Lecture 24

Overview of final exam
Review of Assignment 2

April 12, 2018

Evaluation

- Three Assignments (10% each)
- Midterm Exam (20%)
- Final Exam (50%)

You can replace your midterm exam grade with your final exam grade, i.e. final exam would be 70%.

Final Exam

50 points   (28 questions, all short answer)

- 25 points on lectures 1-15 (same material as midterm)
- 25 points on eight lectures 16-23

This gives roughly equal balance to all lectures.

VISUAL IMAGE FORMATION

1. geometry (slides) (notes)
   origins of spatial vision, visual angle, aperture, image projection, binocular disparity
2. focus and blur (slides) (notes)
   sampling, thin lens equation, depth of field, accommodation, aging and abnormal vision
3. photoreceptors, color (slides) (notes)
   spectra: emission, reflectance, absorptance; rods and cones, metamers, color displays, color blindness

What ***do*** you need to know?

- everything in gray above: give definitions, do simple calculations & basic reasoning

For all subsequent slides, I will only list what you don't need to know.

VISUAL IMAGE FORMATION

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   origins of spatial vision, visual angle, aperture, image projection, binocular disparity
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   sampling, thin lens equation, depth of field, accommodation, aging and abnormal vision
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   spectra: emission, reflectance, absorptance; rods and cones, metamers, color displays, color blindness

What do you ***not*** need to know?

- f-number
- color displays
- temporal effects in photoreceptors

EARLY VISION

4. retina (slides) (notes)
   spikes, color opponency, center-surround DOGs, cross-correlation
5. orientation selectivity (slides) (notes)
   retinotopic maps, simple cells, Gabor models
6. disparity tuned cells (slides) (notes)
   complex cells in V1, monocular vs. binocular, disparity space
7. image motion 1 (slides) (notes)
   XYT, time dependent receptive fields, 3D Gabors and sine waves, normal velocity
8. image motion 2 (slides) (notes)
   motion constraint equation, intersection of constraints, velocity tuned cells (MT)

What do you ***not*** need to know?

- names of different types of cells in pathway
- XT separable receptive fields

3D SURFACE AND SPACE PERCEPTION

9. egomotion (slides) (notes)
   translation and direction of heading; rotation: VOR, smooth pursuit eye movements
10. depth from blur, binocular steropsis (slides) (notes)
   blur on slanted planes, Panum's fusional area, accommodation-vergence conflict, random dot stereograms
11. shape from X: perspective, texture, shading (slides) (notes)
   vanishing points, depth gradient and texture cues, slant & tilt; curvature, Lambert's law
12. illumination and reflectance (slides) (notes)
   shape from shading (linear & cloudy day), lightness & color constancy

What do you ***not*** need to know?

- motion field equation formula – don't memorize (but you should know qualitatively what the component fields)
- MST model of motion estimation
- vanishing points
- formulas for slant and tilt (but you *should* know their meaning)
- formulas for shading models (but you *should* understand them)
- details of "von Kries" adaptation and "grey world" model

MEASURING AND MODELLING PERFORMANCE

13. psychophysics (slides) (notes)
    psychometric curves, thresholds, contrast and disparity sensitivity
14. maximum likelihood (slides) (notes)
    examples of likelihoods, probability review
15. cue combinations, Bayesian models (slides) (notes)
    priors, MAP, depth reversal ambiguity

What do you ***not*** need to know?

- formulas for linear cue combination (how to define cue weights?)

LINEAR SYSTEMS THEORY

16. convolution (slides) (notes)
    impulse response functions, complex numbers review
17. Fourier transform and filtering (slides) (notes)
    examples, convolution theorem, low/band/high pass filters

[after midterm starts here]

What do you ***not*** need to know?

- proofs that

$$cos\left(\frac{2\pi k}{N}x\right) * \square(x) = a\ cos\left(\frac{2\pi k}{N}x\right) + b\ sin\left(\frac{2\pi k}{N}x\right)$$

$$a\ cos\left(\frac{2\pi k}{N}x\right) + b\ sin\left(\frac{2\pi k}{N}x\right) = \sqrt{a^2 + b^2}\ \cos\left(\frac{2\pi k}{N}x - \phi\right)$$

- formula for Fourier transform of Gaussian

AUDITORY IMAGE FORMATION

18. sound 1 (slides) (notes)
    pressure vs. intensity, dB
19. sound 2 (slides) (notes)
    music and speech sounds, spectrograms

What do you ***not*** need to know?

- null, you need to know it all

AUDITORY SYSTEM & SPATIAL HEARING

20. head and ear (slides) (notes)
    head and outer ear (HRIR, HRTF)
21. auditory pathway, sound localization (slides) (notes)
    cochlea and neural coding, duplex theory, Jeffress model, level and timing differences
22. auditory filters (slides) (notes)
    spectrograms revisited, critical bands and masking, spike triggered averaging and A1
23. echolocation and recognition by bats and porpoises (slides) (notes)
    constant frequency, frequency modulation, interference

What do you ***not*** need to know?

- details about human auditory bandwidths
- formula for Doppler shift
- details of constructive and destructive interference

PPT -> PDF problems on slides

$$I_{right}(t;\phi,\theta) = \underbrace{\boxed{?}_{right}(t;\ \phi,\theta)}_{\text{HRIR}} * I_{src}(t;\ \phi,\theta)$$

I will try to clean up this PDF coding stuff next week.

In the meantime, use the lecture notes to resolve ambiguities.

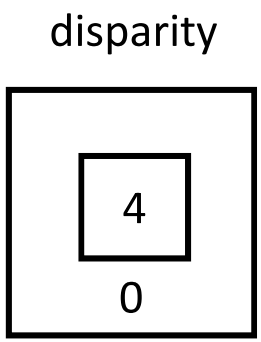
What else?

