

# Multi-standard Software

*COMBINE 2010, session 10*

*Lucian Smith*

*Camille Laibe and Michael Hoehl*

*Henning Hermjakob*

*Augustin Luna*

*Andrei Zinovyev*

*Andrei Zinovyev for Fedor Kolpakov*

# Tales from the code front: Translating Modularity

*COMBINE 2010*

*Lucian Smith*

*University of Washington,*

*Seattle, WA*

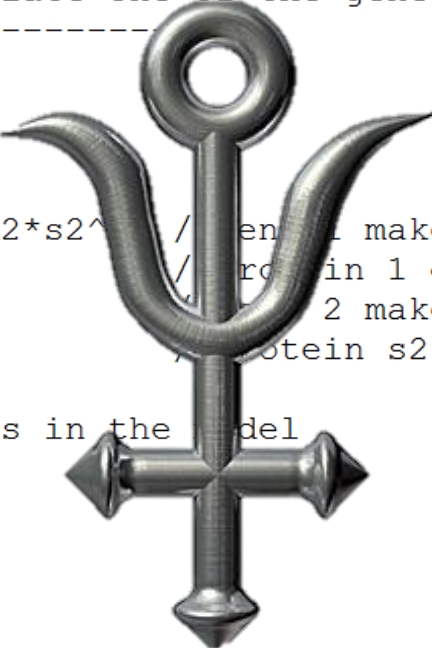
# Antimony and CellML

```
ex_antimony_input.txt - QTAntimony
File Edit View Help
Antimony - ex_antimony_input.txt SBML - bistable * SBML - ffn * SBML - ringoscil * SBML - combined_model * SBML *
//-----
//Bistable Switch
//Two genes down-regulate one another. Hill coefficient =
//input x can be used to upregulate one of the genes
//-----

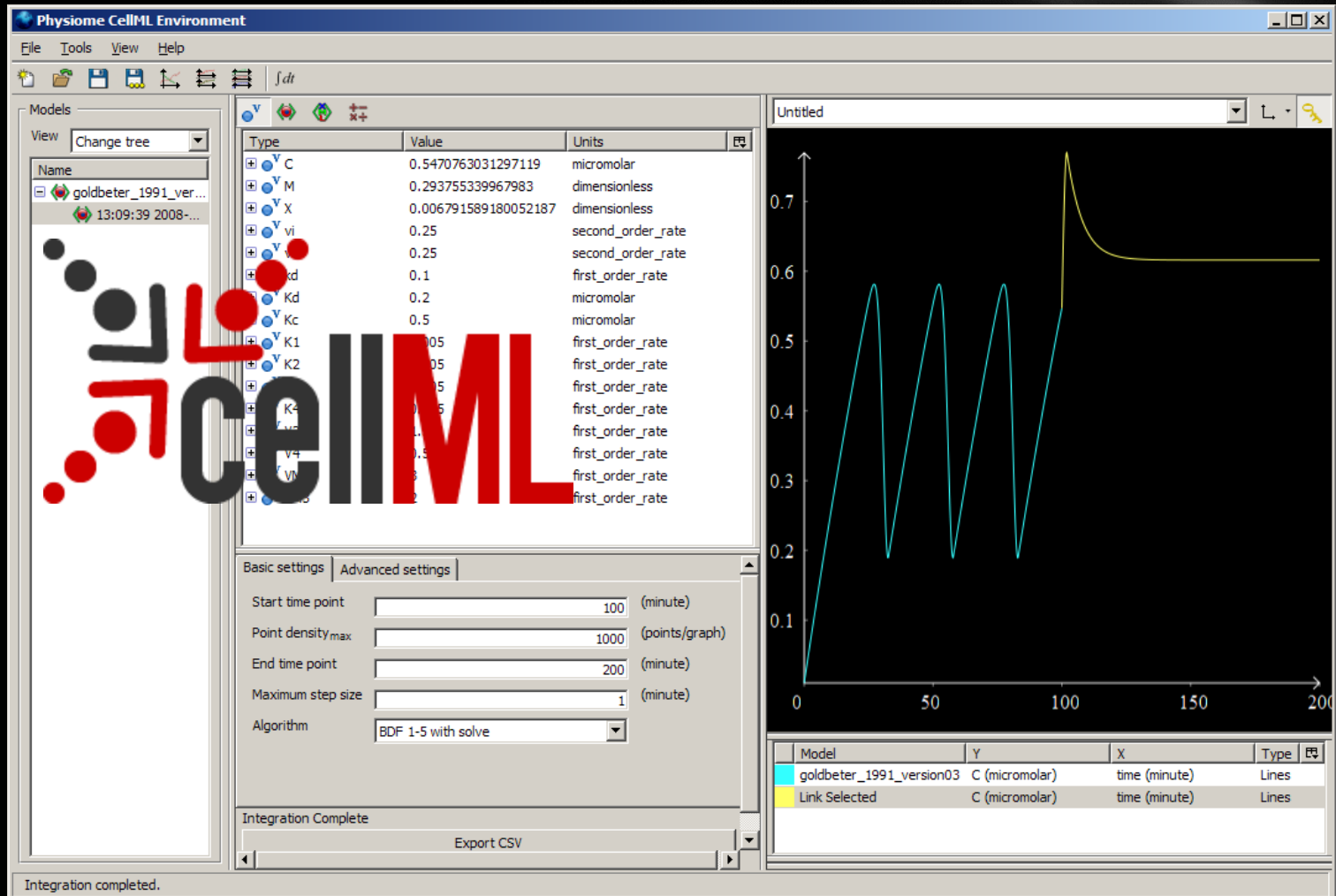
model bistable(s1, s2)
  gene g1, g2;
  species s1, s2;
  g1: -> s1; k1*(1 + x)/(1 + k2*s2^2) // gene 1 makes prot
  s1 -> ; k0*s1 // protein 1 degrade
  g2: -> s2; k3/(1 + k4*s1^2) // gene 2 makes prot
  s2 -> ; k0*s2 // protein s2 degra

  k0 = 0.1 //parameters in the model
  k1 = 1
  k2 = 1
  k3 = 1
  k4 = 1
end

//-----
//Feed Forward Network (Coherent Type 1)
//The FFN is meant to reduce noise -- the signal x has to
```



# Antimony and CellML



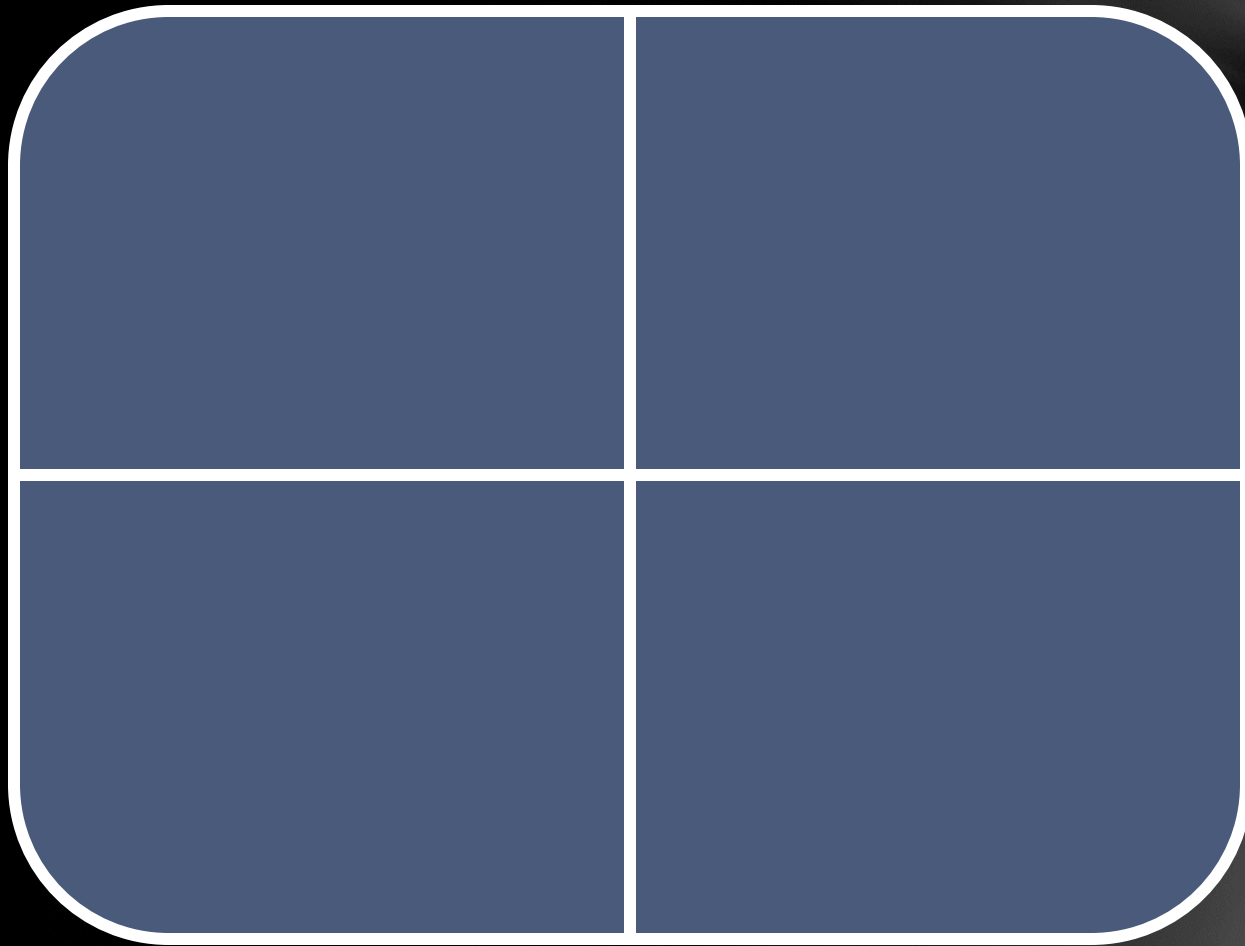
# Translation (Antimony 1.4)



