PETRI NETS IN A NUTSHELL

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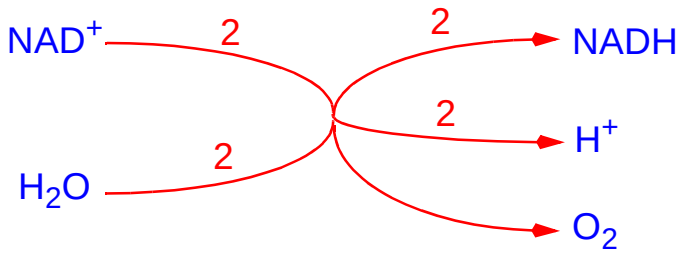
...

ARE NETWORKS OF BIOCHEMICAL REACTIONS

$2\ NAD^+ + 2\ H_2O \rightarrow 2\ NADH + 2\ H^+ + O_2$



. . .

ARE NETWORKS OF BIOCHEMICAL REACTIONS

. . .

NATURALLY EXPRESSIBLE AS PETRI NETS

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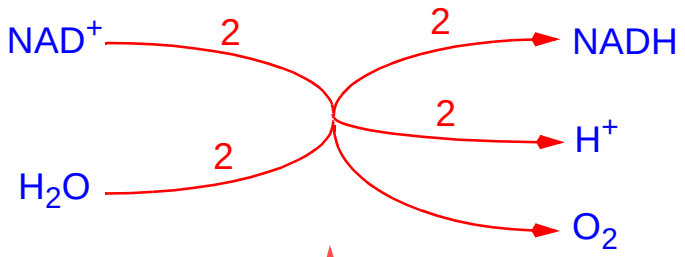
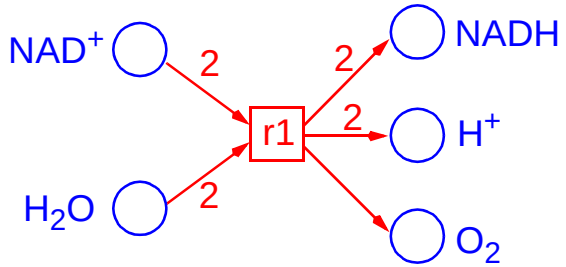


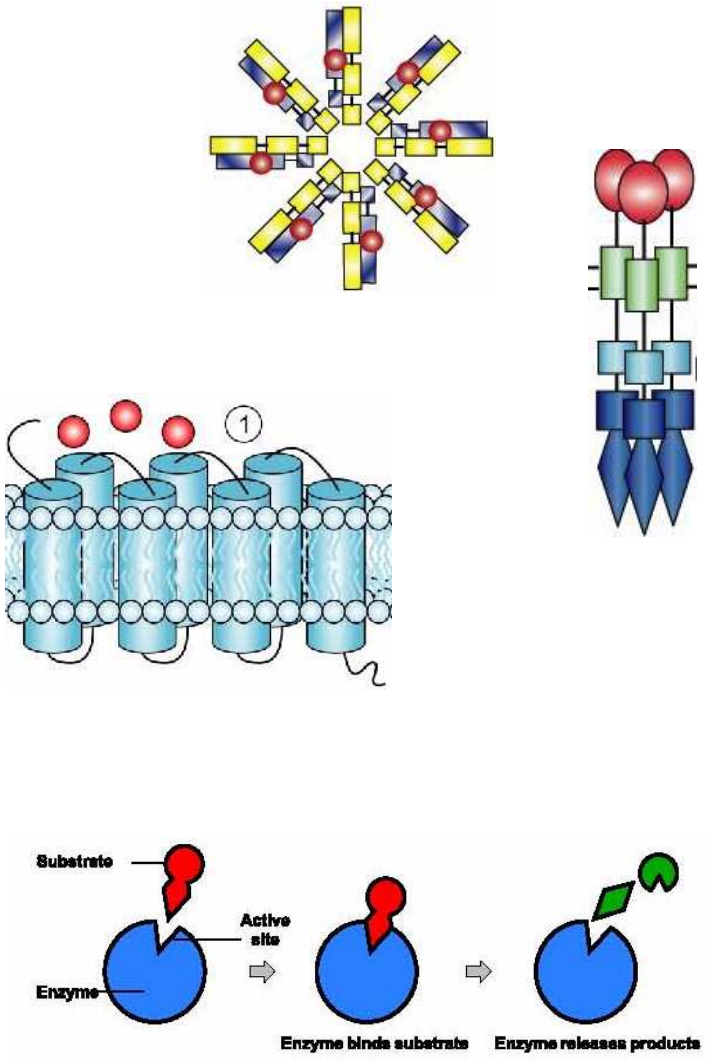
hyper-arcs



PLACES, TRANSITIONS - SOME BIO INTERPRETATIONS

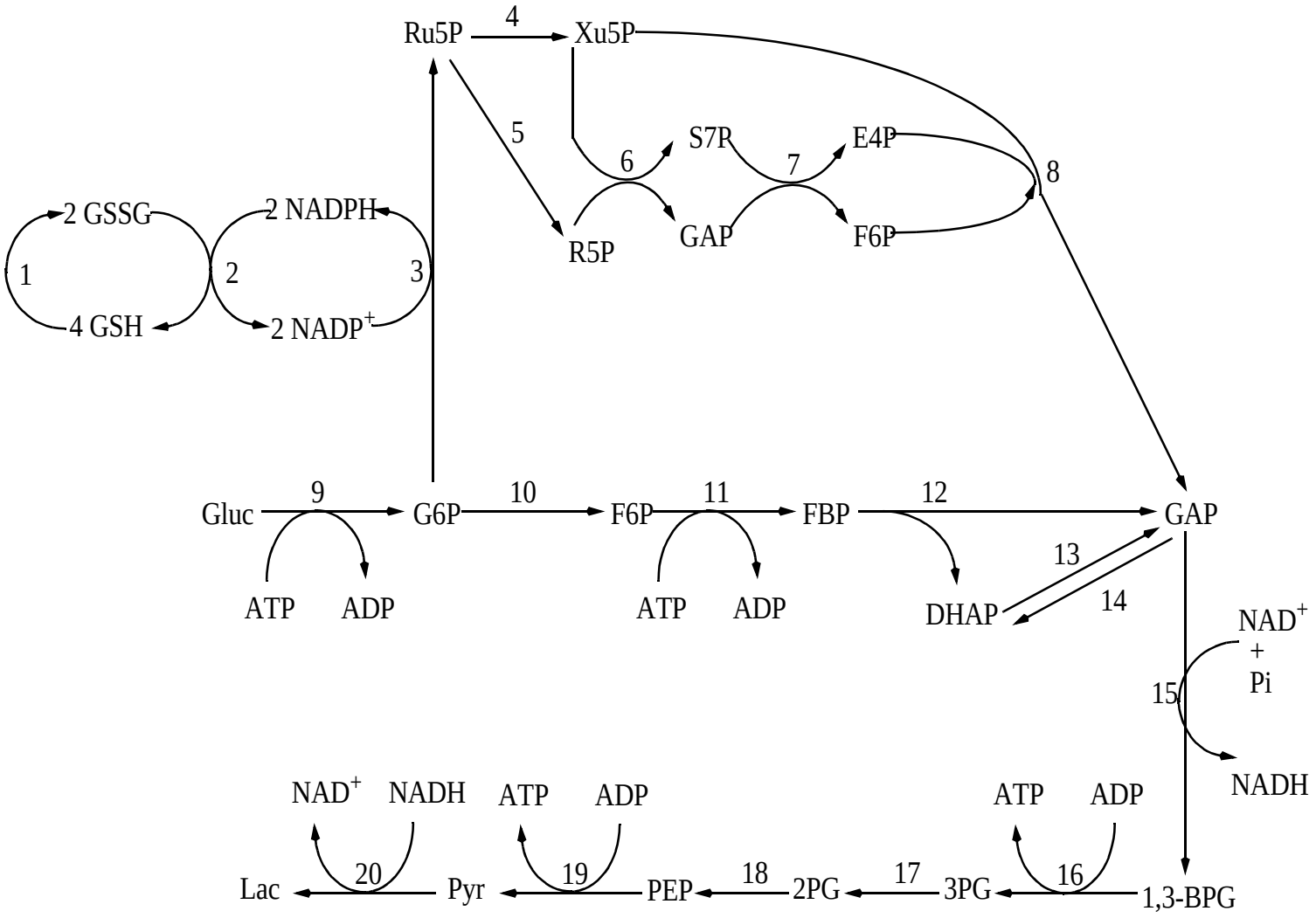
- **places -> model variables**
  - -> *(bio-) chemical compounds*
  - -> *proteins*
  - -> *protein conformations*
  - -> *complexes*
  - -> *genes, . . . , etc.*
  - *. . . in different locations*

- **transitions -> atomic events**
  - -> *(stoichiometric) chemical reaction*
  - -> *complexation / decomplexation*
  - -> *phosphorylation / dephosphorylation*
  - -> *conformational change*
  - -> *transport step, . . . , etc.*
  - *. . . in different locations*



Ex1 - Glycolysis and Pentose Phosphate Pathway

[Reddy 1993]



