Pitch fluctuations in accurate and inaccurate singers: Are they the same?

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Singing voice

What we know

- Complexity of the signal

  (e.g. Larrouy-Maestri et al., 2014; Sundberg, 2013)

- Parameters contributing to the beauty of the voice

  (Ekholm et al., 1998; Garnier et al., 2007; Rothman et al., 1990)

- Pitch fluctuation (vibrato) associated with quality for Western operatic voices

  (Larrouy-Maestri et al., in press)

Occasional singers

What we know

- Not « operatic » but pitch fluctuations
- Evaluation of melodic accuracy based on median or mean F0 of stable portion of tones

  (e.g. Berkowska & Dalla Bella, 2013; Dalla Bella, Giguère, & Peretz, 2007, 2009; Hutchins & Peretz, 2012; Hutchins, Larrouy-Maestri, & Peretz, in press; Larrouy-Maestri et al., 2013; Larrouy-Maestri & Morsomme, 2014; Pfordresher & Brown, 2007, 2009; Pfordresher et al., 2010; Pfordresher & Mantell, 2014)
- Difference between accurate and inaccurate singers regarding deviation from the target
- Several possible causes

  (e.g. Hutchins et al., in press; Hutchins & Peretz, 2012; Pfordresher & Brown, 2009; Pfordresher & Mantell, 2014)

Occasional singers

What we don't know

- Which pitch fluctuations ?
- Depends on the quality of the singer ?

Occasional singers

What are we doing?

- Which pitch fluctuations ?

  Model describing pitch fluctuations

- Depends on the quality of the singer ?

  Comparison accurate/inaccurate singers

Description of pitch fluctuations

Descriptive model of pitch fluctuation

- Modification of the temporal adaptation model of Large, Fink & Kelso (2002)
  - Goal: evaluating adaptation to changes in pitch space
- Designed to get relevant summary statistics for pitch fluctuations
  - Not based on physiology of phonation

Pitch at time *t*
Comes from "**s**tart" fluctuations
and "**e**nd" fluctuations
influencing an ***asym***ptote

