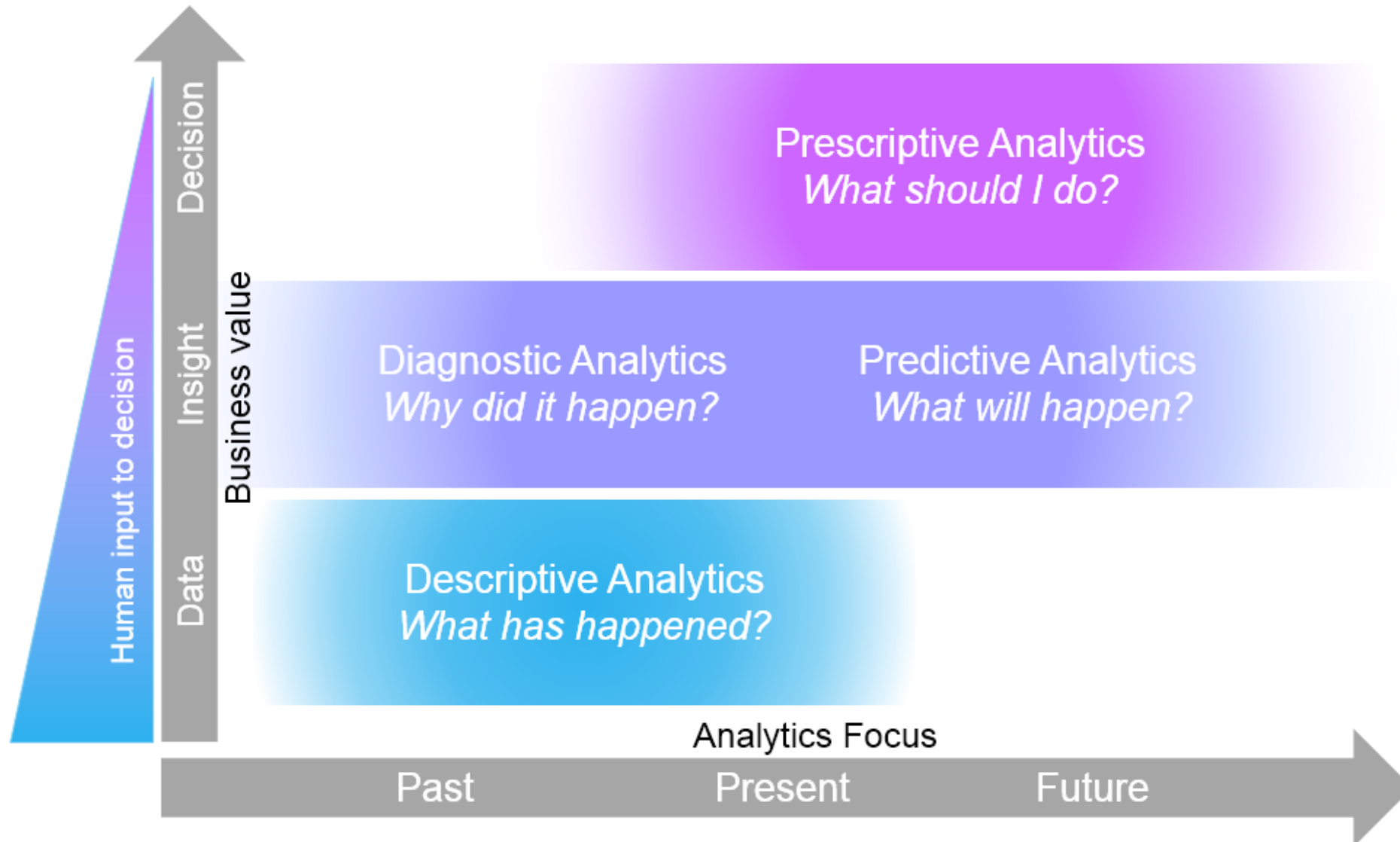


# Optimization via Machine Learning-based Simulation: Application to Modern Call Centers Management

**Stefano Gualandi,**  @famo2spaghi  
Department of Mathematics, University of Pavia

# Analytics Landscape

[JF. Puget, blogpost 21/09/2015]

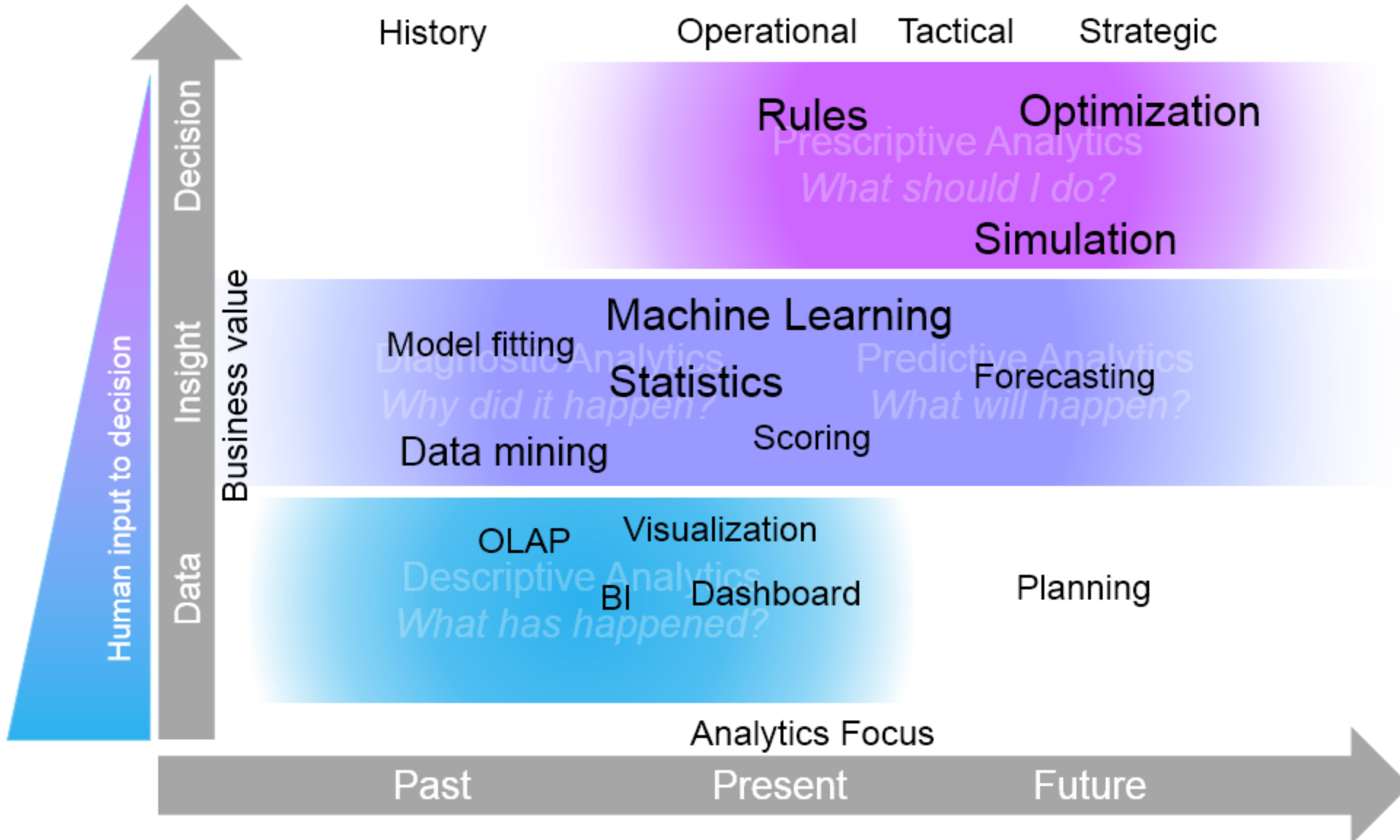


Source: <http://ibm.co/1gJyfl3>



# Analytics Landscape

[JF. Puget, blogpost 21/09/2015]

