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Fast algorithms for partial fractions

An approximate partial fraction decomposition (APFD) of a rational function $f = q/p \in \mathbf{C}(z)$ is given by approximate factors $p_1, \ldots, p_l$ of p and corresponding numerators $q_1, \ldots, q_l$. Define $\tilde{p}$ and $\tilde{q}$ by $\tilde{p} = p_1 \cdots p_l$ and $\tilde{q}/\tilde{p} = \sum q_j/p_j$. The parameters $s, t, \gamma \in \mathbf{N}$ measure the quality of the APFD as follows: An (s, t, γ)-APFD fulfils $\|p - \tilde{p}\| < 2^{-s}$ and $\|q - \tilde{q}\| < 2^{-t}$ for a norm $\|\cdot\|$ on $\mathbf{C}[z]$, and for all j, any two roots of p_j have distance at most $2^{-\gamma}$.

We describe and analyze algorithms that compute an (s, t, γ)-APFD from the coefficients of q and p with $\deg q \leq \deg p \leq n$ with $O(n^3 \cdot \gamma + n \cdot (s + t))$ single precision operations (neglecting logarithmic factors). The relation to root finding algorithms is discussed.

The author's papers in *Proc. ISSAC 1992, ACM* (pp. 16–26) and *Proc. ISSAC 1998, ACM* (to appear) provide details.