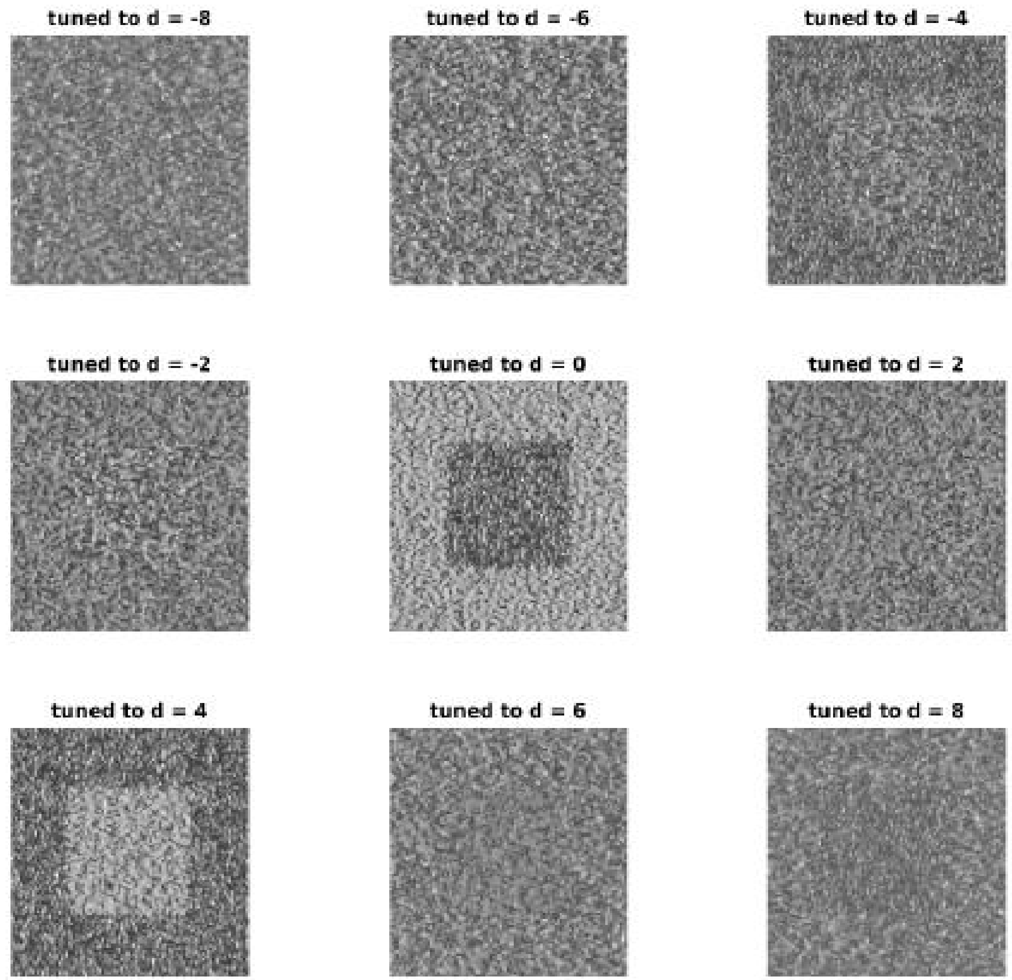
- Assignments:

  If you didn't understand some questions, then review solutions. *See me if you need help.*

- Exercises:
  - There will be several questions on the final exam taken from Exercises
  - good way of testing your understanding

