Fig. 4. *Top:* Trajectories of the dancing honey bees for sequences 1 to 6, colored by *waggle* (red), *turn right* (blue) and *turn left* (green) dances. *Bottom:* Sine of the bee's head angle measurements colored by ground truth labels for 400 frames of each sequence. The data are available at http://www.cc.gatech.edu/ borg/ijcv_psslds/.
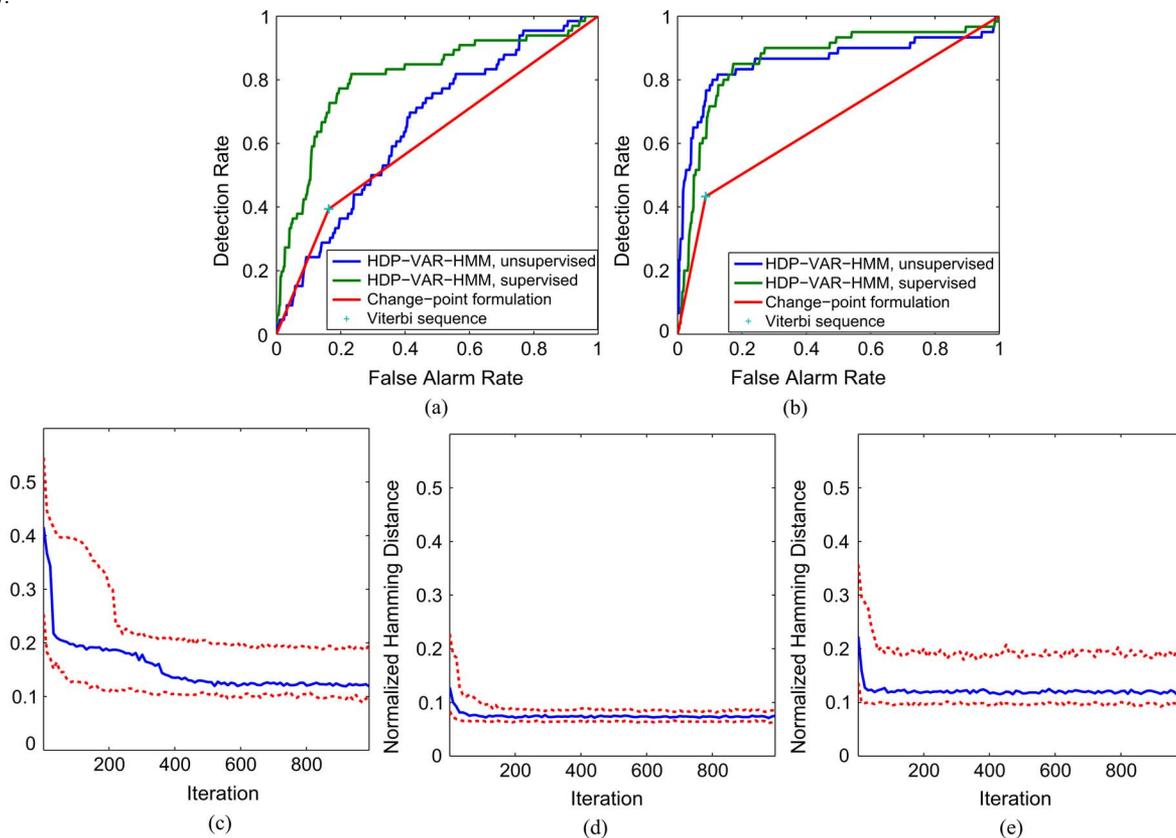

Fig. 5. (a)-(b) ROC curves for the unsupervised HDP-VAR-HMM, partially supervised HDP-VAR-HMM and change-point formulation of [15] using the Viterbi sequence for segmenting datasets 1–3 and 4–6, respectively. (c)-(e) The 10th, 50th, and 90th Hamming distance quantiles over 100 trials are shown for sequences 4–6, respectively.

a supervised formulation. Specifically, the ground truth labels for all but one of the sequences are employed in the inference of the labels for the remaining held-out sequence, and the kernels used in the MCMC procedure depend on the ground truth labels. (The authors also considered a "parameterized segmental SLDS (PS-SLDS)," which makes use of domain knowledge specific to honey bee dancing and requires additional supervision during the learning process.) Nonetheless, in Table III we report the performance of these methods as well as the median performance (over 100 trials) of the unsupervised HDP-VAR(1)-HMM in order to provide a sense of the level of performance achievable without detailed, manual supervision. As seen in Table III, the HDP-VAR(1)-HMM yields very good

performance on sequences 4 to 6 in terms of the learned segmentation and number of modes (see Fig. 6); the performance approaches that of their supervised method.

For sequences 1 to 3—which are much less regular than sequences 4 to 6—the performance of our unsupervised procedure is substantially worse. In Fig. 4, we see the extreme variation in head angle during the waggle dances of sequences 1 to 3.[3] As noted by Oh, the tracking results based on the vision-based tracker are noisier for these sequences and the patterns of

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[3]From Fig. 4, we also see that even in sequences 4 to 6, the ground truth labeling appear to be inaccurate at times. Specifically, certain time steps are labeled as waggle dances (red) that look more typical of a turning dance (green, blue).