Ex1 - Glycolysis and Pentose Phosphate Pathway

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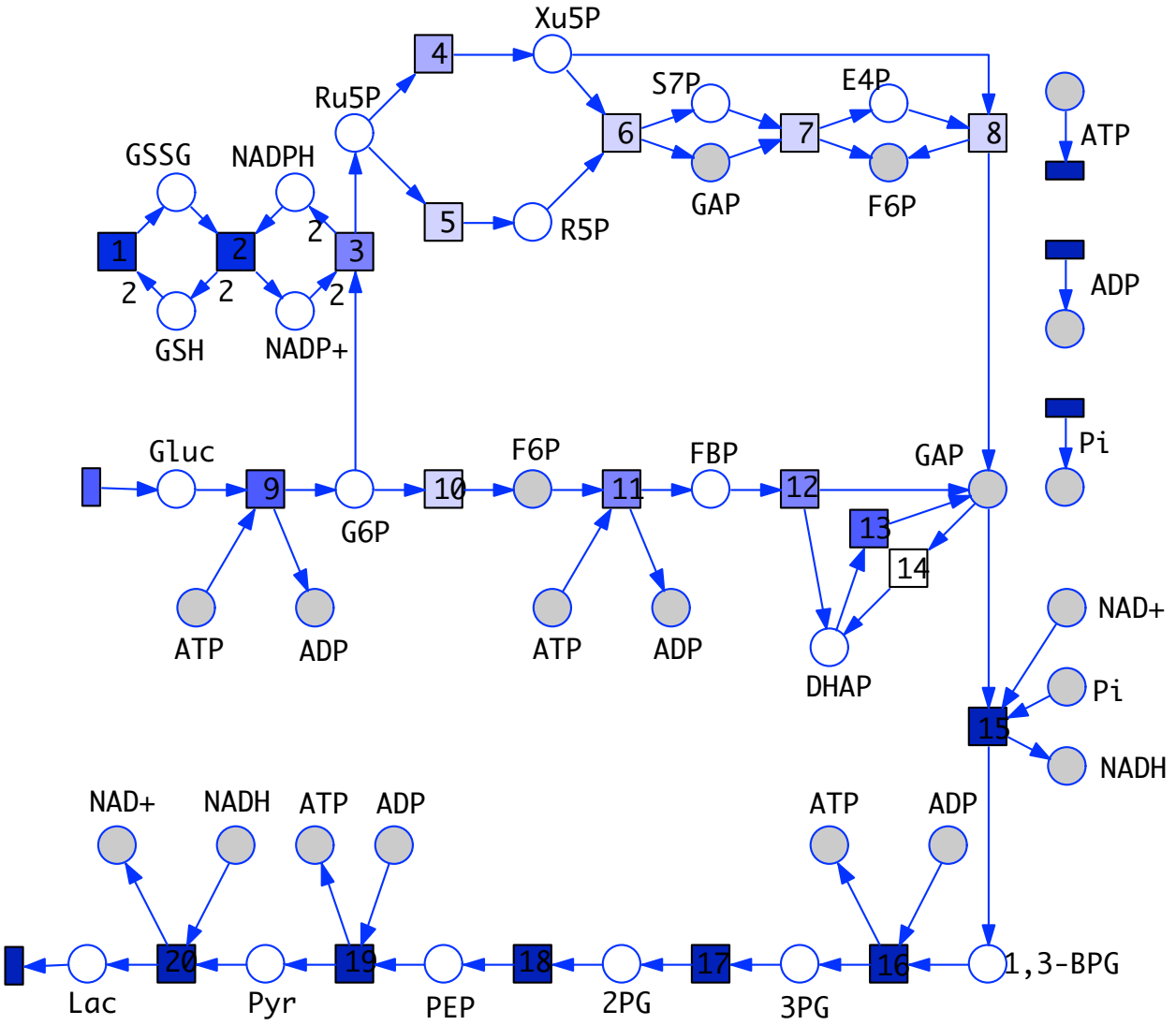
[Heiner 1998]



Ex1 - Glycolysis and Pentose Phosphate Pathway

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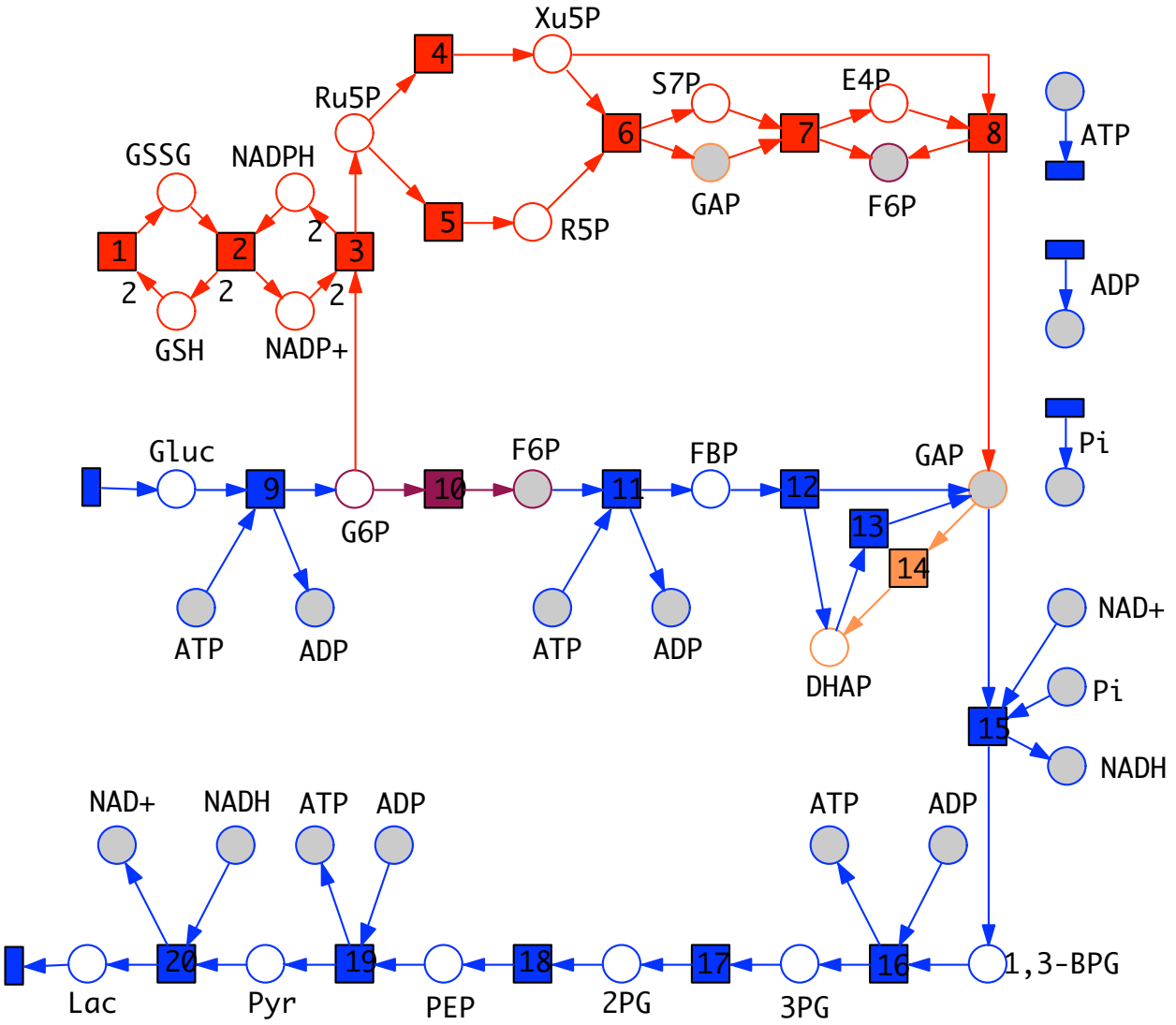
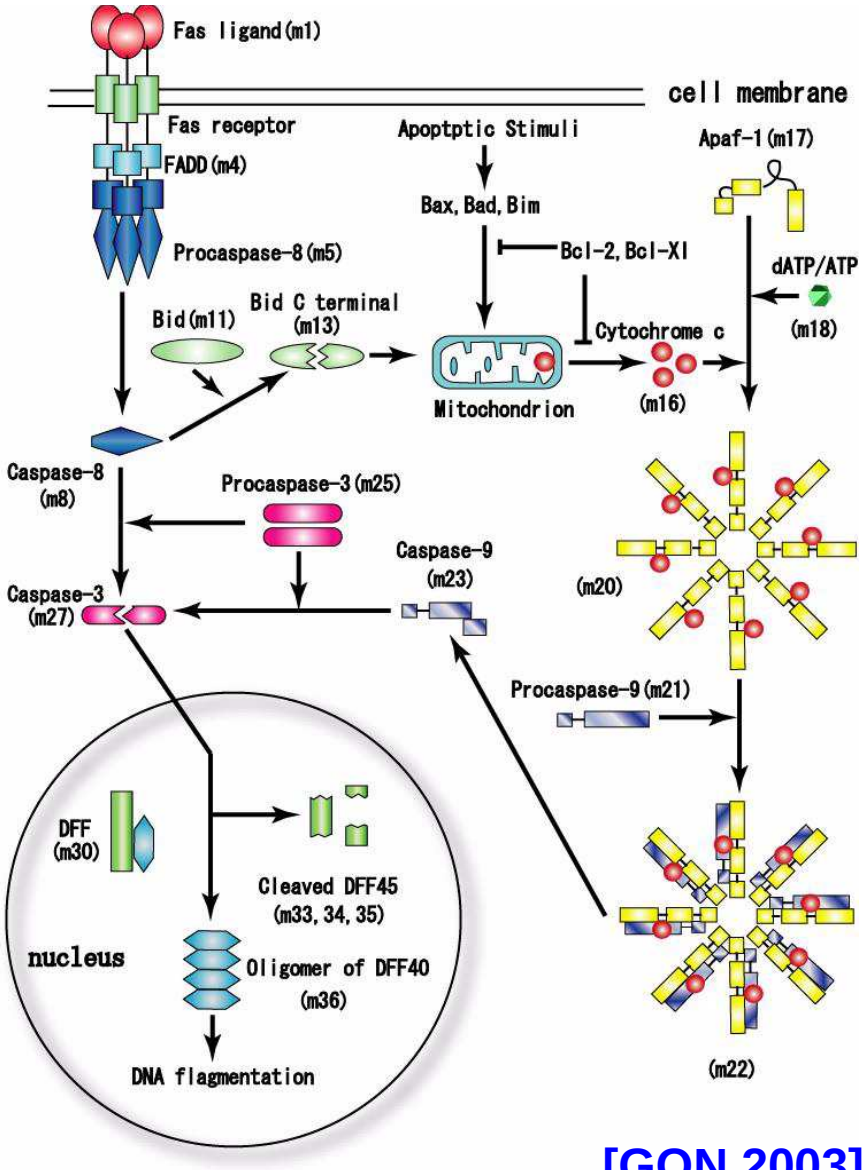
[Heiner 1998]
[Heiner 2009]