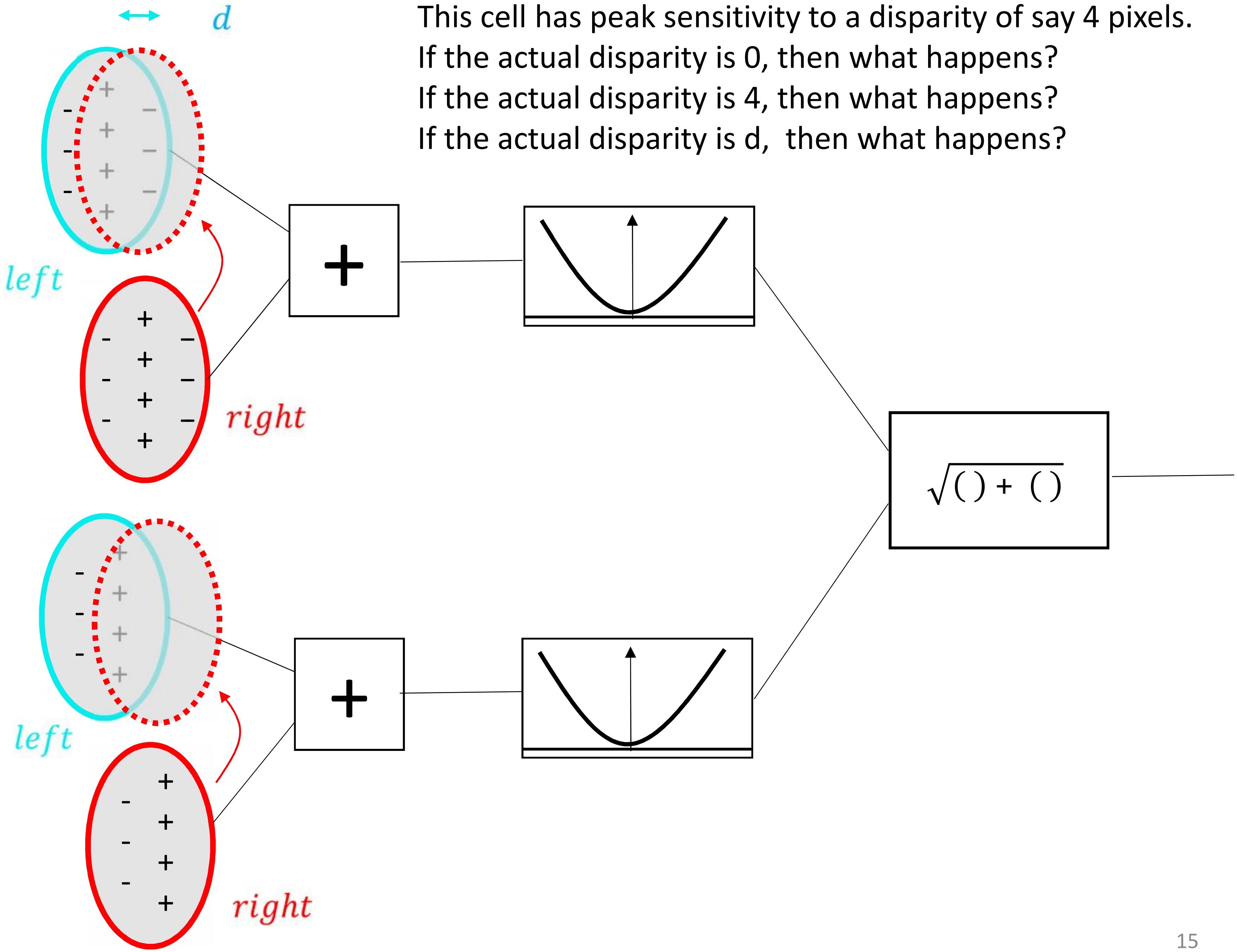
Assignment 2 Question 1



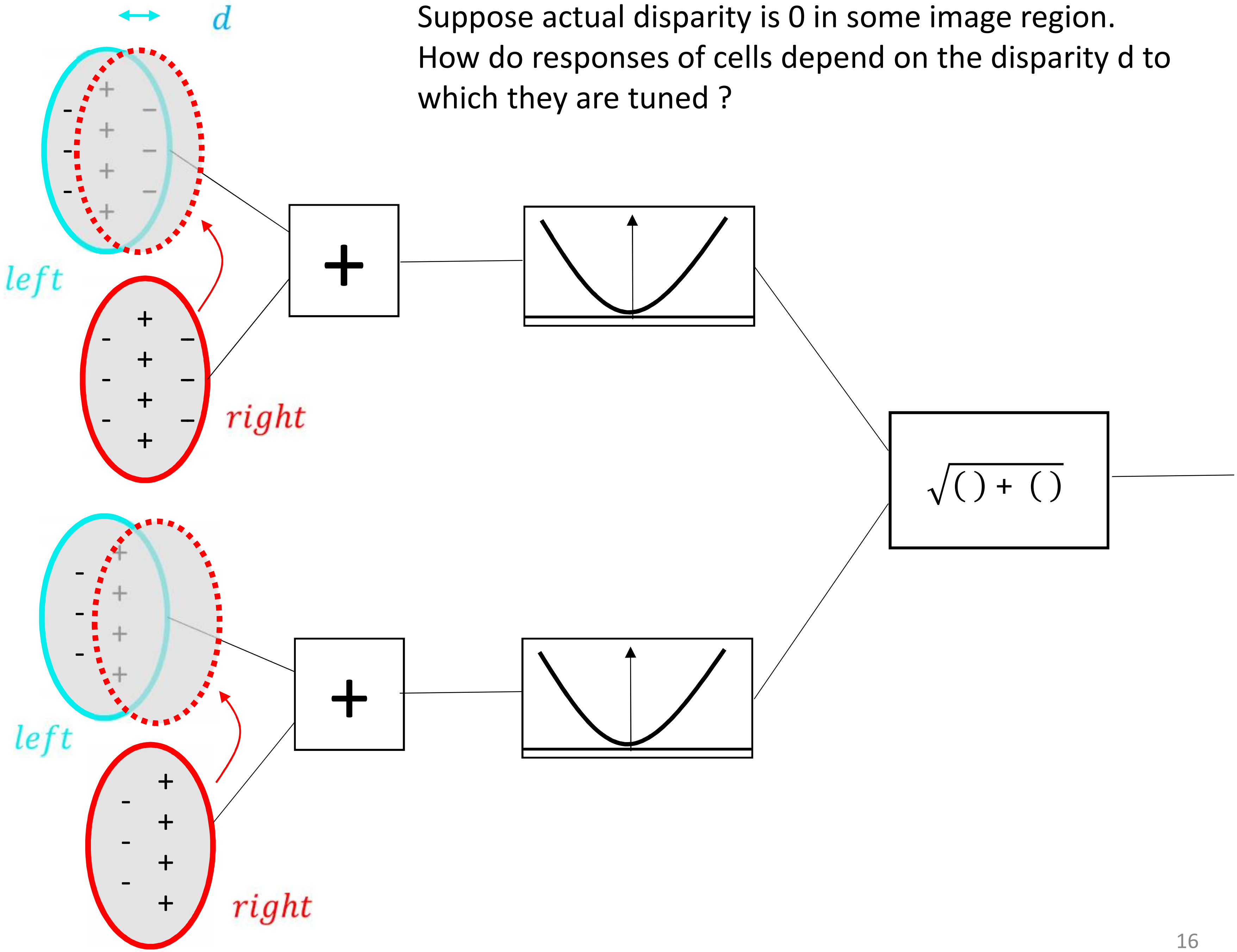


Responses of complex Gabor cells tuned to different disparities

This cell has peak sensitivity to a disparity of say 4 pixels.
If the actual disparity is 0, then what happens?
If the actual disparity is 4, then what happens?
If the actual disparity is d, then what happens?



Suppose actual disparity is 0 in some image region.
How do responses of cells depend on the disparity d to which they are tuned ?



