

Lecture 16

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Natural Computation

Natural computation is computation that occurs in nature or is inspired by computation occurring in nature

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Optimization in Natural Computation

- Good, but suboptimal solutions may be preferable to optima if:
 - suboptima can be obtained more quickly
 - suboptima can be adapted more quickly
 - suboptima are more robust
 - an ill-defined suboptimum may be better than a sharp optimum
- “The best is often the enemy of the good”

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Robust Optima

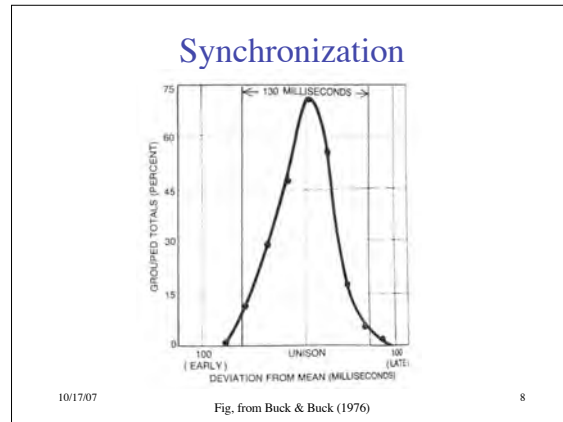
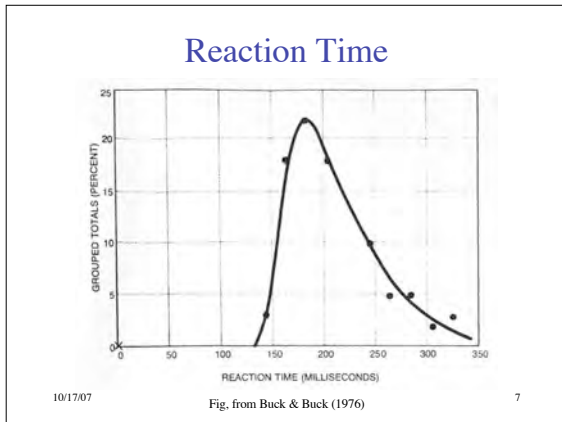
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Effect of Error/Noise

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Demonstration: Human Synchronization

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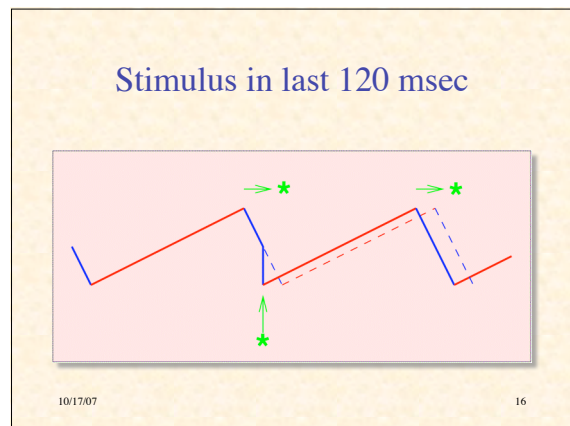
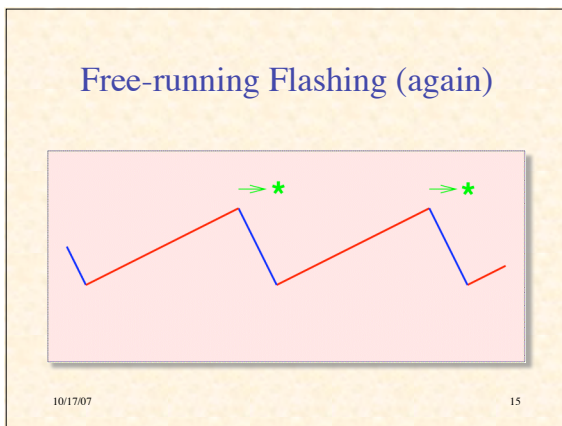
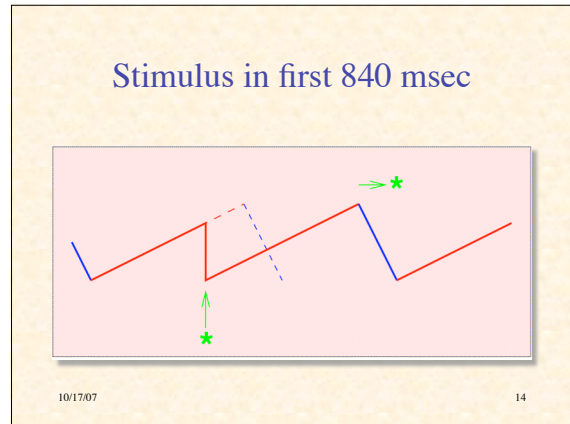
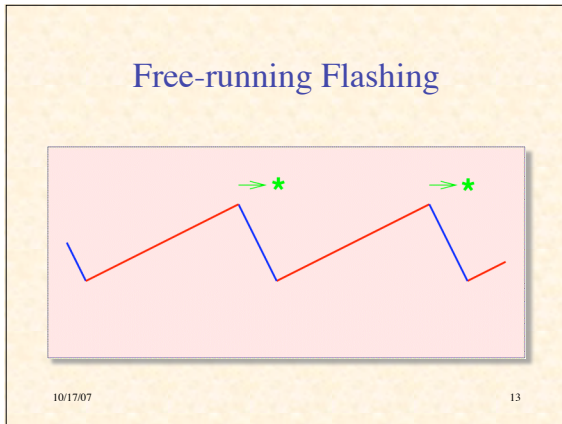
Flashing Among Fireflies

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- ### Synchronous Flashing
- In only two places enormous numbers of fireflies gather in trees and flash in synchrony
 - SE Asia (India, Philippines, New Guinea)
 - Elkmont in the Smoky Mountains!
 - A group of trees spread over 1/10 mile may flash in synchrony
 - Only males do synchronous flashing
 - Had been unexplained for 300 years
 - Early 1900s: claimed to be an illusion because no explanation could be imagined
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- ### Why Do They Do It?
- Females identify males of their own species by flashing rate
 - difficult to do if they flash chaotically
 - i.e., enhanced discrimination
 - Allows males to detect (unsynchronized flashing of nearby females)
 - i.e., enhanced detection
 - Allows small groups of males to attract larger numbers of females
 - i.e., signal enhancement
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- ### How Do They Do It?
- “innate individual rhythmicity with phase-dependent sensitivity to mutual influences”
 - Natural flashing period: 965 ± 90 msec (≈ 1 sec)
 - Flash from firefly *A* will reset the clock of nearby firefly *B*
 - thereby shifting the *phase* of *B*'s clock
 - If *A* flashes in first 840 ms of *B*'s cycle, will inhibit *B*'s next flash & delay until 1 sec after stimulus (i.e. retarded so it is in sync with *A*)
 - If *A* flashes in last 160 ms, *B*'s next flash occurs normally, but subsequent flash will be advanced to be in sync with *A*
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Camazine's Model of Firefly Synchronization

[Run Firefly.nlogo Simulation](#)

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Wilensky's Model of Firefly Synchronization

[Run Fireflies-mobile.nlogo Simulation](#)

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