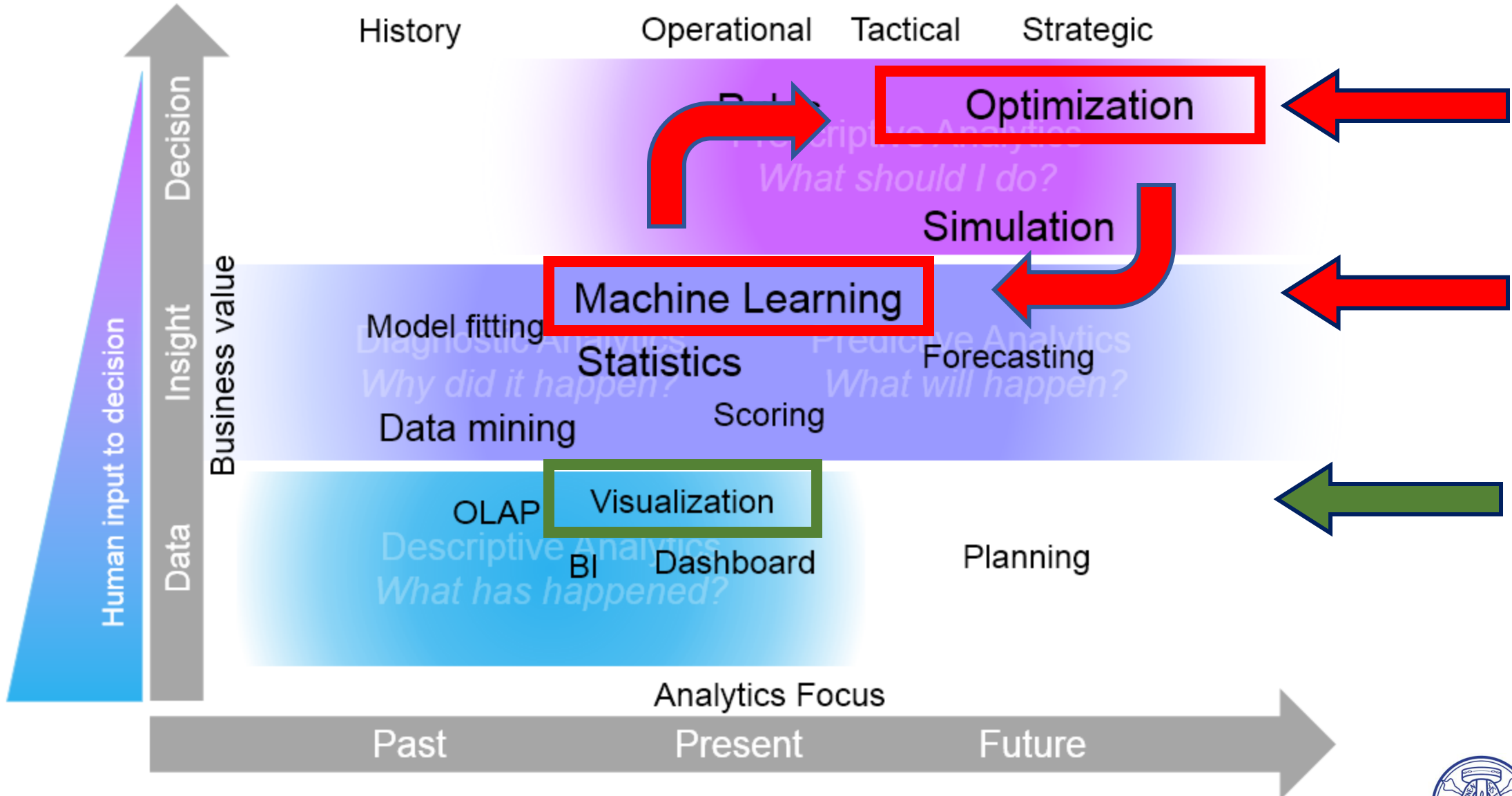


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# Analytics Landscape

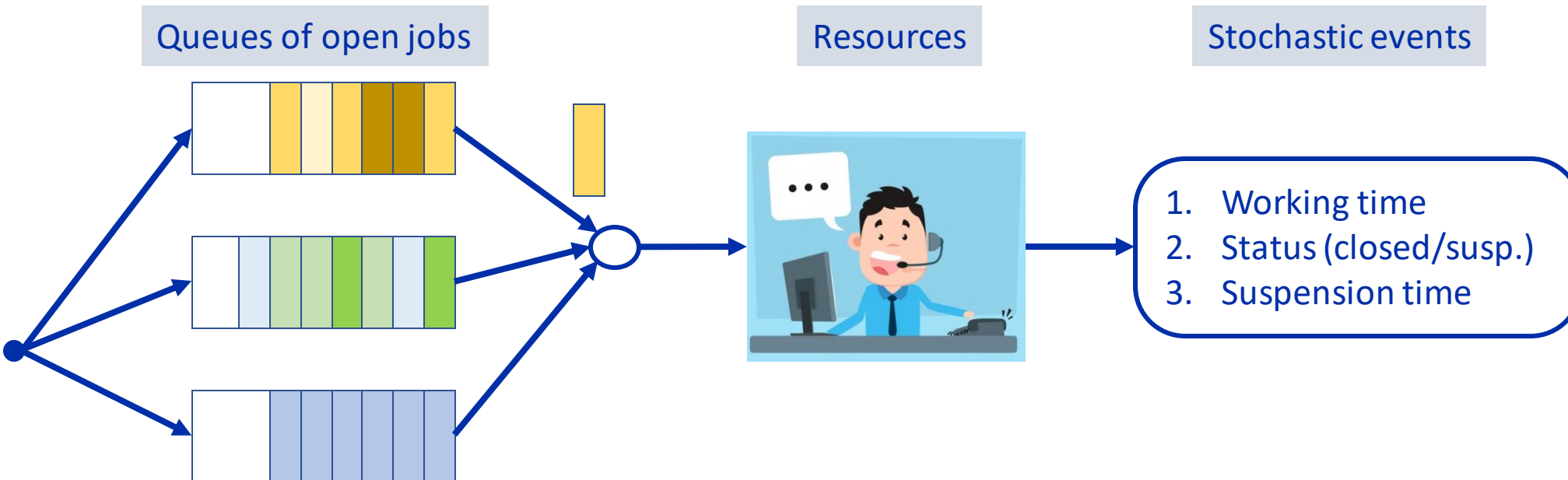
[JF. Puget, blogpost 21/09/2015]



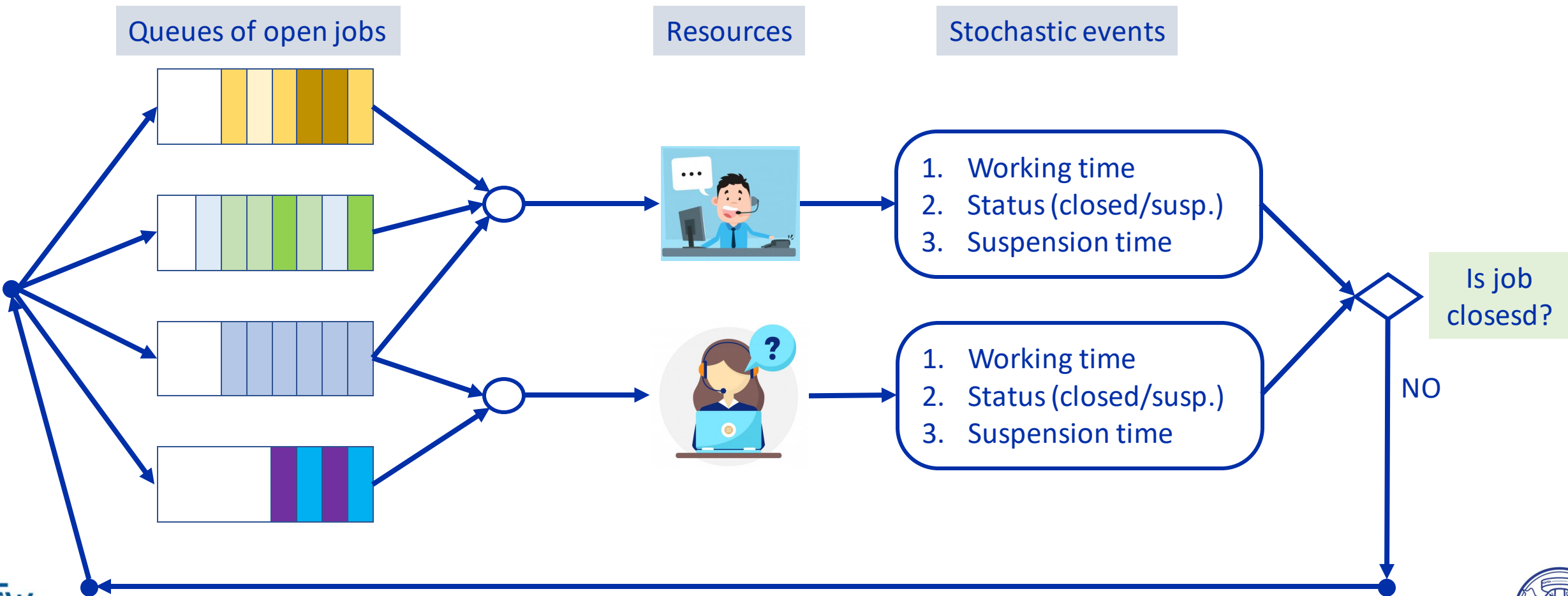
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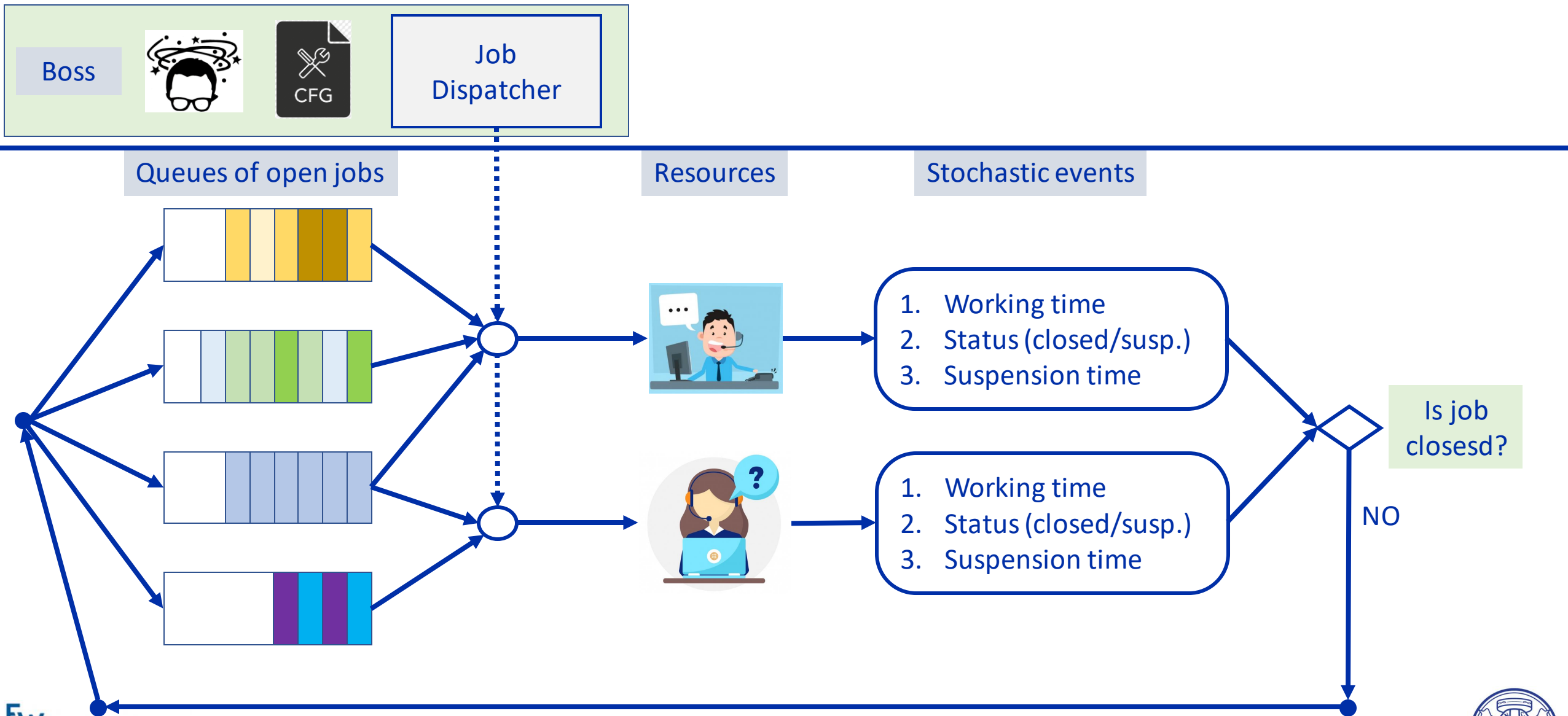
# Modern Call Centers - Backoffice



