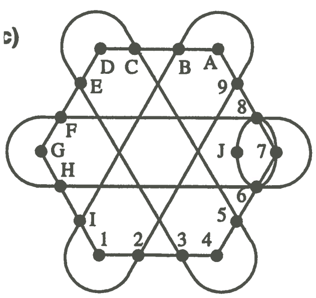
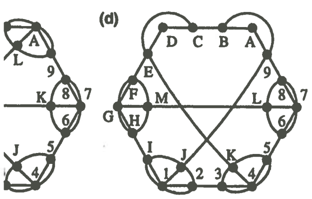


vith: (1) loops of size 3: (a) (b) 24(22)–13 not containing 2: (c) 19(18)–10. Between of size 3, all containing the



loops of size 2: (1) — not .1 isomorphic to Kernaghan of Fig. 3.18 nor systems (a)

nent realizes a two-qubit irst qubit is represented he photon polarization. it state

(3.54)

a horizontally polarized photon going through a reflected at a polarizing

$\langle 0'| - |1'\rangle_{11}\langle 1'|,$
$\langle 0'| - |1'\rangle_{22}\langle 1'|,$ (3.55)

where

$$|0'\rangle_i = \frac{1}{\sqrt{2}}(|0\rangle_i + |1\rangle_i), \qquad |1'\rangle_i = \frac{1}{\sqrt{2}}(|0\rangle_i - |1\rangle_i), \qquad i = 1, 2. \tag{3.56}$$

One performs the experiment measuring various X_i, Z_i combinations according to a table given by Adán Cabello [Cabello, 2000], which corresponds to the KS set shown in Fig. 3.18 (a). Quantum mechanics, of course, always gives a definite set of results, but an attempt to keep the outcomes of previous measurements fixed and to use them in subsequent ones must fail. If we try to ascribe 0 and 1 to the points in Fig. 3.18 (a) according to the rules from p. 168 (any edge must contain one 1 and three 0s), we will soon find that this is impossible.

3.3 Quantum Algorithms

As we mentioned on pp. xiii and 31, in 1947 the head of that computing center in Harvard, Howard Aiken estimated the no more than six computers would satisfy the computing needs of the entire United States. One reason for such an underestimate of future computing needs was the absence of Boolean algorithms and software at the time. Today we have a similar situation with quantum algorithms and quantum software for would-be quantum computers. Practically all known quantum algorithms are based on a single function—the *quantum Fourier transform* (a quantum version of the classical *discrete Fourier transform*). On the other hand, there is still no universal quantum algebra for quantum computers analogous to Boolean algebra for classical computers. Therefore, we will present several algorithms and in the end discuss possibilities for constructing a universal quantum algebra.

3.3.1 Quantum Coin—Deutsch's Algorithm

When a magician performs a trick with a classical coin, we can only see the top side of it, which will show either heads or tails. We are curious to learn whether the coin is fair or fake (having heads on both sides or tails on both sides), but we are not allowed to climb the stage to turn the coin over and look at the bottom side. However, if we gave the magician a quantum coin and used what is known as *Deutsch's algorithm* [Deutsch, 1985], we would be able to distinguish a fair from a fake coin in one step.

The algorithm uses two kinds of *evaluating functions* $f\colon \{0,1\} \to \{0,1\}$:

- *Constant functions* $f_1(x) = 0$ and $f_2(x) = 1$, where 0 and 1 stand for heads and tails respectively (or the other way around) and x for the