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| Article | Key Notes | Thoughts/Comments |
| Hu & Shum 2012  Nonparametric identification of Dynamic Models with Unobserved State Variables | **Primary:**  This paper proposes a novel method for identifying a hidden Markov process,   * Only 5 observations are needed in nonstationary cases, while only 4 are enough in stationary cases. * (W t , X t ∗ ) jointly evolves. * After the Markov kernel is identified, other relevant quantities can be recovered:  |  | | --- | | Markov kernel = CCP\*state law of  motion |  * Application: dynamic optimization models with unobserved process. * Strength:   + - Allow time-varying unobserved     - Evolve depending on past values of observables   **Model:**   * Observables: two components {action(decision), state} * Eq. 2 and 3 * Eq. 7       **Assumptions:**   * A1\_1. First-order Markovian * A1\_2. Limited Feedback * A2: Invertibility. Three injective   linear operators.      Completeness   * A3: Uniqueundness of decomposition * A4: Monotonicity and   Normalization.   * X\_t is scalar and continuous * How to connect Carrol’s assumptions with those in this paper? * Lemma\_1: Representation of the observed density * Lemma\_2: Representation of the Markov Law of Motion * Lemma\_3: Identification of   (Identification of f\_V t +1 |W t ,X t ∗ )  **Identification Strategy:**   * Based on Hu&Schennach 2008 and Carrol 2010. * Unique spectral decomposition: A1~A4 * Three-step identification:   + - Step 1: By A1~A4, f\_V t +1 |W t ,X t ∗ identified.     - Step 2: By Lemma\_2, identify the Markov kernel.     - Step 3: Identify the joint distribution of the initial condition: f\_W\_(t −1)\_X ∗ . * For stationary case, left as an exercise. | *How to identify other relevant quantities? Which formulae can illustrate?*  *Equation (1)*  *Why CCP and SLOM can be recovered??*  *See Arellano Bonhemme 2017 Review paper, where more applications and examples are discussed.*  *Why similar to Carrol 2010? In which S denotes a binary indicator, here no such binary sample.*  *Why need the two equations?*   * *A1, A2 restrict the attention of models studied.* * *A2 has an equivalent expression. See A&B 2017.* * *Why transform? V\_t exists.* * *It rules out X\_t-1 has direct effects on W\_t, or timing restriction.* * *A4: imposed on eigenfunctions. Since they are identified up to an one-to-one transformation of Xt\** * *Deserves reading more about this high-level. Why high-level?*  Can prove Lemma\_1 by direct definitions of Linear Operator?  * should be defined on V\_t-2! Otherwise, equation 7 does not make sense. * Use lemma 1 and lemma 3 to derive the spectrum decomposition, from which f\_Vt+1|(W\_t, X\_t) can be identified. * *Stationary: 4 periods is enough, due to Lemma 2’s equation.*   *A1 ~ A4 ensures the uniqueness of the spectral decomposition.*  *Step 1 iterates two times, moving back by one period.* |