EX2 - APOPTOSIS IN MAMMALIAN CELLS



[GON 2003]

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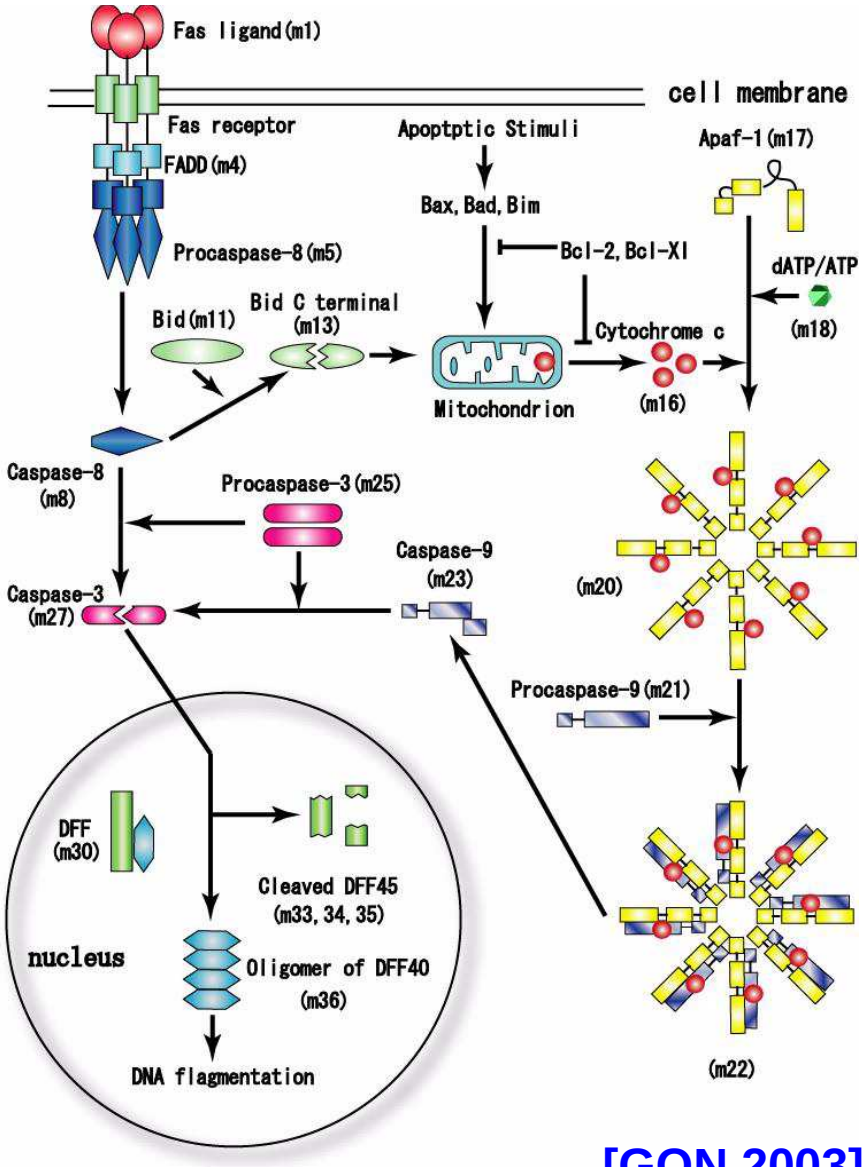
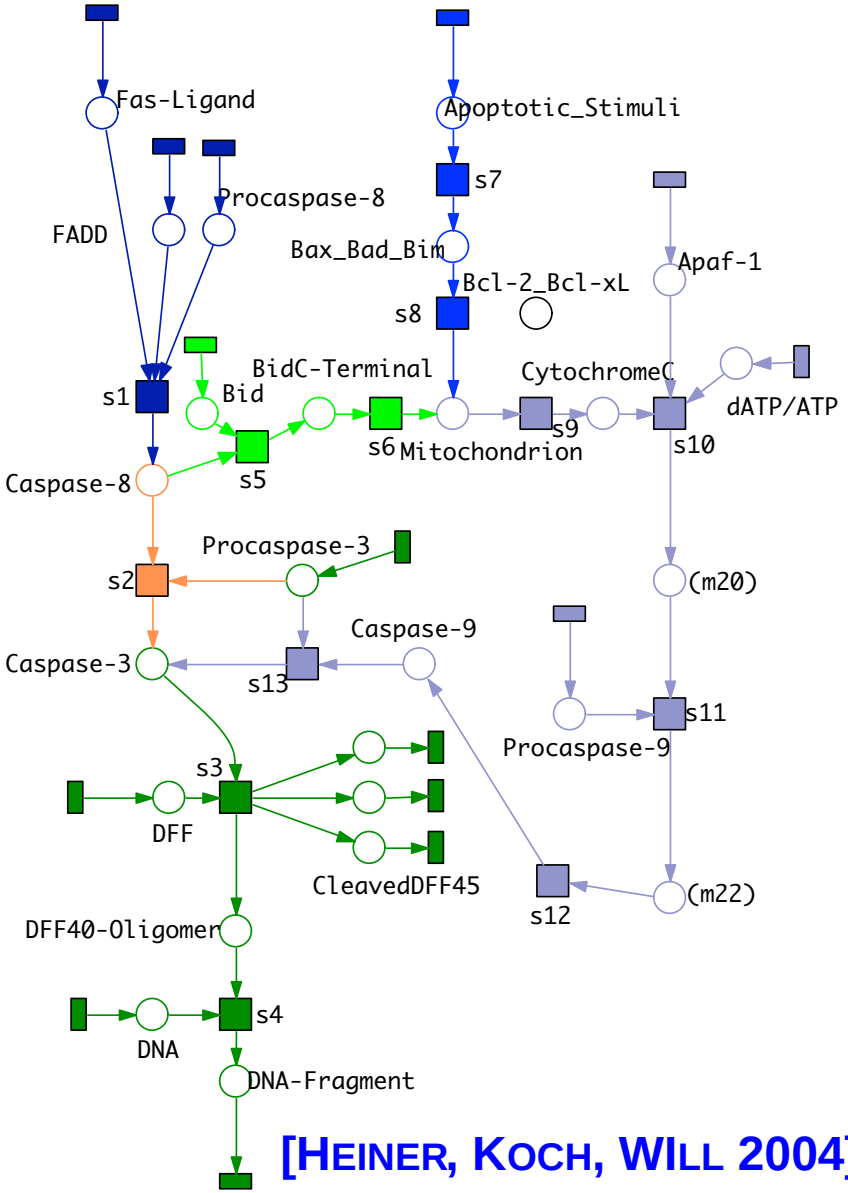
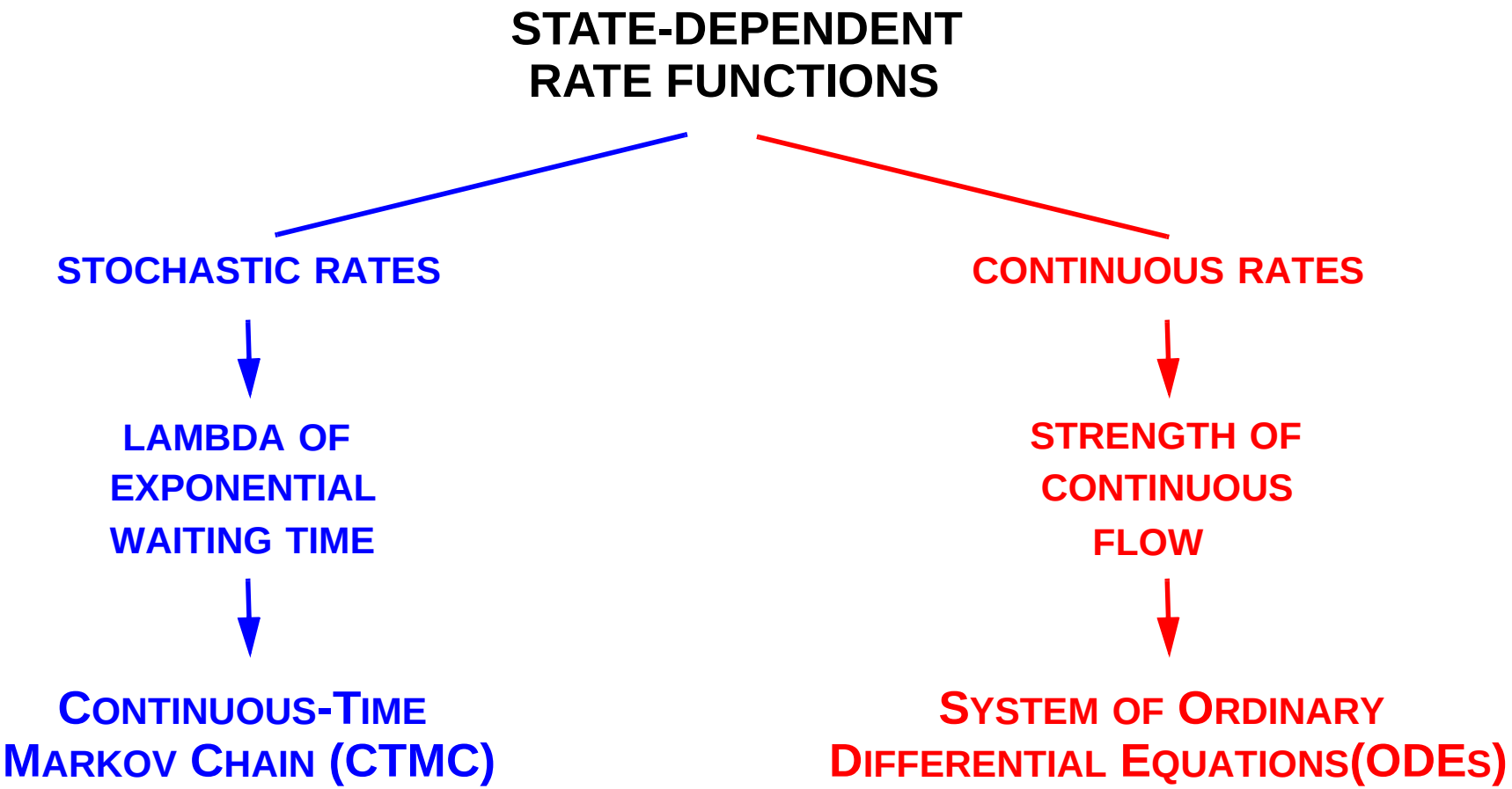


