Thank you all for the helpful reviews. We first address concerns shared among reviewers:

Experiments (real world networks): The Segmentation_11 network is a real-world network taken from the UAI Probabilistic Inference competition (2006 to 2014). It is a factor graph that was used to do image segmentation/classification, "and the goal is to figure out what type of object each pixel corresponds to" [Forouzan, 2015].

As suggested, we will run and report experiments on more networks, for a more comprehensive picture of our algorithm.

Structured decomposability (significance): As suggested, we will work on motivating this. Structured decomposability makes the following tasks tractable: multiplying distributions, computing KL-divergence of distributions, equivalence checking on logical circuits, conjoining/disjoining logical circuits.

Therefore, structured decomposable ACs are used when one wants to compose a tractable representation of a distribution or a logical formula using multiply/conjoin/disjoin. This includes inducing distributions over arbitrary logical formulae [Kisa *et al.*, 2014] or compiling a logical formula bottom-up [Oztok and Darwiche, 2015].

Reviewer 1: *Smoothing circuits subsection...* We will focus more on the real-world networks.

Segmentation-11 details... See above section on **experiments**. The collapsed sampling algorithm does inference on a factor graph by first compiling it into an SDD (a subset of structured decomposable circuit) and then smoothing the SDD. So, the AC given as input to the smoothing task is always structured decomposable.

Motivating structured decomposability... See above section on **structured decomposability**.

Reviewer 2: *Hand-crafted not representative...* See above section on **experiments**.

Report speedup factor... OK, we will change this.

Quadratic is too expensive... In recent years the size of AC's have grown to 100k/1m, and can have hundreds/thousands of variables [Friedman and Van den Broeck, 2018; Rooshenas and Lowd, 2014] (Seg_11_processed has $> 3k$ variables).

Proposed algorithm requires a structured circuit... See above section on **structured decomposability**. ACs may be constructed through a series of multiply/conjoins/disjoins, so structuredness would already be there.

The checklist asserts... Sorry this wasn't clear. The Seg_11_processed network is in the folder Collapsed-Compilation/Segmentation_11_processed/. We run inference on the given network, so there is no data to report (which is why we checked the box originally).

L 120 Variable m is the size (number of edges) of the circuit. L98-99 was meant to specify this.

L 159 You're right, it is better to define it to solve the smoothing task. We will update this.

L 177 Yes, this was a typo. A fix was included in the supplemental zip file (since they already locked changes to pdf)

L 181 Yes, here m is the number of intervals. It corresponds (with a constant factor) to the size of the circuit.

L 186 Here n is the number of variables. The inv-ack takes both number of variables and number of intervals as input.

L 204 Good point, we will re-formulate it as you suggested. Thanks.

L 211 Ok. It is meant to refer to algorithms satisfying Def 10. We will make this more precise.

L 253 Thank you.

discuss more clearly the significance... improve experiments... OK, we will work on these (see above sections).

Reviewer 3: *Better explain the backgrounds on AC* Ok.

Definition 8 could be splitted... Ok, we will update this.

Results on real world... See section on **experiments**.

References

Sholeh Forouzan. Approximate inference in graphical models. *UC Irvine*, 2015.

Tal Friedman and Guy Van den Broeck. Approximate knowledge compilation by online collapsed importance sampling. In *NeurIPS*, pages 8024–8034, 2018.

Doga Kisa, Guy Van den Broeck, Arthur Choi, and Adnan Darwiche. Probabilistic sentential decision diagrams. In *KR*, 2014.

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