Priority-Based Synchronization of Distributed Data

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We consider the general problem of synchronizing the data on two devices using a minimum amount of communication, a core infrastructural requirement for a large variety of distributed systems. Our approach considers the interactive synchronization of prioritized data, where, for example, certain information is more time-sensitive than other information. We propose and analyze a new scheme for efficient priority-based synchronization, which promises benefits over conventional synchronization.

**CPIsync** is a Characteristic Polynomial Interpolation-based synchronization algorithm that translates the data synchronization problem into rational function interpolation.

**Basic Algorithm: CPIsync**

1. **Step 1:** Generate characteristic polynomial locally (denoted $P_A(z)$)
   - $S_A = \{1, 2, 4, 16, 21\}$
   - $P_A(z) = (z-1)(z-2)(z-4)(z-16)(z-21)$
2. **Step 2:** Evaluate polynomials on finite field (4 evaluations on $F_7$, at here)
   - $P_A(-1) = 69$, $P_A(-2) = 12$
   - $P_A(-3) = 60$, $P_A(-4) = 61$
   - $P_B(-1) = 1$, $P_B(-2) = 7$
   - $P_B(-3) = 60$, $P_B(-4) = 45$
3. **Step 3:** Interpolate $f(z) = P_A(z)P_B(z)$
   - Idles
     - $f(-1) = 69$, $f(-2) = 22$
     - $f(-3) = 1$, $f(-4) = 55$
4. **Step 4:** All 3 symmetric differences determined & communicated
   - $S_A - S_B = \{4, 16\}$
   - $S_B - S_A = \{6\}$
   - $z^2 + 5z + 6 = (z-4)(z-16)$
   - $z^2 + 6z + 5 = (z-6)(z-6)$

**Conclusion**

We introduced our algorithm to synchronize sets with prioritized data and corresponding data structure. This new scheme supports some desirable features in busy network and/or harsh environment:
(i) memory-less fast restart after interruption
(ii) high-probability communication and computation complexity related to the number of difference only and effectively independent of the set size.

**Reference:** Jiaxi Jin, Ari Trachtenberg, David Starobinski, Priority-Oriented Interactive Set Reconciliation, submitted.