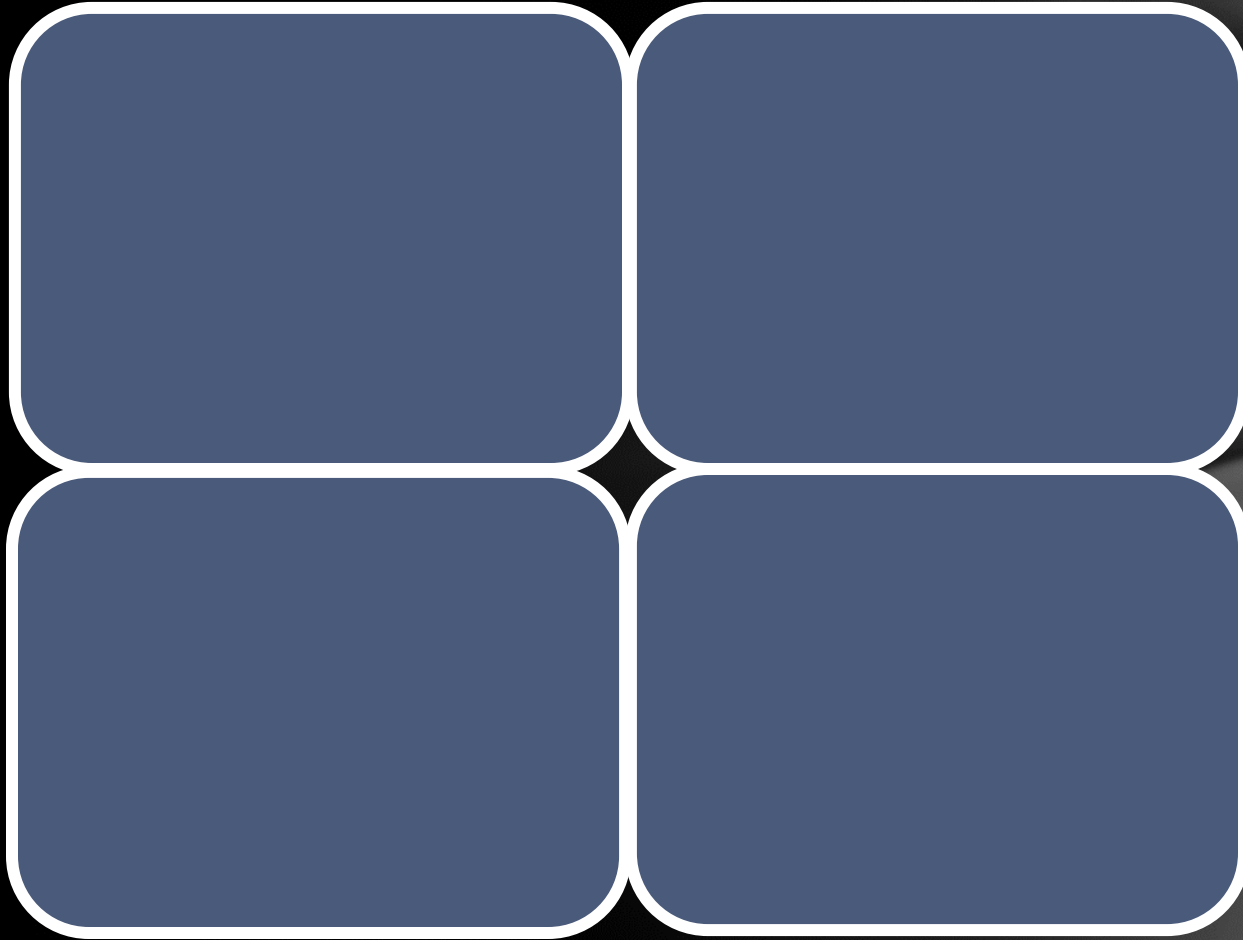
# Modularity



# Modularity

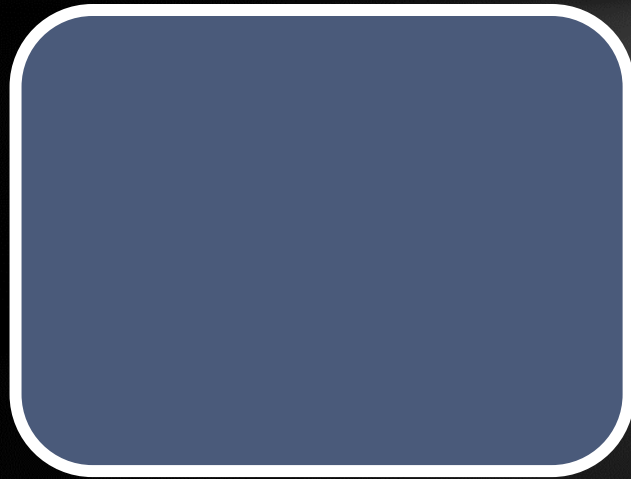


# Modularity

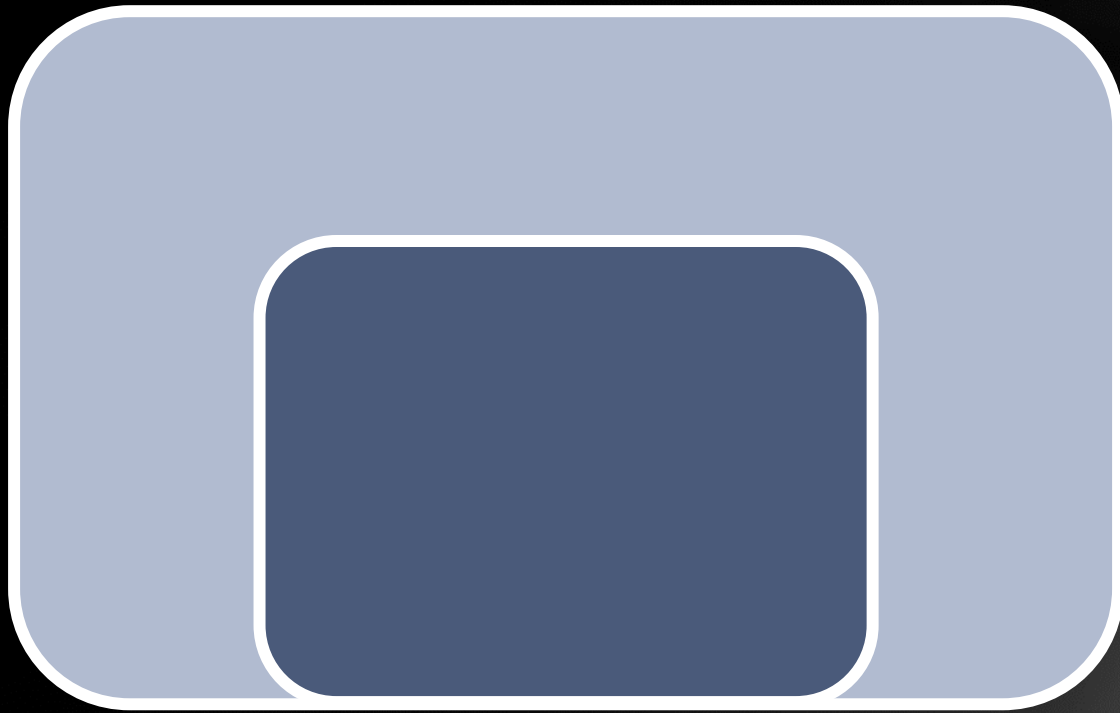




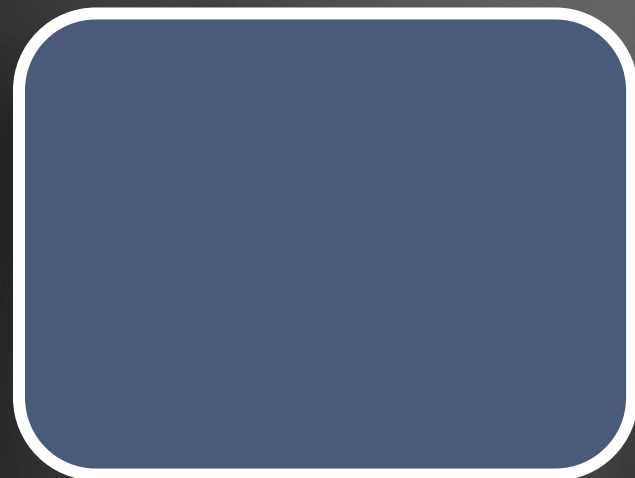
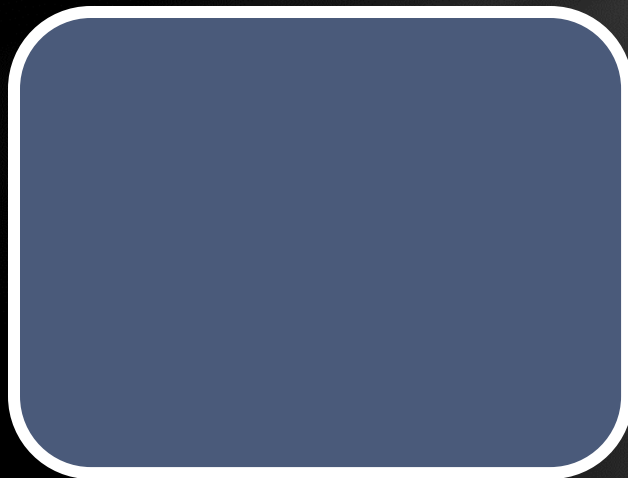
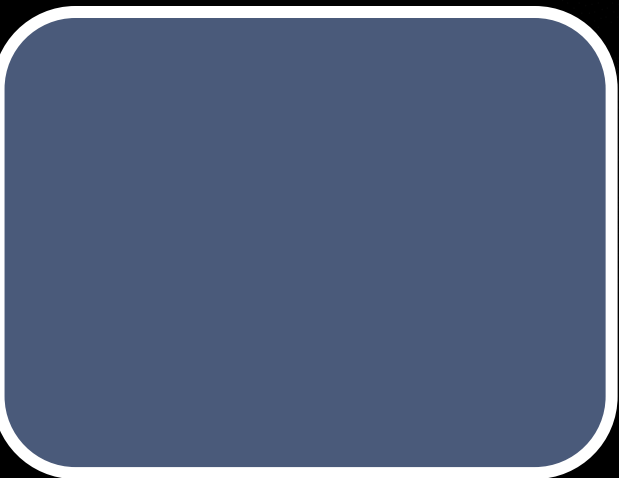
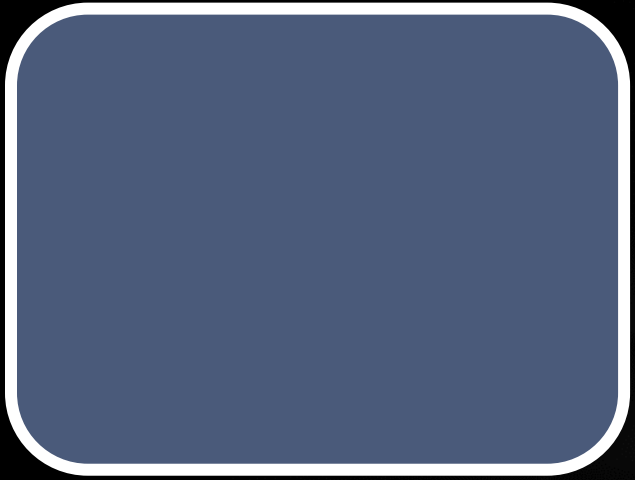
# Modularity