[GON 2003]



[HEINER, KOCH, WILL 2004]

STATE-DEPENDENT RATE FUNCTIONS

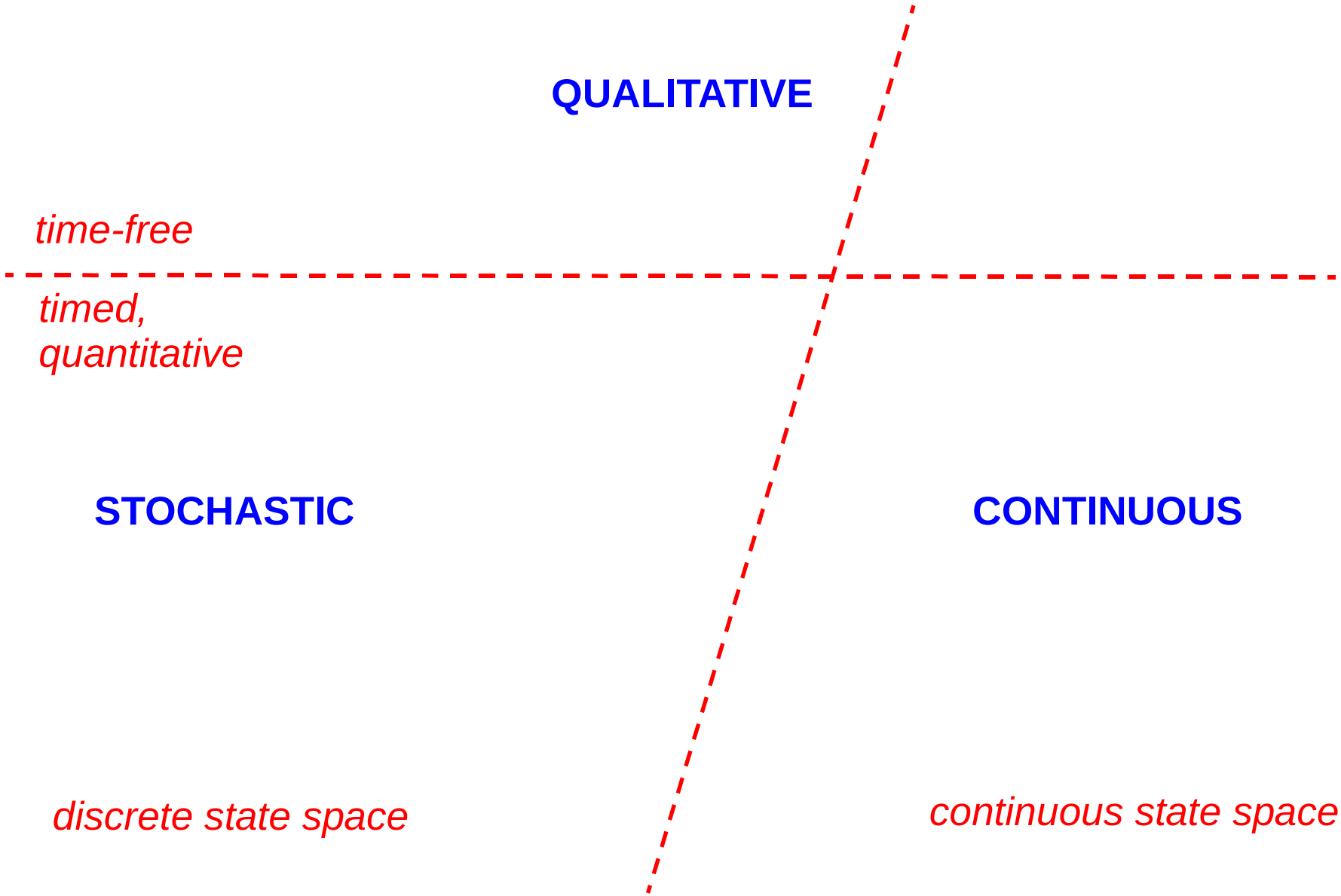

STATE-DEPENDENT
RATE FUNCTIONS
STOCHASTIC RATES
CONTINUOUS RATES
LAMBDA OF
EXPONENTIAL
WAITING TIME
STRENGTH OF
CONTINUOUS
FLOW
CONTINUOUS-TIME
MARKOV CHAIN (CTMC)
SYSTEM OF ORDINARY
DIFFERENTIAL EQUATIONS(ODES)