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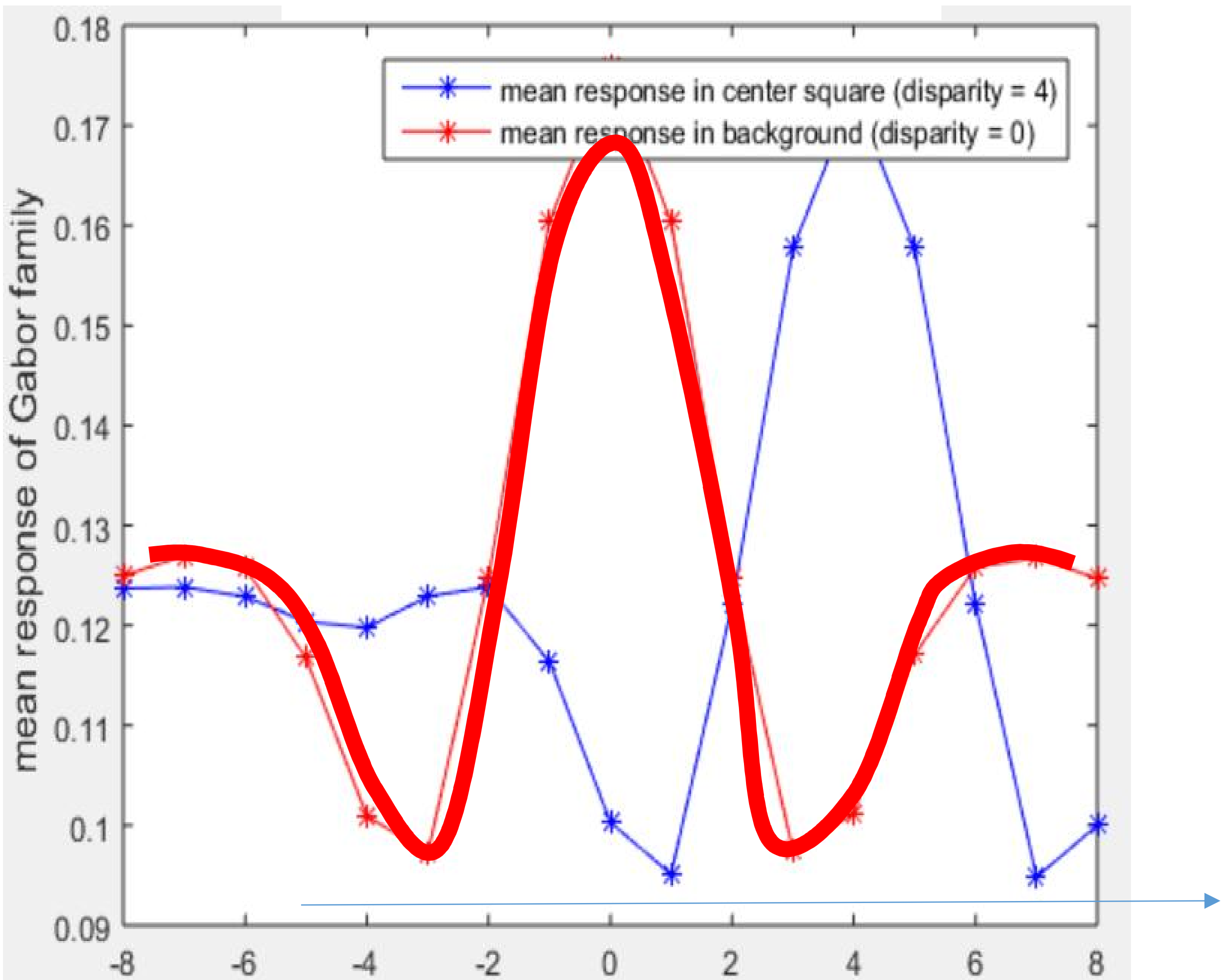