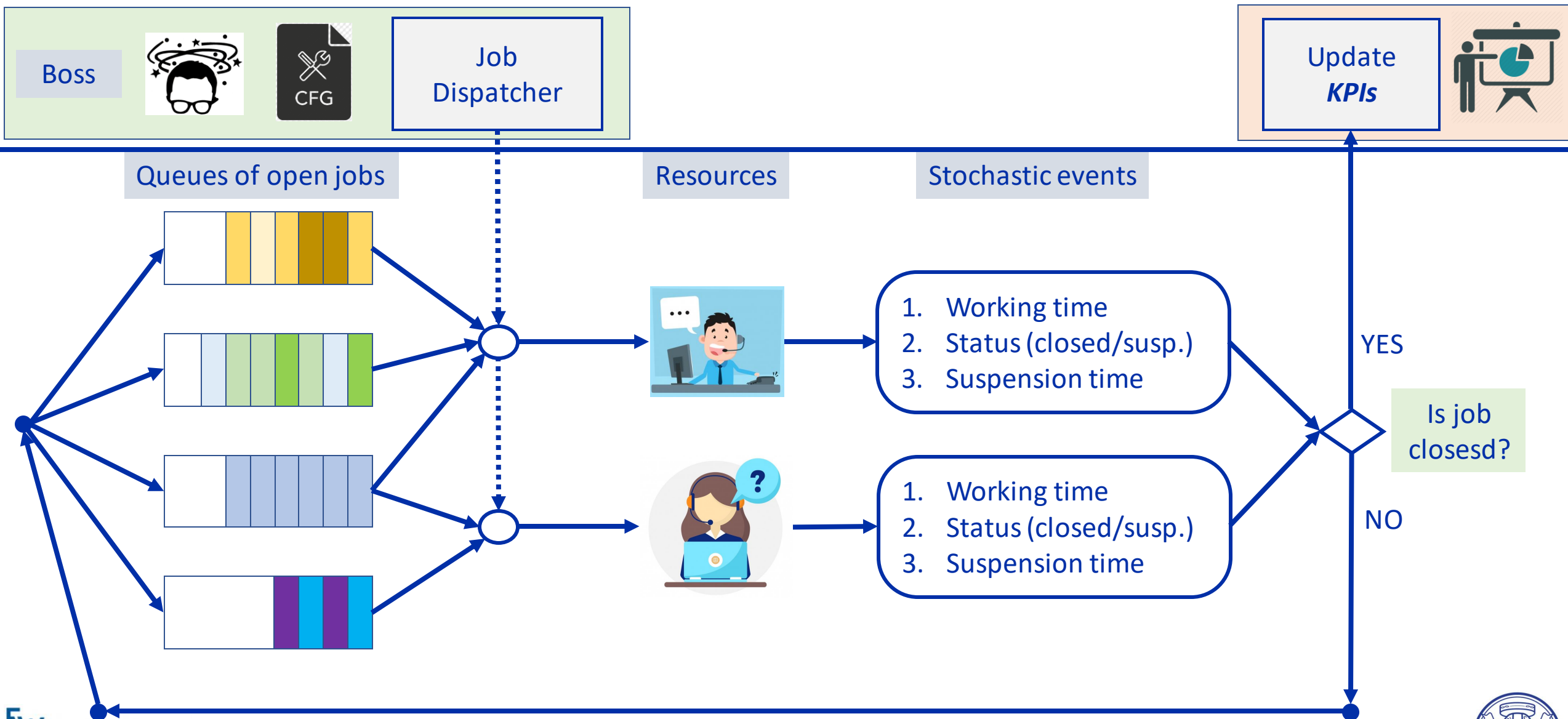
# Modern Call Centers - Backoffice



# Modern Call Centers - Backoffice

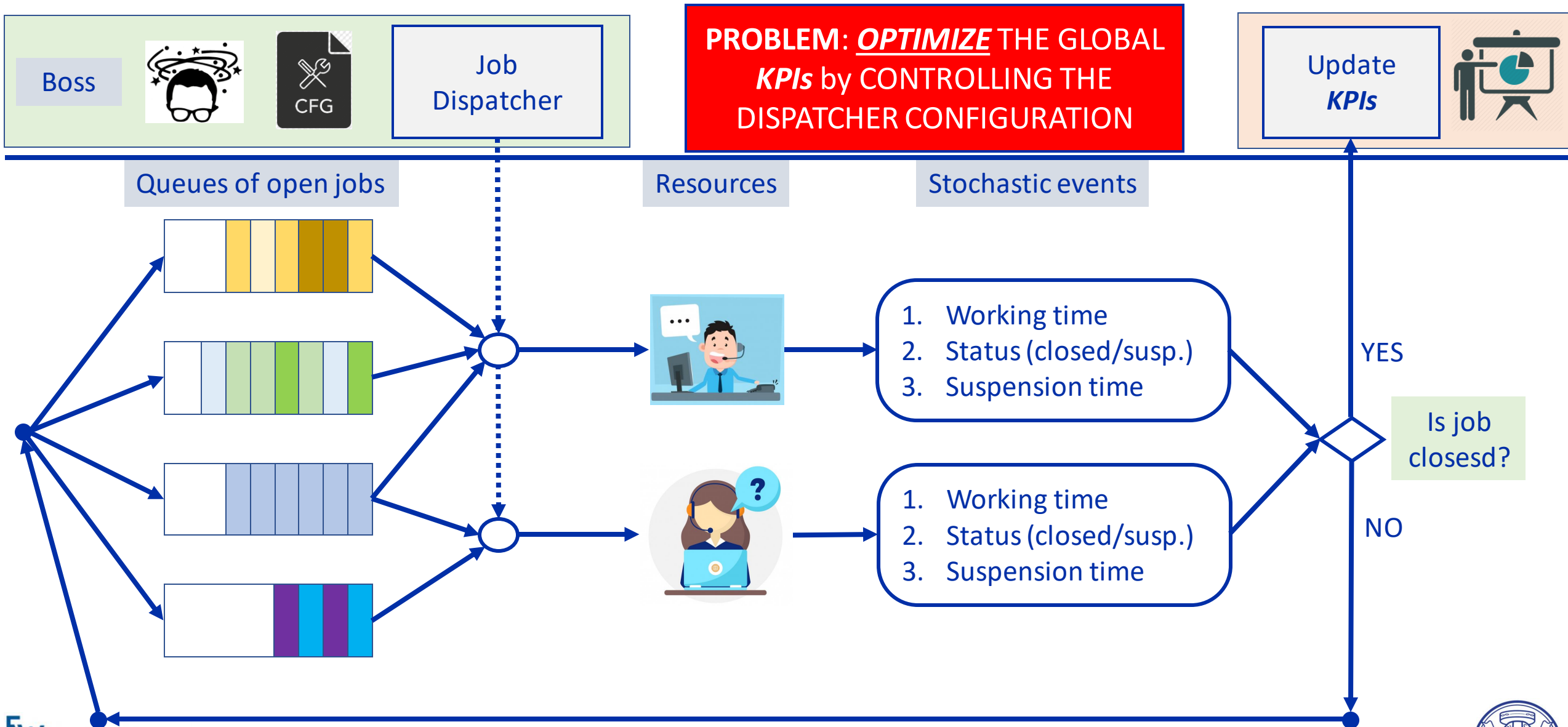


# Modern Call Centers - Backoffice

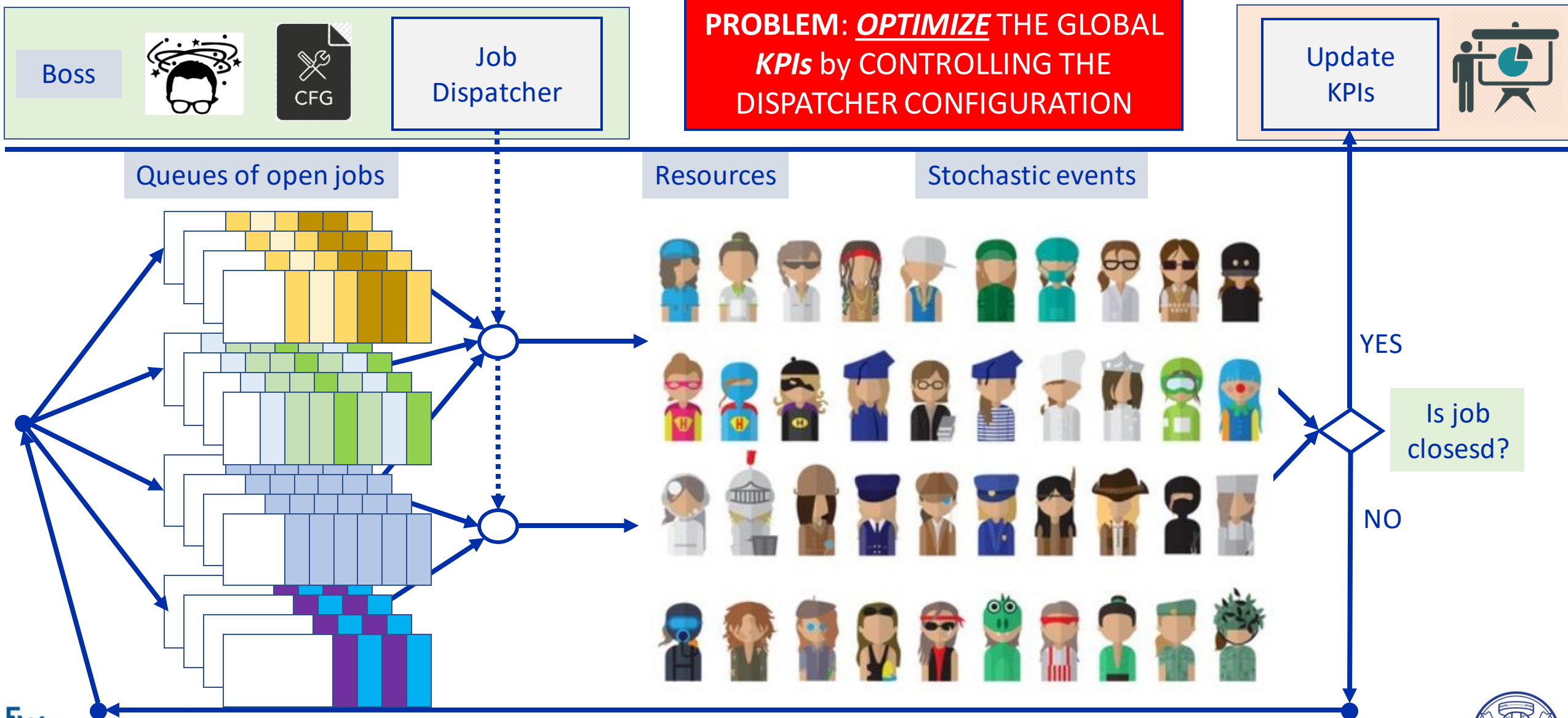




# Modern Call Centers - Backoffice

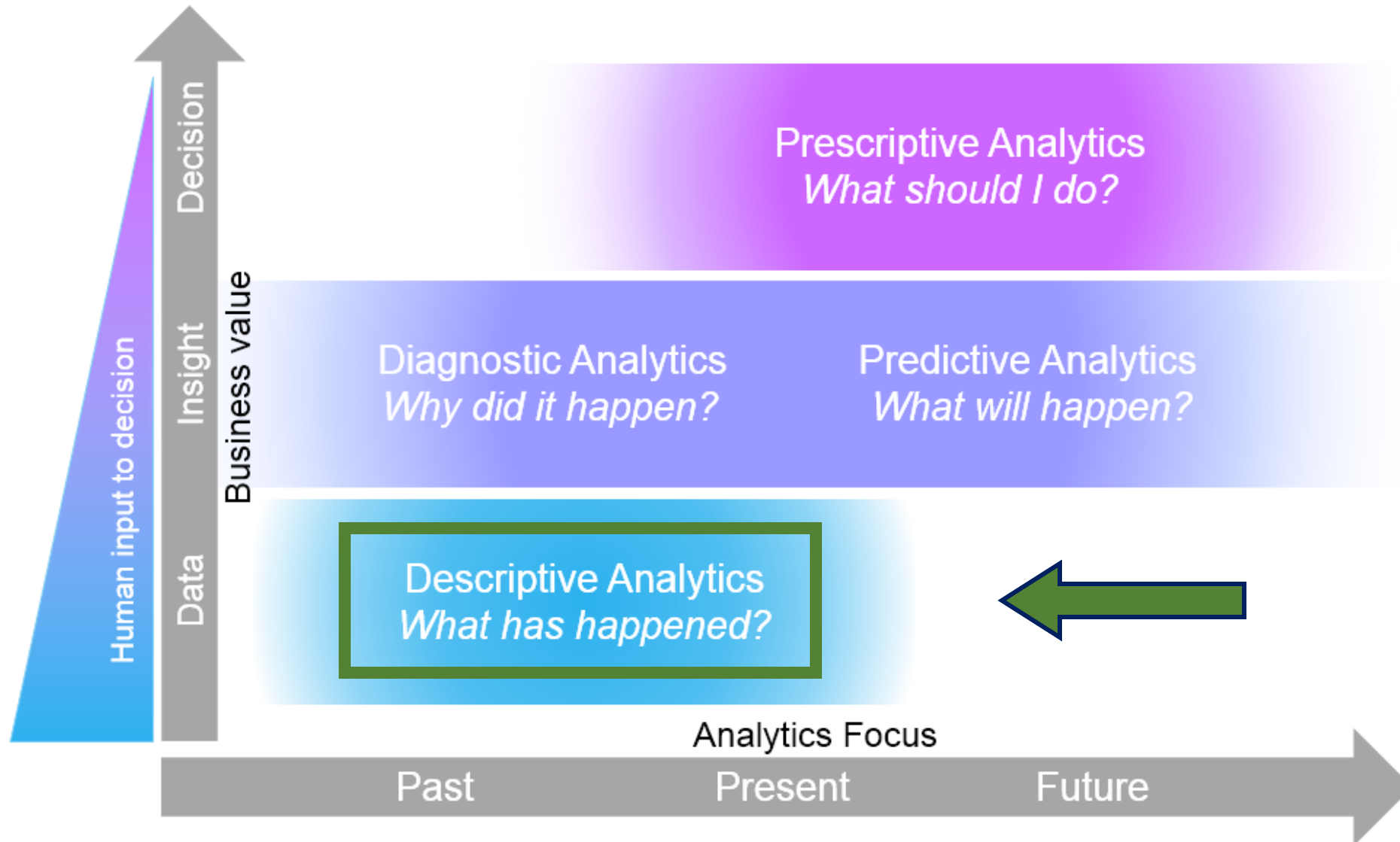