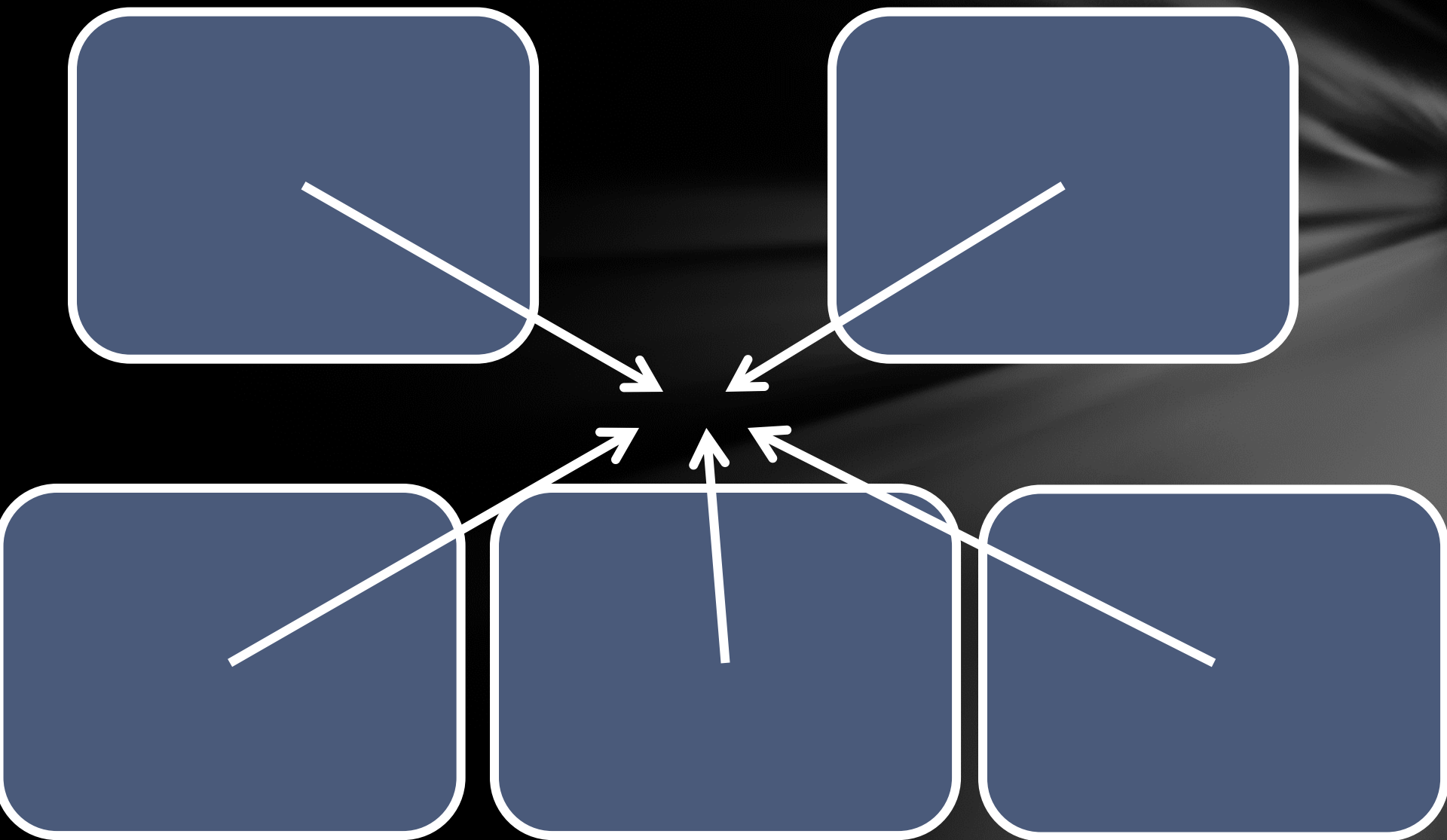
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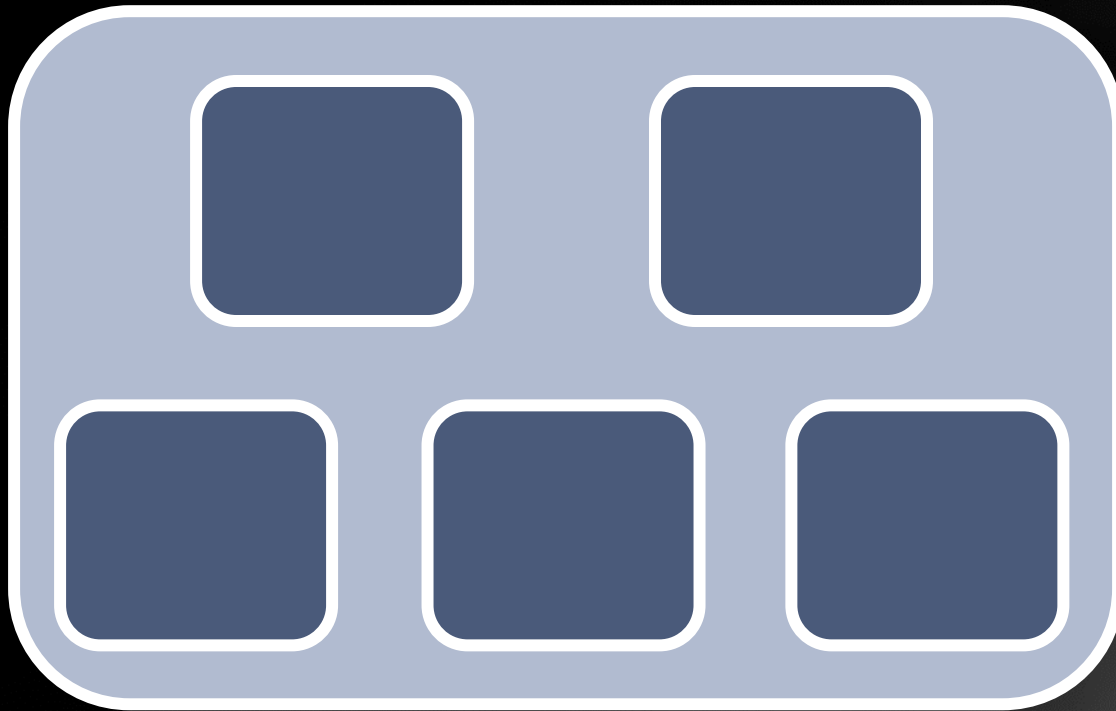
# Modularity