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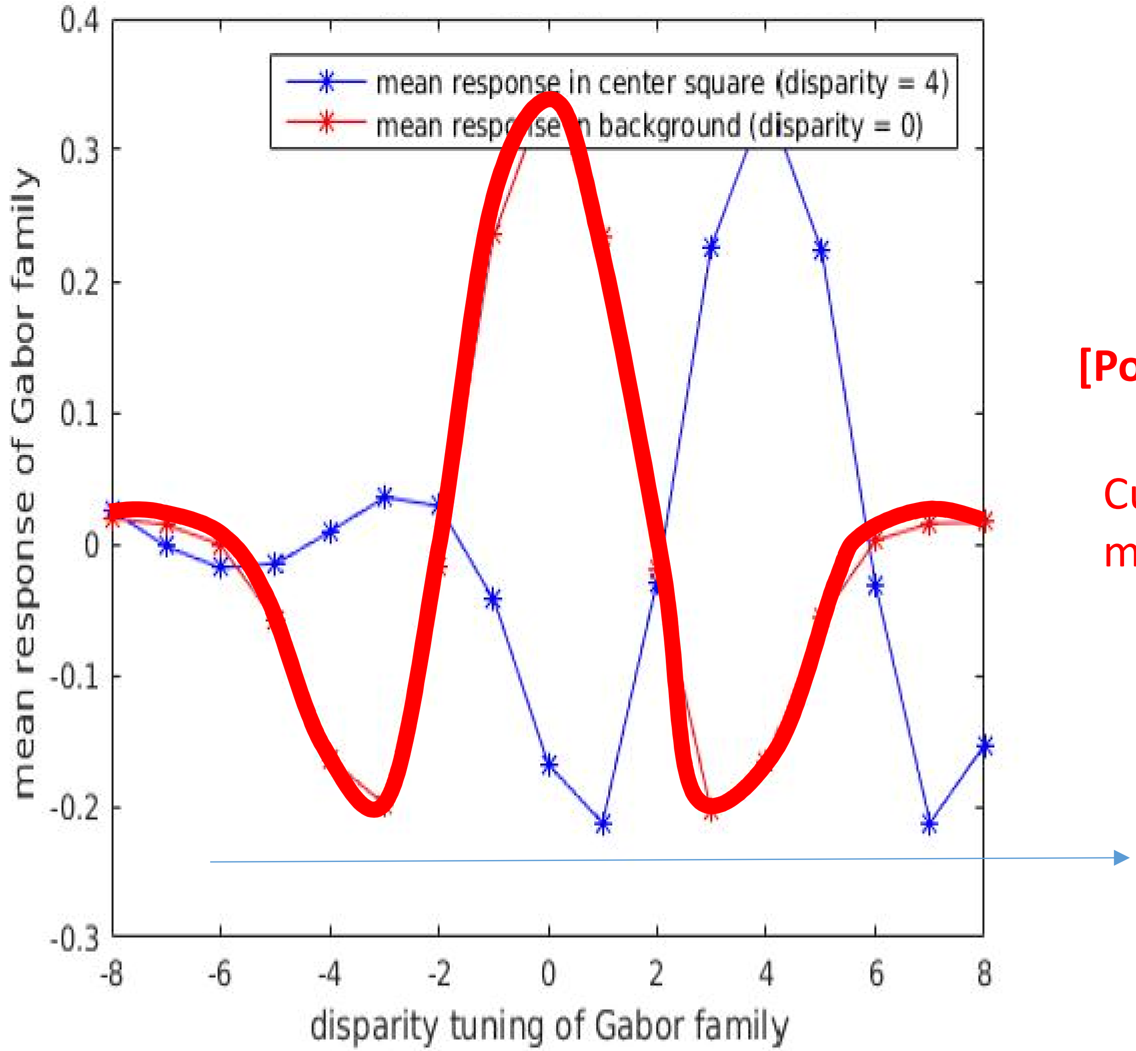
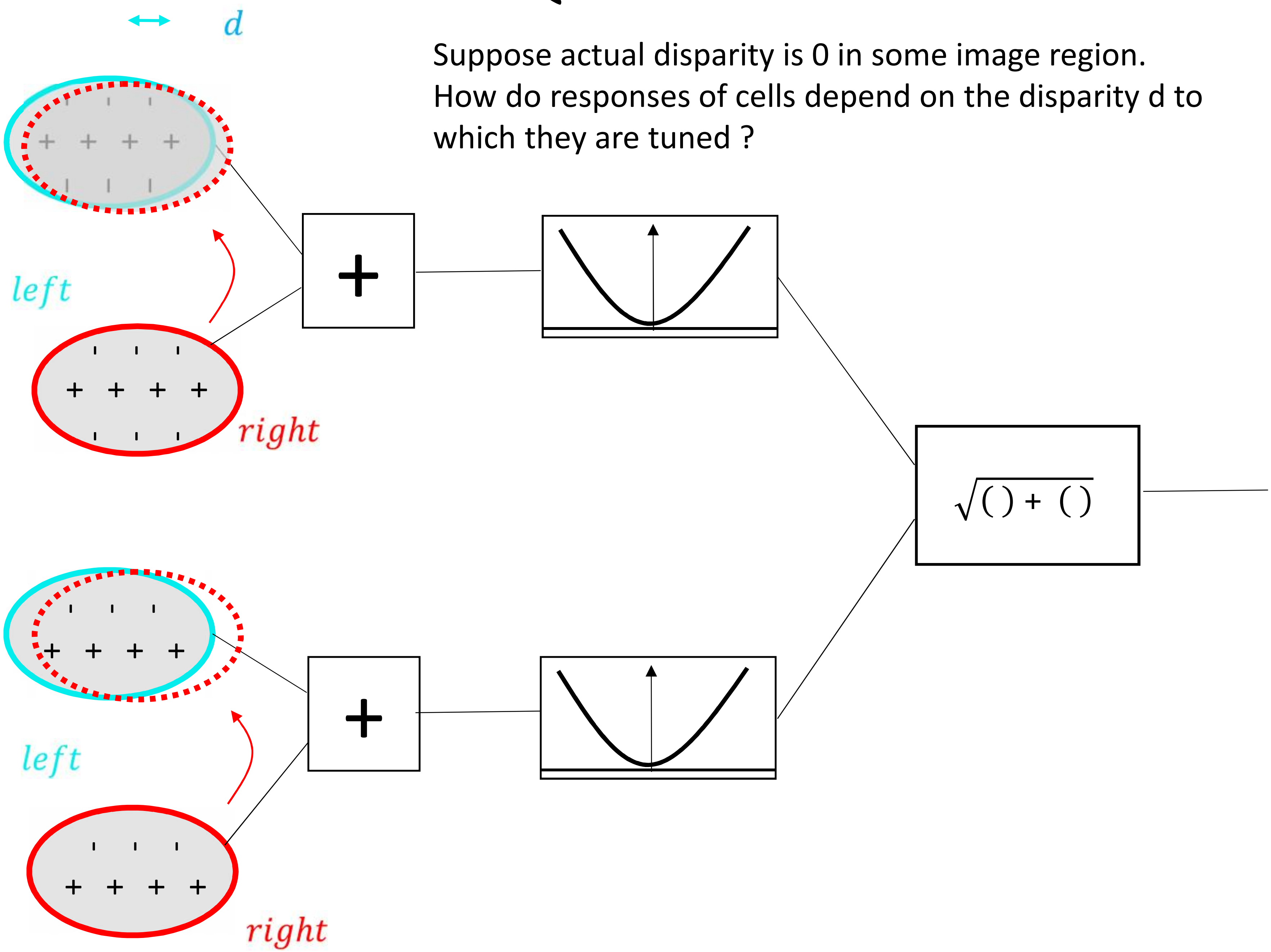


[Posted solution:]

Curves shifted so mean is 0.

Question 2

Suppose actual disparity is 0 in some image region. How do responses of cells depend on the disparity d to which they are tuned ?



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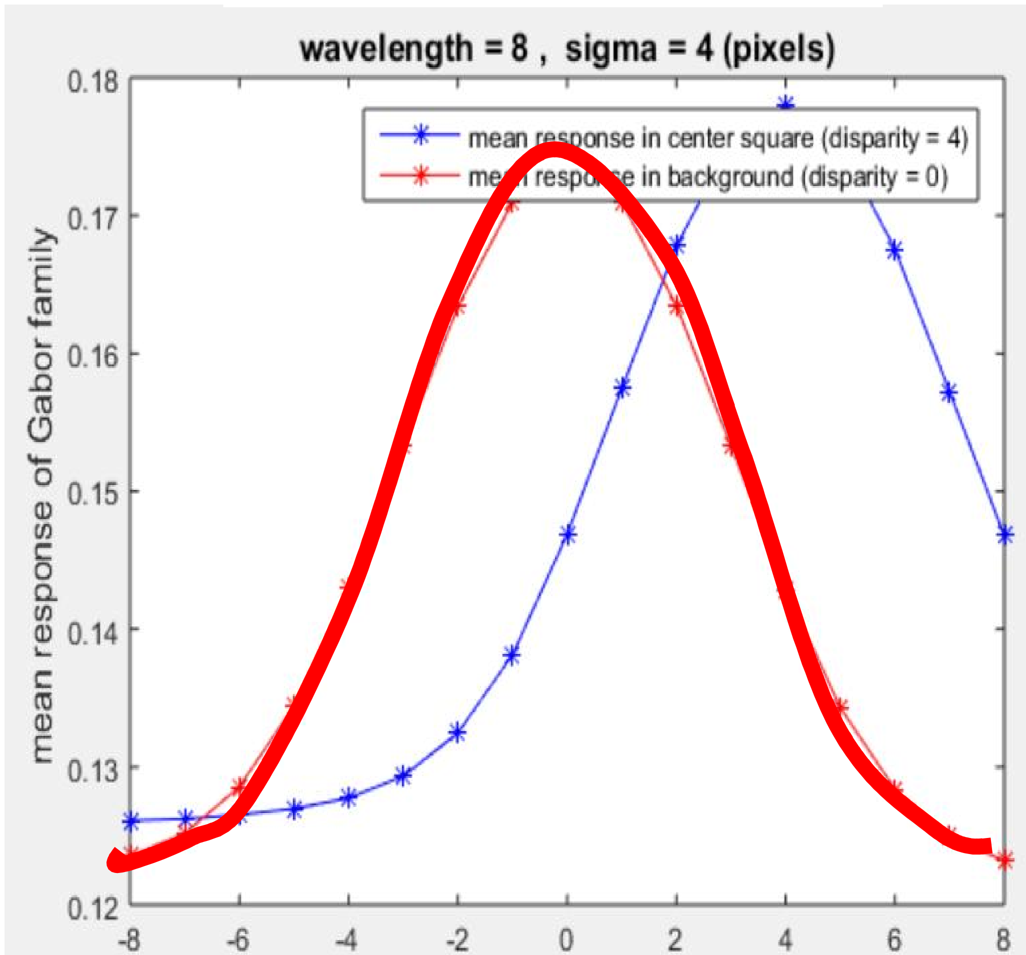