$$Pitch_t = Y_{s_t} + Y_{e_t} + asym$$

Descriptive model of pitch fluctuation

$$Pitch_t = Y_{s_t} + Y_{e_t} + asym$$

$$Y_{s_t} = \left[A_s * \exp(-b_s t) * \cos(2\pi f_s t + \theta_s) \right]$$

Beginning perturbation

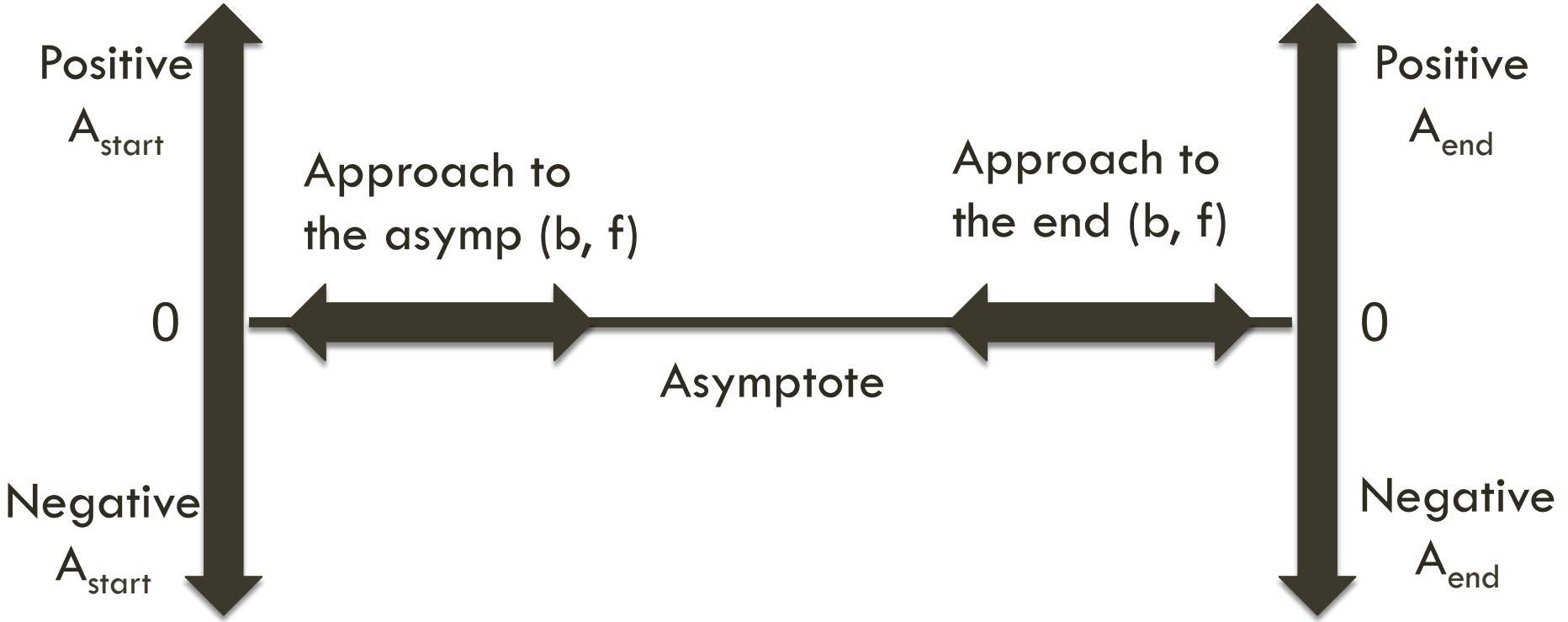
Approach to asymptote

Oscillation around target (overshoot)

Approach is down (= 0) Or up (= pi)

Similar to starting fluctuations, except
-Time values mirror reversed
-New and adjusted parameters

Descriptive model of pitch fluctuation



➔ Description of pitch fluctuation in accurate singers ?

➔ Difference between accurate/inaccurate singers ?

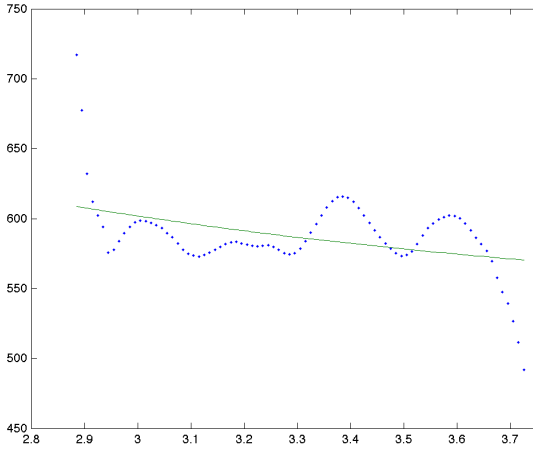
Database

- Pfordresher & Mantell (2014)
  - Melodic sequences imitation (Pfordresher & Brown, 2007)
    - Using the first 5 notes of C-major scale
    - Adatpted to the gender of the participant
    - Presented at a slow rate (1s per tone)
  - Several conditions
    - Accurate singers as a model
    - Inaccurate singers as a model
    - Self-imitation
  - Categorization of the singers according to their global deviation from the target to imitate (limit: 50 cents)
- Present study
  - 12 “inaccurate” and 17 “accurate” singers
  - Imitation of accurate singers
  - Melodies of 4 notes
  - 1854 tones (already segmented) to analyse