# Modern Call Centers - Backoffice



# Analytics Landscape

[JF. Puget, blogpost 21/09/2015]



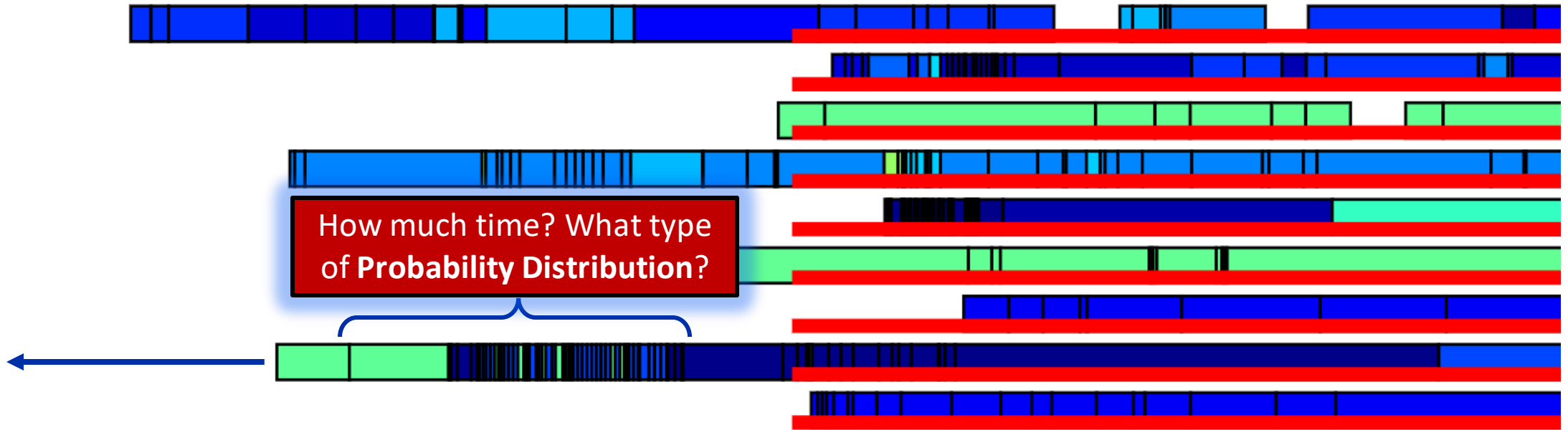
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# Descriptive Analytics: Taking the Big Picture (ZOOM IN)

**(ZOOM IN)**

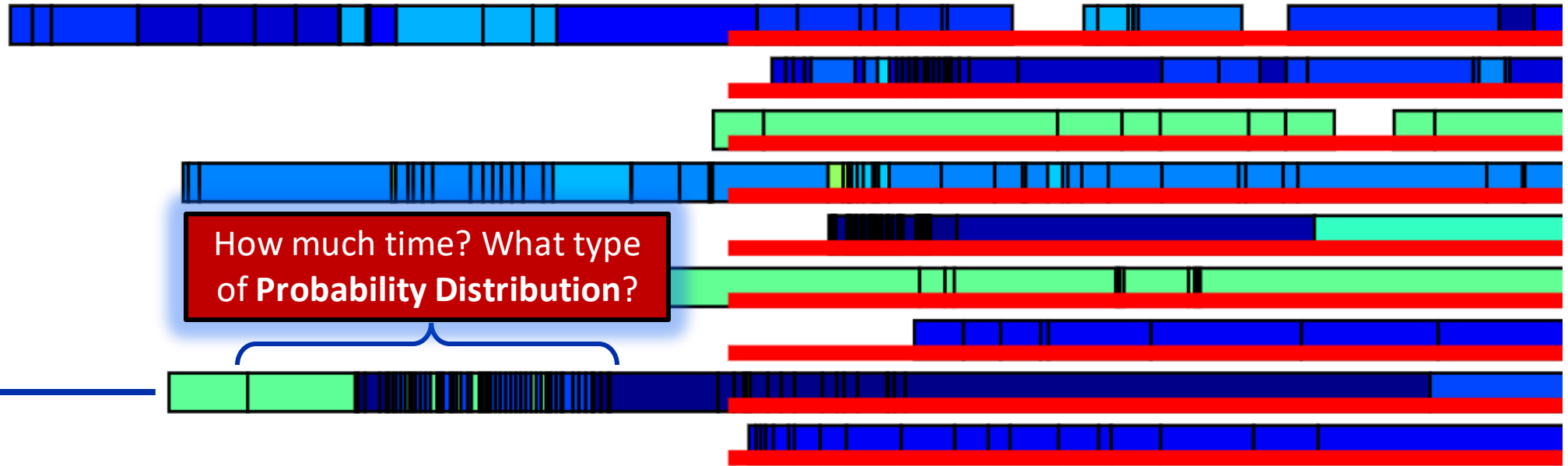
Each row represents a set of jobs worked by a resource



