

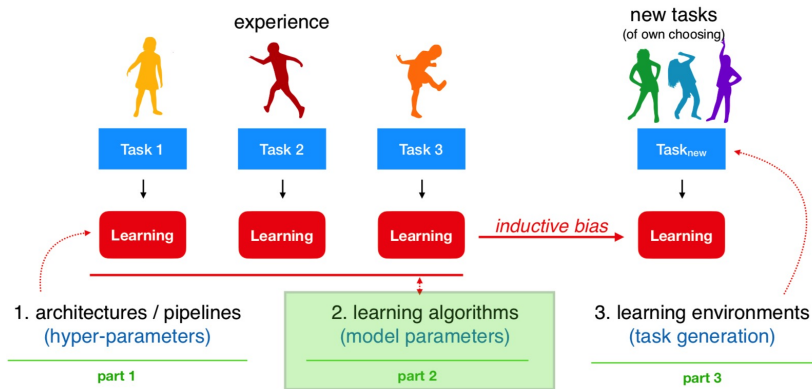
# AutoML: Meta-Learning

Learning model priors

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# What can we learn to learn?

*3 pillars*



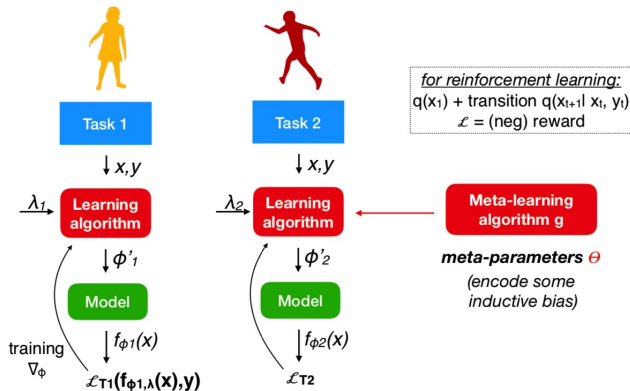
# Terminology (reminder)

**Task:** distribution of samples  $q(x)$   
outputs  $y$ , loss  $\mathcal{L}(x, y)$

**Learner:** *model parameters*  $\phi$ ,  
*hyper-parameters*  $\lambda$   
optimizer

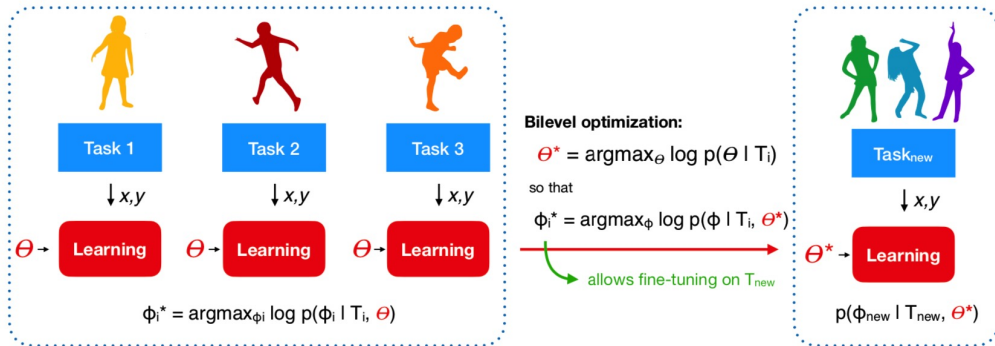
$$\begin{aligned}\phi^* &= \operatorname{argmax}_{\phi} \log p(\phi \mid T) \\ &= \operatorname{argmin}_{\phi} \mathcal{L}(f_{\phi, \lambda}(x), y)\end{aligned}$$