QUALITATIVE

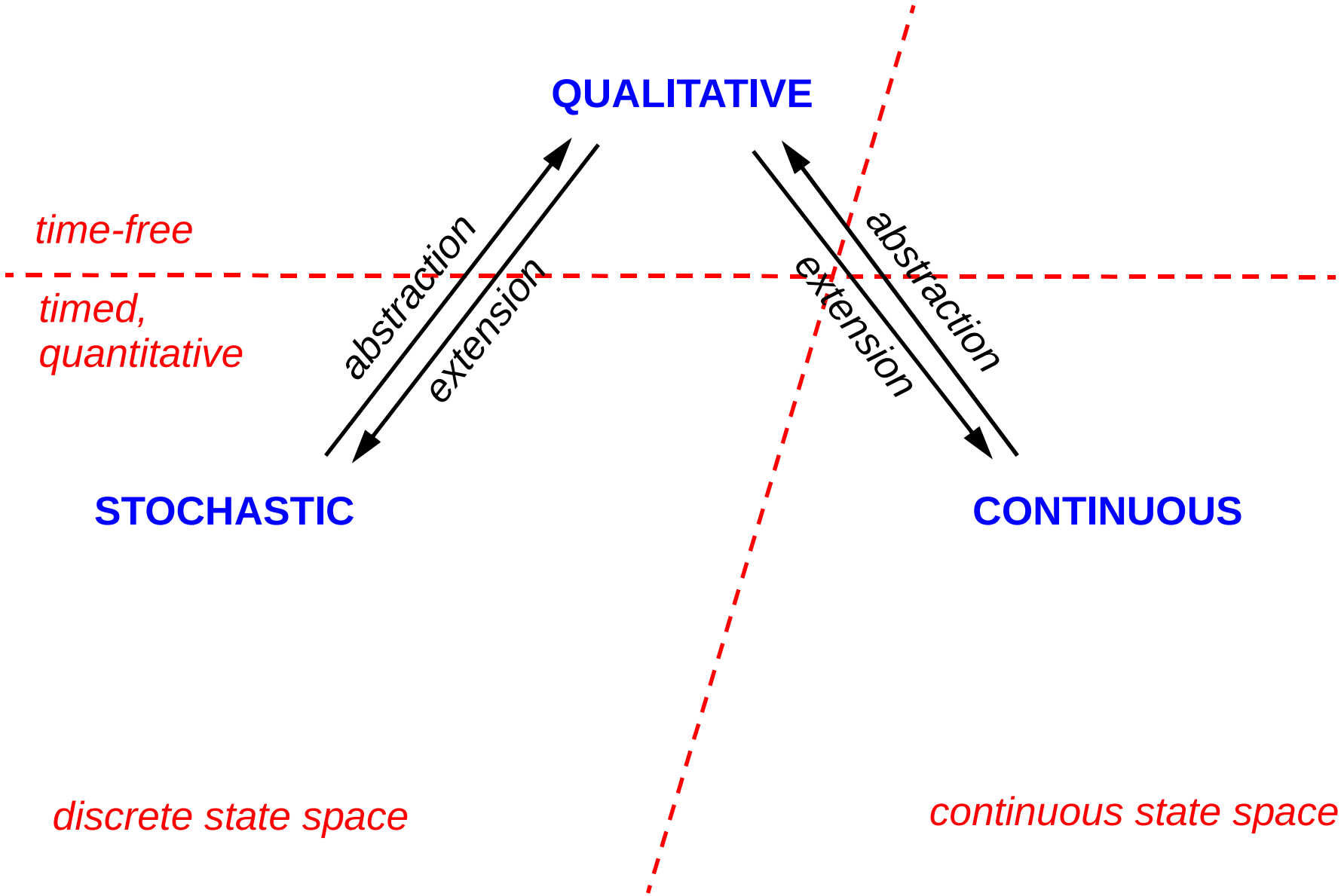
STOCHASTIC

CONTINUOUS

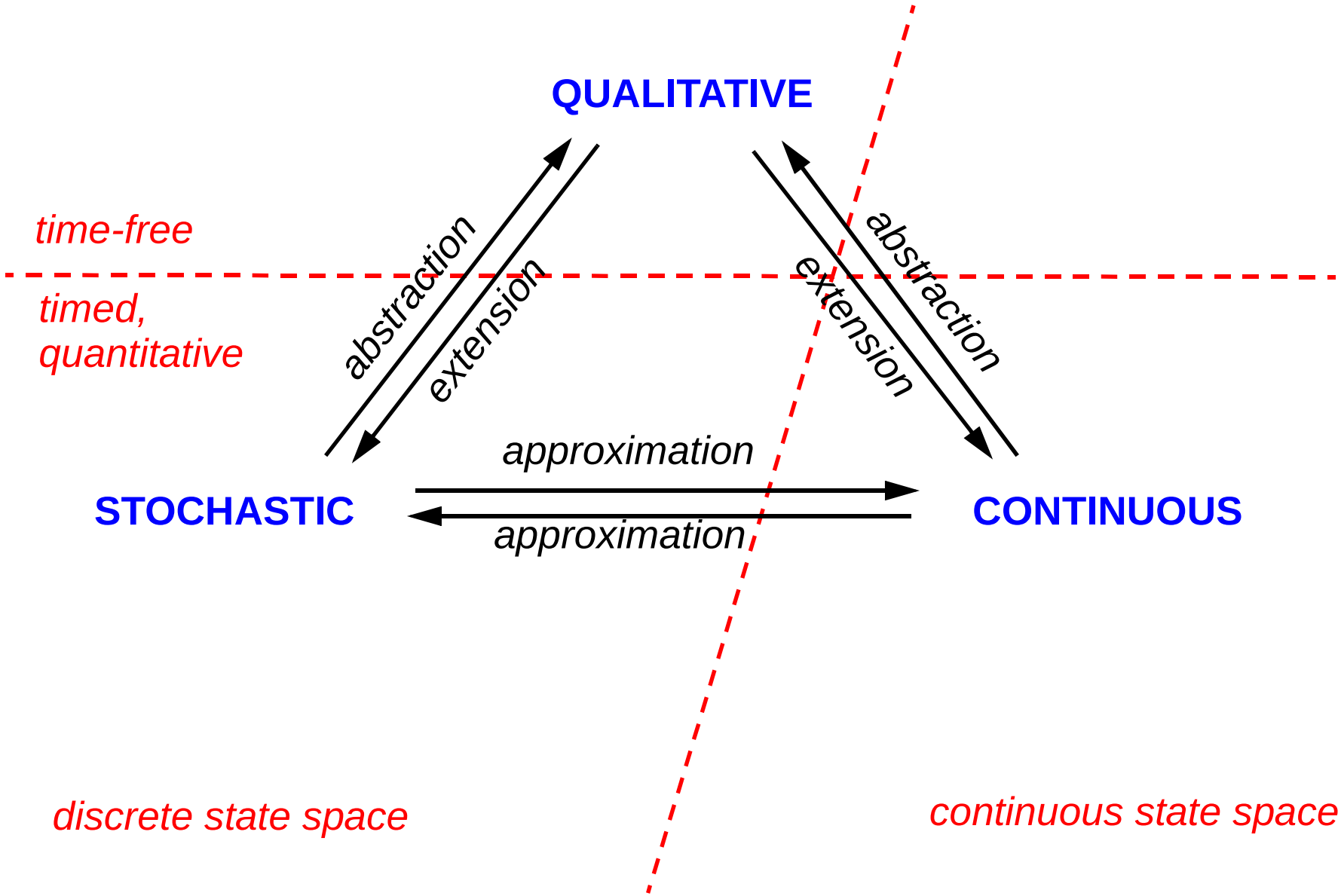
FRAMEWORK 2007



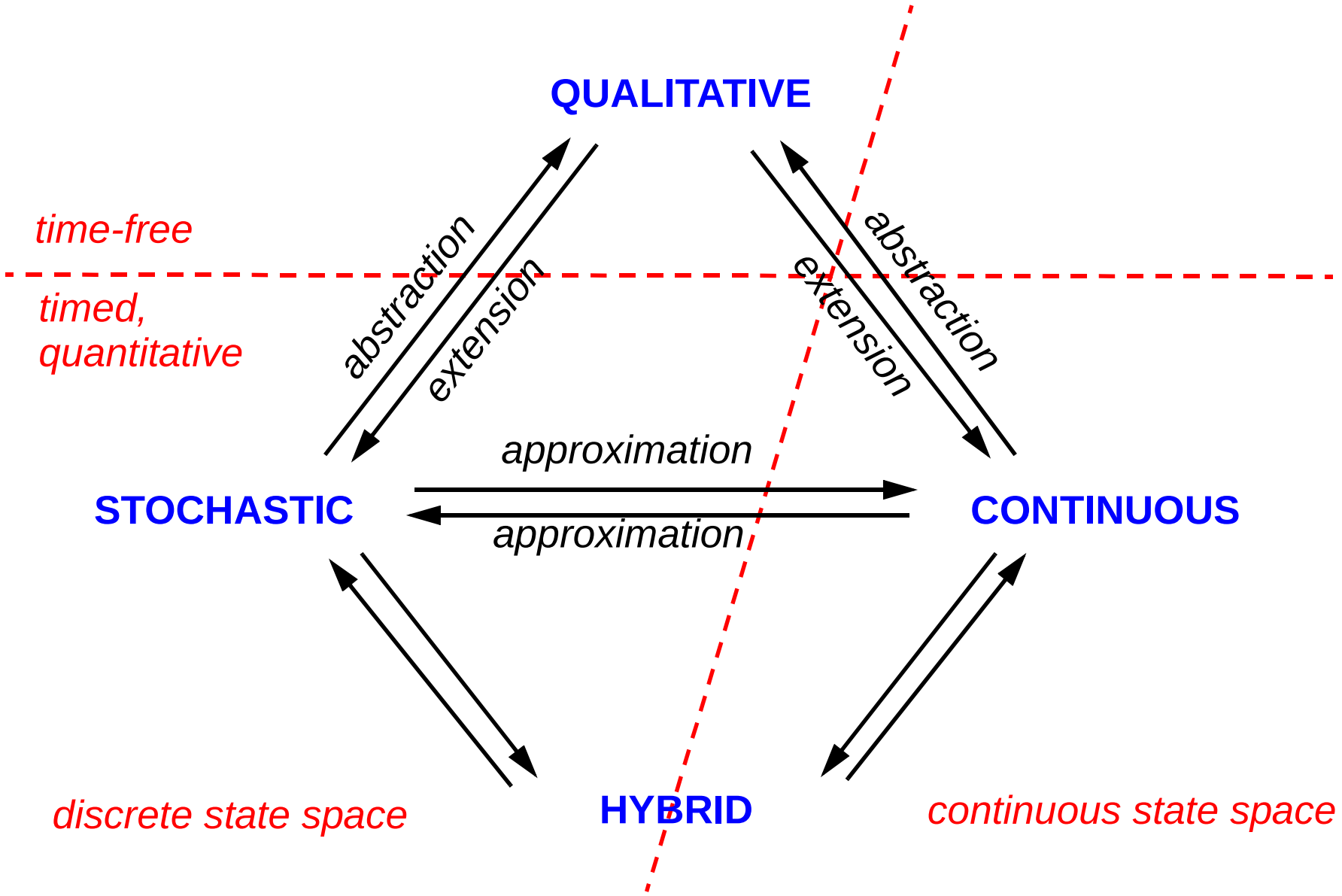
FRAMEWORK 2007



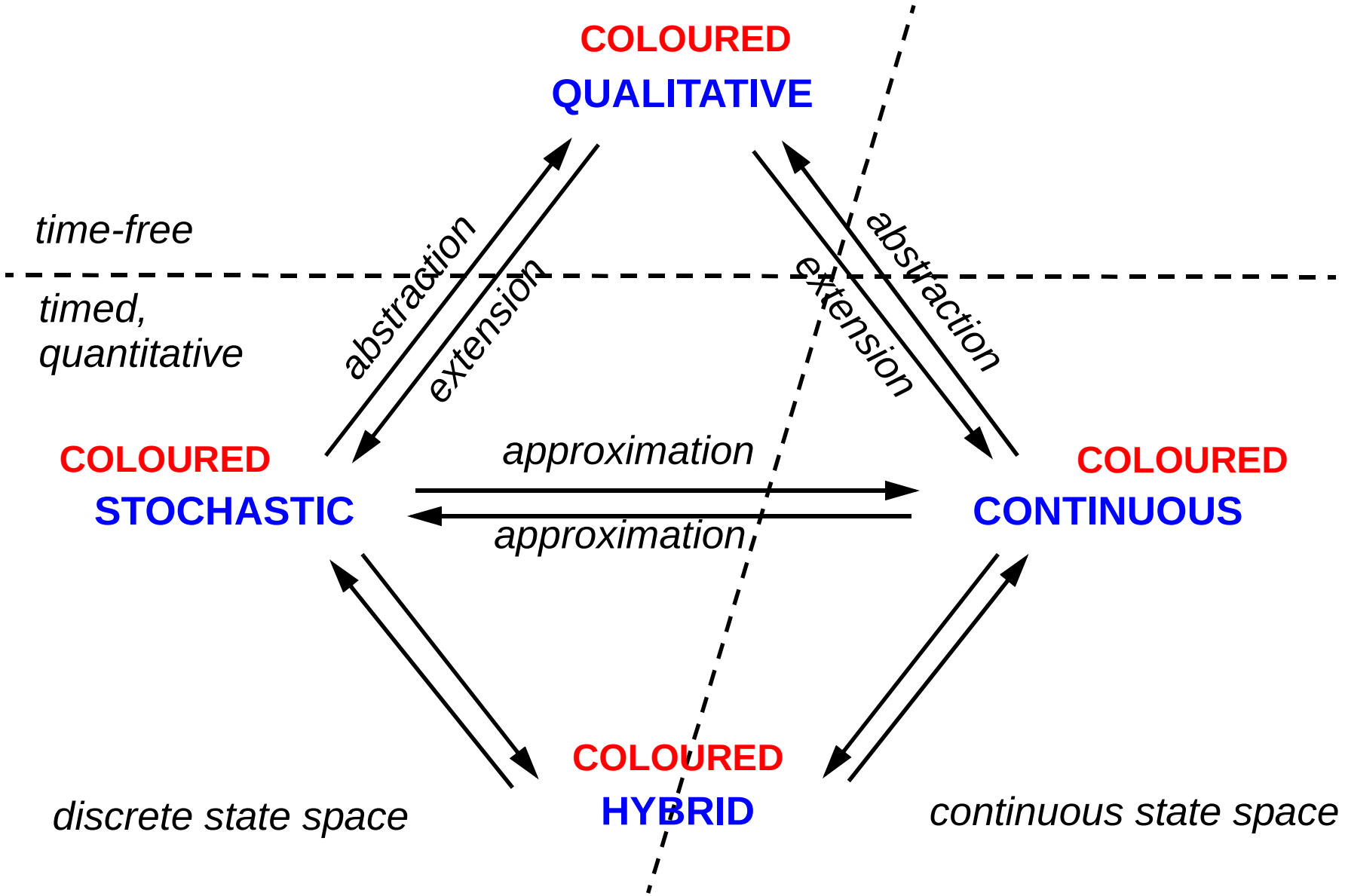
FRAMEWORK 2007



FRAMEWORK 2010



COLOURED FRAMEWORK 2011



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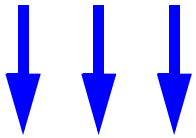
4x2