# Descriptive Analytics: Taking the Big Picture (ZOOM IN)

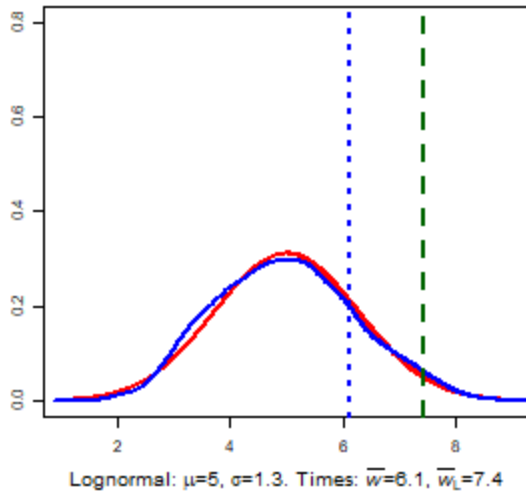
**(ZOOM IN)**

Each row represents a set of jobs worked by a resource

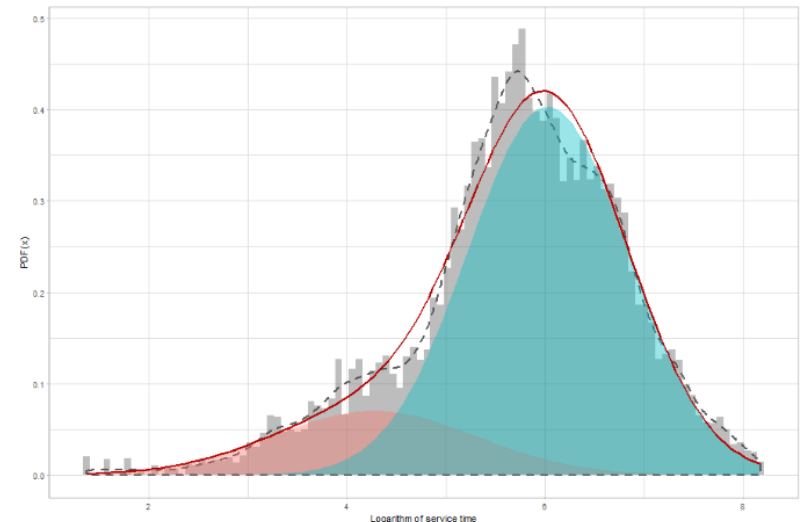
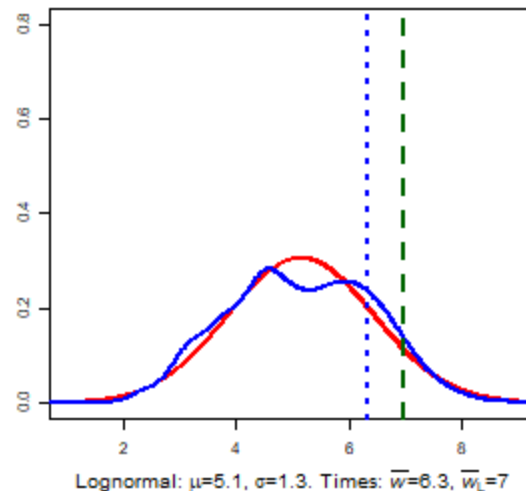


How much time? What type of Probability Distribution?

Job Type: 4  
Population size: 11513 samples



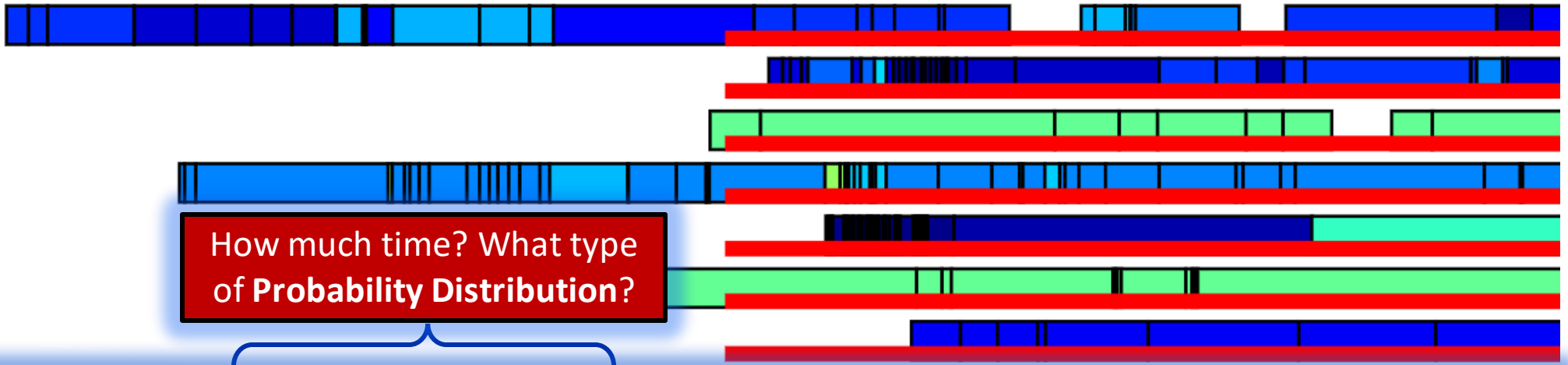
Job Type: 2  
Population size: 18872 samples



# Descriptive Analytics: Taking the Big Picture (ZOOM IN)

(ZOOM IN)

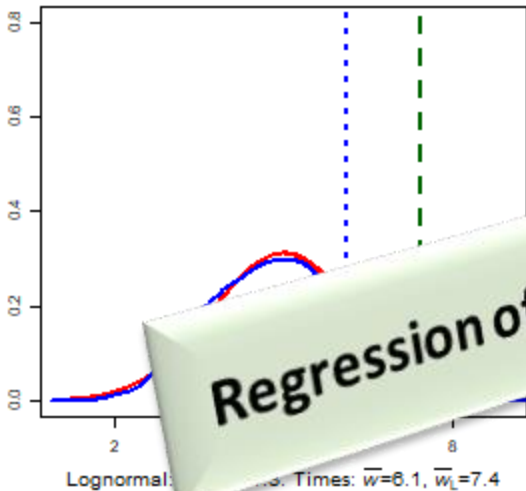
Each row represents a set of jobs worked by a resource



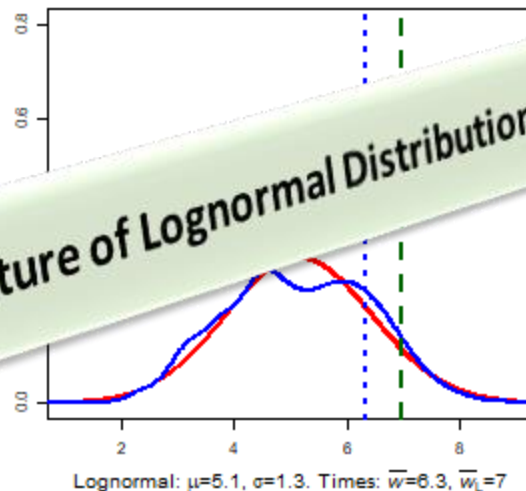
How much time? What type of Probability Distribution?

S. Gualandi, G. Toscani. *Call center service times are lognormal: A Fokker–Planck description.* Mathematical Models and Methods in Applied Sciences 28 (08), 1513-1527, 2019

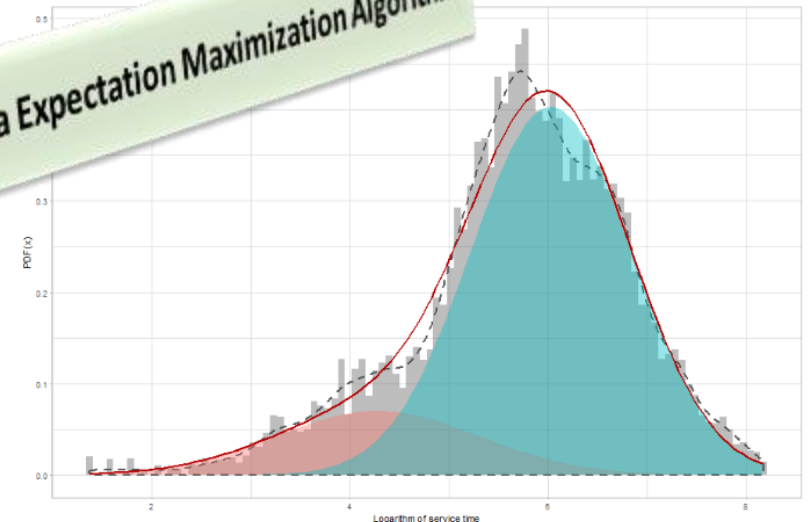
Job Type: 4  
Population size: 11513 samples