# Modularity



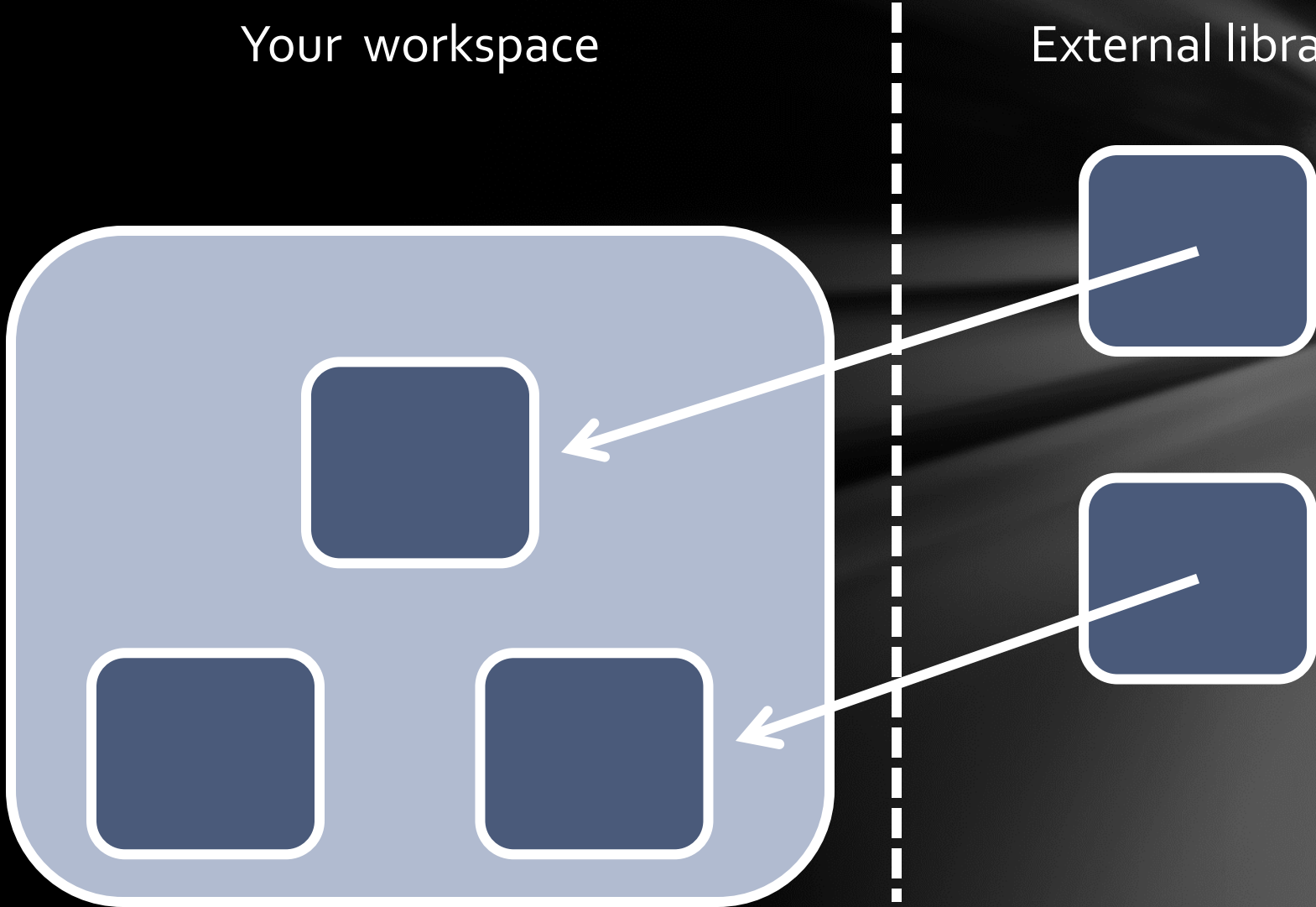
# Modularity



# Modularity

Your workspace

External library



# Modularity

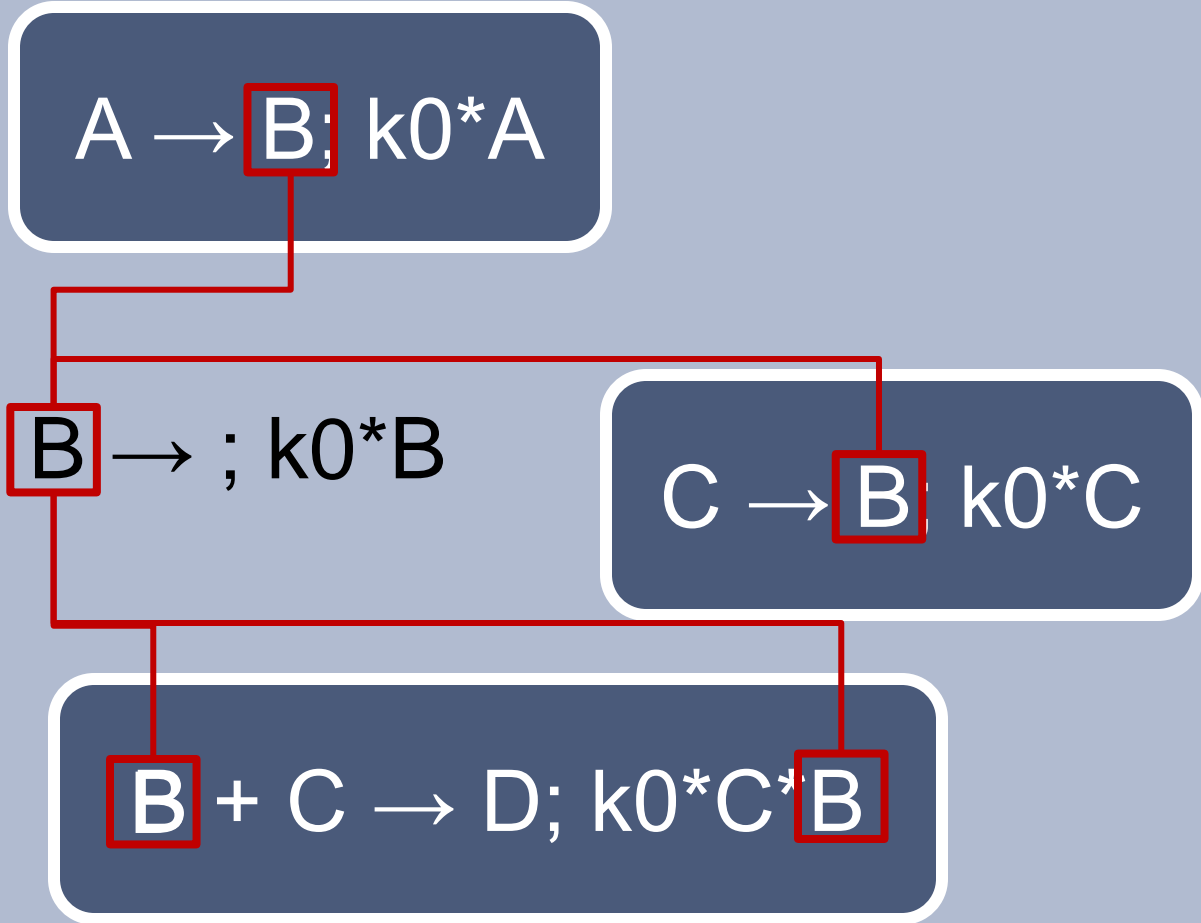
$$A \rightarrow B; k_0^*A$$
$$B \rightarrow ; k_0^*B$$
$$C \rightarrow B; k_0^*C$$
$$B + C \rightarrow D; k_0^*C^*B$$

# Modularity

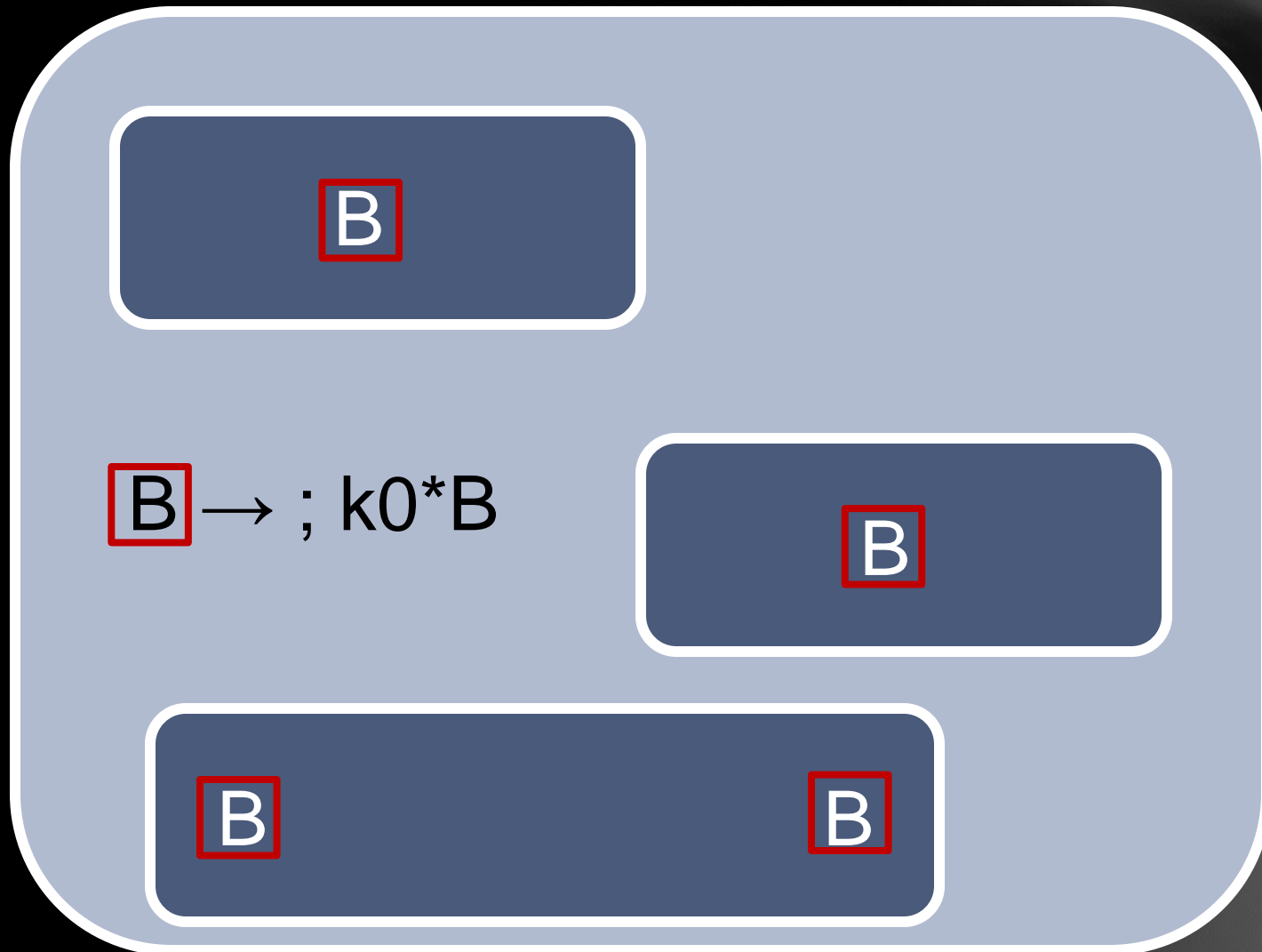
$$A \rightarrow \boxed{B}; k_0 * A$$
$$\boxed{B} \rightarrow ; k_0 * B$$
$$C \rightarrow \boxed{B}; k_0 * C$$
$$\boxed{B} + C \rightarrow D; k_0 * C * \boxed{B}$$