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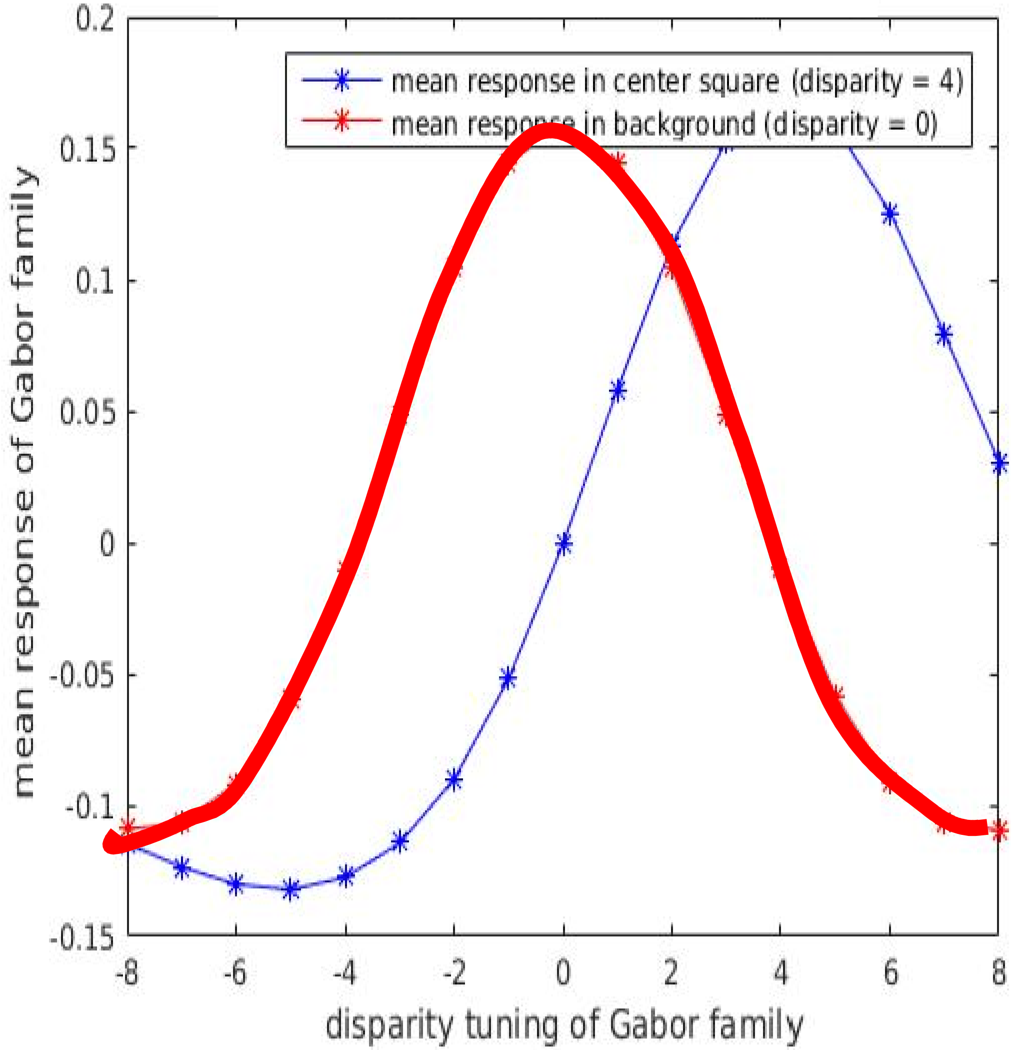
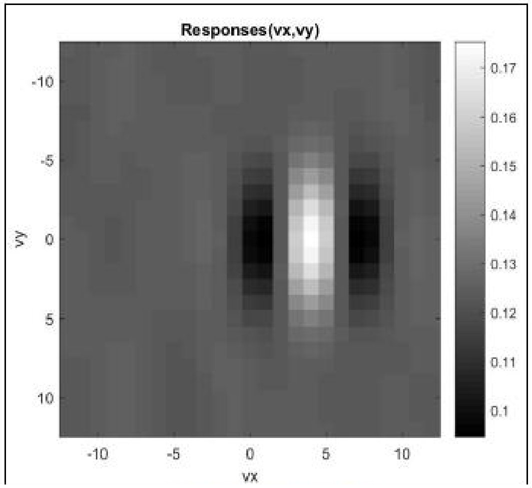


[Posted solution:]

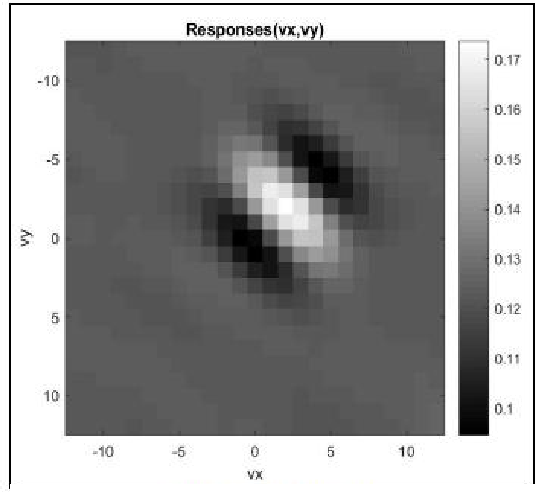
Curves shifted so mean is 0.

