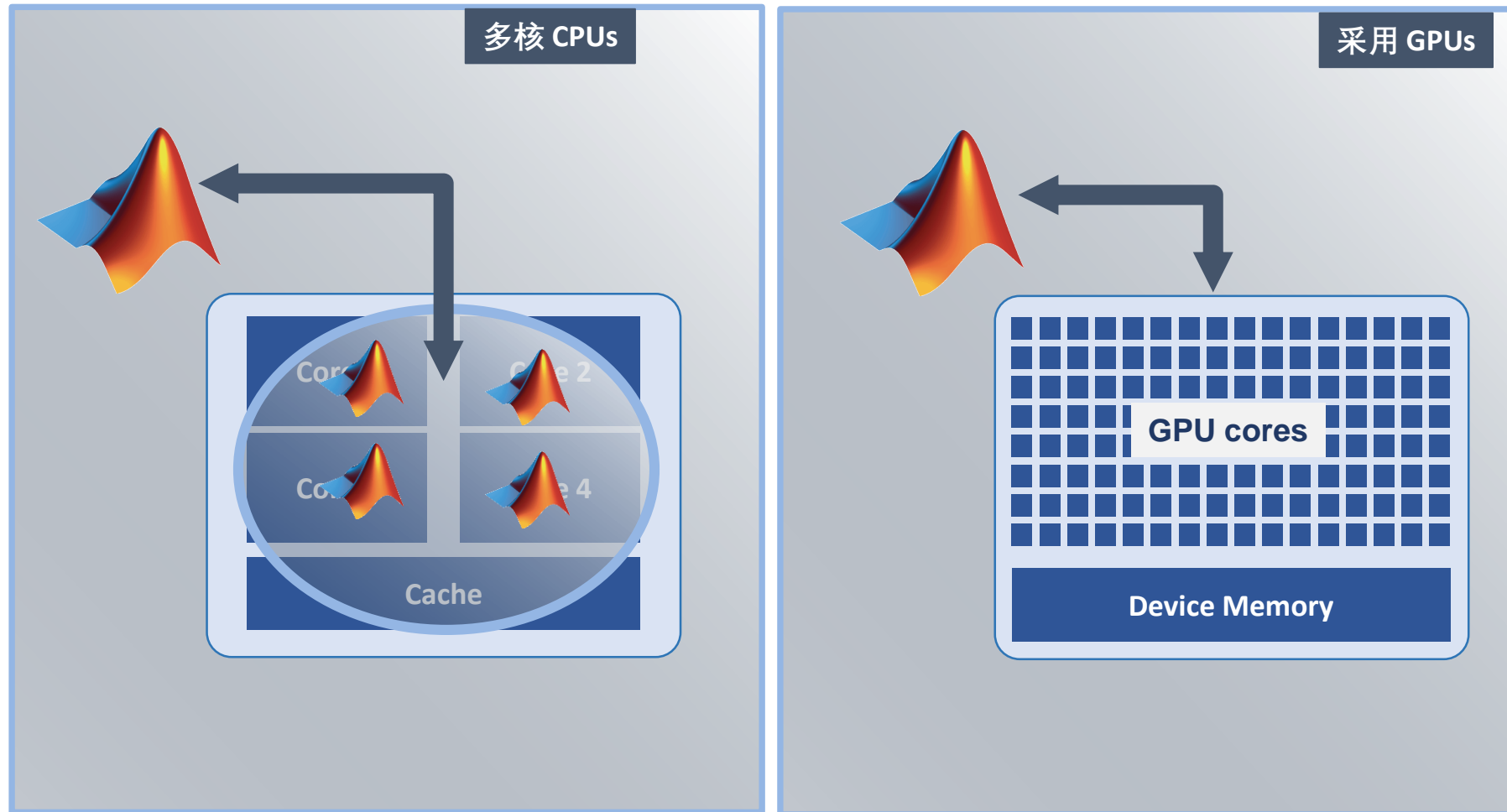
粒子群



遗传