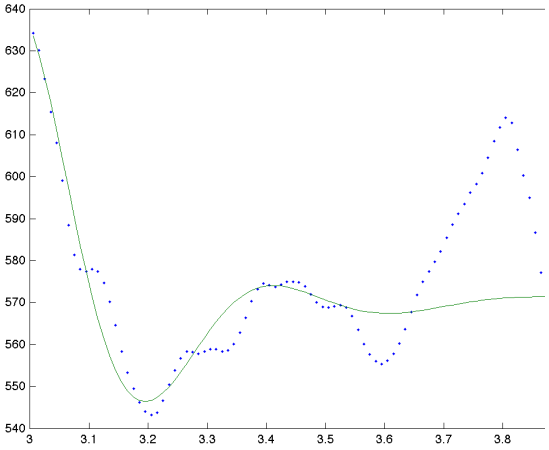
Model

- Goodness of fit: VAF (>25%)
  - Not different depending on the quality of the singer ($p = .82$)
  - Mean $VAF_{accurate} = .61$, $SE = .02$
  - Mean $VAF_{inaccurate} = .61$, $SE = .01$

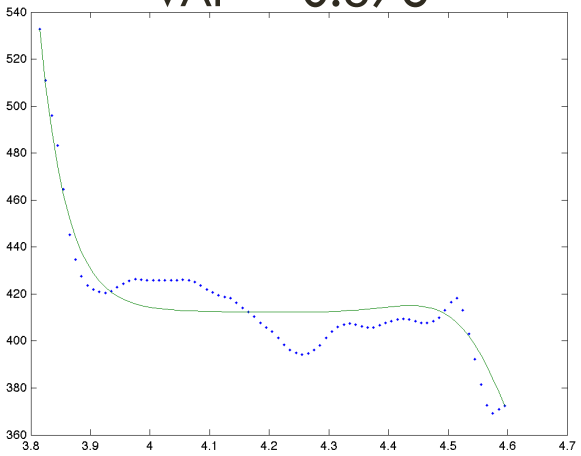
VAF = 0.172



VAF = 0.522



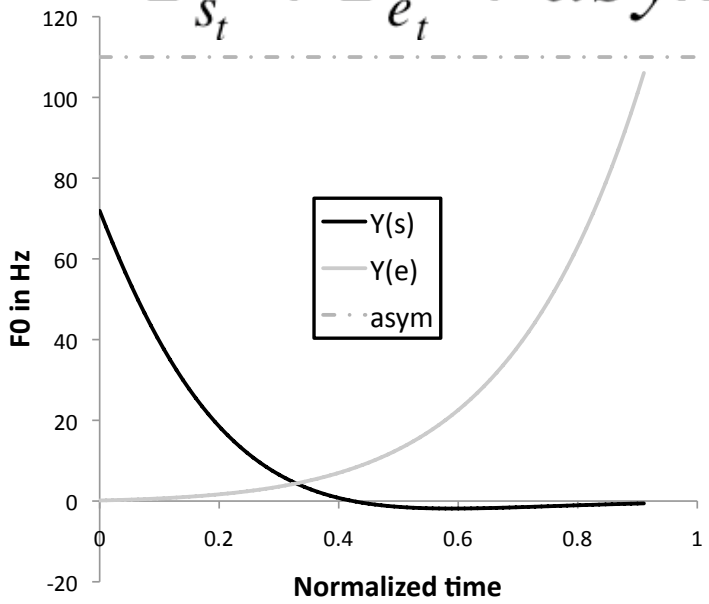
VAF = 0.876



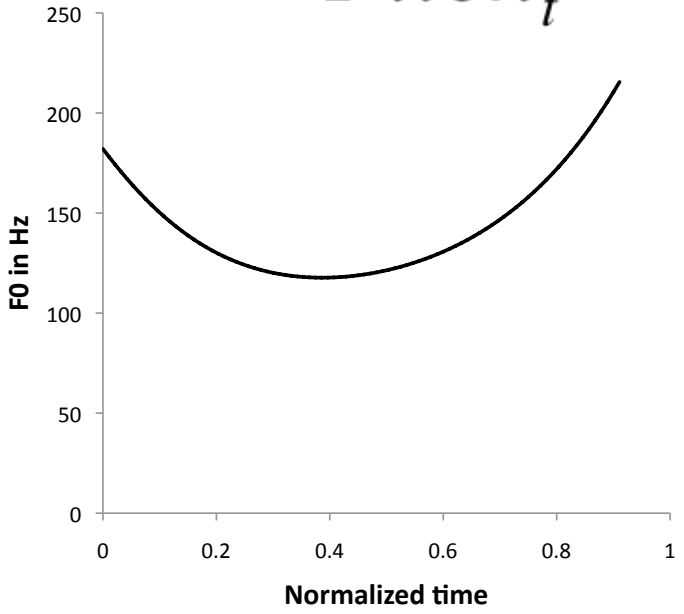
Accurate singers

- Scoop at the start: up (49.5%) or down (50.5%)
- Scoop at the end: majority down (81.3%)

$$Y_{s_t} + Y_{e_t} + asym$$



$$Pitch_t$$



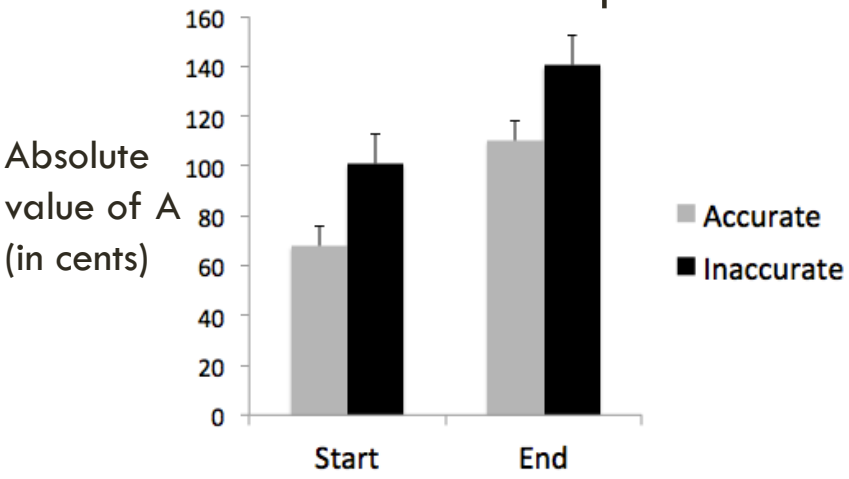
$$Y_{s_t} = \left[71.91 * \exp(-5.27 * t) * \cos(2\pi * 0.58 * t)\right]$$

$$Y_{e_t} = \left[106.07 * \exp(-4.55 * t) * \cos(2\pi * -0.26 * t)\right]$$

$$asym = 110$$

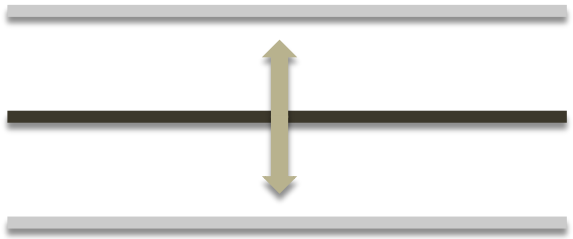
Comparing accurate/inaccurate singers

- Start
  - No difference regarding the direction (up or down)
  - Greater scoop for inaccurate singers
    - ($t(27) = -2.91$, $p = .007$)
  - No difference for other parameters
- End
  - No difference regarding the direction (up or down)
  - Greater scoop for inaccurate singers
    - ($t(27) = -1.98$, $p = .058$)
  - No difference for other parameters