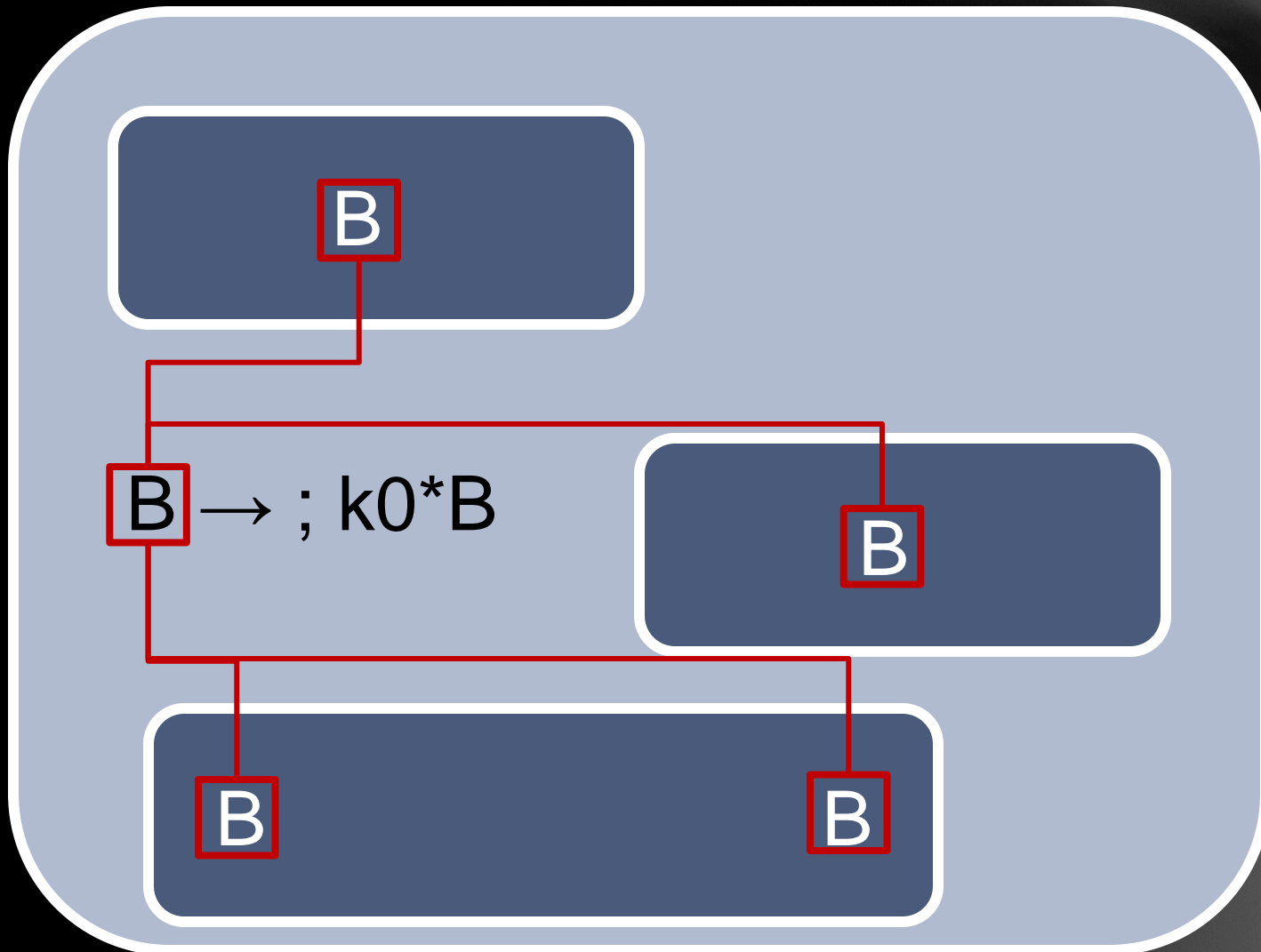
# Modularity



# 'Black Box' Modularity



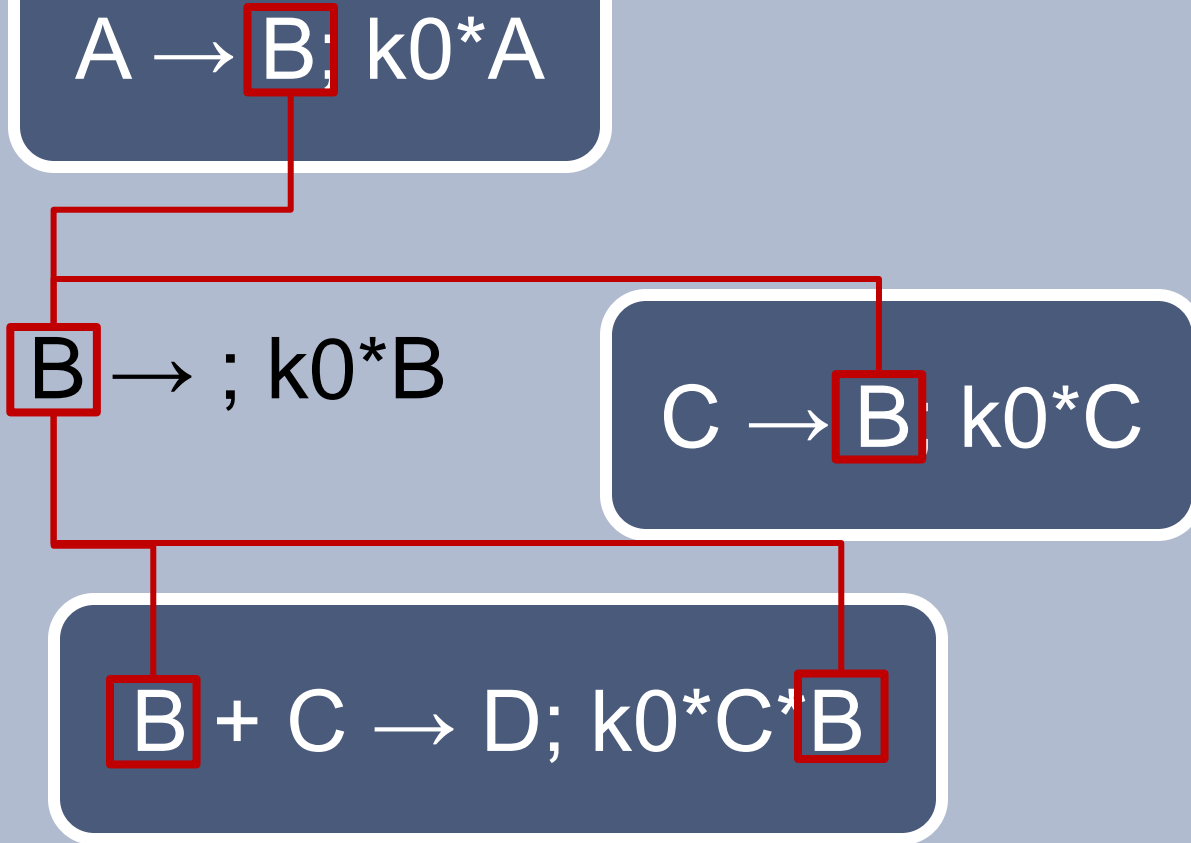
# 'Black Box' Modularity



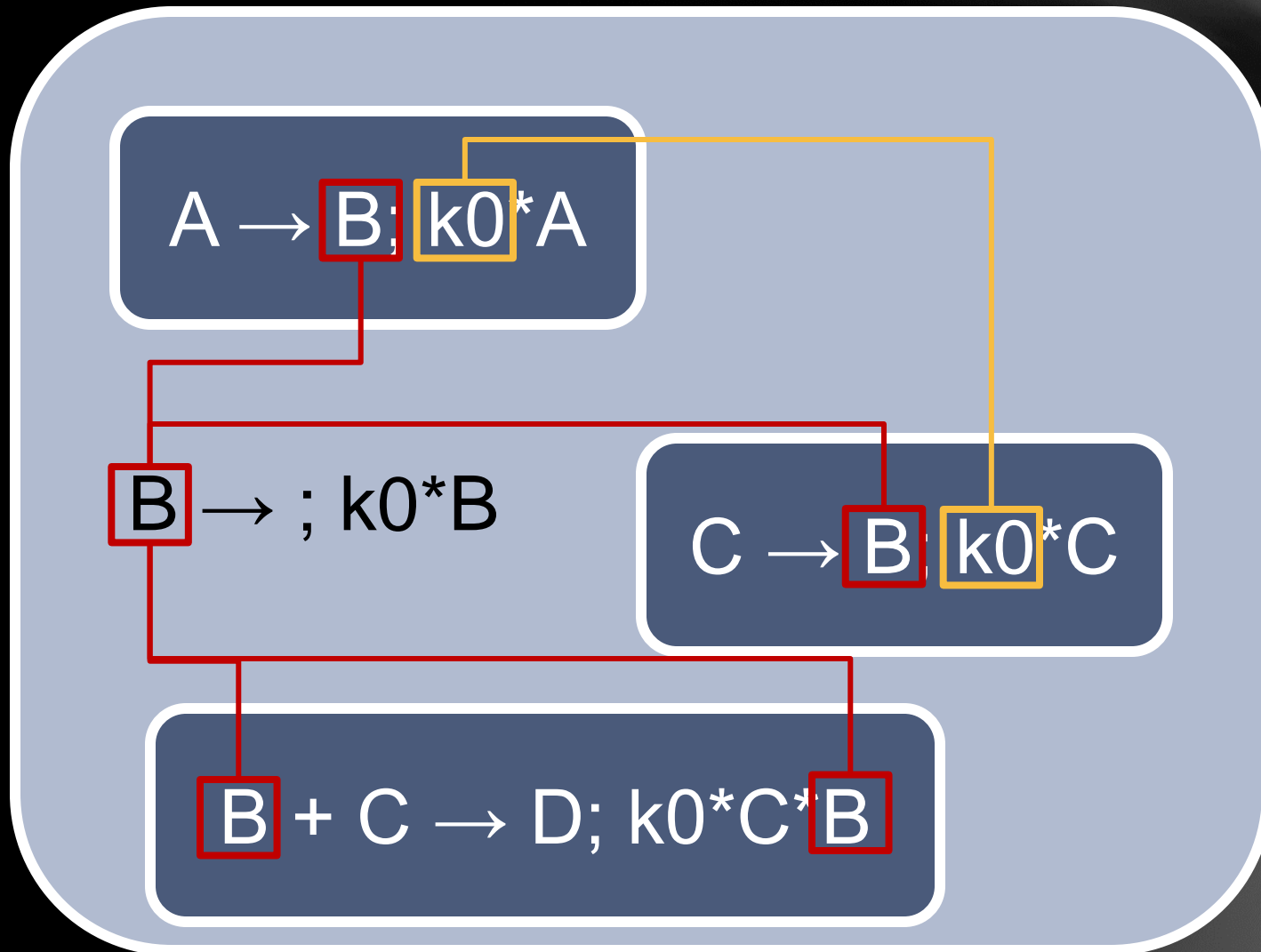
# Model Composition



# Model Composition



# Model Composition



# 'Black Box' Translation

B

$B \rightarrow ; k_0 * B$

B

B

B

# 'Black Box' Translation

$B$   $k_0$

$B \rightarrow ; k_0 * B$

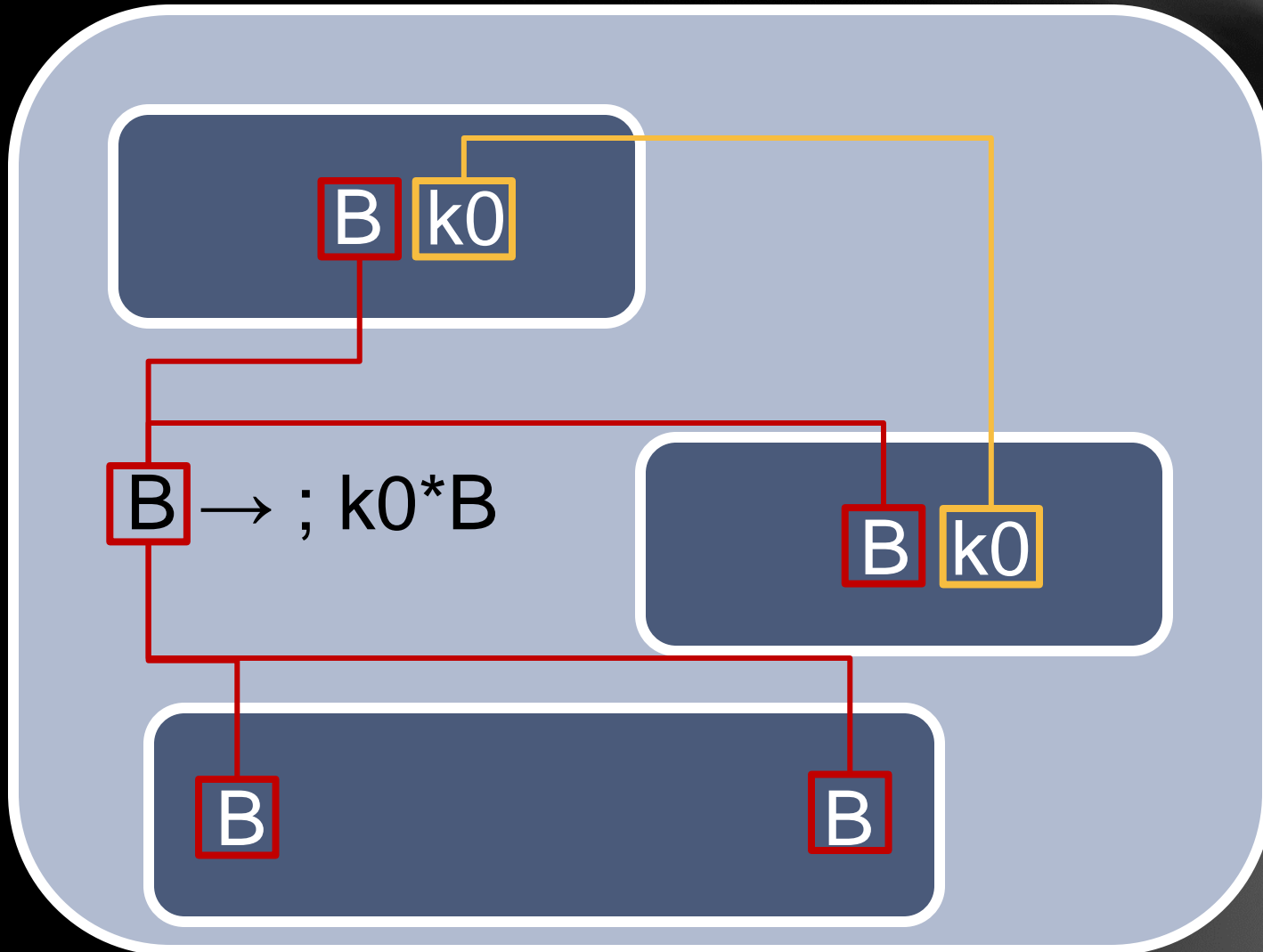
