0. Introduction
Analyzing Latvian and Lithuanian tones in terms of high and low pitch, as sequences of different levels of pitch, is less adequate than analyzing them in terms of contour and register. Pitch-oriented approach overlooks some of the facts and observations about Latvian and Lithuanian tones, mostly because they are published in Latvian and Lithuanian and may be difficult to find. My task is to offer a new analysis that would take these facts into consideration. (No new experimental research has been conducted; the empirical data in the paper are taken from the literature.)

1. Tonal features
Pitch. Tones are most often described in terms of pitch levels. A falling tone has a falling pitch pattern characterized by high pitch in the beginning and low pitch in the end. A level tone has the same pitch level during its realization.

Contour. A falling tone has a contour which a level tone lacks.

Register. The word may be used in different meanings even with respect to language tones. Here it stands for types of phonation. Pitch reflects the fundumental frequency with which the vocal folds vibrate, whereas types of phonation reflect the variations in the state of the vibrating vocal folds; see (Ladefoged & Maddieson 1996: 49).

- breathy voice (the vocal folds are slightly more apart than normal)
- creaky voice or laryngealization (the vocal folds are held more tightly together)
  - glottal stop/closure (a full closure of the vocal folds)

2. Latvian and Lithuanian tonal systems
Latvian and Lithuanian tones (pitch accents) are dependent on stress, although to a different extent. Tones are only distinguished on heavy syllables (long vowels, diphthongs and so-called diphthongal sequences of a short vowel and a sonorant).

2.1. Latvian

<table>
<thead>
<tr>
<th>Western Latvian (Low Latvian)</th>
<th>Standard Latvian</th>
<th>Eastern Latvian (High Latvian)</th>
</tr>
</thead>
<tbody>
<tr>
<td>level</td>
<td>level</td>
<td>broken</td>
</tr>
<tr>
<td>mīt ‘change’ (INF.)</td>
<td>mīt ‘exist’ (PRS.3)</td>
<td>mīt ‘tread’ (INF.)</td>
</tr>
</tbody>
</table>

The names for the level and the falling tone reflect their pitch movement (the level tone may have a slightly rising pitch). The level tone is characterized by a longer duration. The level and the falling tones are reported to have the same intensity pattern.

The broken tone involves glottal stop or creaky voice. According to its pitch movement and intensity profile, the broken tone may be described as falling-rising.


In unstressed position the level and the falling tone merge into one that is sometimes referred to as falling (Kariņš 1996: 134–5) and sometimes as level (Ābele 1932: 159). This merged tone is contrasted to the broken tone as having no laryngeal features.

In dialects, the three tones are reduced into two.

The well-known facts only deal with one type of non-modal phonation, that is, creaky voice that is used as a subsitute for glottal stop. But the falling tone may be also associated with breathy voice.
• In the Selonian subdialect of High Latvian the falling tone, resulting from the merge with the level tone, is accompanied with breathy voice before voiceless consonants. Sometimes this is interpreted by dialectologists as an insertion of [x], as in māsa > māšu ‘sister’ (Rudzīte 1964: 312–31).
• In Low Latvian, under the rising sentence intonation, both the level and the falling tone appear as rising but the difference is maintained by the falling tone being accompanied by ‘Lufterfüllte Stimme’ (breathy voice) (Ābele 1931: 92).

2.2. Lithuanian

acute          circumflex
klōstė ‘tuck’ (PST.3)      klōstė ‘fold’ (NOM.SG.)

• pitch: the acute is falling while the circumflex is rising (Kurschat 1876: 57–63; Javnis 1908–1916: 34, 44–5)
• intensity: the acute is ‘strong in the beginning’ and has stress on the first mora, while the circumflex is ‘strong in the end’ and has stress on the second mora (Javnis 1908–1916: 34, 44–5)

The phonetic manifestation of the contrast is complex, involving different parameters depending on the type of the syllable. On long vowels the contrast is mostly achieved by pitch, while on diphthongs and diphthongal sequences the main part is played by the different duration of the components; the shorter component is often a reduced vowel (Pakerys 1982: 182–9). Girdenis (2003: 271–274) define the acute as ‘rough’ and the circumflex as ‘smooth’; see also (Dogil 1999: 887). In the Zhemayt dialect, the acute may be also manifested by glottal stop or creaky voice; the duration of the components and vowel reduction are not employed as means of maintaining the tonal contrast on diphthongs and diphthongal sequences.

3. Previous analyses of the Latvian and Lithuanian tones

• Lithuanian: (Kenstowicz 1972), (Halle and Vergnaud 1987: 190–203), (Blevins 1993), and (Dogil 1999)
• Latvian: (Kariņš 1996)

with the exception of (Dogil 1999), interpret the Latvian and Lithuanian tones in terms of high and low pitch. (In some cases pitch may be determined metrically.)