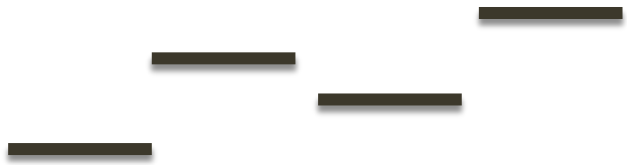


Comparison for each condition

- Global deviation
  - Sharp of flat

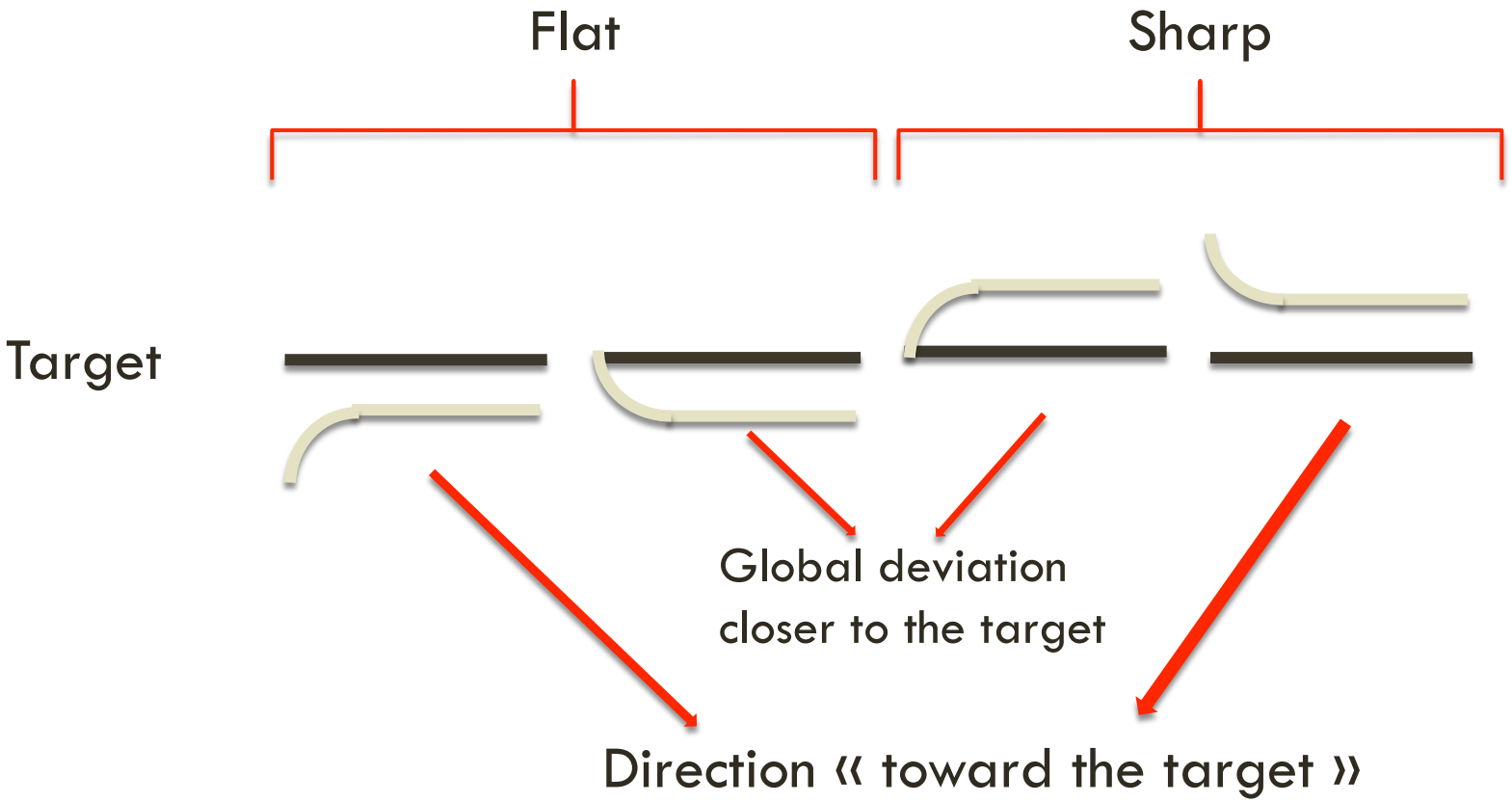


- Melodic context
  - No previous tone
  - Higher previous tone
  - Lower previous tone