MODELS SHARING STRUCTURE

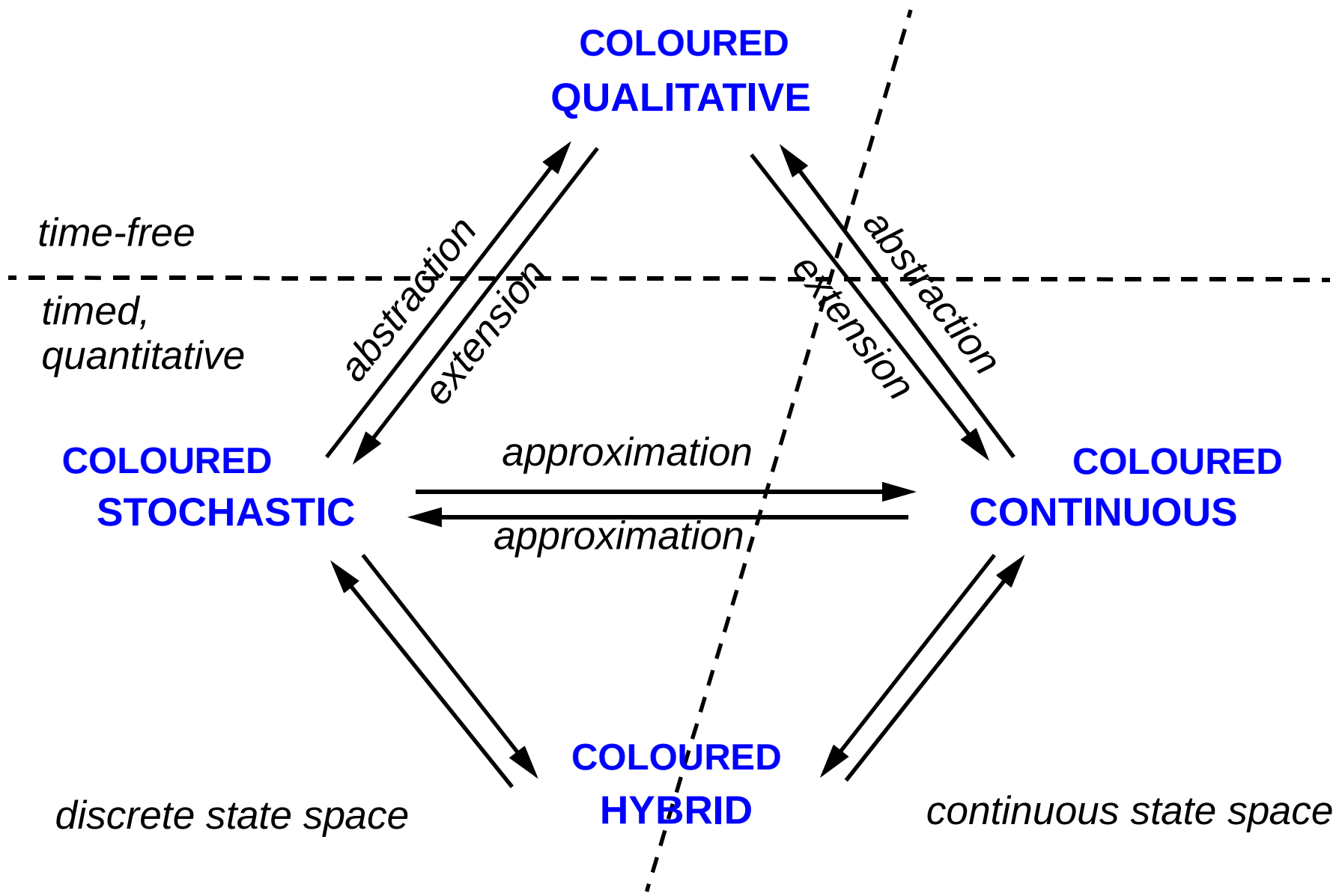


QUANTITATIVE MODEL = QUALITATIVE MODEL

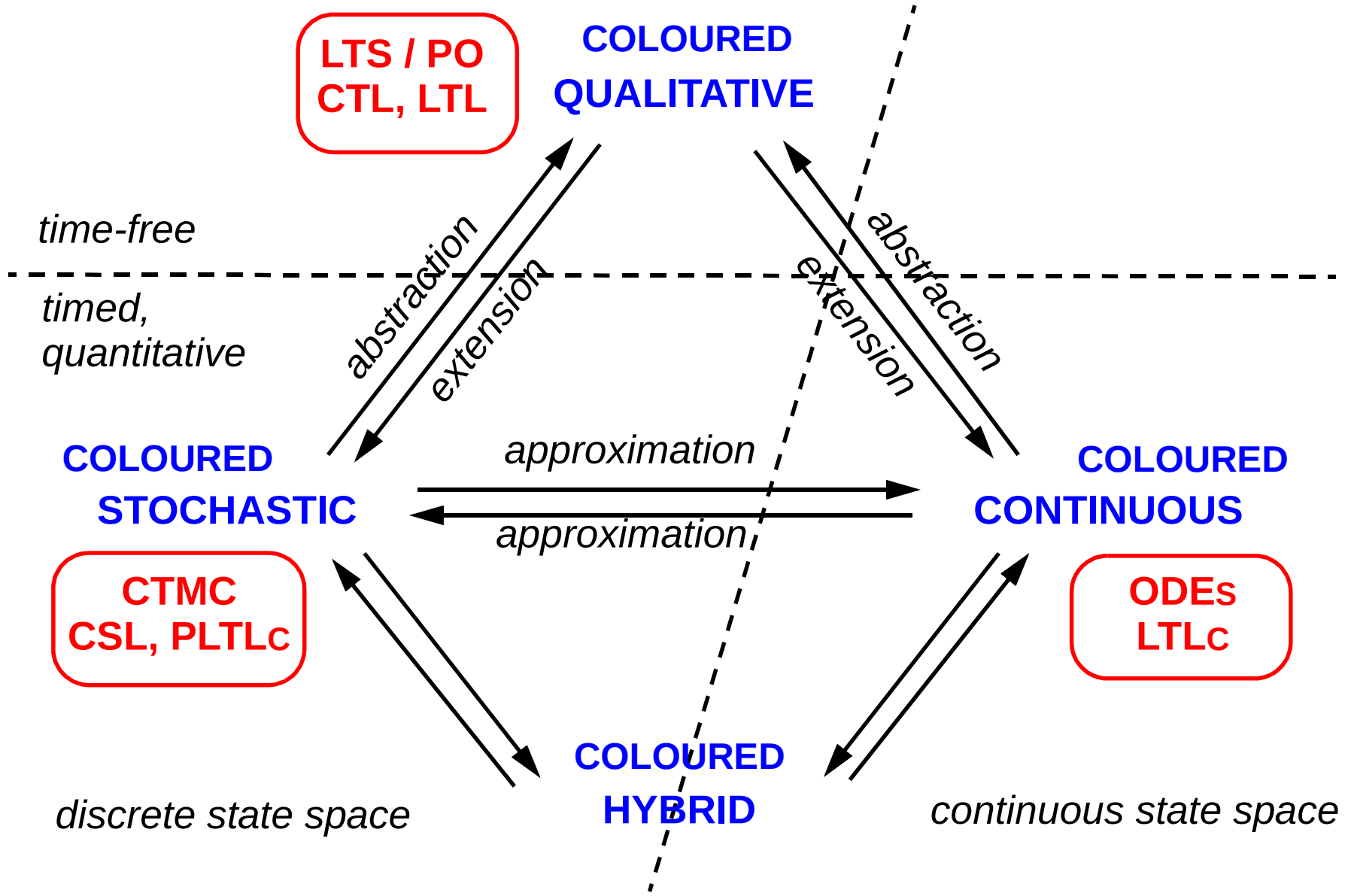
+

RATE FUNCTIONS (KINETICS)

FRAMEWORK


COLOURED
QUALITATIVE
time-free
timed,
quantitative
abstraction
extension
abstraction
extension
approximation
approximation