<table>
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<tr>
<th>Latvian falling tone</th>
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<th>Latvian broken tone</th>
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</thead>
<tbody>
<tr>
<td>Latvian acute</td>
<td>Lithuanian circumflex</td>
<td>cf. Livonian (Kiparsky), Danish (Mester &amp; Itô)</td>
</tr>
<tr>
<td>µ µ</td>
<td>µ µ</td>
<td>µ µ</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H(L)</td>
<td>(H)H</td>
<td>H LH</td>
</tr>
</tbody>
</table>

The approach that represents the Latvian and Lithuanian tones as sequences of high and low pitch levels dispenses with the other phonetic parameters of the tones far too quickly and easily.

• The analyses of the Lithuanian tones are actually based on the classical works by Kurschat and Javnis and pay no attention to the considerable amount of research made by contemporary Lithuanian phonologists and dialectologists. There is a clear need for an analysis that would incorporate the achievements by Lithuanian phonologists into its frame (Girdenis’ definition of the acute as ‘rough’ and the circumflex as ‘smooth’).

• Is there is a real need to reduce the laryngeal features of the Latvian broken tone (and the Zhemayt acute) to a particular pitch pattern? Cf. register languages.

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1 The names for the tones actually come back to (Saussure 1922).
2 For more detail on the phonetic correlates of the Zhemayt acute and circumflex see works by Aleksas Girdenis and other authors.
3 See (Kudirka 2005: 3; Bacevičiūtė 2011: 14–15) for surveys on phonetic studies of tones in Lithuanian dialects.
4. An alternative analysis

Pham (2003) encountered a similar problem in Vietnamese and introduced such tone features as Contour and Register instead of different pitch levels.

- Contour offers an excellent way to formalize the ‘roughness’ of the Lithuanian acute as the presence of contour and the ‘smoothness’ of the circumflex the absence of contour. The Latvian falling tone is marked by the presence of contour and the level tone by the absence of contour; see also (Seržants 2006: 100).
- Register may deal with the laryngeal features of the Latvian broken tone and the Zhemayt acute; it may also take care of the other types of non-modal phonation accompanying the Latvian tones in dialects.

4.1. In Latvian, one of the three tones has the marked feature for contour, one has the marked feature for register, and one tone is unspecified.

(a) The broken tone is specified for register, the falling contour must have the marked feature for contour, and the level tone must be unspecified.

(b) The broken tone is specified for register, the falling tone is unspecified, but the level tone is specified for the absence of contour.

Both the falling and the level tones may rise as the result of neutralization.

- Register is not sensitive to stress, but contour is. The unspecified tone of unstressed syllables is identified as falling (Kariņš 1996: 134–5) or as level (Ābele 1932: 159).
- Newly formed syllables produced by resyllabification are automatically given the falling tone.

In borrowings heavy syllables automatically receive the level tone, ārmiņa ‘army’.

Both (a) and (b) must be found in real varieties of Latvian because the development of tones in dialects shows that there might have been two slightly different starting points for the change (see 4.2.).

4.2. The three tones may be viewed as an overlap of two categories, register (with the feature register) and tone (with the feature contour), cf. (Andronov 2002: 328 n.18). In dialects only one feature remains, either by eliminating the other feature or by merging the features.

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<td>level</td>
<td>falling</td>
</tr>
<tr>
<td>falling or broken</td>
<td>falling</td>
<td>broken</td>
</tr>
<tr>
<td>broken or falling</td>
<td></td>
<td>broken (rising in Selonian)</td>
</tr>
</tbody>
</table>

- In High Latvian the absence of contour, which was the marked feature of the level tone, must have been removed, making register the only feature responsible for the tonal contrast.
- In Low Latvian the falling tone, specified for contour, merges with the broken tone, specified for register. The merge of contour and register may be explained by the falling tone also being specified for register (see 2.1.). The non-modal phonation might have served as a foundation for the merge between the falling and the broken tones.

In Lithuanian the acute has the marked feature for contour, the circumflex is unspecified. The manifestation of the Zhemayt acute as glottal stop is reminiscent of the development in Low Latvian, even though there has been no tonal merge in Zhemayt. (A contour tone that shows the
transition between contour and register must not necessarily be falling — the Selonian rising tone corresponds to the broken tone in the rest of Latvian.)

5. Conclusion
Latvian and Lithuanian tones can be adequately analyzed in terms of contour and register. Such analysis is also preferable over an analysis in terms of pitch levels because it captures the relationship between non-modal phonation and contour tones which is found in dialects of both languages.

References
Ābele, Anna. 1932. Par neuzsvērto zīlbu intonācijām. Filologu Biedrības Raksti XII, 149–163.