$B$   $k_0$

$B$

$B$



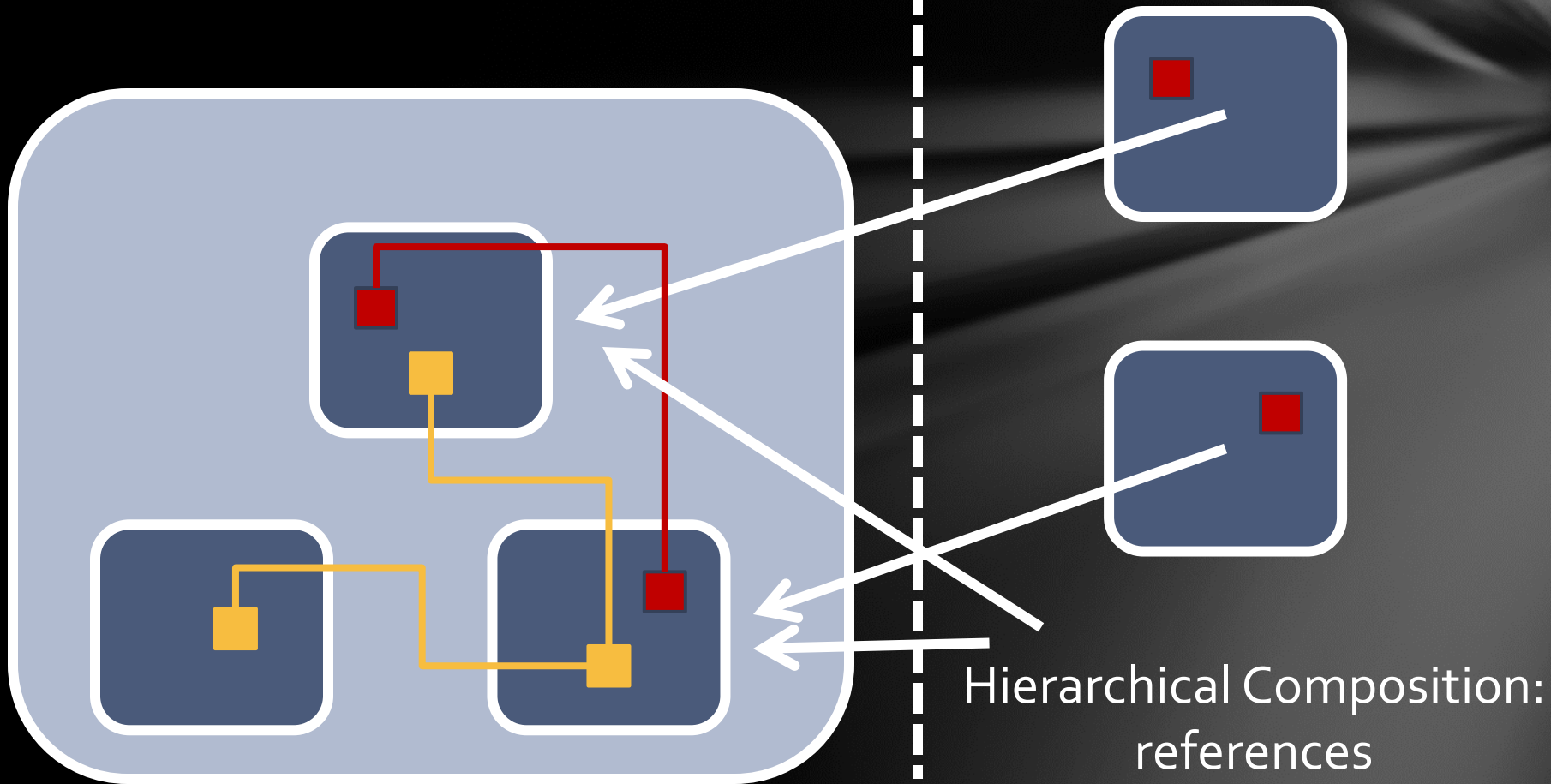
# 'Black Box' Translation



# Implications for libraries

Your workspace

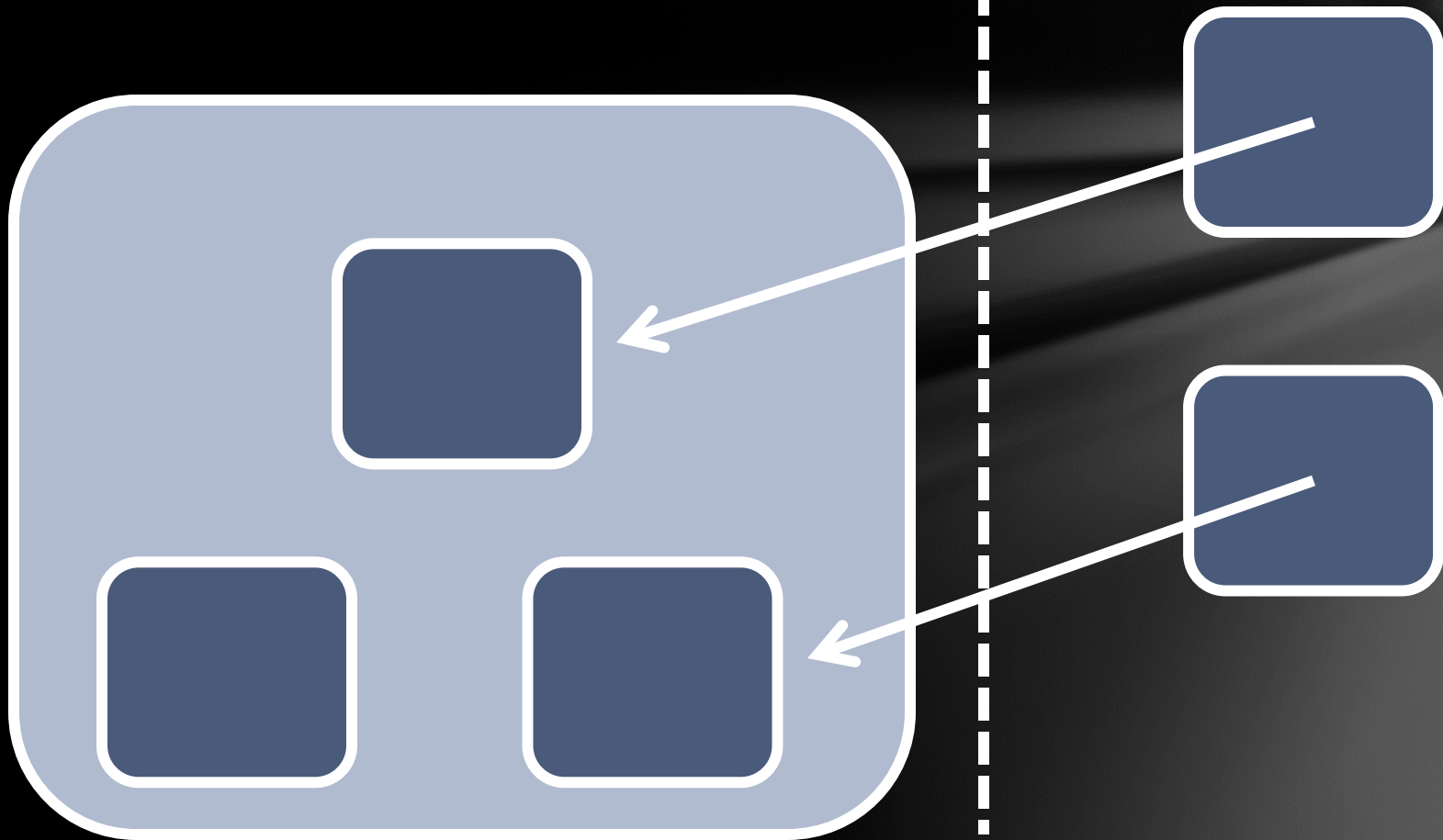
External library



# Implications for libraries

Your workspace

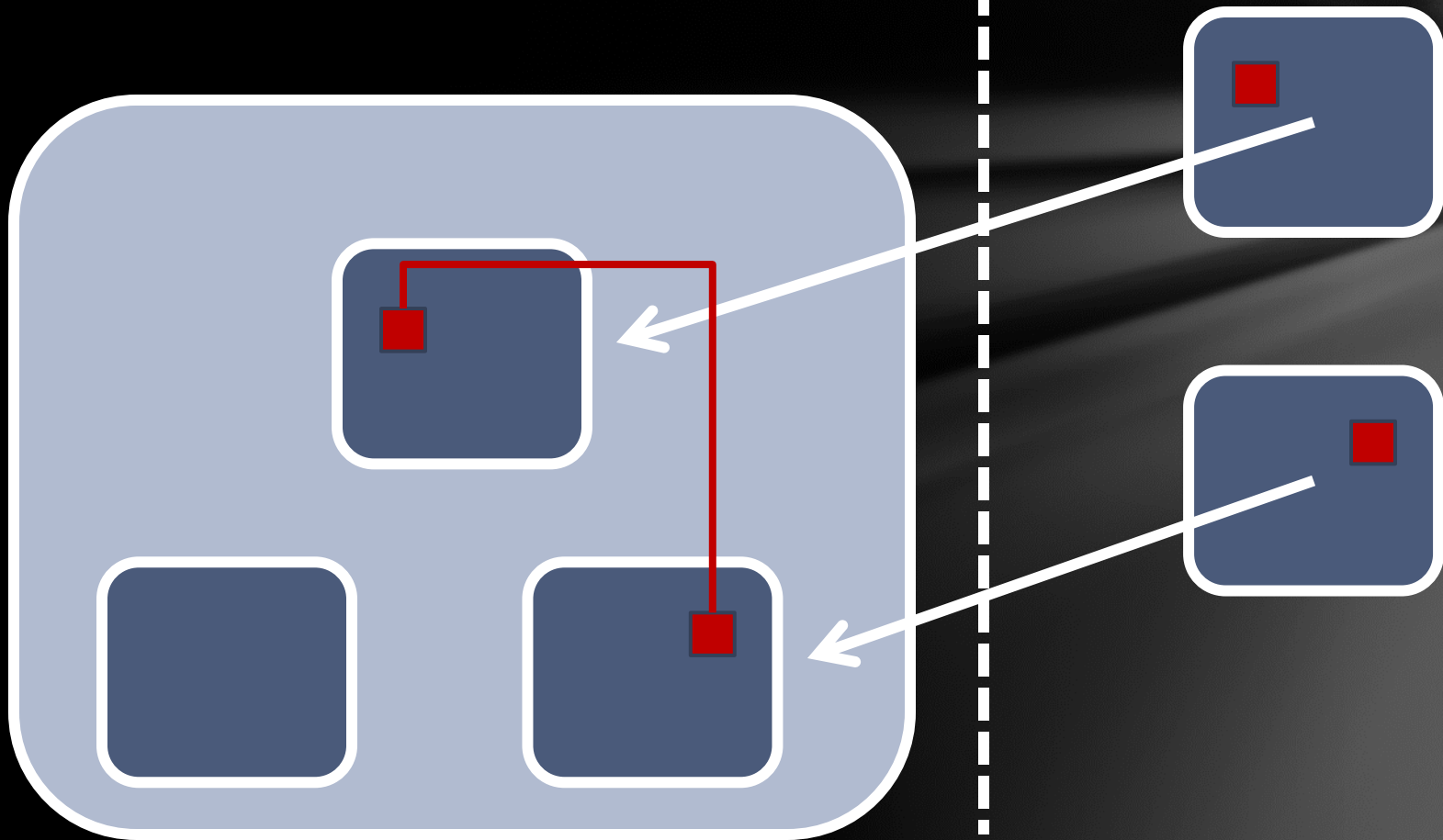
External library



# Implications for libraries

Your workspace

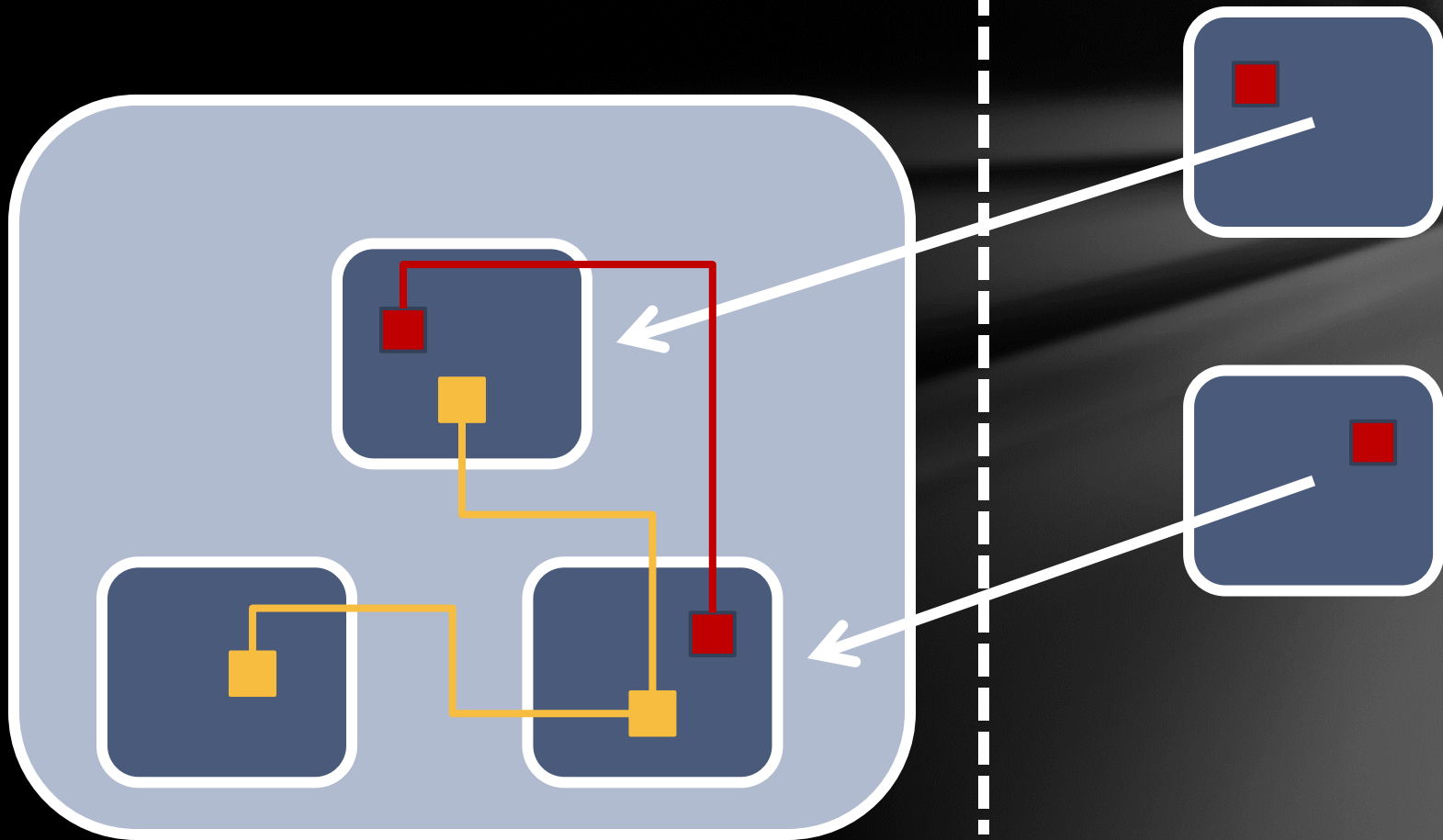
