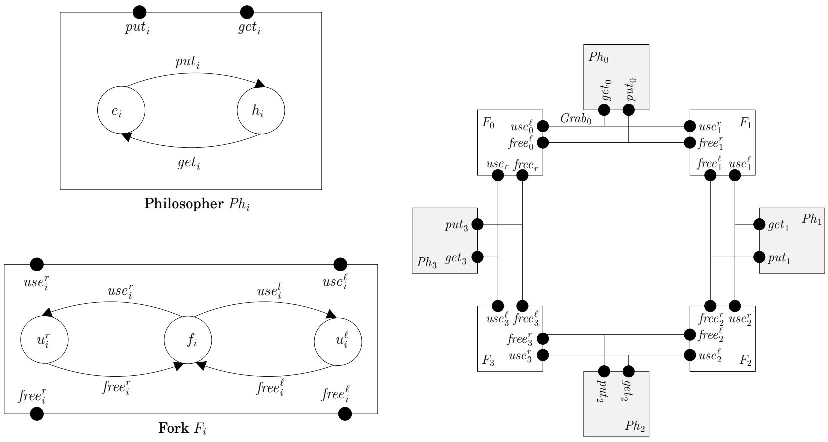

(a) Philosopher Ph_i and fork F_i atomic components.

(b) Dining philosophers composite component with four philosophers.

Fig. 1. Dining philosophers.

philosopher). From state u_i^r (resp. u_i^ℓ), F_i is released by the right philosopher (resp. left philosopher) and so moves back to state f_i (free).

In practice, we describe the transition system using some syntax, e.g., involving local variables (BIP does not have shared variables). We abstract away from issues of syntactic description since we are only interested in enablement of ports and actions. In BIP, the enablement of a port depends only on the local state of a component. In particular, it cannot depend on the state of other components. For example, state e_i in atomic component Ph_i of Figure 1(a) enables port put_i as there exists a transition from e_i labeled with port put_i. Hence, there exists a predicate $enb_{p_i}^i$ that holds in state s_i of component B_i iff port p_i is enabled in s_i, i.e., $s_i(enb_{p_i}^i) = true$ iff $s_i \xrightarrow{p_i}_i$.

Definition 2.2 **(Interaction)** *For a given system built from a set of n atomic components $\{\mathsf{B}_i = (Q_i, P_i, \rightarrow_i)\}_{i=1}^n$, we require that their respective sets of ports are pairwise disjoint, i.e., for all i, j such that $i, j \in \{1..n\} \wedge i \neq j$, we have $P_i \cap P_j = \emptyset$. An* interaction *is a set of ports not containing two or more ports from the same component. That is, for an interaction a we have $\mathsf{a} \subseteq P \wedge (\forall i \in \{1..n\} : |\mathsf{a} \cap P_i| \leq 1)$, where $P = \bigcup_{i=1}^n P_i$ is the set of all ports in the system. When we write $\mathsf{a} = \{p_i\}_{i \in I}$, we assume that $p_i \in P_i$ for all $i \in I$, where $I \subseteq \{1..n\}$.*

The Connectors that connect ports in Figure 1(b) illustrate interactions. For example, the interaction $Grab_0 = \{get_0, use_0^\ell, use_1^r\}$ connects ports get_0, use_0^ℓ, and use_1^r from components Ph_0, F_0, and F_1 respectively, and corresponds to philosopher component Ph_0 acquiring both forks and moving to it's eating state.

Execution of an interaction $\mathsf{a} = \{p_i\}_{i \in I}$ involves all the components which have ports in a. We denote by $components(\mathsf{a})$ the set of atomic components participating in a. Formally, $components(\mathsf{a}) = \{\mathsf{B}_i \mid p_i \in \mathsf{a}\}$.

Definition 2.3 **(Composite Component)** *A* composite component *(or simply* component*) $\mathsf{B} \triangleq \gamma(\mathsf{B}_1, \ldots, \mathsf{B}_n)$ is defined by a composition operator parameterized by a set of interactions $\gamma \subseteq 2^P$. B has a transition system $(Q, \gamma, \rightarrow)$, where $Q = Q_1 \times \cdots \times Q_n$ and*