Question 5

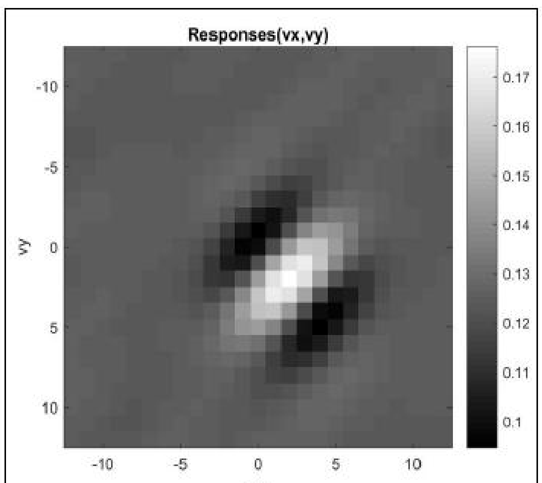
Recall the plots show responses of cells tuned to "normal velocity" (velocity in their "normal" direction).



Family tuned to (4,0)



Family tuned to (2,-2)



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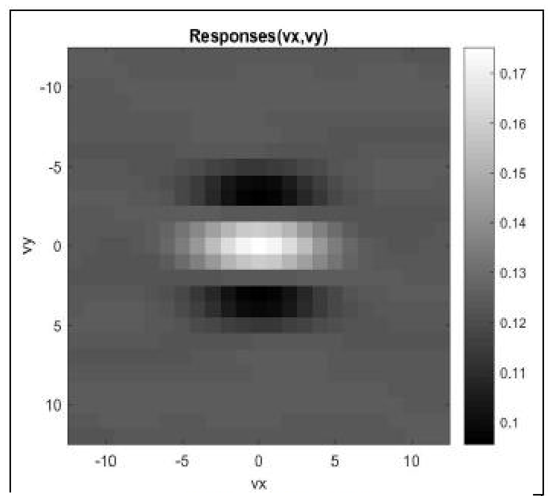
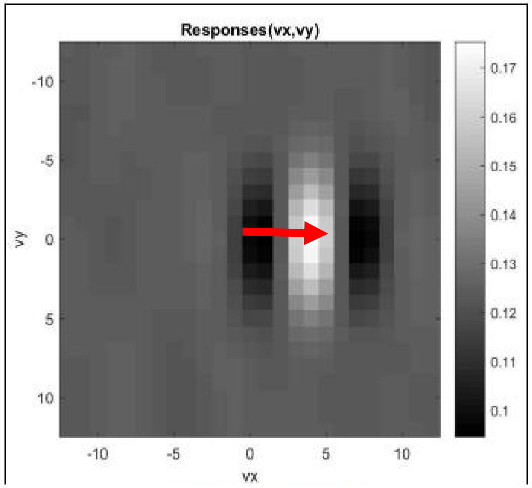


Family tuned to (0,0)

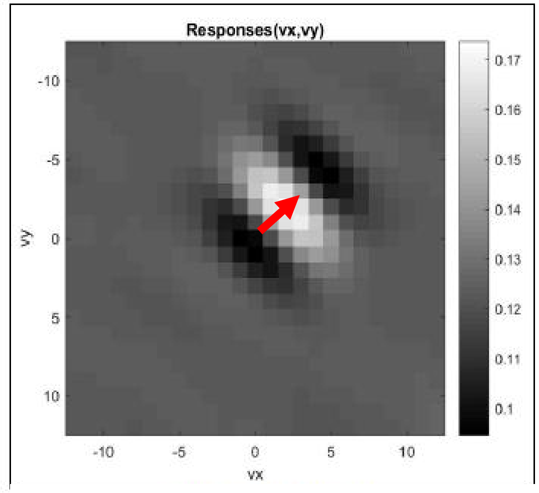
Question 5

Recall the plots show responses of cells tuned to "normal velocity" (velocity in their "normal" direction).



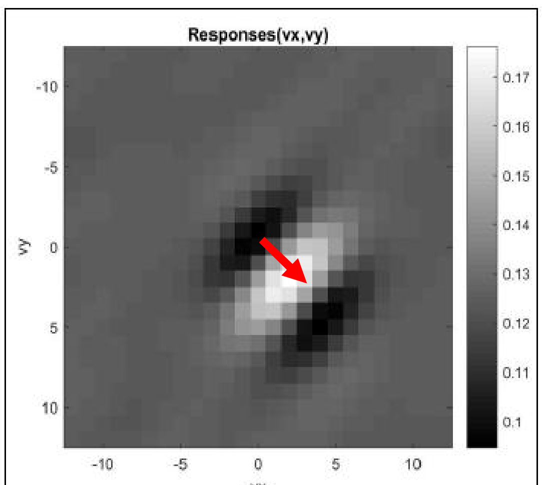
Normal speed =4

Family tuned to (4,0)



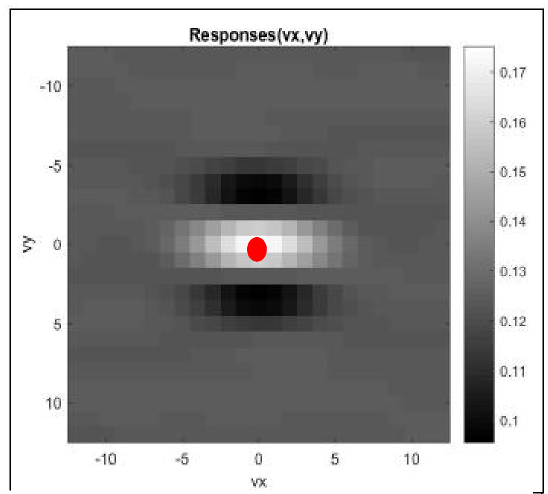
Family tuned to (2,-2)

Normal speed $=\sqrt{8}$



Normal speed $=\sqrt{8}$

Family tuned to (2,2)