External library



# Implications for libraries

Your workspace

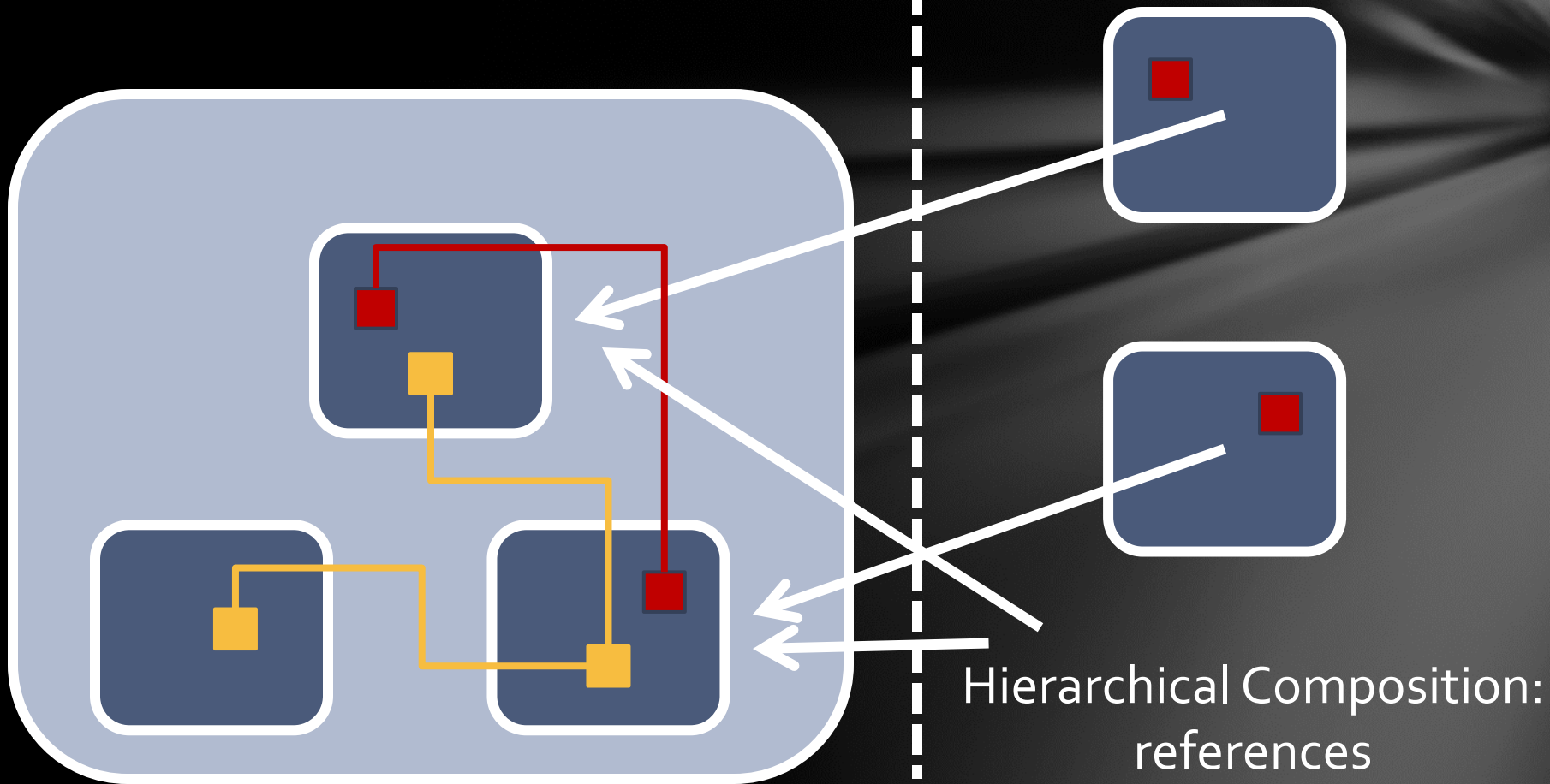
External library



# Implications for libraries

Your workspace

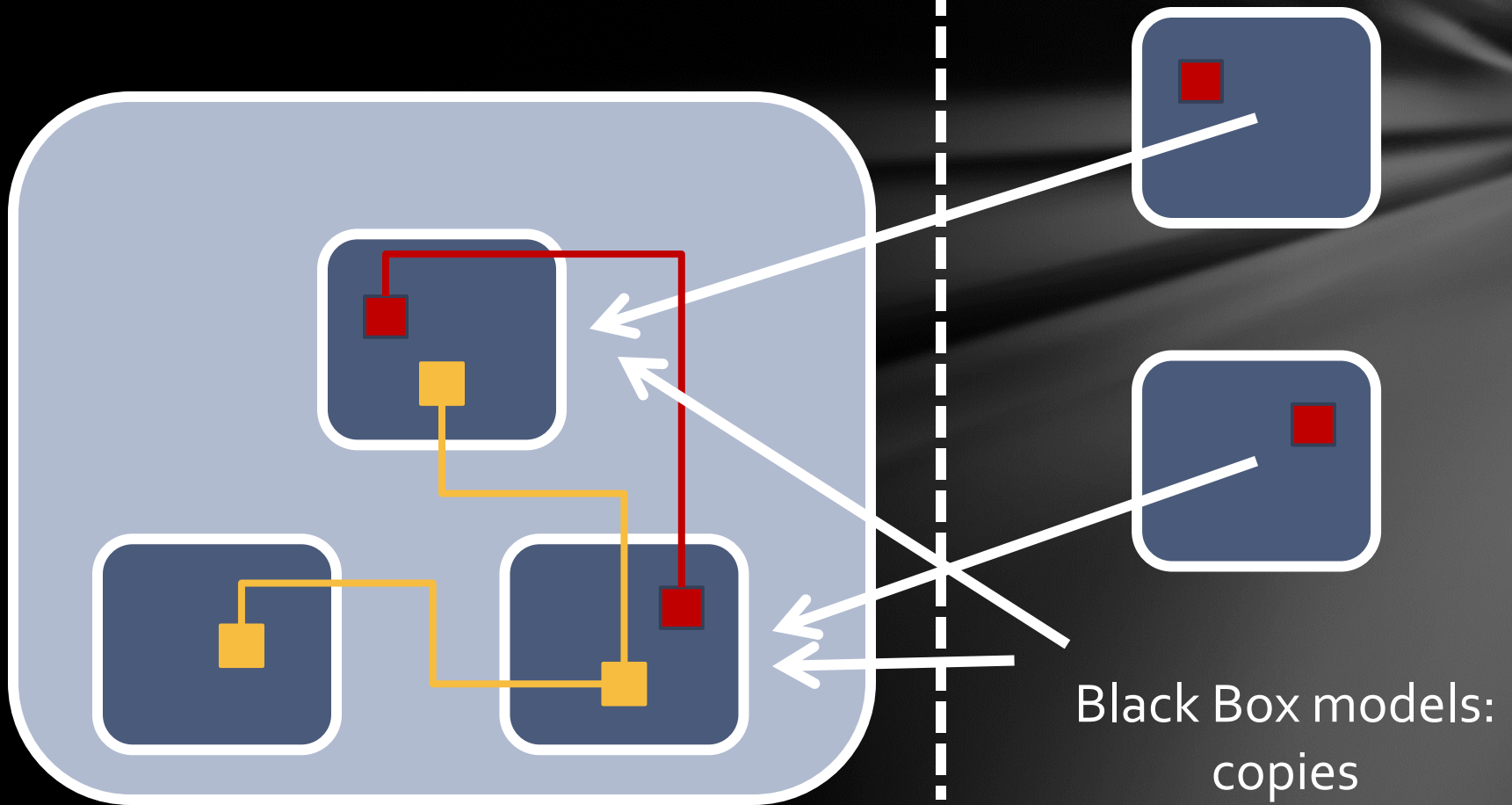
External library



# Implications for libraries

Your workspace

External library



# Math vs. Objects

$$J_0 = k_0 * A$$

$$dA/dt = -J_0$$

$$dB/dt = J_0$$





# Math vs. Objects

$$J_0 = k_0 * A$$