COLOURED
STOCHASTIC
COLOURED
CONTINUOUS
COLOURED
HYBRID
discrete state space
continuous state space

FRAMEWORK - ANALYSIS TECHNIQUES



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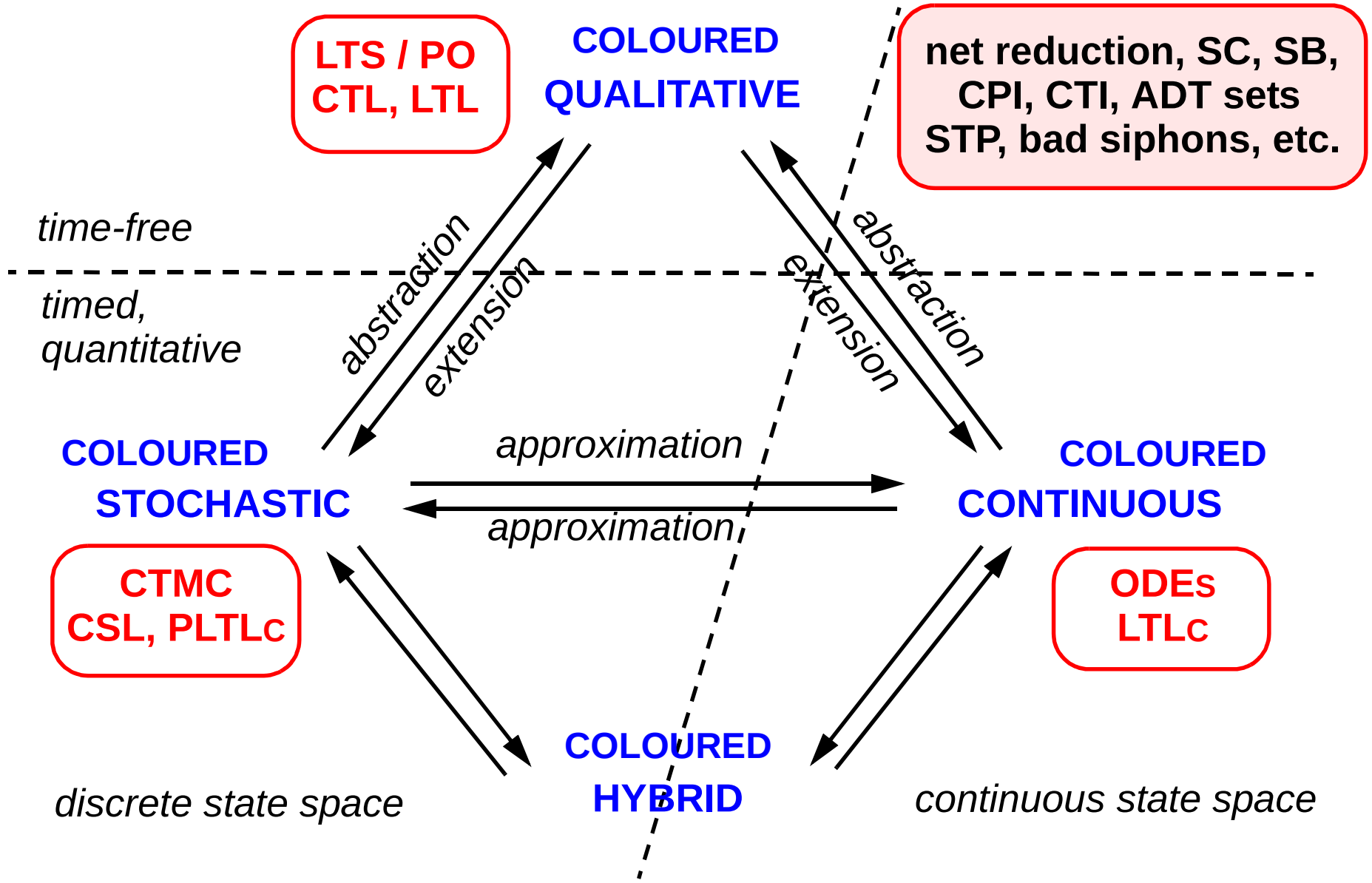
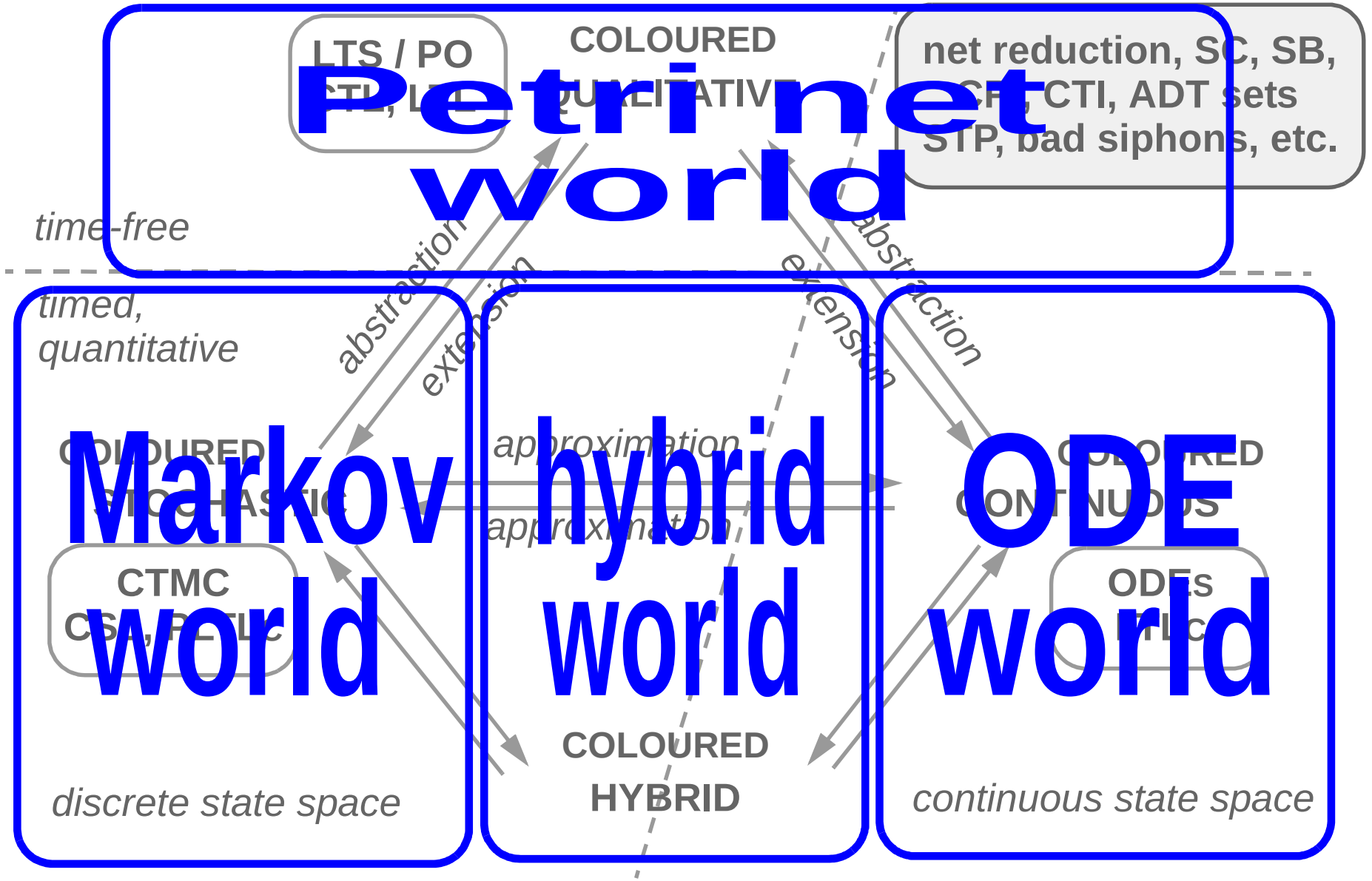
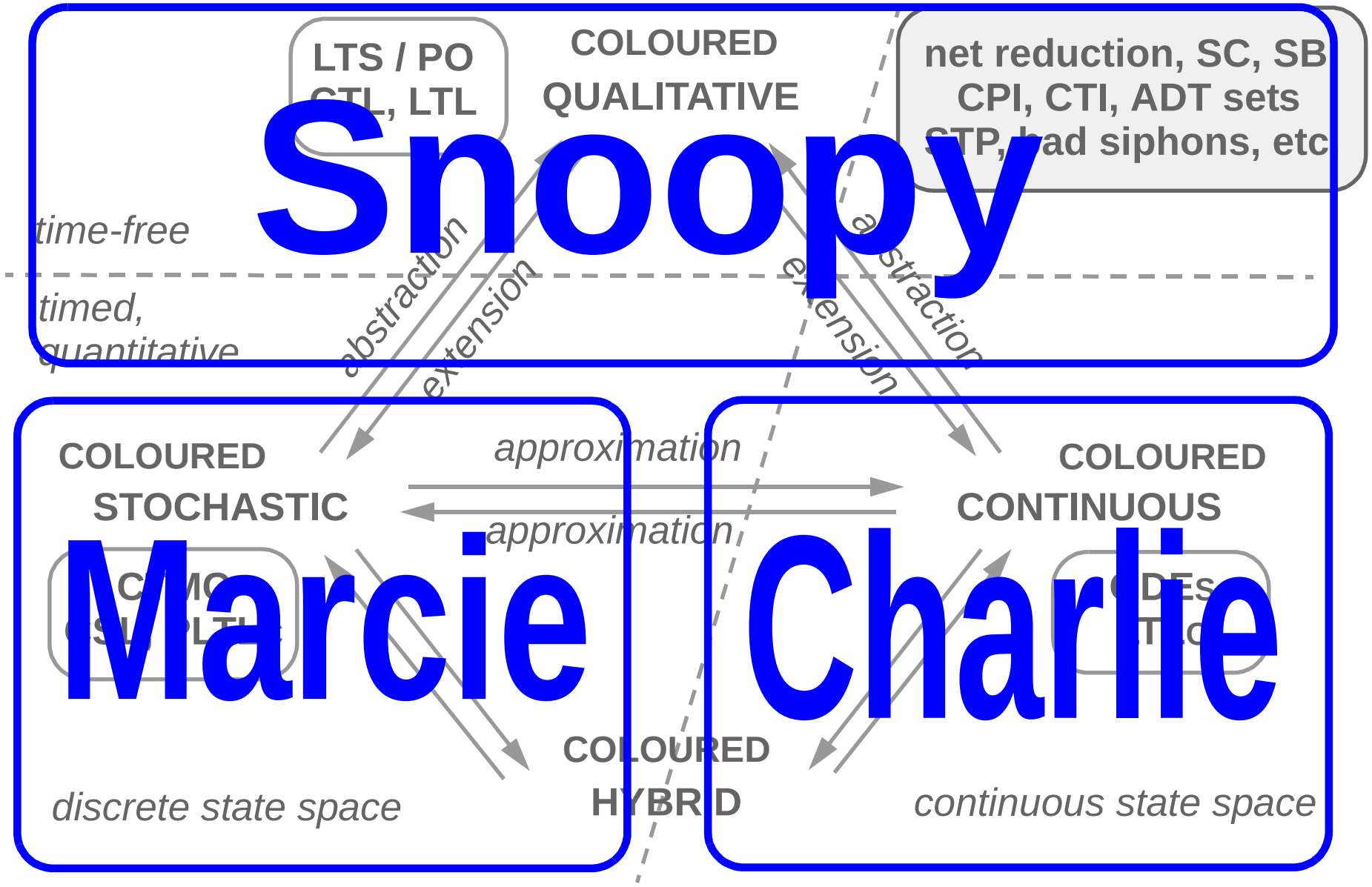