Start and global deviation

- Four possibilities

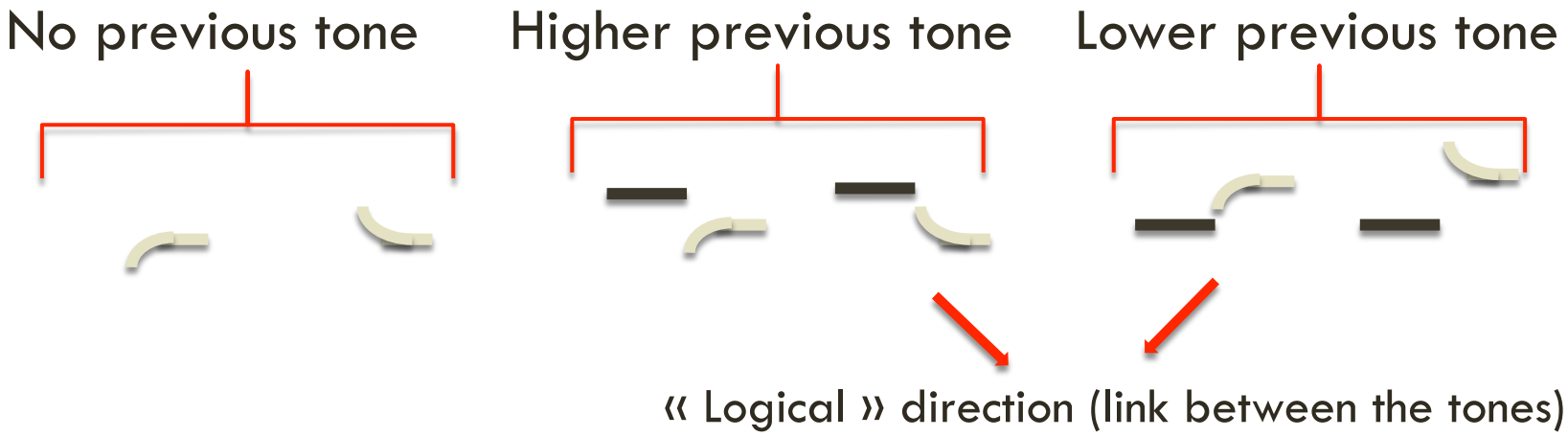


Start and global deviation

				
% of trials				
Accurate	7	5	39	50
Inaccurate	9	7	43	41
p-value	ns	ns	ns	ns
Mean (SE) abs value of A				
Accurate	111.4 (20.90)	86.15 (16.34)	71.38 (5.36)	56.49 (6.08)
Inaccurate	108.3 (10.20)	103.3 (27.88)	103.6 (12.59)	69.30 (11.27)
p-value	ns	ns	.014	ns

Start and melodic context

- Six possibilities



Start and melodic context

						
% of trials						
Accurate	66	34	48	52	33	67
Inaccurate	64	36	47	53	50	50
p-value	ns	ns	ns	ns	ns	ns
Mean (SE) abs value of A						
Accurate	118.71 (12.24)	86.44 (11.05)	60.92 (7.62)	49.85 (8.25)	48.81 (5.24)	57.63 (6.35)
Inaccurate	163.05 (21.13)	88.87 (23.10)	79.46 (8.74)	78.08 (14.19)	85.69 (13.42)	61.12 (7.49)
p-value	.063	ns	ns	.078	.008	ns

Conclusions

- Acoustical description of vocal tones
  - Modeling voices of occasional singers
- Profile of inaccurate singers
  - No difference with accurate singers regarding direction of scoops
  - Difference for amplitude of scoops at the start
    - → An indicator of singing ability in addition to the pitch deviation?
  - Depends on the condition
    - Scoop up
    - Going closer to the target
    - Logical condition regarding the context
    - → Fine motor control deficit or preconceived plan not precise enough
- Perceivers' judgment of pitch accuracy influenced by these fluctuations?

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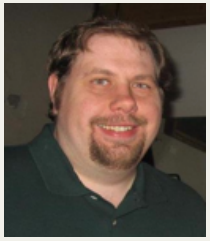
Undergrad assistance from UB

Malak Sharif

Michael Wright



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Thank you!

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