Abstract
In most of the world’s languages, one can transform a statement into a question by raising the pitch at the end. This transformation is distinct in tonal languages, as it would transform neutral form into another.

- Does one ask a question in a tone language?
- Is there a question intonation?
- Are there question boundary tones?

We build and train models of tonal Chinese intonation to answer these questions. The resulting models have RMS errors of 0.1 Hz or less.

We find that questions are marked by:
- A slightly raised, but otherwise unmarked, phrase tone;
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What is the ML model?
The ML model learns several things:
- Phase and phrase termination are modeled in parallel.
- Phase phase transition is modeled using transition rules.
- Phrasal consistency between adjacent tone units is modeled.
- Phrase transition is modeled using transition rules.
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Here are the small-scale models:

- The model for small-scale models.
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**Data and Tone**

- **Plot**

**Stem-ML Optimizer**

- **Strength**

**Tone**

- **Phrase Curve**

**Stem-ML strength**

- **Parameter sharing:** words in the same position, with the same color are assumed to have the same strength.

- **Natural variation of tone shapes in the corpus.**

- **All these variations are accounted for by strength of tones and their neighbors.**
All four models show a consistent pattern of prosodic strength: questions are stronger near the end. In the Stem–ML models we used here, the increase in strength causes the tones to match their templates more closely. The stronger templates have an expanded pitch range.