Job Type: 2  
Population size: 18872 samples

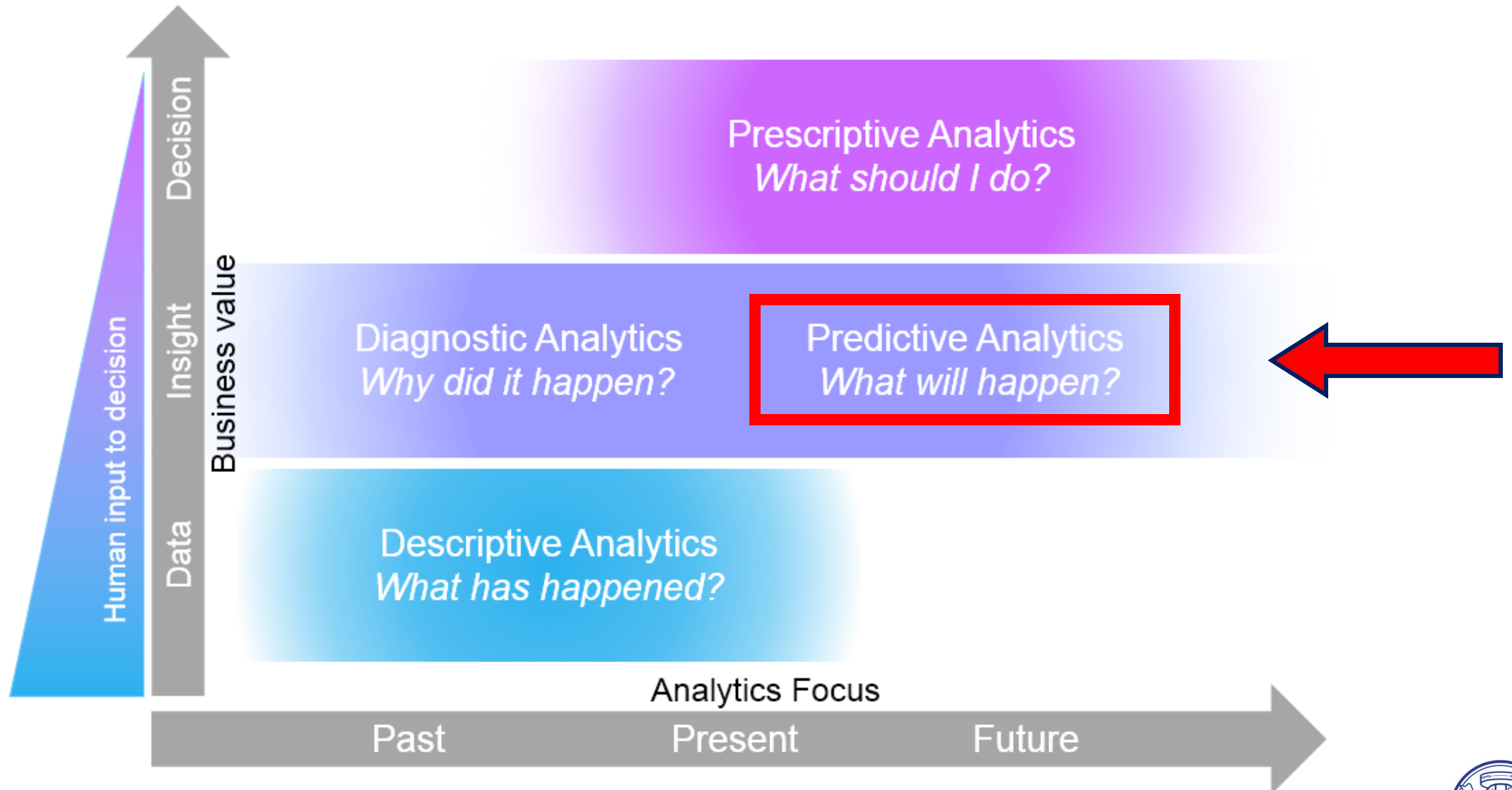


Regression of Mixture of Lognormal Distributions via Expectation Maximization Algorithm



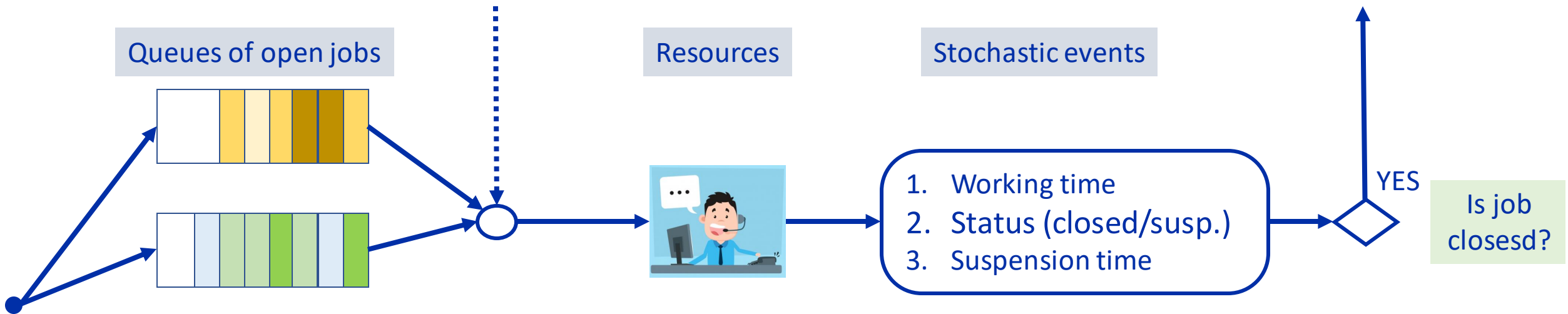
# Analytics Landscape

[JF. Puget, blogpost 21/09/2015]



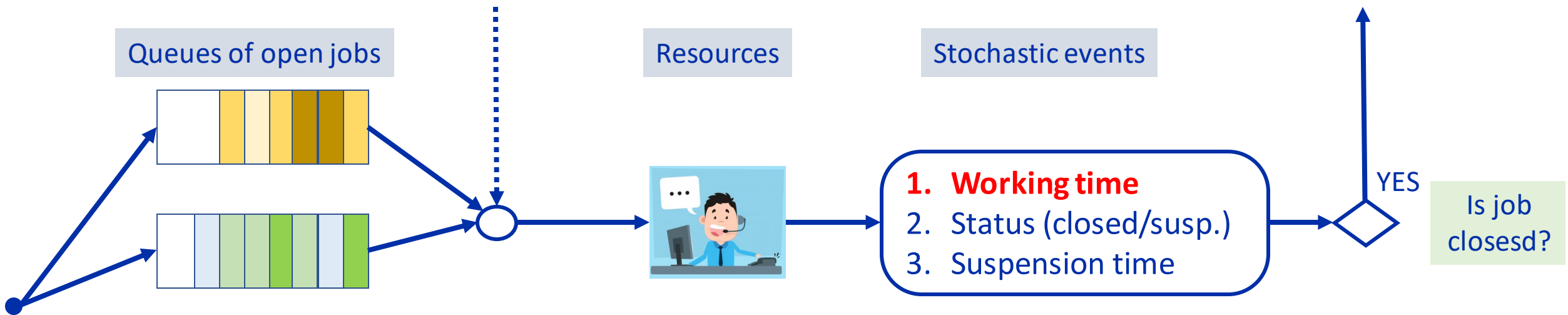
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# Predictive Analytics: Machine Learning in Action

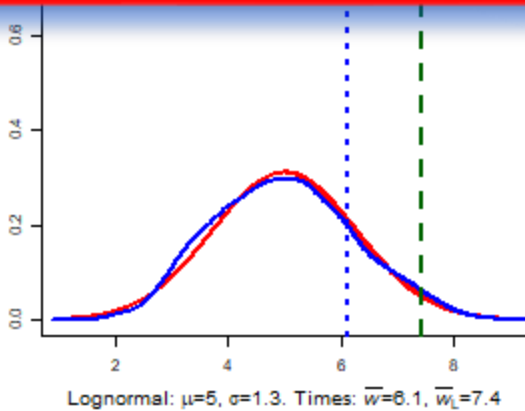




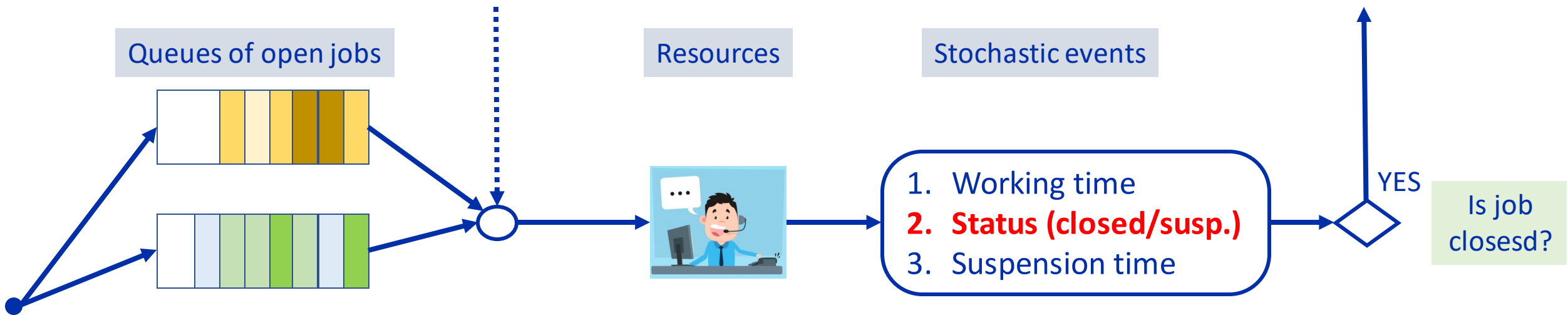
# Predictive Analytics: Machine Learning in Action