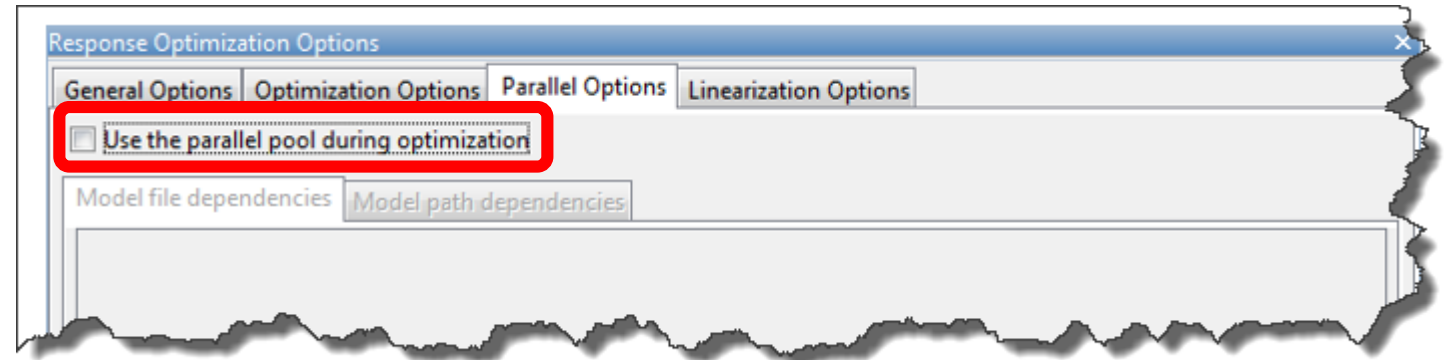
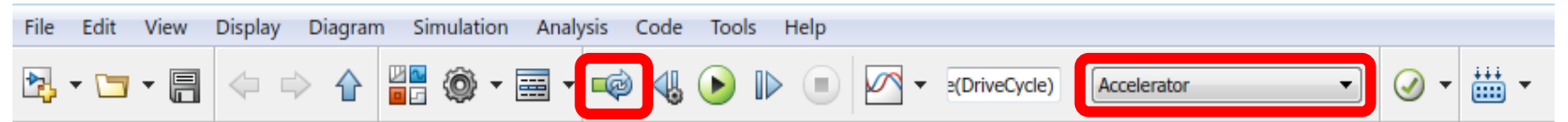
硬件换性能