Petri net world
LTS / PO
COLOURED
net reduction, SC, SB,
CFP, CTI, ADT sets
STP, bad siphons, etc.
time-free
timed,
quantitative
abstraction
extension
extension
abstraction
approximation
approximation
Markov world
hybrid world
ODE world
CTMC
COLOURED
HYBRID
ODEs
discrete state space
continuous state space

FRAMEWORK - TOOLBOX



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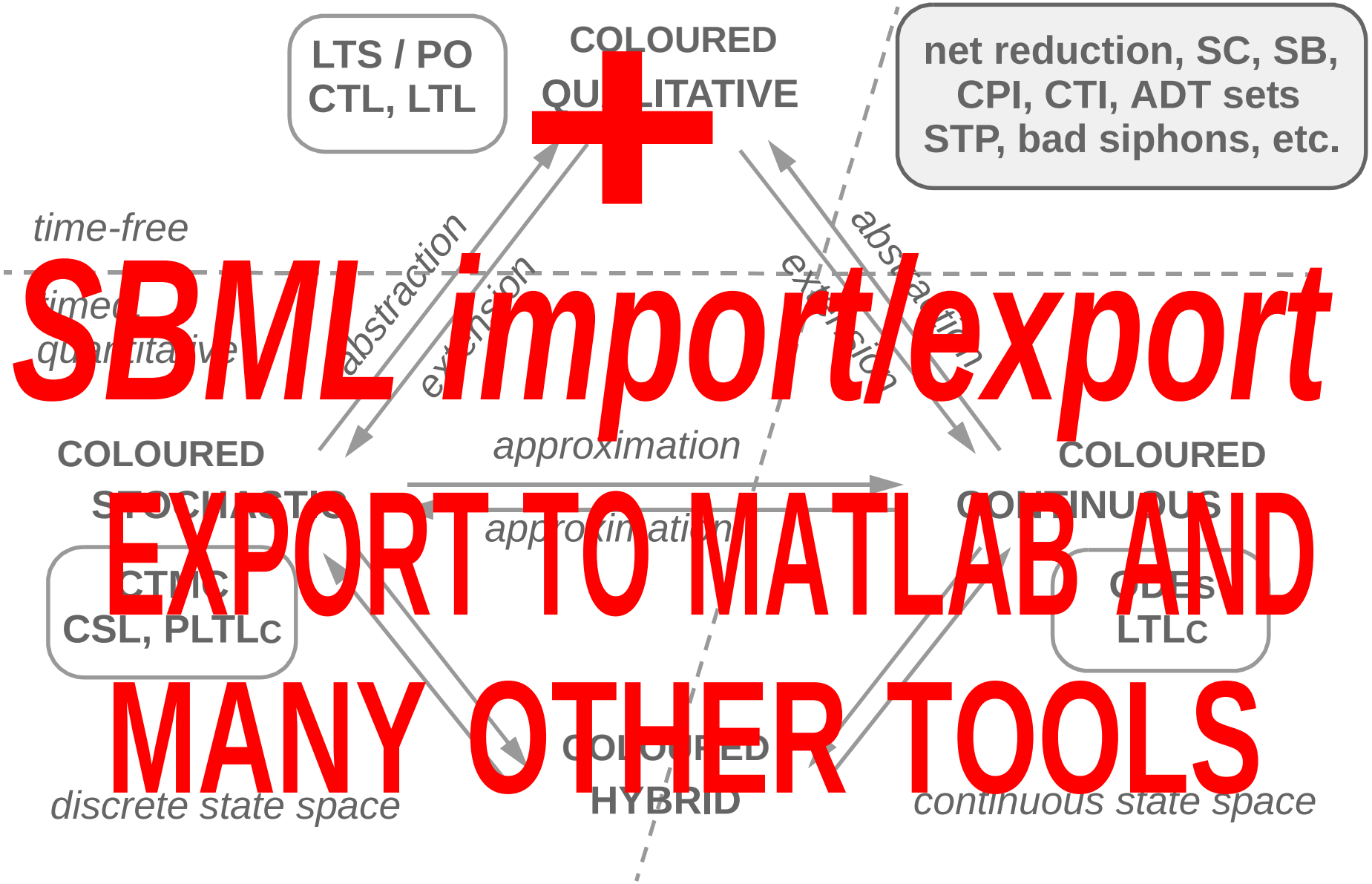

SBML import/export

EXPORT TO MATLAB AND MANY OTHER TOOLS