## 1. REGRESSION PROBLEM: MIXTURE OF LOGNORMAL



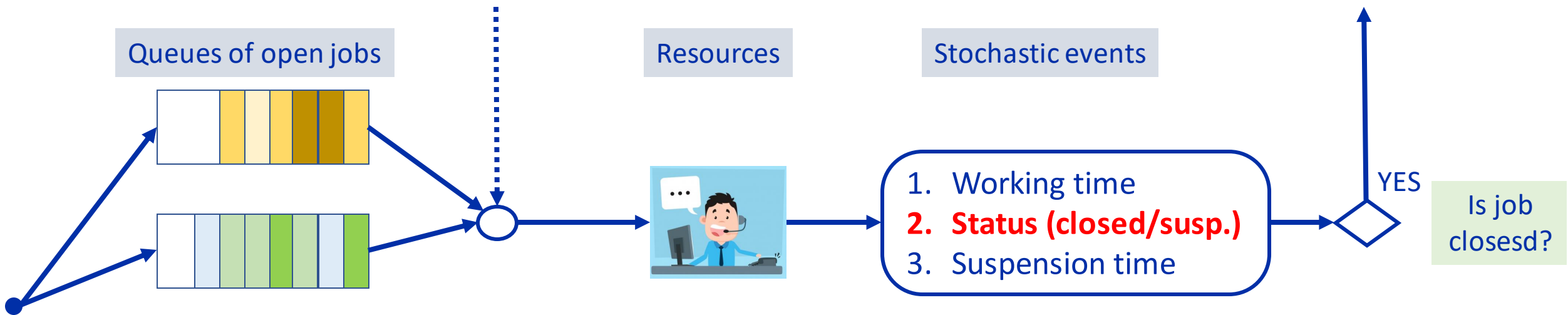
# Predictive Analytics: Machine Learning in Action



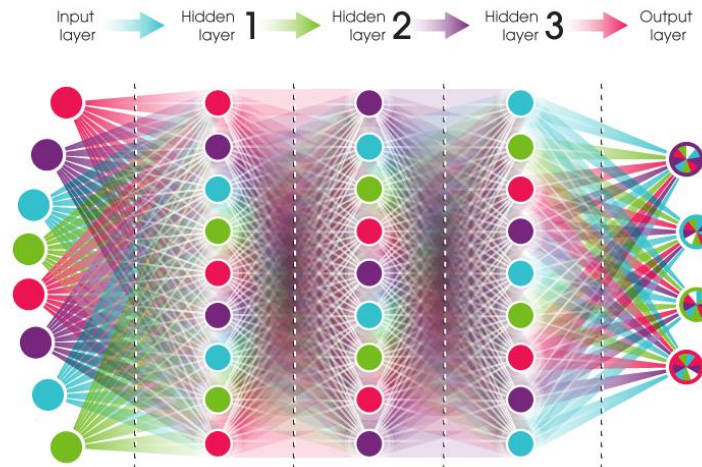
2. CLASSIFICATION PROBLEM:  
BAYESIAN CLASSIFIER

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

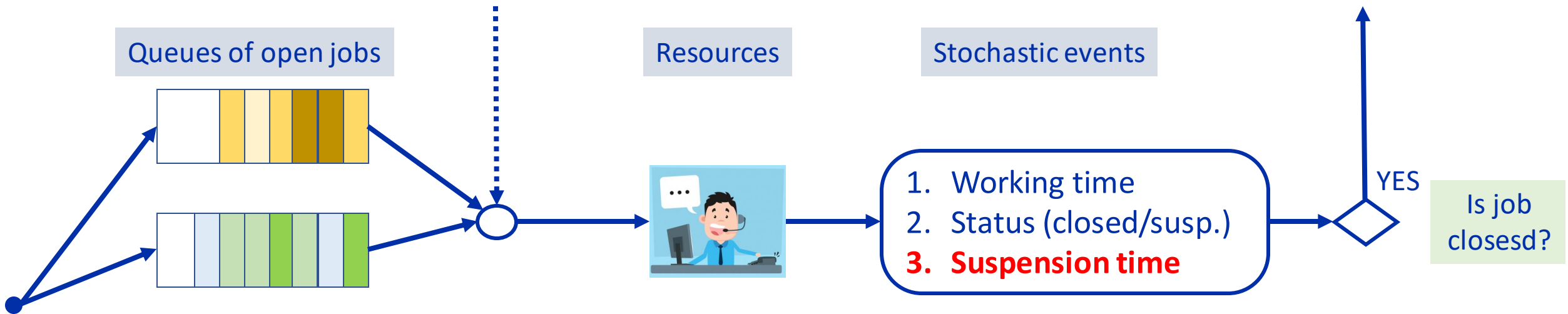
# Predictive Analytics: Machine Learning in Action



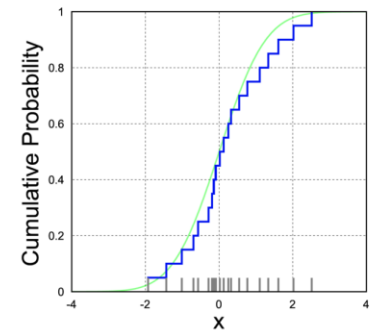
## 2. CLASSIFICATION PROBLEM: NEURAL NETWORK (?)



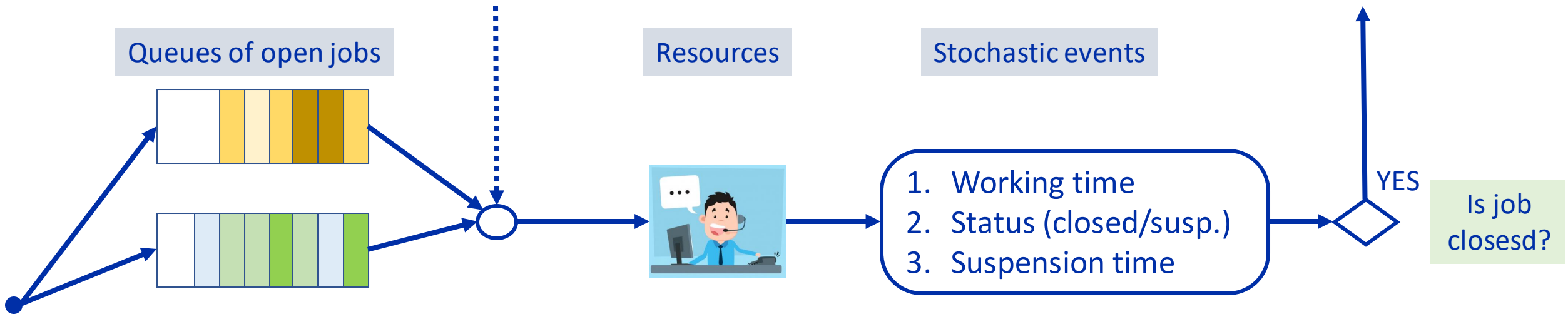
# Predictive Analytics: Machine Learning in Action



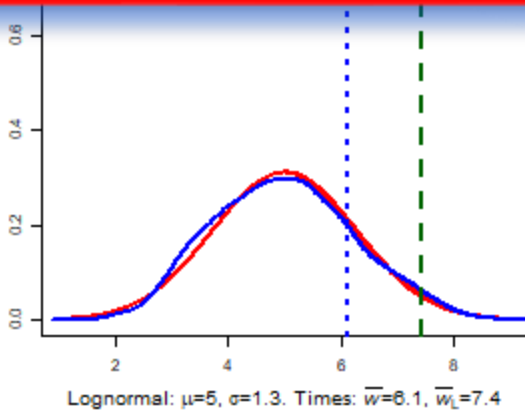
## 3. REGRESSION PROBLEM: EMPIRICAL DISTRIBUTION



# Predictive Analytics: Machine Learning in Action



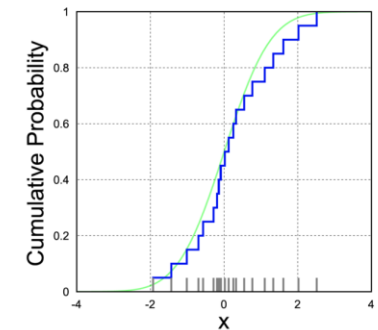
**1. REGRESSION PROBLEM:  
MIXTURE OF LOGNORMAL**



