# label\_detection\_results/12\_17\_19\_ch4\_spacy.json

# atom 6

Let $M$ be a Turing machine where $Q$ is the set of states, $\blank$ is the blank symbol, and $\Gamma$ is the tape alphabetalphabet.\footn{Supernerd note: we will always assume $Q$ and $\Gamma$ are disjoint sets.} To understand how $M$'s computation proceeds we generally need to keep track of three things: (i)~the state $M$ is in; (ii)~the contents of the tape; (iii)~where the tape head is. These three things are collectively known as the ``configuration'' of the TM. More formally: a \defn{configuration} for~$M$ is defined to be a string $uqv \in (\Gamma \cup Q)^\*$, where $u, v \in \Gamma^\*$ and $q \in Q$. This represents that the tape has contents $\cdots \blank \blank \blank uv \blank \blank \blank \cdots$, the head is pointing at the leftmost symbol of~$v$, and the state is~$q$. A configuration is an \defn{accepting configuration} if $q$ is $M$'s acceptaccept state and it is a \defn{rejecting configuration} if $q$ is $M$'s rejectreject state.\footn{There are some technicalities: The string $u$ cannot start with $\blank$ and the string $v$ cannot end with $\blank$. This is so that the configuration is always unique. Also, if~$v = \epsilon$ it means the head is pointing at the $\blank$ immediately to the right of~$u$.}  
  
Suppose that $M$ reaches a certain configuration~$\alpha$ (which is not acceptingaccepting or rejecting). Knowing just this configuration and $M$'s transition function~$\delta$, one can determine the configuration $\beta$ that $M$ will reach at the next step of the computation. (As an exercise, make this statement precise.) We write  
\[  
 \alpha \vdash\_M \beta  
\]  
and say that ``$\alpha$ yields $\beta$ (in~$M$)''. If it's obvious what $M$ we're talking about, we drop the subscript $M$ and just write $\alpha \vdash \beta$.   
  
Given an input $x \in \Sigma^\*$ we say that $M(x)$ \defn{halts} if there exists a sequence of configurations (called the \defn{computation trace}) $\alpha\_0, \alpha\_1, \dots, \alpha\_{T}$ such that:  
  
\begin{enumerate}  
 \item[(i)] $\alpha\_0 = q\_0x$, where $q\_0$ is $M$'s initial state;  
 \item[(ii)] $\alpha\_t \vdash\_M \alpha\_{t+1}$ for all $t = 0, 1, 2, \dots, T-1$;  
 \item[(iii)] $\alpha\_T$ is either an accepting configuration (in which case we say $M(x)$ \defn{accepts}) or a rejecting configuration (in which case we say $M(x)$ \defn{rejects}).  
\end{enumerate}  
Otherwise, we say $M(x)$ \defn{loops}.