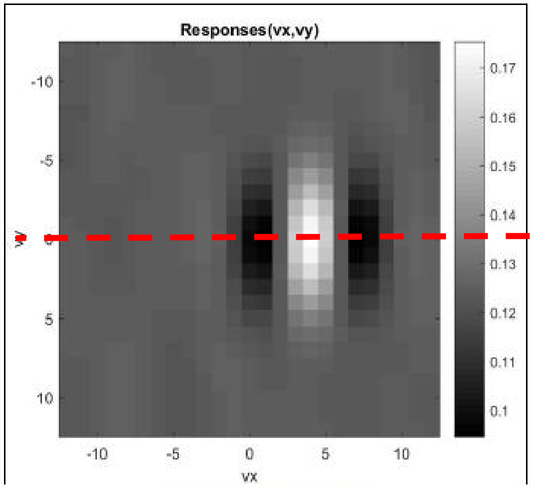
Family tuned to (0,0)

Normal speed =0

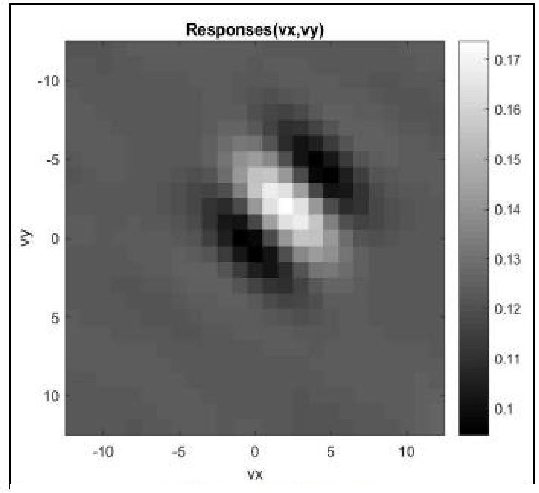
Question 5

Recall the plots show responses of cells tuned to motion in their "normal" direction to patterns moving with velocity (v_x, v_y)

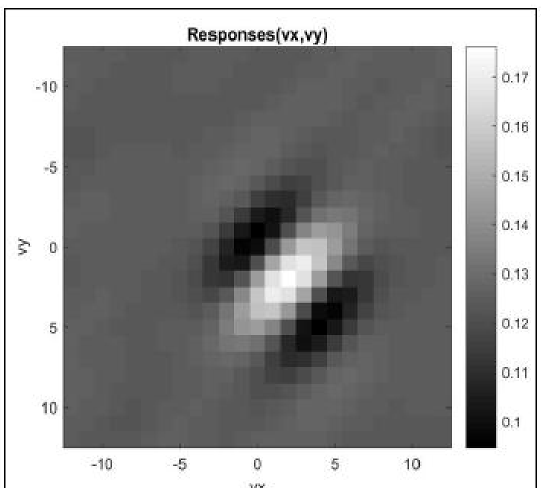
Same as Q1



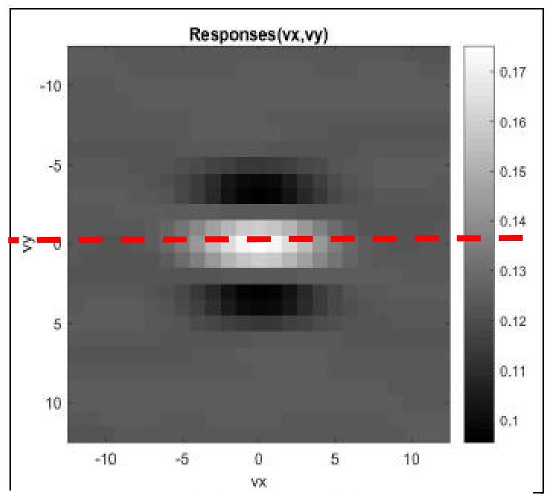
Family tuned to (4,0)



Family tuned to (2,-2)



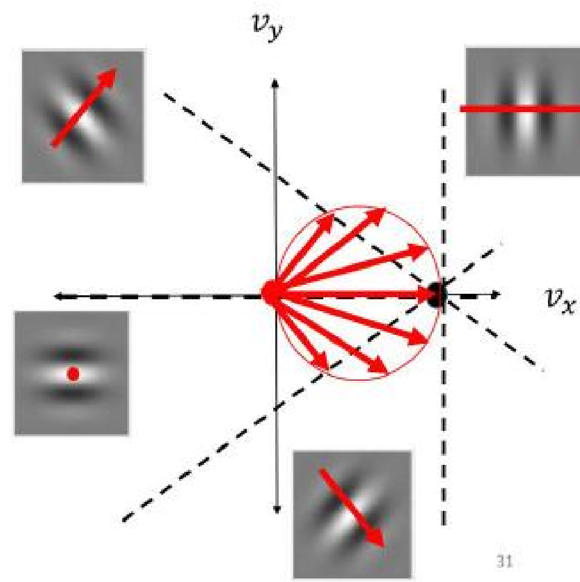
Family tuned to (2,2)



Family tuned to (0,0)

Same as Q2

Question 6



Sum of responses for chosen family of cells is biggest for velocity (4,0).
That's how I chose the cells!

To build a detector for another velocity, you would need to use a different family of cells.

True Velocity (vx,vy)	Family 1 (4,0)	Family 2 (2,-2)	Family 3 (2,2)	Family 4 (0,0)	Sum Response
(4,0)	**0.1785**	**0.1555**	**0.1590**	**0.1464**	**0.6394**
(-4,0)	0.1277	0.1204	0.1251	**0.1464**	0.5196
(0,4)	0.1171	0.1211	**0.1590**	0.0990	0.4962
(0,-4)	0.1172	**0.1555**	0.1230	0.0990	0.4947
(0,0)	0.1000	0.0982	0.0996	**0.1769**	0.4747

Office Hours

- Friday 10-11,   2-4
- Tuesday April 17, 10-2   + one other day that week
- Tuesday April 24, 10-2:30 + one other day that week

Please do the Course Evaluations.

Your chance to give feedback and let me and the department know what you thought.

Interested in Research or a Project?

Ugrads: COMP 396 or 400

MSc: Project or Thesis

Don’t be shy. Let me know.