**2. CLASSIFICATION PROBLEM:  
BAYESIAN CLASSIFIER**

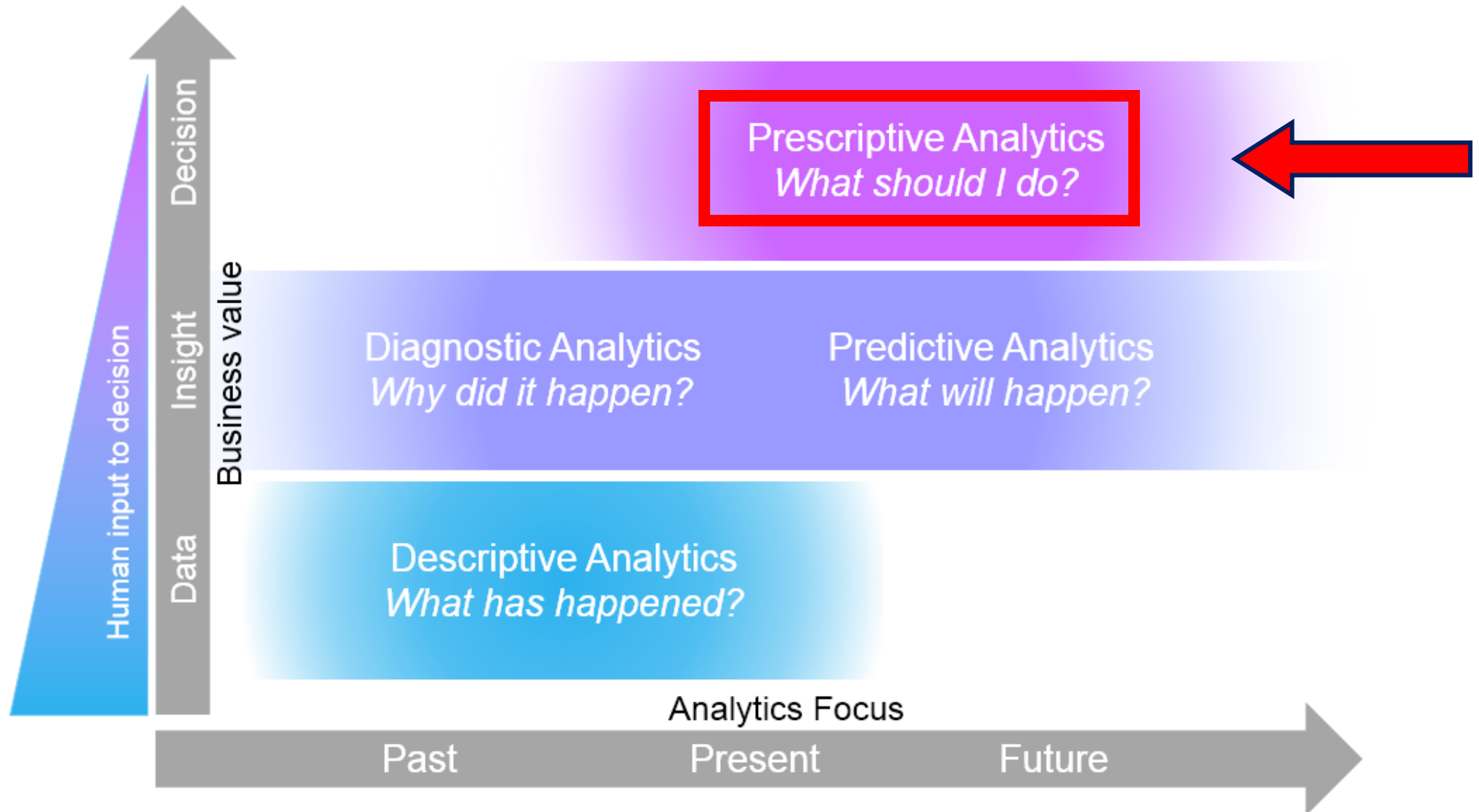
$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

**3. REGRESSION PROBLEM:  
EMPIRICAL DISTRIBUTION**



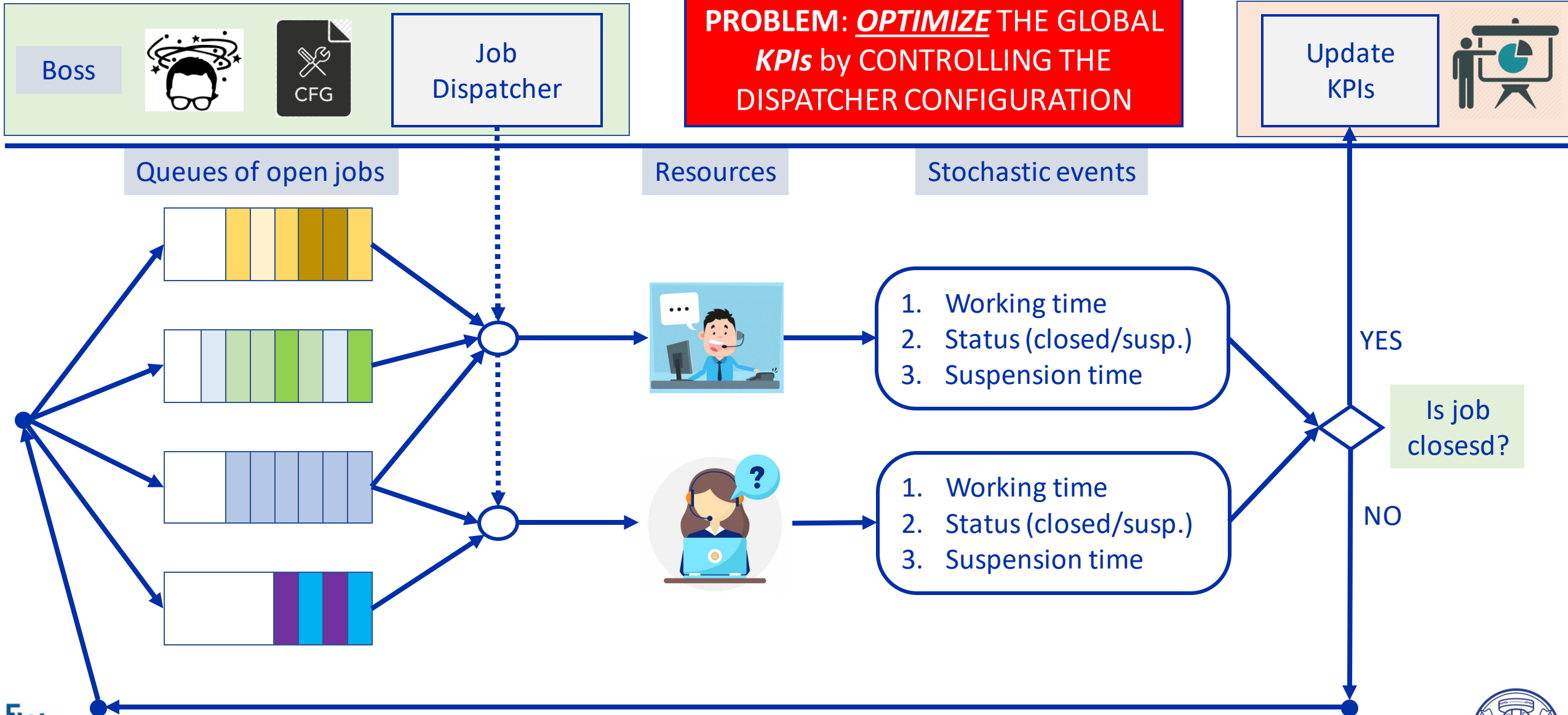
# Analytics Landscape

[JF. Puget, blogpost 21/09/2015]

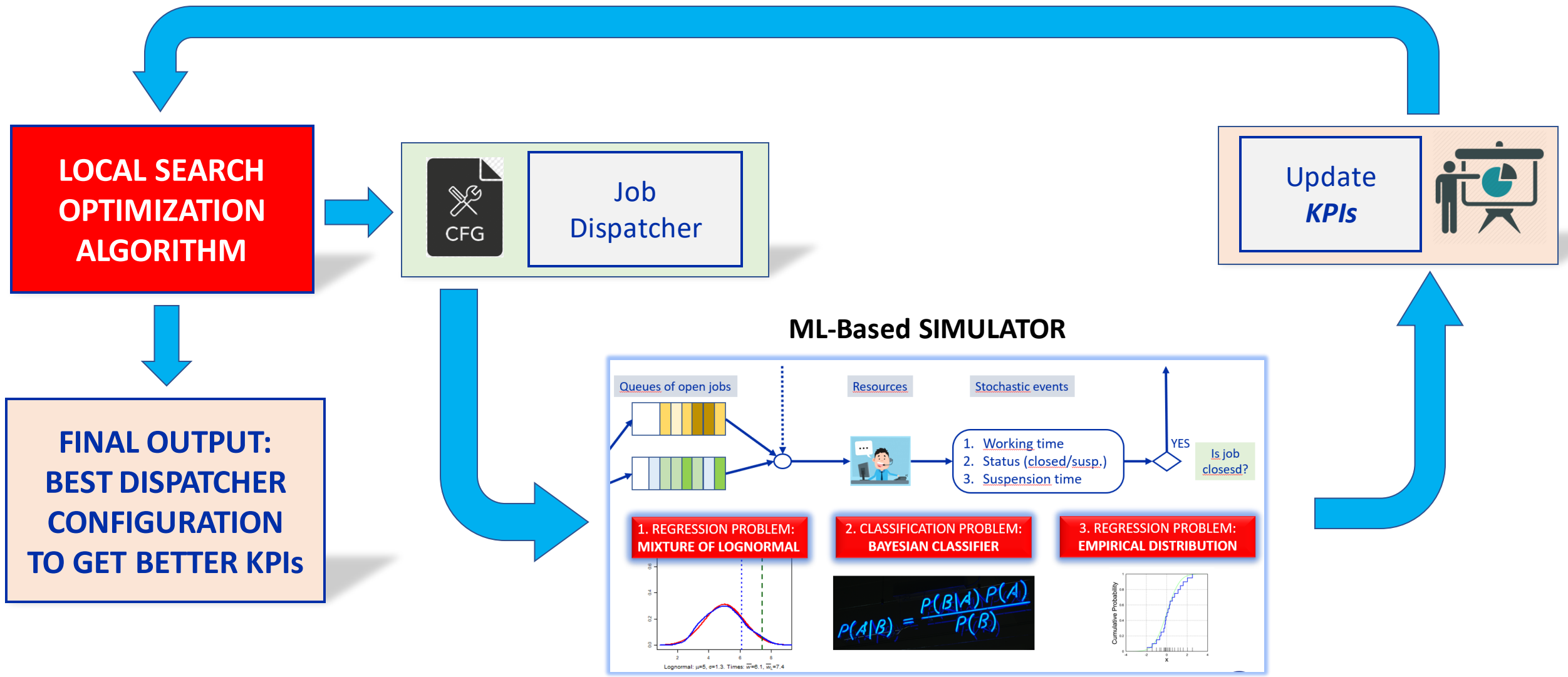


Source: <http://ibm.co/1gJyfl3>

# Modern Call Centers - Backoffice



# Prescriptive Analytics: Simulation-based Optimization





# OR meets ML: Take home messages

1. Find out the best **visualization** to get «*the big picture*»
2. «*Divide et Impera*»: name your *Machine Learning* subproblems
3. Explainable Machine Learning models are easier to get accepted

# Questions?