**Model:**  $f_{\phi}(x) = y'$



# Strategy 1: bilevel optimization

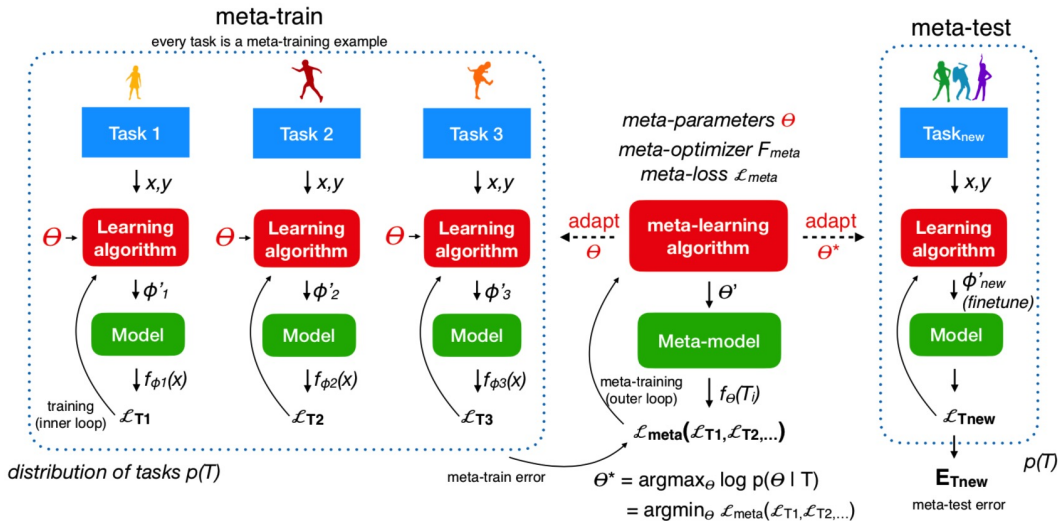
parameterize some aspect of the learner that we want to learn as meta-parameters  $\theta$   
meta-learn  $\theta$  across tasks



$\Theta(\text{Prior})$ , could encode an initialization  $\phi$ , the hyperparameters  $\lambda$ , the optimizer,...

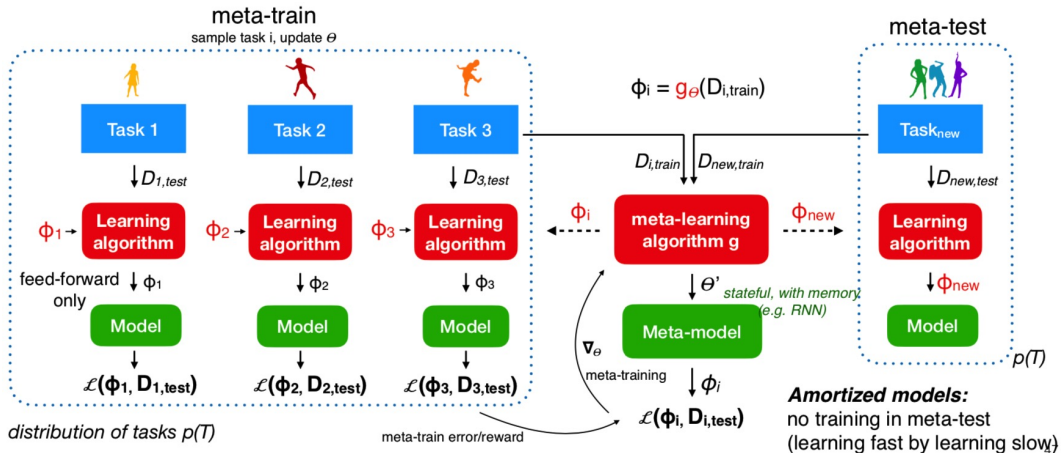
*Learned  $\theta^*$  should learn  $T_{\text{new}}$  from small amount of data, yet generalize to a large number of tasks*