$$J_1 = k_1 * C$$

$$dA/dt = -J_0$$

$$dC/dt = -J_1$$

$$dB/dt = J_0 + J_1$$



# Math vs. Objects

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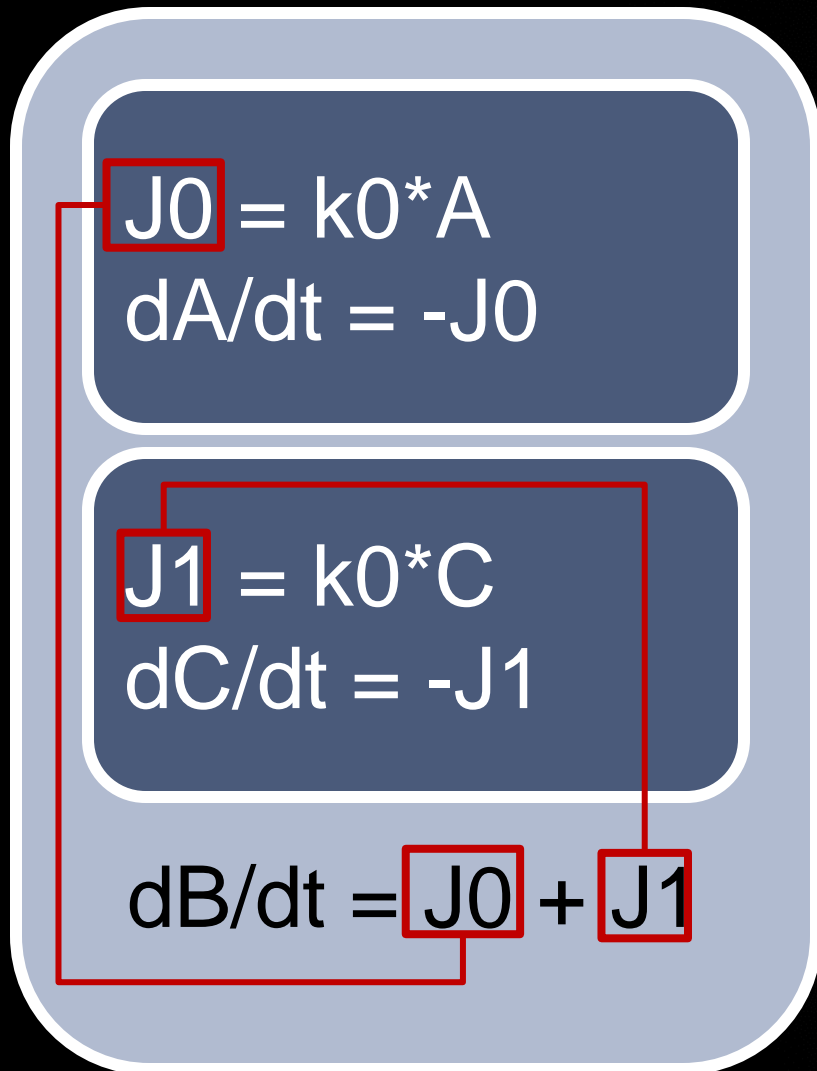
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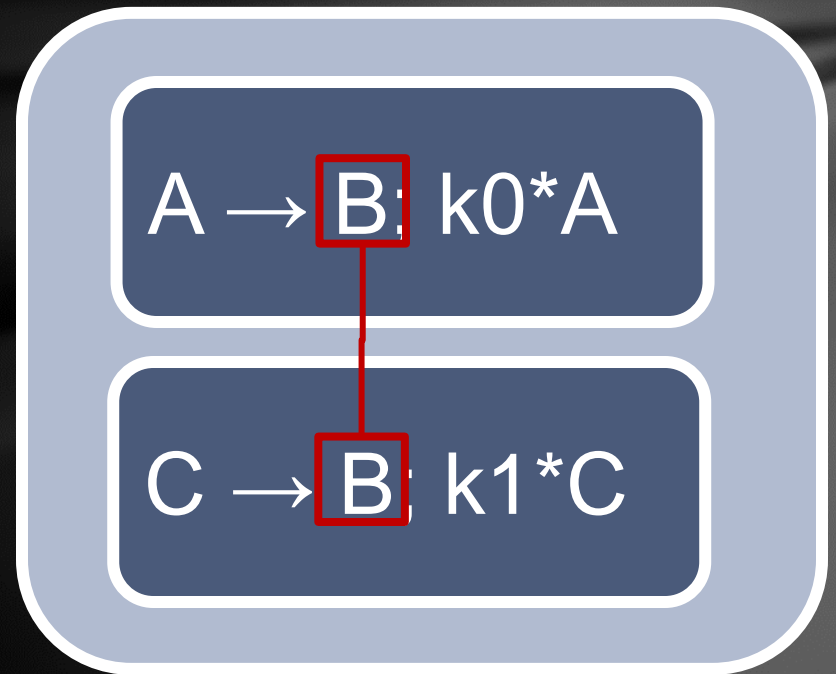
$$dB/dt = J_0 + J_1$$



# Math vs. Objects



Big Difference!!!



# Math vs. Objects

# Math vs. Objects

black box vs. model composition