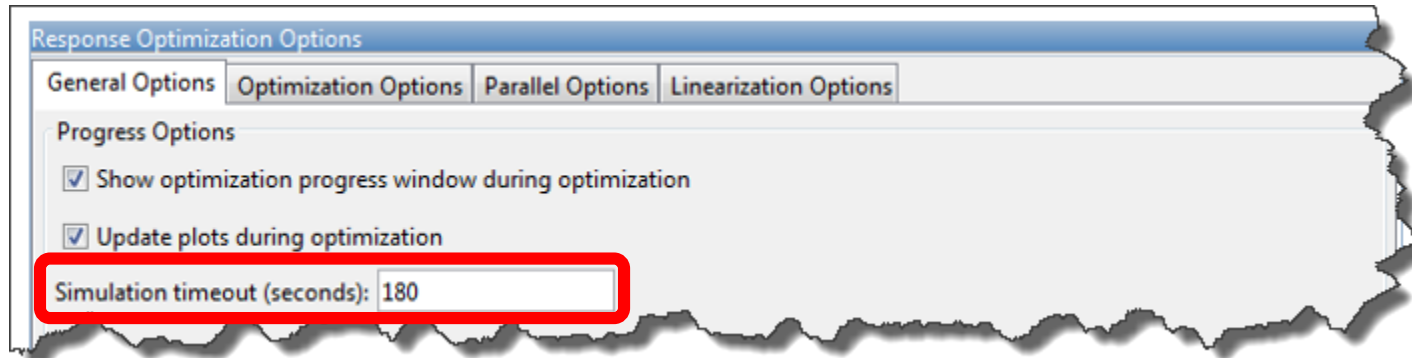
Simulink Design Optimization

- 加速方法

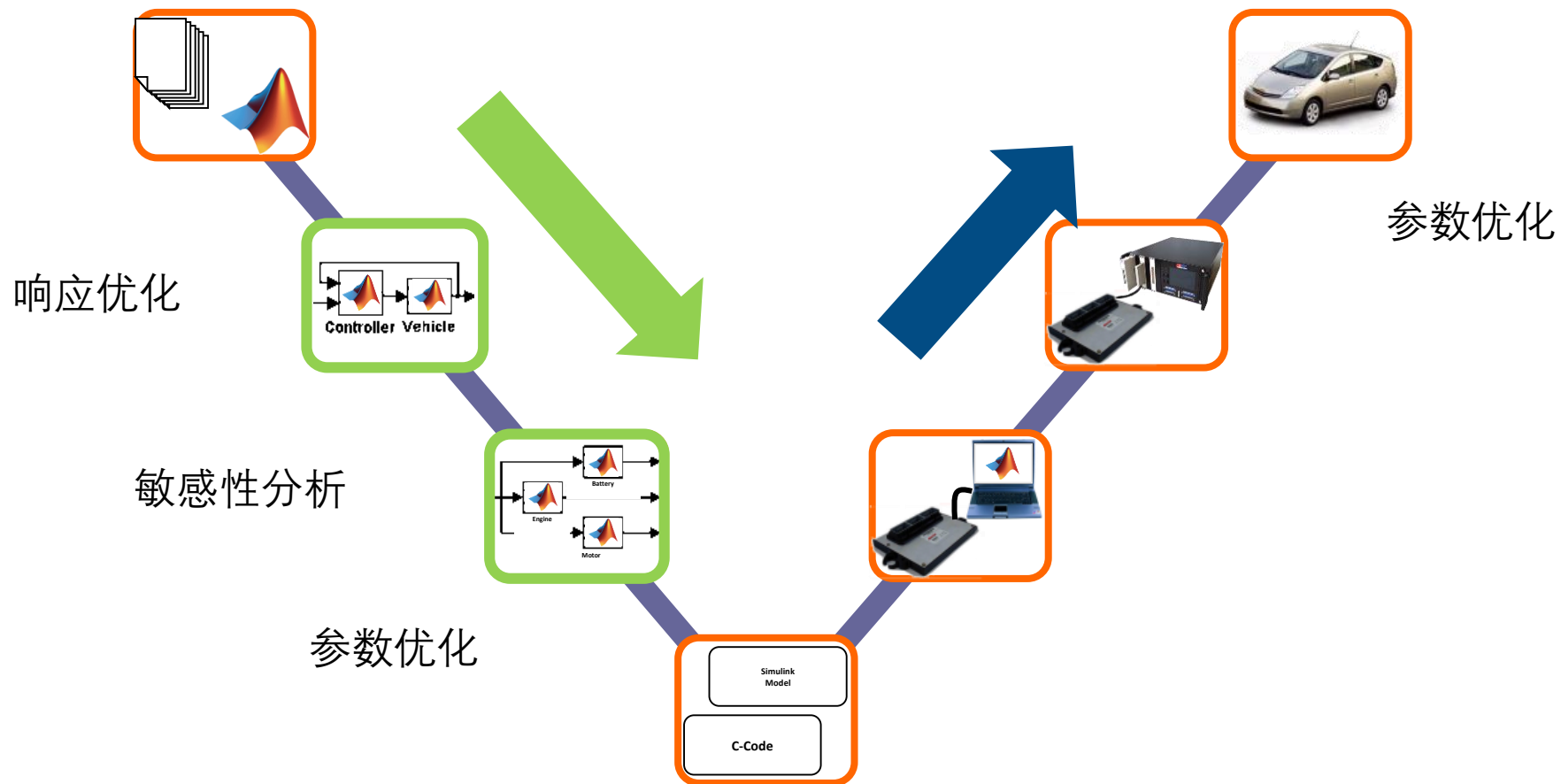
- 加速模式
- 快速启动模式
- 并行计算



- 尽早退出仿真



工程优化



Q&A