# Meta-learning with bilevel optimization

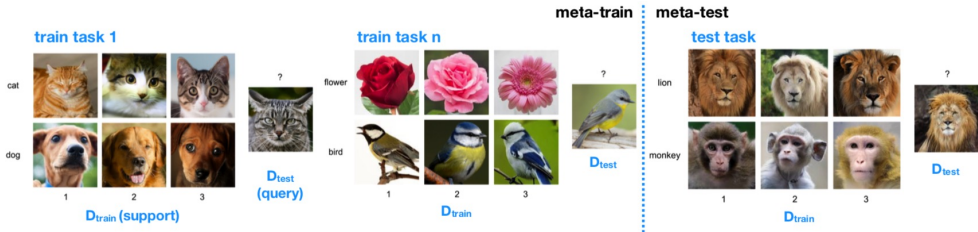


## Strategy 2: black-box models

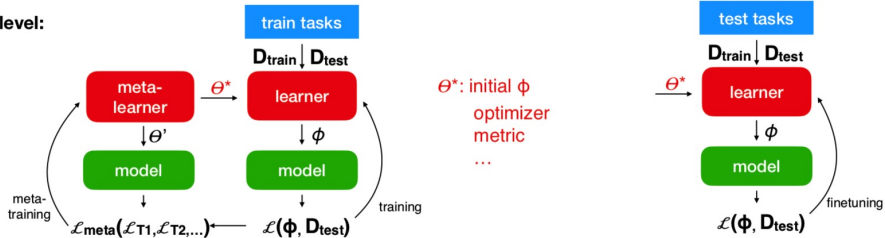
*black box meta-model  $g_\theta$  predicts  $\phi$  given  $D_{train}$  (theta is hidden)  
hypernetwork where input embedding learned across tasks*



# Example: few-shot classification



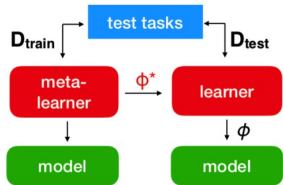
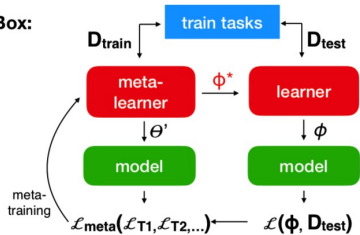
**Bilevel:**



# Example: few-shot classification



**Black Box:**





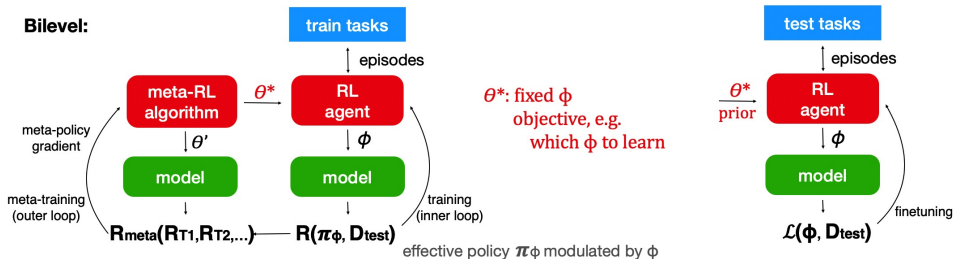
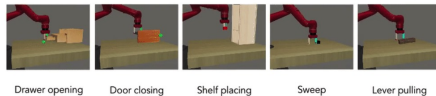
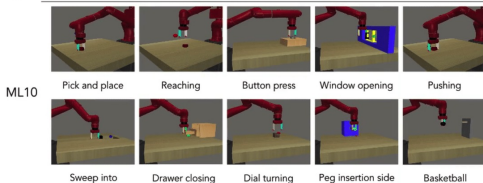
# Example: meta-reinforcement learning

initial state:  
randomized object  
and goals positions

Train tasks

Test tasks

other initial states  
or related tasks



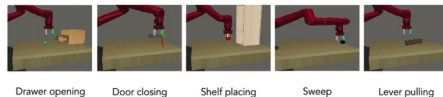
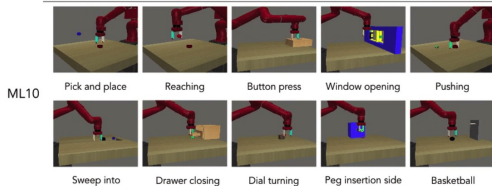
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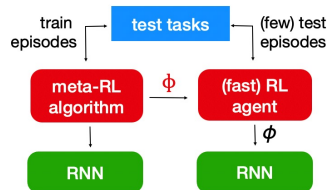
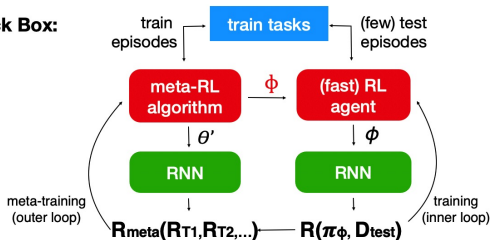
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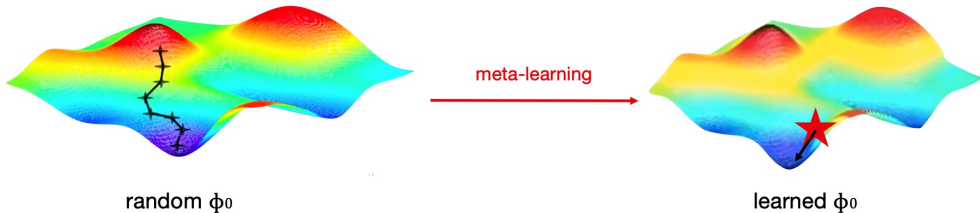
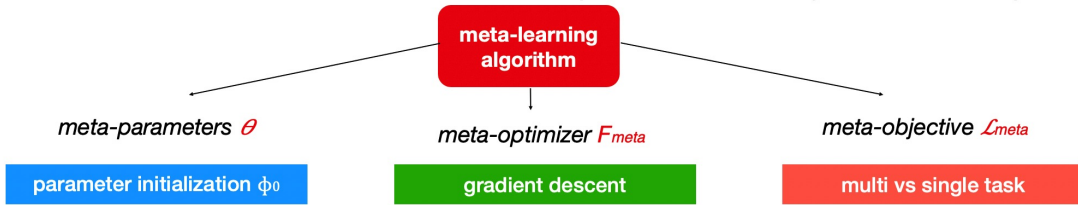


**Black Box:**



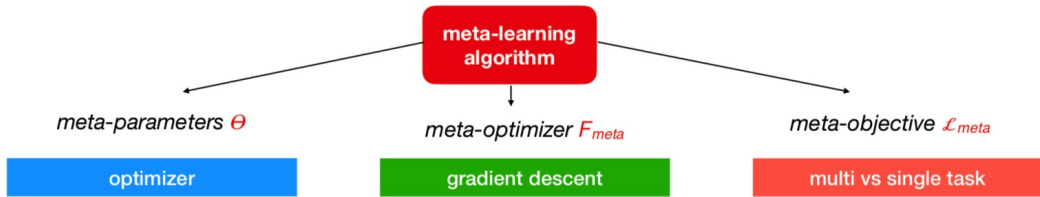
# Taxonomy of meta-learning methods

like base-learners, meta-learners consist of a representation, an objective, and an optimizer



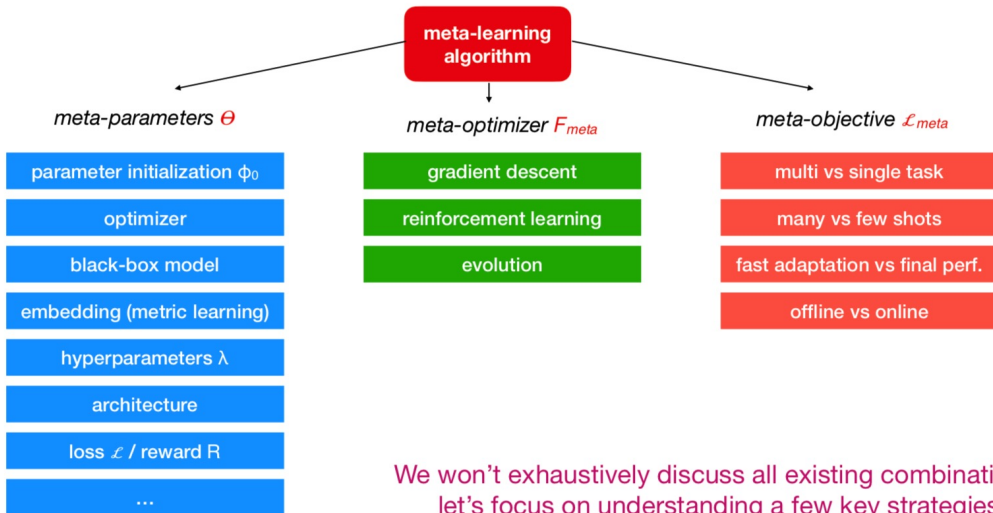
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We won't exhaustively discuss all existing combinations,  
let's focus on understanding a few key strategies